SEDAR

Southeast Data, Assessment, and Review

SEDAR 26

Stock Assessment Report

U.S. Caribbean Queen Snapper

December 2011

SEDAR
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405

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SECTION I: Introduction

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1. SEDAR PROCESS DESCRIPTION

SouthEast Data, Assessment, and Review (**SEDAR**) is a cooperative Fishery Management Council process initiated in 2002 to improve the quality and reliability of fishery stock assessments in the South Atlantic, Gulf of Mexico, and US Caribbean. SEDAR seeks improvements in the scientific quality of stock assessments and the relevance of information available to address fishery management issues. SEDAR emphasizes constituent and stakeholder participation in assessment development, transparency in the assessment process, and a rigorous and independent scientific review of completed stock assessments.

SEDAR is managed by the Caribbean, Gulf of Mexico, and South Atlantic Regional Fishery Management Councils in coordination with NOAA Fisheries and the Atlantic and Gulf States Marine Fisheries Commissions. Oversight is provided by a Steering Committee composed of NOAA Fisheries representatives: Southeast Fisheries Science Center Director and the Southeast Regional Administrator; Regional Council representatives: Executive Directors and Chairs of the South Atlantic, Gulf of Mexico, and Caribbean Fishery Management Councils; and Interstate Commission representatives: Executive Directors of the Atlantic States and Gulf States Marine Fisheries Commissions.

SEDAR is organized around two workshops and a series of webinars. First is the Data Workshop, during which fisheries, monitoring, and life history data are reviewed and compiled. The second stage is the Assessment Process, which is conducted via a series of webinars, 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. The completed assessment, including the reports of all 3 workshops and all supporting documentation, is then forwarded to the Council SSC for certification as 'appropriate for management' and development of specific management recommendations.

SEDAR workshops are public meetings organized by SEDAR staff and the lead Cooperator. Workshop participants are drawn from state and federal agencies, non-government organizations, Council members, Council advisors, and the fishing industry with a goal of including a broad range of disciplines and perspectives. All participants are expected to contribute to the process by preparing working papers, contributing, providing assessment analyses, and completing the workshop report.

SEDAR Review Workshop Panels consist of a chair, 3 reviewers appointed by the Center for Independent Experts (CIE), and three reviewers appointed from the SSC of the Council having jurisdiction over the stocks being assessed. The Review Workshop Chair is appointed by the Council from their SSC. Participating councils may appoint additional representatives of their SSC, Advisory, and other panels as observers.

2. MANAGEMENT OVERVIEW (*(Prepared by Graciela García-Moliner and Bill Arnold)*

2.1. *Fishery Management Plan, Plan Amendments, and Local Regulations*

The U.S. Caribbean includes the islands of Puerto Rico and the U.S. Virgin Islands (USVI) including St. Thomas, St. John, and St. Croix. The state waters of Puerto Rico extend 9 nm from the shore and the state waters of the USVI extend 3 nm from shore. The following summary applies to these jurisdictions separately.

The following is a summary of the management measures that directly or indirectly have impacted the queen snapper (*Etelis oculatus*) fishery in the U.S. Caribbean. The Fishery Management Plan for the Shallow-water Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands (1985) did not include any of the deep-water fishes in the fishery management unit (FMU). The deep-water snappers were incorporated into the Reef Fish Fishery Management Plan in 1993 (formerly known as the Fishery Management Plan for the Shallow-water Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands; Federal Register, Vol. 50, No. 167: 34850-34855). The species incorporated under Lutjanidae included: queen snapper (*Etelis oculatus*), silk snapper (*L. vivanus*), black snapper (*Apsilus dentatus*), blackfin snapper (*L. buccannella*), wenchman (*Pristipomoides. aquilonaris*) and vermillion snapper (*Rhomboplites aurorubens*) as well as deep-water groupers, jacks, and tilefish. The decline in landings in general, and in deep-water snapper aggregate specifically, from 1979 to 1990 (from 340 to 80 metric tons) prompted the incorporation of these species into the FMU (Reef Fish FMP Amendment 2, 1993). The primary objective of the incorporation was for the Council to take regulatory action if needed since at the time of the amendment the deep-water snapper fishery was “of less importance than the shallow-water fishery in terms of effort and landings”. The species of concern at the time was the silk snapper, since about 90% of the silk snapper individuals harvested were less than the minimum size at maturity (Matos 1992). However, silk snapper was also one of the most economically valuable species in the landings. There are no specific regulations regarding queen snapper harvest in the U.S. Caribbean.

Measures in the original FMP, and in the follow-on amendments, that might affect queen snapper include changes to requirements for the constructions of traps (in both the Spiny Lobster and Shallow-water Reef Fish FMPs) as well as seasonal and/or area closures established through amendments to the Reef Fish FMP and the Coral FMP:

Description of Action	FMP/Amendment	Effective Date
Traps: construction and requirement for degradable panel	Spiny Lobster FMP	1985
Traps: construction and requirement for degradable panel; changes to mesh size.	Reef Fish FMP/Amen. 1/ Reg. Amen./Amen. 2/SFA	1985; 1990;1993;2005
Seasonal area closure	Reef Fish FMP/Amen. 2; Amen. 3/Interim Rule/ SFA	1993,1996, 1999,2005
Closed area	Coral FMP Amen. 1	1999

Seasonal closure for snapper unit 1 (silk, black, blackfin, vermillion)	SFA	2005

In 2005 the Council ratified the Sustainable Fisheries Act (SFA) Amendment, which categorized snapper (along with grouper and other species) into fishery management units (FMUs). Snapper unit 2 (SU2) included the queen snapper and the wenchman (deep –water wenchman or cardinal snapper as proposed by the 2010 Annual Catch Limit Amendment to the FMPs). Also included in the SFA Amendment, specifically as Amendment 3 to the Reef Fish Fishery Management Plan of Puerto Rico and the USVI, was a determination that SU2 was not undergoing overfishing although Snapper Unit 1 (SU1; silk, black, blackfin, vermilion) was determined to be undergoing overfishing. To respond to this determination, measures were included in the SFA Amendment to institute a closed season for SU1 during the peak spawning months of October through December each year. This regulation has an indirect impact on the protection of queen snapper in the areas where it might co-occur with silk snapper, and fishers avoid these areas during the seasonal closure. The implementation took place on November 28, 2005, and continues to the present. At the time of implementation, the closure applied only to U.S. Caribbean EEZ waters. Again, there are no management measures specific to the queen snapper implemented in the U.S. Caribbean EEZ or in state or territorial waters.

A compatible seasonal closure for SU1 was implemented by the Government of the Territory of the USVI for their local water on July 5, 2006, but only for the Districts of St. Thomas and St. John (not for St. Croix). The seasonal closure for SU1 in territorial waters extends from October 1 to December 31 of each consecutive year. Although the SU1 closure has an indirect impact on queen snapper, there are specific regulations regarding queen snapper harvest in the USVI.

In Puerto Rico there are no specific regulations regarding queen snapper harvest. Puerto Rico followed a slightly different strategy for silk snapper by initially implementing size limits rather than a seasonal closure via Regulation 6768 with an implementation date of March 12, 2004. That regulation first defined "chillo" as one of three species: chillo ojo amarillo (silk snapper, *L. vivanus*), negra or alinegra (blackfin, *L. buccannella*) and chilla, chilla rubia or besugo (vermillion, *Rhomboplites aurorubens*).

The Government of Puerto Rico repealed the minimum size limit for silk snapper in 2007 via Regulation 7326. That regulation also implemented a seasonal closure for silk and blackfin snapper, concurrent with the seasonal SU1 closure in the EEZ, from October 1 to December 31 of each consecutive year. Additionally, to prevent damage to corals, Puerto Rico prohibited the placement of traps on coral reefs.

Note that minimum size limits during 2004-2006 in Puerto Rico, and the closed seasons in all three island groups, were designed to directly benefit SU1 including silk snapper. The seasonal area closures described in Tables 2.1.1, 2.1.2, and 2.1.3 were not designed specifically for the protection of SU2 (including queen snapper) but indirectly benefit SU2 because the closure areas encompass habitats occupied by SU2 species including queen snapper and deep-water wenchman. The SFA Amendment also prohibited placement of bottom tending gear (e.g., traps, bottom longlines, nets) within Habitat Areas of Particular Concern (HAPCs).

Table 2.1.1. Annual Commercial/Recreational Queen Snapper Regulatory Summary: St. Croix

		Minimum size limit			Trip limit			Closed season		Closed Area		
Year	Fishing Year	Size	Start date	End date	Amount	Start date	End date	Start date	End date	Area/Seasonal[5]	Start date	End date
1993										LangBank[1]	11/15	12/31
1994										LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28[4]; 12/31 6/30
1995										LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
1996										LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
1997										LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
1998										LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
1999										LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
2000										LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
2001										LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
2002										LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
2003										LangBank[1]	1/1;	2/28;

										 Mutton Snapper[3]	12/1 3/1	12/31 6/30
2004										LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
2005								11/28[1]	12/31[1]	LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
2006								10/1[1]	12/31[1]	LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
2007								10/1[1]	12/31[1]	LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
2008								10/1[1]	12/31[1]	LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
2009								10/1[1]	12/31[1]	LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
2010								10/1[1]	12/31[1]	LangBank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30

[1]EEZ waters only; [2]Applies to snapper unit 1 (silk, blackfin, black, vermilion, and proposed to include wenchman) in EEZ waters; [3]1993 territorial area closure; 1994 EEZ and territorial area closure; 1996 boundary change to make EEZ compatible with state; [4]2/29 during leap years; [5]Bottom tending gear (e.g., traps, nets, bottom longlines) prohibited from seasonally closed areas (i.e., HAPCs); [6]Boundary change to Tourmaline Bank closed area; [7]Closure extended to six months (October 1 through March 31) beginning with 2011 calendar year; [8]Size limits for silk snapper apply in Puerto Rico commonwealth waters only. Additionally, regulations went into effect in 2004 but with no penalties; [9]Closure instituted in Puerto Rico commonwealth waters beginning in 2007, for silk and blackfin snapper only; [10]Beginning in 2006, closure applies to both EEZ and St. Thomas/St. John territorial waters.

Table 2.1.2. Annual Commercial/Recreational Queen Snapper Regulatory Summary: St. Thomas

		Minimum size limit			Trip limit			Closed season		Closed Area		
Year	Fishing Year	Size	Start date	End date	Amount (lbs)	Start date	End date	Start date	End date	Area/Seasonal[5]	Start date	End date
1990										HindBank(MCD)	12/1	12/31
1991										HindBank(MCD)	1/1; 12/1	2/28; 12/31
1992										HindBank(MCD)	1/1; 12/1	2/28; 12/31
1993										HindBank(MCD)	1/1; 12/1	2/28; 12/31
1994										HindBank(MCD)	1/1; 12/1	2/28; 12/31
1995										HindBank(MCD)	1/1; 12/1	2/28; 12/31
1996										HindBank(MCD)	1/1; 12/1	2/28; 12/31
1997										HindBank(MCD)	1/1; 12/1	2/28; 12/31
1998										HindBank(MCD)	1/1; 12/1	2/28; 12/31
1999										HindBank(MCD)	1/1; 12/1	2/28; 12/31
2000										HindBank(MCD)	1/1	12/31
2001										HindBank(MCD)	1/1	12/31
2002										HindBank(MCD)	1/1	12/31
2003										HindBank(MCD)	1/1	12/31
2004										HindBank(MCD)	1/1	12/31
2005								11/28[1]	12/31[1]	HindBank(MCD) Grammanik Bank	1/1 2/1	12/31 4/30
2006								10/1[10]	12/31[10]	HindBank(MCD) Grammanik Bank	1/1 2/1	12/31 4/30

2007								10/1[10]	12/31[10]	HindBank(MCD) Grammanik Bank	1/1 2/1	12/31 4/30
2008								10/1[10]	12/31[10]	HindBank(MCD) Grammanik Bank	1/1 2/1	12/31 4/30
2009								10/1[10]	12/31[10]	HindBank(MCD) Grammanik Bank	1/1 2/1	12/31 4/30
2010								10/1[10]	12/31[10]	HindBank(MCD) Grammanik Bank	1/1 2/1	12/31 4/30

[1]EEZ waters only; [2]Applies to snapper unit 1 (silk, blackfin, black, vermilion, and proposed to include wenchman) in EEZ waters; [3]1993 territorial area closure; 1994 EEZ and territorial area closure; 1996 boundary change to make EEZ compatible with state; [4]2/29 during leap years; [5]Bottom tending gear (e.g., traps, nets, bottom longlines) prohibited from seasonally closed areas (i.e., HAPCs); [6]Boundary change to Tourmaline Bank closed area; [7]Closure extended to six months (October 1 through March 31) beginning with 2011 calendar year; [8]Size limits for silk snapper apply in Puerto Rico commonwealth waters only. Additionally, regulations went into effect in 2004 but with no penalties; [9]Closure instituted in Puerto Rico commonwealth waters beginning in 2007, for silk and blackfin snapper only; [10]Beginning in 2006, closure applies to both EEZ and St. Thomas/St. John territorial waters.

Table 2.1.3. Annual Commercial/Recreational Queen Snapper Regulatory Summary: Puerto Rico

		Minimum size limit			Trip limit			Closed season		Closed Area		
Year	Fishing Year	Size	Start date	End date	Amount (lbs)	Start date	End date	Start date	End date	Area/Seasonal[5]	Start date	End date
1983												
1984												
1985												
1986												
1987												
1988												
1989												
1990												
1991												
1992												
1993										Tourmaline Bank	11/15	12/31
1994										Tourmaline Bank	1/1; 12/1	2/28; 12/31
1995										Tourmaline Bank	1/1; 12/1	2/28; 12/31
1996										Tourmaline Bank[6]	1/1; 12/1	2/28; 12/31
1997										Tourmaline Bank Abrir La Sierra Bajo de Sico	1/1; 12/1 1/1; 12/1 1/1; 12/1	2/28; 12/31 2/28; 12/31 2/28; 12/31
1998										Tourmaline Bank Abrir La Sierra Bajo de Sico	1/1; 12/1 1/1; 12/1 1/1; 12/1	2/28; 12/31 2/28; 12/31 2/28; 12/31
1999										Tourmaline Bank	1/1;	2/28;

										 Abrir La Sierra Bajo de Sico	12/1 1/1; 12/1 1/1; 12/1	12/31 2/28; 12/31 2/28; 12/31
2000										Tourmaline Bank Abrir La Sierra Bajo de Sico	1/1; 12/1 1/1; 12/1 1/1; 12/1	2/28; 12/31 2/28; 12/31 2/28; 12/31
2001										Tourmaline Bank Abrir La Sierra Bajo de Sico	1/1; 12/1 1/1; 12/1 1/1; 12/1	2/28; 12/31 2/28; 12/31 2/28; 12/31
2002										Tourmaline Bank Abrir La Sierra Bajo de Sico	1/1; 12/1 1/1; 12/1 1/1; 12/1	2/28; 12/31 2/28; 12/31 2/28; 12/31
2003										Tourmaline Bank Abrir La Sierra Bajo de Sico	1/1; 12/1 1/1; 12/1 1/1; 12/1	2/28; 12/31 2/28; 12/31 2/28; 12/31
2004		305[8] mm (12”) FL	3/1	12/31						Tourmaline Bank Abrir La Sierra Bajo de Sico	1/1; 12/1 1/1; 12/1 1/1; 12/1	2/28; 12/31 2/28; 12/31 2/28; 12/31

2005		356[8] mm (14”) FL	1/1	12/31				11/28[2]	12/31[2]	Tourmaline Bank Abrir La Sierra Bajo de Sico	1/1; 12/1 1/1; 12/1 1/1; 12/1	2/28; 12/31 2/28; 12/31 2/28; 12/31
2006		410[8] mm (16”) FL	1/1	12/31				10/1[2]	12/31[2]	Tourmaline Bank Abrir La Sierra Bajo de Sico	1/1; 12/1 1/1; 12/1 1/1; 12/1	2/28; 12/31 2/28; 12/31 2/28; 12/31
2007								10/1[2, 9]	12/31[2, 9]	Tourmaline Bank Abrir La Sierra Bajo de Sico	1/1; 12/1 1/1; 12/1 1/1; 12/1	2/28; 12/31 2/28; 12/31 2/28; 12/31
2008								10/1[2, 9]	12/31[2, 9]	Tourmaline Bank Abrir La Sierra Bajo de Sico	1/1; 12/1 1/1; 12/1 1/1; 12/1	2/28; 12/31 2/28; 12/31 2/28; 12/31
2009								10/1[2, 9]	12/31[2, 9]	Tourmaline Bank Abrir La Sierra Bajo de Sico	1/1; 12/1 1/1; 12/1 1/1; 12/1	2/28; 12/31 2/28; 12/31 2/28; 12/31
2010								10/1[2, 9]	12/31[2, 9]	Tourmaline Bank Abrir La Sierra Bajo de Sico	1/1; 12/1 1/1; 12/1 1/1;	2/28; 12/31 2/28; 12/31 2/28;

											12/1	12/31
2011								10/1[2, 9]	12/31[2, 9]	Tourmaline Bank Abrir La Sierra Bajo de Sico[7]	1/1; 12/1 1/1; 12/1 1/1; 12/1	2/28; 12/31 2/28; 12/31 2/28; 12/31

[1]EEZ waters only; [2]Applies to snapper unit 1 (silk, blackfin, black, vermilion, and proposed to include wenchman) in EEZ waters; [3]1993 territorial area closure; 1994 EEZ and territorial area closure; 1996 boundary change to make EEZ compatible with state; [4]2/29 during leap years; [5]Bottom tending gear (e.g., traps, nets, bottom longlines) prohibited from seasonally closed areas (i.e., HAPCs); [6]Boundary change to Tourmaline Bank closed area; [7]Closure extended to six months (October 1 through March 31) beginning with 2011 calendar year; [8]Size limits for silk snapper apply in Puerto Rico commonwealth waters only. Additionally, regulations went into effect in 2004 but with no penalties; [9]Closure instituted in Puerto Rico commonwealth waters beginning in 2007, for silk and blackfin snapper only; [10]Beginning in 2006, closure applies to both EEZ and St. Thomas/St. John territorial waters.

2.2. Control Date Notices

The CFMC at its 130th meeting on March 24-26, 2009, established a control date of March 24, 2009, for every fishery managed by the Council, including SU1.

2.3. Management Program Specifications

The following is a summary of general information regarding management of queen snapper in the U.S. Caribbean:

Species	Queen Snapper
Management Unit	Snapper Unit 2
Management Unit Definition	Includes queen snapper and wenchman (Cardinal snapper will be included and wenchman moved to SU1 if the 2010 ACL Amendment is approved)
Management Entity	Caribbean Fishery Management Council
Management Contacts SERO / Council	William Arnold - SERO Graciela García-Moliner - CFMC
Current stock exploitation status	Unknown
Current stock biomass status	Unknown

As described in the following table, the 2005 SFA Amendment established reference points for SU2. This fishery unit includes queen snapper and wenchman. The 2010 ACL Amendment proposes to move the wenchman to SU1, add cardinal snapper to SU2, and redefine management reference points based on average current catch for each geographically distinct area (i.e., Puerto Rico, St. Thomas/St. John (STT/STJ), and St. Croix (STX)).

Note that reference points were based upon commercial and recreational landings only. Although discards may occur in these fisheries, there has been no available method for estimating the extent of those discards.

Criteria	Current		Proposed	
	Definition	Value	Definition	Value
MSST	MSST = [(1-M) or 0.5 whichever is greater]*B_{MSY}	289,000	MSST = [(1-M) or 0.5 whichever is greater]*B_{MSY}	SEDAR 26
MFMT	F_{MSY} Proxy	0.44	F_{MSY}	SEDAR 26
MSY	Yield at F_{MSY} Proxy	151,000	Yield at F_{MSY}	SEDAR 26
F_{MSY}	M	0.44	F_{MAX}	SEDAR 26
OY	Yield at F_{OY}	151,000	Yield at F_{OY}	SEDAR 26
F_{OY}	F_{OY} = 0.75 * F_{MSY} Proxy	Not specified	F_{OY} = 50%,75%, 85% F_{MSY}	SEDAR 26
M		0.44		SEDAR 26

Stock Rebuilding Information

According to NOAA's Fish Stock Sustainability Index (http://www.nmfs.noaa.gov/sfa/statusoffisheries/2011/first/FSSInonFSSIstockstatusQ1_2011.pdf), SU2 is considered to be unknown. Thus no rebuilding plan is required.

Stock Projection Information

The 2010 ACL Amendment to the FMPs proposes the following criteria for applying AMs in the management of queen snapper (SU2):

Requested Information	Value
First Year of Management	2012
Projection Criteria during interim years should be based on (e.g., exploitation or harvest)	Commercial + Recreational Landings in Puerto Rico, Commercial Landings in the USVI
Projection criteria values for interim years should be determined from (e.g., terminal year, avg of X years)	2011 landings for 2012; average of 2011-2012 landings for 2013, and average 3 years of landings for 2014 and forward

The proposed 2010 Caribbean ACL Amendment is not yet approved but it would establish an ACL for SU2 in Puerto Rico (commercial and recreational) and for snappers in the USVI:

Current Quota Value ACL (pounds)	212,619 (PR); 157,382 (STT/STJ) 121,113(STX)
Next Scheduled Quota Change	TBD
Annual or averaged quota	Averaged

If averaged, number of years to average	6-7 years[1]
Does the quota include bycatch/discard ?	No

How is the quota calculated - conditioned upon exploitation or average landings?

Average landings.

Does the quota include bycatch/discard estimates? If so, what is the source of the bycatch/discard values? What are the bycatch/discard allowances?

No.

Are there additional details of which the analysts should be aware to properly determine quotas for this stock?

The CFMC recognizes the limitations of the data. Improvements in data collection are anticipated resulting from more fisherman-friendly reporting forms and enhanced data collection and effort monitoring. For most effective management of the fisheries, the CFMC will need timely in-season data which is currently lacking for the U.S. Caribbean.

2.4. Management and Regulatory Timeline

There are no regulations specific to SU2 in the US Caribbean. .

The principal and only gear- used in targeting queen snapper is hook and line (usually more than 1 hook per line). There are no regulations in Puerto Rico, the USVI, or the EEZ regarding hook and line fishing gear.

2.5 *References*

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Matos, D. 1992. Annual report to the National Marine Fisheries Service Interjurisdictional Fisheries Program. P.R. Dept. Nat. Res. Fish. Res. Lab. 55 pp

3. ASSESSMENT HISTORY AND REVIEW

Caribbean queen snapper have not been formally assessed prior to SEDAR 26.

4. REGIONAL MAPS

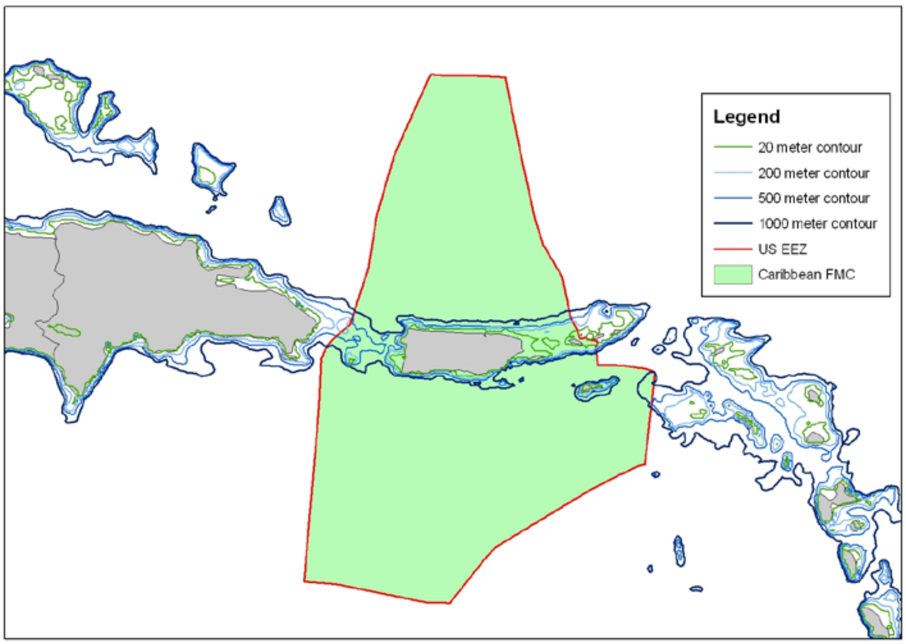

Figure 4.1 Caribbean management region including Council and EEZ Boundaries.

5. ASSESSMENT SUMMARY

The Summary Report provides a broad but concise view of the salient aspects of the stock assessment. It recapitulates: (a) the information available to and prepared by the Data Workshop; (b) the application of those data, development and execution of one or more assessment models, and identification of the most reliable model configuration as the base run by the Assessment Process; and (c) the findings and advice determined during the Review Workshop.

Executive Summary

The Review Panel was in agreement that data poor methods to assess the status of queen snapper stocks across the different regions (Puerto Rico, St. Thomas/St. John, and St. Croix) was appropriate given the substantial uncertainty in virtually all of the data and input parameters. There was also agreement that, in general, appropriate methods were applied to ascertain status of the stocks given the data poor situation. Given that a time-series analysis of size frequency distributions of the stock across the three regions is the primary information available for assessing relative total mortality estimates, the consensus of the Review Panel is that the Trip Interview Program (TIP) be continued and, if feasible, enhanced. Basic life history information from the US Caribbean is also considered to be extremely important to more fully assess the status of the stocks and it is the opinion of the Review Panel that further investments in this research will provide, over time, substantial benefits.

Stock Status and Determination Criteria

Data limitations in the US Caribbean preclude the use of advanced quantitative analyses that provide measures of uncertainty. However, the following conclusions can be drawn based on the data-poor methods employed in this assessment, the fundamental principles of population dynamics, and an overall interpretation of the raw data.

Given the available information for all three islands there is no evidence to suggest overfishing for queen snapper is occurring in the US Caribbean. The overfished status is unknown.

Stock Identification and Management Unit

- Silk snapper are found in western Atlantic waters, as far north as Cape Hatteras, North Carolina and Bermuda and as far south as Brazil. They are also found in the Gulf of Mexico along the continental shelf.
- Literature reports depths of 100 to 500m, but suggestions during the SEDAR 26 Data Workshop were that they can be found depth deeper than 500m.
- The queen snapper management areas within the U.S. Caribbean include the islands of Puerto Rico and the U.S. Virgin Islands (USVI) including St. Thomas, St. John, and St. Croix. The state waters of Puerto Rico extend 9 nm from the shore and the state waters of the USVI extend 3 nm from shore.

Assessment Data

A detailed summary table of the data available for consideration during this assessment can be found in Section VI: Addendum of the Stock Assessment Report.

- Species-specific commercial landings are available from 1983 – 2009 for Puerto Rico, which were used for qualitative interpretation of the overfishing status. “Snapper” commercial landings are available for USVI from 1998-2008, which not useful for queen and silk snapper interpretation because no species-specific landings.
- Recreational landings and discard estimates are available for Puerto Rico for the years 2000-2010 via MRFSS/MRIP however data were not used in quantitative or qualitative

analyses to determine overfishing status. No recreational information was available for the USVI.

- One standardized index was produced for Puerto Rico, but not recommended for use in the assessment as the time series is believed to reflect catchability changes, not abundance trends.
- Commercial length data were available from the Trip Interview Program:
  - Hook and line data from St. Croix for years 1984-1997, 2002-2006, 2008-2010
  - Hook and line data from Puerto Rico for years 1983, 1986-1993, 1995-2008
- The reported ranges for age and growth parameters were:
  - L_{inf} : 1020mm-1030mm TL
  - K: 0.29-0.61 per year
- The following life history parameter inputs were used in the length-frequency analysis:
  - For assessment central (base) case VBG values of K=0.45 per year, L_{inf}=888 mm
  - Lower and upper values for K 0.25 and 0.165 per year used in sensitivity analyses for Puerto Rico, and lower and upper values of K 0.18 and 0.68 per year for St. Croix
  - Lower and upper values for L_{inf} 846 and 906 mm used in sensitivity analyses for Puerto Rico, and lower and upper values of 799 mm and 899 mm for St. Croix

Release Mortality

No data on release mortality for queen snapper in the U.S. Caribbean exists. Release mortality information is not required for the length-based approach attempted in this assessment.

Assessment Methods

Puerto Rico and St. Croix

- The length frequency analysis for queen snapper hook and line fishery in Puerto Rico focused on time series analyses and relative differences in total mortality estimates rather than on absolute values of total mortality due to considerable uncertainty in age-growth parameters.
- Total mortality (Z) estimates and the ability to detect changes in mortality were explored using a variant of the Beverton-Holt length-based mortality estimator.
- A standardized abundance index for queen snapper in Puerto Rico was also developed for the commercial handline fishery as an additional means to examine population status. Caution should be used when interpreting the CPUE trends as to accurately reflecting stock abundance.

St. Thomas/St. John

- Insufficient sample size for queen snapper precluded the application of the length-based mortality estimator for St. Thomas/St. John.

Catch Trends

- Commercial landings in Puerto Rico reveal a steady increase from the start of the time series until a peak in 2006, with the two most recent years showing a minor decrease. This increase most likely represents the reported shift in targeting from silk snapper to queen snapper in the commercial line fishery.
- Recreational landings of queen snapper in Puerto Rico have remained relatively stable over the time series of the available data.

Fishing Mortality Trends

Estimates of total mortality can be translated to fishing mortality (F) by subtracting natural mortality (M). Lacking direct estimates of natural mortality, life history invariant relationships would have to be used and given the uncertainty in total mortality estimates this was not pursued.

Stock Abundance and Biomass Trends

Given the data limitations, accurate estimates of stock abundance or biomass could not be developed.

Key Sources of Scientific Uncertainty

- The calculation of traditional benchmarks based on MSY theory using the mean length mortality estimation method was not possible due to considerable uncertainty in the available life-history parameters. Lack of current, species-specific life history information greatly hindered the assessment.
- Small sample size for the length data in recent years complicated the interpretation of the results.

Projections:

Given the data limitations, projections for future status could not be constructed.

Figures

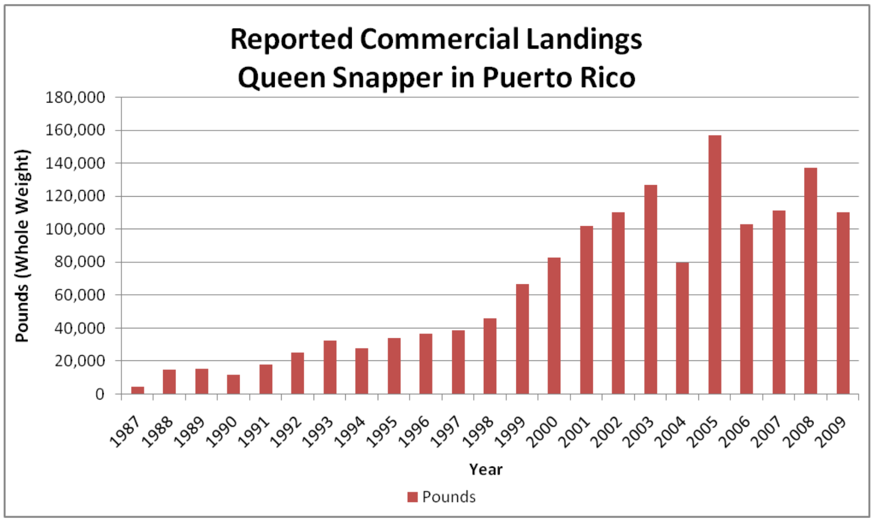

Figure 1. Reported commercial landings of queen snapper in Puerto Rico 1987-2009. 2009 data are preliminary. (*Figure 3.1.6.2 in the Assessment Workshop Report*)

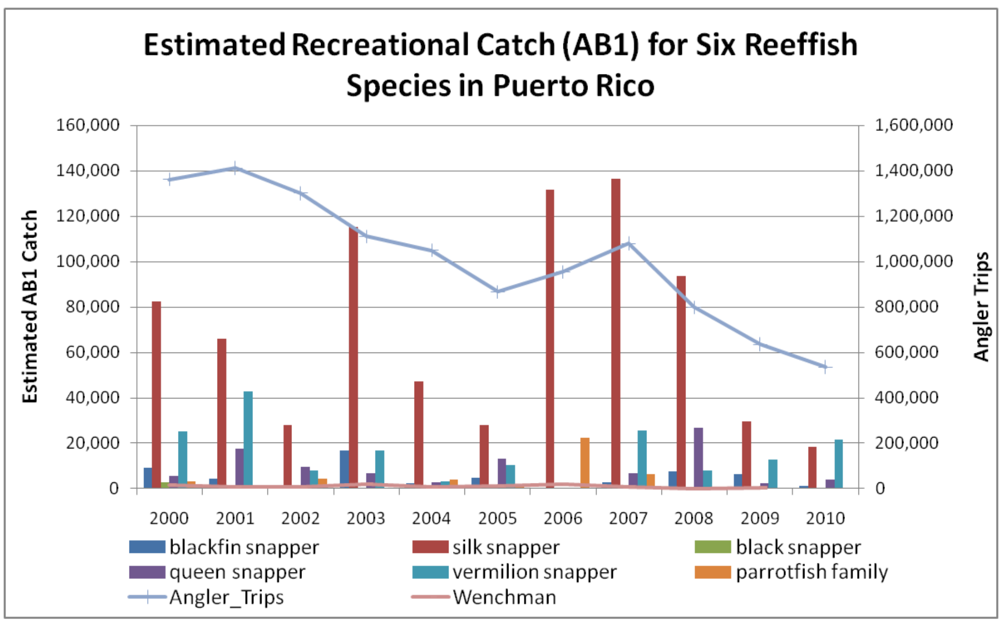

Figure 2. Estimated AB1 catch for six Reeffish species and number recreational angler trips in Puerto Rico, 2000-2010. Units are numbers of fish. Source =MRIP survey. (*Figure 2.5.1 in the Assessment Workshop Report*)

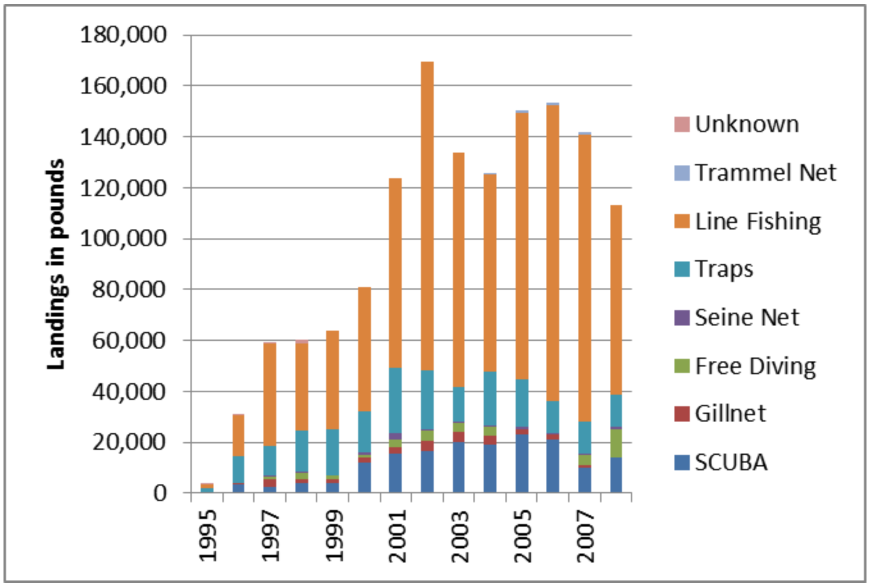

Figure 3. Yearly commercial landings of snappers (all species) by gear fished as reported (no expansion factors applied) on fisher logbooks from St. Croix. *(Figure 4.8.1 from the Data Workshop Report*)

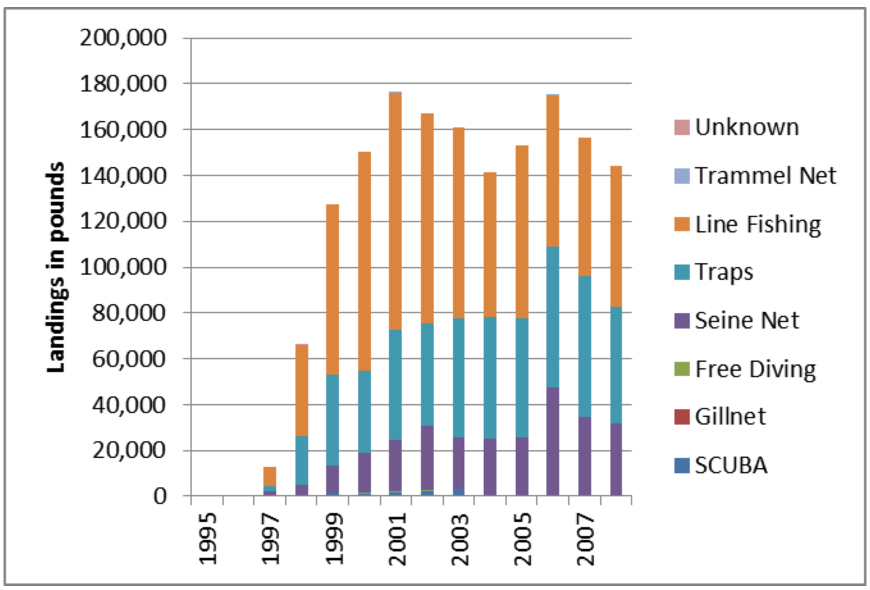

Figure 4. Yearly commercial landings of snappers (all species) by gear fished as reported (no expansion factors applied) on fisher logbooks from St. Thomas and St. John. *(Figure 4.8.2 from the Data Workshop Report*)

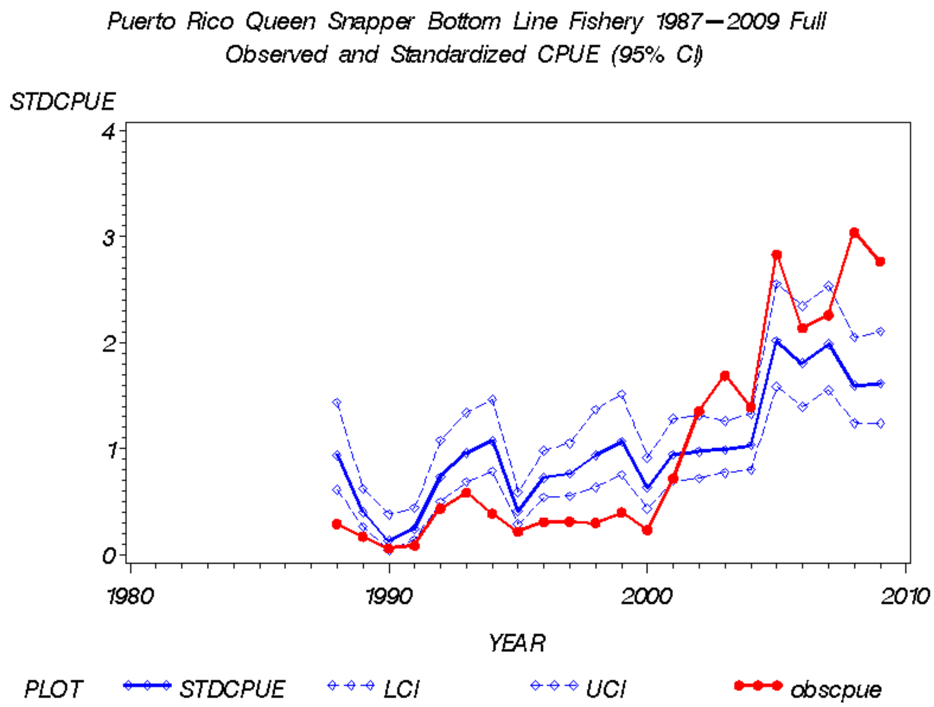

Figure 5. Standardized Delta –Lognormal CPUE, Upper and Lower 95% CI intervals and Nominal CPUE for Queen Snapper fishery Base Run. (*Figure 3.1.6.8 in the Assessment Workshop Report*)

6. SEDAR ABBREVIATIONS

ABC	Allowable Biological Catch
ACCSP	Atlantic Coastal Cooperative Statistics Program
ADMB	AD Model Builder software program
ALS	Accumulated Landings System; SEFSC fisheries data collection program
ASMFC	Atlantic States Marine Fisheries Commission
B	stock biomass level
BMSY	value of B capable of producing MSY on a continuing basis
CFMC	Caribbean Fishery Management Council
CIE	Center for Independent Experts
CPUE	catch per unit of effort
F	fishing mortality (instantaneous)
F_{MAX}	fishing mortality that maximizes the average weight yield per fish recruited to the fishery
F_{MSY}	fishing mortality to produce MSY under equilibrium conditions
F_{OY}	fishing mortality rate to produce Optimum Yield under equilibrium
$F_{XX\%\ SPR}$	fishing mortality rate that will result in retaining XX% of the maximum spawning production under equilibrium conditions
F_0	a fishing mortality close to, but slightly less than, Fmax
FL FWCC	Florida Fish and Wildlife Conservation Commission
FWRI	(State of) Florida Fisheries and Wildlife Research Institute
GA DNR	Georgia Department of Natural Resources
GLM	general linear model
GMFMC	Gulf of Mexico Fishery Management Council
GSMFC	Gulf States Marine Fisheries Commission
GULF FIN	GSMFC Fisheries Information Network
M	natural mortality (instantaneous)
MARMAP	Marine Resources Monitoring, Assessment, and Prediction
MFMT	maximum fishing mortality threshold, a value of F above which overfishing is deemed to be occurring
MRFSS	Marine Recreational Fisheries Statistics Survey; combines a telephone survey of households to estimate number of trips with creel surveys to estimate catch and effort per trip
MRIP	Marine Recreational Information Program

MSST	minimum stock size threshold, a value of B below which the stock is deemed to be overfished
MSY	maximum sustainable yield
NC DMF	North Carolina Division of Marine Fisheries
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
OY	optimum yield
SAFMC	South Atlantic Fishery Management Council
SAS	Statistical Analysis Software, SAS Corporation
SC DNR	South Carolina Department of Natural Resources
SEDAR	Southeast Data, Assessment and Review
SEFSC	Fisheries Southeast Fisheries Science Center, National Marine Fisheries Service
SERO	Fisheries Southeast Regional Office, National Marine Fisheries Service
SPR	spawning potential ratio, stock biomass relative to an unfished state of the stock
SSB	Spawning Stock Biomass
SSC	Science and Statistics Committee
TIP	Trip Incident Program; biological data collection program of the SEFSC and Southeast States.
Z	total mortality, the sum of M and F

SEDAR

Southeast Data, Assessment, and Review

SEDAR 26

U.S. Caribbean Silk Snapper, Queen Snapper, and Redtail Parrotfish

SECTION II: Data Workshop Report

August 2011

SEDAR
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405

Table of Contents

1. INTRODUCTION

1.1. WORKSHOP TIME AND PLACE

The SEDAR 26 Data Workshop was held May 16-20, 2011 in St. Croix, USVI.

1.2. TERMS OF REFERNCE

1. Review stock structure and unit stock definitions and consider whether changes are required.
2. Review, discuss, and tabulate available life history information
   - e.g., age, growth, natural mortality, reproductive characteristics
   - provide appropriate models to describe growth, maturation, and fecundity by age, sex, or length as applicable.
   - Evaluate the adequacy of available life-history information for conducting stock assessments and recommend life history information for use in population modeling.
3. Recommend discard mortality rates.
   - Review available research and published literature
   - Consider research directed at queen and silk snapper or redtail parrotfish, as well as similar species from the Caribbean and other areas.
   - Provide estimates of discard mortality rate by fishery, gear type, depth, and other feasible or appropriate strata.
   - Include thorough rationale for recommended discard mortality rates.
   - Provided justification for any recommendations that deviate from the range of discard mortality provided in available research and published literature.
4. Provide measures of population abundance that are appropriate for stock assessment.
   - Consider and discuss all available and relevant fishery dependent and independent data sources.
   - Document all programs evaluated; address program objectives, methods, coverage, sampling intensity, and other relevant characteristics.
   - Provide maps of survey coverage.
   - Develop CPUE and index values by appropriate strata (e.g., age, size, area, and fishery) and include measures of precision and accuracy.
   - Discuss the degree to which available indices adequately represent fishery and population conditions.
   - Recommend which data sources are considered adequate and reliable for use in assessment modeling.
5. Provide commercial catch statistics, including both landings and discards in both pounds and number.
   - Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector or gear.
   - Provide length and age distributions if feasible.

- Provide maps of fishery effort and harvest.

6. Evaluate and provide, if available, recreational catch statistics, including both landings and discards in both pounds and number.
   - Evaluate and discuss the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector or gear.
   - Provide length and age distributions if feasible.
   - Provide maps of fishery effort and harvest.
7. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on sampling intensity (number of samples including age and length structures) and appropriate strata and coverage.
8. Develop a spreadsheet of assessment model input data that reflects the decisions and recommendations of the Data Workshop.
9. Develop a list of tasks to be completed following the workshop.
10. Prepare the Data Workshop report providing complete documentation of workshop actions and decisions (Section II. of the SEDAR assessment report).

1.3. LIST OF PARTICIPANTS

Workshop Panel

Daniel Matos .... PR DNER
Gerson Martínez .... STX Industry rep
Jed Brown .... St. Croix DPNR
Jens Skov .... STX Industry rep
Jesus Leon .... PR DNER
Jose Alberto Sanchez .... STX Industry rep
Kevin McCarthy .... NMFS/SEFSC/Miami
Luis Rivera .... PR DNER
Meaghan Bryan .... NMFS/SEFSC/Miami
Nancie Cummings .... NMFS/SEFSC/Miami
Noemi Peña .... PR DNER
Patricia Skov .... STX Industry rep
Ron Hill .... NMFS/SEFSC/Galveston
Todd Gedamke .... NMFS/SEFSC/Miami
Tom Daley .... STX Industry rep
Walter Ingram .... NMFS/SEFSC/Pascagoula
Walter R. Keithly, Jr. .... SSC Rep/ LSU
William Tobias .... STX Representative

Council Representation

Eugenio Pineiro-Soler .... CFMC

Observers

Juan Cruz .... STX DPNR

Staff

Julie A. Neer .... SEDAR

Bill Arnold .... SERO
Graciela García-Moliner .... CFMC Staff
Kari Fenske .... SEDAR
Tyree Davis .... NMFS Miami

1.4. LIST OF DATA WORKSHOP WORKING PAPERS AND REFERNCE DOCUMENTS

Document #	Title	Authors	Working Group
Documents Prepared for the Data Workshop			
SEDAR26-DW-01	A review of the life history characteristics of silk snapper, queen snapper, and redtail parrotfish	Bryan, M.D., M. del Mar Lopez, and B. Tokotch	Life History
SEDAR26-DW-02	Summarized information on recreational catches of silk and queen snapper and parrotfish in Puerto Rico since 2000	Cummings, N.J. and V. Matter	PR Catch Statistics
SEDAR26-DW-03	Updated landings information for the commercial shallow in Puerto Rico with emphasis on silk and queen snapper and parrotfish fisheries	Cummings, N.J. and Daniel Matos-Caraballo	PR Catch Statistics
SEDAR26-DW-04	Preliminary Evaluation of available length-frequency information in the US Caribbean Trip Interview Program (TIP) data	Matthew Campbell, Todd Gedamke, Walter Ingram	
SEDAR26-DW-05	Updated catch per unit abundance indices for silk and queen snapper from the commercial fisheries in Puerto Rico	Cummings, N.J.	Indices
SEDAR26-DW-06	Not received		
SEDAR26-DW-07	Delta-lognormal and multinomial approaches to index development for parrotfish, silk snapper, and queen snapper from Puerto Rican Trip Tickets	Ingram, Jr., G.W.	Indices
SEDAR26-DW-08	Reported commercial landings of parrotfish, snappers, groupers, and unclassified finfish in the United States Virgin Islands, 1974-2008	McCarthy, K.J.	USVI Catch Statistics
SEDAR26-DW-09	Standardized catch rates of	McCarthy, K.J.	Indices

	parrotfish from commercial fish traps, SCUBA, and gillnets in the US Virgin Islands, 1998-2008		
SEDAR26-DW-10	Summary of Fishery Independent Data from Puerto Rico and the U.S. Virgin Islands	Adam G. Pollack and G. Walter Ingram, Jr.	Indices

2. LIFE HISTORY

2.1. OVERVIEW

The Life History working Group consisted of Noemí Peña Alvarado – Group Leader (Puerto Rico, Department of Natual Resources and Environment (DNER), Fisheries Research Laboratory (FRL), (Cabo Rojo, Puerto Rico) and Meaghan Bryan (NOAA/NMFS/SEFSC, Miami Laboratory)

2.2. REVIEW OF WORKING PAPERS

SEDAR26-DW-01: A review of the life history characteristics of silk snapper, queen snapper, and redtail parrotfish
Meaghan D. Bryan, Maria del Mar Lopez, and Britni Tokotch

The Life History Working Group (LHWG) reviewed the report SEDAR 26-DW-01. SEDAR 26-DW-01 summarizes information on silk and queen snapper and parrotfish.

2.3. SILK SNAPPER

2.3.1. Stock Definition and Description

Silk snapper are found in western Atlantic waters, as far north as Cape Hatteras, North Carolina and Bermuda and as far south as Brazil (Bohlke and Chaplin 1967, Froese and Pauly 2011, Figure 2.8.1). They are also found in the Gulf of Mexico along the continental shelf (Bohlke and Chaplin 1967, Boardman and Weiler 1980, Sylvester et al. 1980). The reported depth range for silk snapper is 64m – 300m (Sylvester et al. 1980, Parker and Mays 1998, Cummings 2003). Depth distribution and ontogenetic stage are positively correlated, where younger, smaller fish are generally found in shallower depths than older and larger individuals (Boardman and Weiler 1980).

2.3.2. Natural Mortality

The range of published natural mortality estimates was large, ranging from 0.19 and 0.86 per year. The LHWG felt the upper range was unreasonable. For example, Martinez-Andrade (2003) estimated natural mortality to be between 0.54 and 0.56 per year using the equation published in the FishBase manual (Froese and Pauly 2011). Attempts made to replicate these estimates using a realistic temperature for Caribbean waters produced results much lower than Martinez-Andrade's estimates. The LHWG thus recommended that these natural mortality estimates be ignored. Additionally the highest estimate of natural mortality from Tabash and Sierra (1996) was considered high and it was recommended that it not be used for the assessment.

2.3.3. Discard Mortality (Scientific studies)

Discard Mortality was not considered by the LHWG.

2.3.4. Age and growth

The age-length and length-weight relationships for silk snapper were discussed. The literature estimates for the von Bertalanffy parameters discussed during the data workshop were deemed reasonable. The reported ranges for L_{inf}, K, and t_0 were 600mm-1170mm total length (TL), 0.051-0.32 per year, and -2.309 - -0.04 years, respectively. Some concern was expressed by the LHWG regarding the highest estimate of L_{inf} and the highest value of K (i.e., 1170mm TL and 0.32 per year).

No concern was expressed about the estimates of the length-weight parameter collected from the literature. The reported range for the allometric growth parameter, *b*, was 2.86 - 3.1 and the range for the scaling parameter, *a*, was $1e^{-5}$ - 0.117.

2.3.5. Reproduction

Silk snapper are gonochronistic (i.e., sexes are distinct; Sylvester et al. 1980). Silk are thought to spawn year round (Sylvester et al. 1980). Peak spawning months for silk in the USVI are April-June and October-December (Sylvester 1974). Parker and Mays (1998) have suggested that peak spawning months in the southeast USA are July-September and again in October-December.

Estimates of length-at-maturity, L_{mat}, from the literature varied. The lowest estimates of L_{mat} were 296mm fork length (FL) and 267mm FL for males and females, respectively (Rosario et al. 2006). The remaining estimates ranged between 340mm TL and 600mm TL. L_{mat} was generally determined by macroscopic inspection of the gonads. Rosario et al. (2006), however, conducted a histological investigation, which may more accurately represent L_{mat}. Estimates of age-at-maturity, t_{mat}, were also discussed. The range for t_{mat} was between two and six years. The discussed ranges for L_{mat} and t_{mat} were deemed reasonable for assessment purposes.

2.3.6. Movements & Migrations

Movements and migrations were not considered by the LHWG.

2.3.7. Meristics & Conversion factors

Meristics and conversion factors were not discussed by the LHWG.

2.3.8. Comments on adequacy of data for assessment analyses

Table 2.7.1 summarizes the recommended life history parameters for all silk and queen snapper and redtail parrotfish. The symbols used in Table 2.7.1 are as follows: L_{inf} is asymptotic length, K is the growth coefficient and determines how quickly L_{inf} is reached, t_0 is the length at which size is zero and allows for fish between the ages of zero and one year to be a non-zero value, L_{max} is the observed maximum length, t_{max} is the maximum age, L_{mat} is the length-at-maturity, t_{mat} is the age-at-maturity, M is natural mortality, *a* is the length-weight scaling parameter, and *b* is the length-weight power parameter.

The "base" parameter recommendations are those that should be used for the baseline stock assessment model run. The lower and upper bounds are recommended for sensitivity analysis. The lower bound for silk snapper, unless stated otherwise, is the lowest value from the published literature. The upper bound is generally the highest value reported from the literature. The base case was calculated as the mean of the reported range, unless stated otherwise. It should be noted that one recommendation was made for each t_{max} and the allometric growth parameter because the estimates for t_{max} from the reviewed literature were the same and very similar among the reviewed literature for the allometric growth parameter.

2.4. QUEEN SNAPPER

2.4.1. Stock Definition and Description

Queen snapper has a similar distribution to silk snapper. They are found in western Atlantic waters, as far north as North Carolina and Bermuda and as far south as Brazil (Bohlke and Chaplin 1967, Froese and Pauly 2011, Figure 2.8.2). They are also found in the Gulf of Mexico along the continental shelf (Bohlke and Chaplin 1967). Gobert et al. (2005) fished for and found queen snapper at depths between 100m and 500m. This was the widest depth distribution found reported in the literature, however, it was suggested during the Data Workshop (DW) that queen snapper are found in waters deeper than 500m.

2.4.2. Natural Mortality

One estimate of natural mortality was found in FishBase, however, the original publication could not be found. Another estimate of natural mortality was provided and was found in Martinez-Andrade (2003), but was deemed unreliable as previously mentioned for silk snapper. In an effort to be thorough, we attempted to replicate his estimates using the reported von Bertalanffy growth parameters and the known range of average temperatures in waters where queen snapper are found. The estimates of natural mortality could not be replicated.

2.4.3. Discard Mortality (Scientific studies)

Discard Mortality was not addressed by the LHWG.

2.4.4. Age and growth

Historical information on queen snapper age and growth is very limited. The reported estimates for L_{inf} and K, were 1020mm TL and 1030mm TL, and 0.29-0.621 per year, respectively (Murray and Moore 1992, Murray et al. 1992, Murray and Neilson 2000).

The reported range for the allometric growth parameter was 2.55-2.908 and the range for the scaling parameter was 0.012-0.0632 (Bohnsack and Harper 1988, Murray and Moore 1992, Rosario et al. 2006).

2.4.5. Reproduction

Queen snapper are gonochronistic (i.e., sexes are distinct) and thought to spawn year round (Rosario et al. 2006). Spawning is thought to peak during October and November in Puerto Rico (Rosario et al. 2006).

Estimates of length-at-maturity, L_{mat}, were discussed. Estimates of L_{mat} from the literature ranged from 230mm and 536mm. Rosario et al. (2006) provided lower estimates, which were measured in millimeters fork length, than Martinez-Andrade (2003). Using the empirical relationship between L_{mat} and L_{inf} published in Froese and Binohlan (2000), Martinez-Andrade (2003) provided estimates of L_{mat} measured in millimeters TL. Estimates of age-at-maturity were also discussed and ranged between one and two years. No concern was expressed about maturity parameter estimates.

2.4.6. Movements & Migrations

Movements and migrations were not considered by the LHWG.

2.4.7. Meristics & Conversion factors

Meristics and conversion factors were not considered by the LHWG.

2.4.8. Comments on adequacy of data for assessment analyses

Life history parameter recommendations were made for a base model run, as well as lower and upper bounds and can be found in Table 2.7.1. The lower and upper bounds reported in Table 2.7.1 are the same as the lowest and highest reported values found in the reviewed literature (see Table 4 SEDAR26-DW-01). The "base" parameter recommendations represent an average of the reviewed parameter estimates.

One recommendation was made for L_{inf} because only one of the two publications with reported estimates of L_{inf} were available for review, the other was from FishBase and was similar to the recommended base case. One recommendation was also made for natural mortality, because there was only one estimate available from the reviewed literature.

2.5. REDTAIL PARROTFISH (AND OTHER PARROTFISH INFORMATION)

2.5.1. Stock Definition and Description

Redtail parrotfish are found as far north as South Florida, throughout the Caribbean, and as far south as Brazil (Bohlke and Chaplin 1967, Figure 2.8.3). Juveniles are associated with seagrass beds and adults are associated with are associated with coral reefs, seagrass, sand and mud flats, and mangroves.

2.5.2. Natural Mortality

Due a lack of published literature focusing on redtail parrotfish life history, literature focusing on stoplight, redfin, and redband parrotfish were also reviewed. Estimates of natural mortality were not found for any of the aforementioned parrotfish species, therefore, the LHWG did not discuss parrotfish natural mortality.

2.5.3. Discard Mortality (Scientific studies)

The LHWG did not discuss discard mortality.

2.5.4. Age and growth

Figures 2.8.4 and 2.8.5 were presented at the data workshop to show the similarities in the age-length relationships for the parrotfish species considered. All have similar growth rates, however, asymptotic length varies among the species. Tables 4-6 in SEDAR26-DW-01 summarize the reported ranges for the age and growth parameters discussed for these species.

2.5.5. Reproduction

The LHWG did not consider reproduction in in detail, but it was mentioned that redtail, stoplight, redfin, and redband parrotfish are all protogynous hermaphrodites (Robertson and Warner 1978,van Rooij et al. 1995, Molina-Urena 2009).

Length-at-maturity estimates were 140mm-242mm standard length (SL) for redtail, 170mm SL ->270mm SL for stoplight, 160mm SL -220mm SL for redfin, estimates for redband were not found. Overall, the range seems reasonable for these species. Age-at-maturity estimates were not found for any of the parrotfish species considered and therefore were not discussed.

2.5.6. Movements & Migrations

Movements and migrations were not considered by the LHWG

2.5.7. Meristics & Conversion factors

Meristics and conversion factors were not considered by the LHWG

2.5.8. Comments on adequacy of data for assessment analyses

The recommended life history parameters for redtail parrotfish were determined from the reviewed literature for redtail, stoplight, redfin, and redband parrotfish. This was done due to the paucity of available information about redtail parrotfish. Recommendations were made for a base model run, as well as lower and upper bounds and can be found in Table 2.7.1. The "base" parameter recommendations are those that should be used for the base stock assessment model run. The lower and upper bounds are recommended for sensitivity analysis. The recommended lower bounds represent the reviewed parameter estimates for redband parrotfish (see Table 6 in SEDAR26-DW-01). The upper bounds were developed from the reviewed parameter estimates for stoplight parrotfish (see Table 5 in SEDAR26-DW-01). The recommended base model parameter inputs were developed from reported parameter estimates for redtail and redfin parrotfish. Parameter recommendations could not be made for age-at-maturity or natural mortality for redtail due to a lack of available information (Table 2.7.1).

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2.7. TABLES

Table 2.7.1. Recommended parameter values for the assessment of silk snapper, queen snapper, and redtail parrotfish. Lower and upper bounds will be used for sensitivity analysis. All length measurements for silk and queen snapper are reported in millimeters TL, except the lower bound and base case for L_{mat}, which is reported in millimetrs FL. L_{mat} for redtail parrotfish are reported in millimeter SL, all other length parameters are reported in terms of millimeters TL.

Species	L_{inf} (mm)			K ($year^{-1}$)			t_0 (years)			L_{max} (mm)		
	LB	Base	UB	LB	Base	UB	LB	Base	UB	LB	Base	UB
Silk	600	794	1170	0.051	0.1	0.3	-2.64	-1.87	-0.04	512	696	830
Queen	-	1030	-	0.29	.45	.61	-0.41	-0.29	-0.18	910	950	1000
Redtail	182	263	472	0.458	0.71	1.18	-0.04	-0.05	-0.06	255	375	490
	t_{max} (years)			L_{mat} (mm)			t_{mat} (years)			M ($year^{-1}$)		
	LB	Base	UB	LB	Base	UB	LB	Base	UB	LB	Base	UB
Silk	-	9	-	265	350	600	2	4	6	.19	.21	.23
Queen	5	8	10	233	360	536	-	1	2	-	.33	-
Redtail	5	7	9	160	220	270	-	-	-	-	-	-
	a			b								
	LB	Base	UB	LB	Base	UB						
Silk	1e-5	1.7e-5	9e-5	-	3	-						
Queen	0.012	0.023	0.063	2.55	2.7	2.9						
Redtail	0.004	0.02	0.07	2.33	3	3.4						

2.8. FIGURES

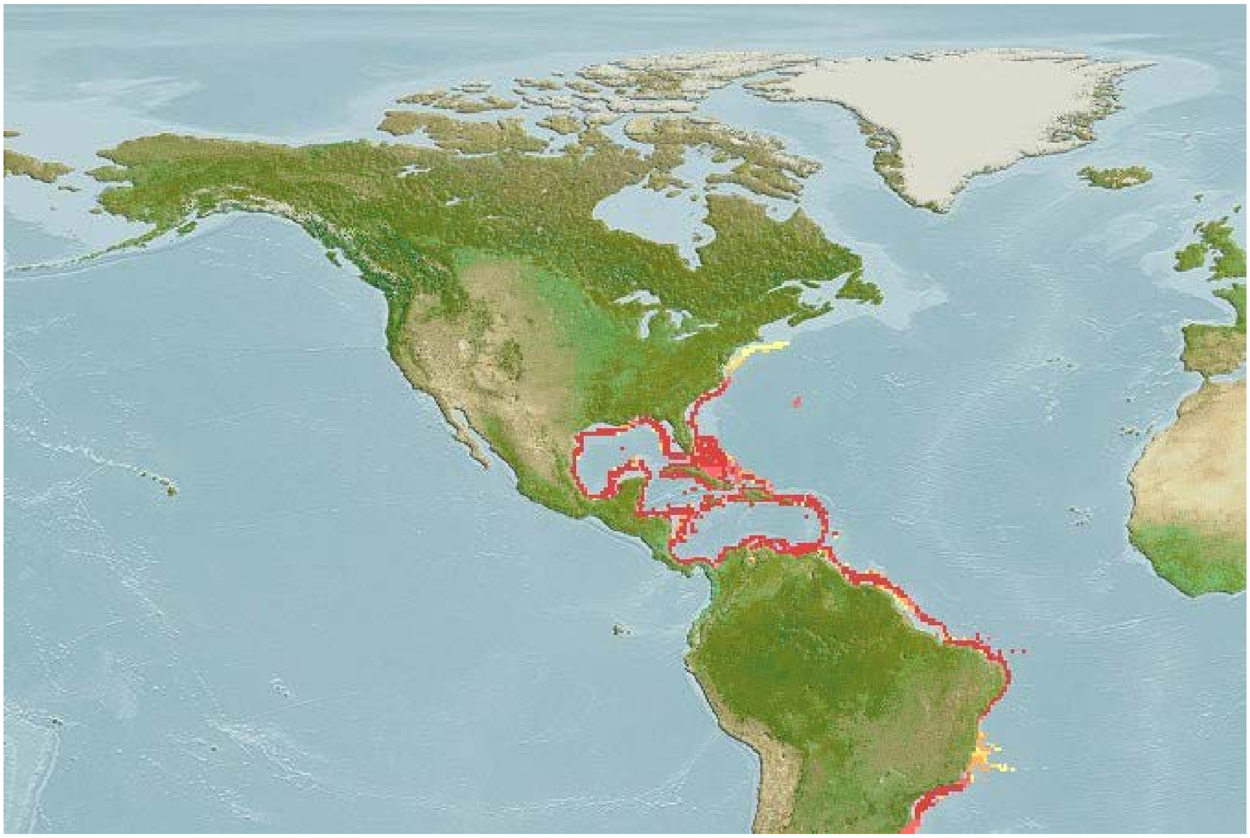

Figure 2.8.1. Geographical distribution of silk snapper, *Lutjanus vivanus* (Froese and Pauly 2011). The relative probability of occurrence in red and pink areas is greater than 60 percent. The relative probability of occurrence in orange areas is between 40 and 59 percent and in yellow areas the relative probability of occurrence is less than 40 percent.

Figure 2.8.2. Geographical distribution of queen snapper, *Etelis oculatus* (Froese and Pauly 2011). The relative probability of occurrence in red and pink areas is greater than 60 percent. The relative probability of occurrence in orange areas is between 40 and 59 percent and in yellow areas the relative probability of occurrence is less than 40 percent.

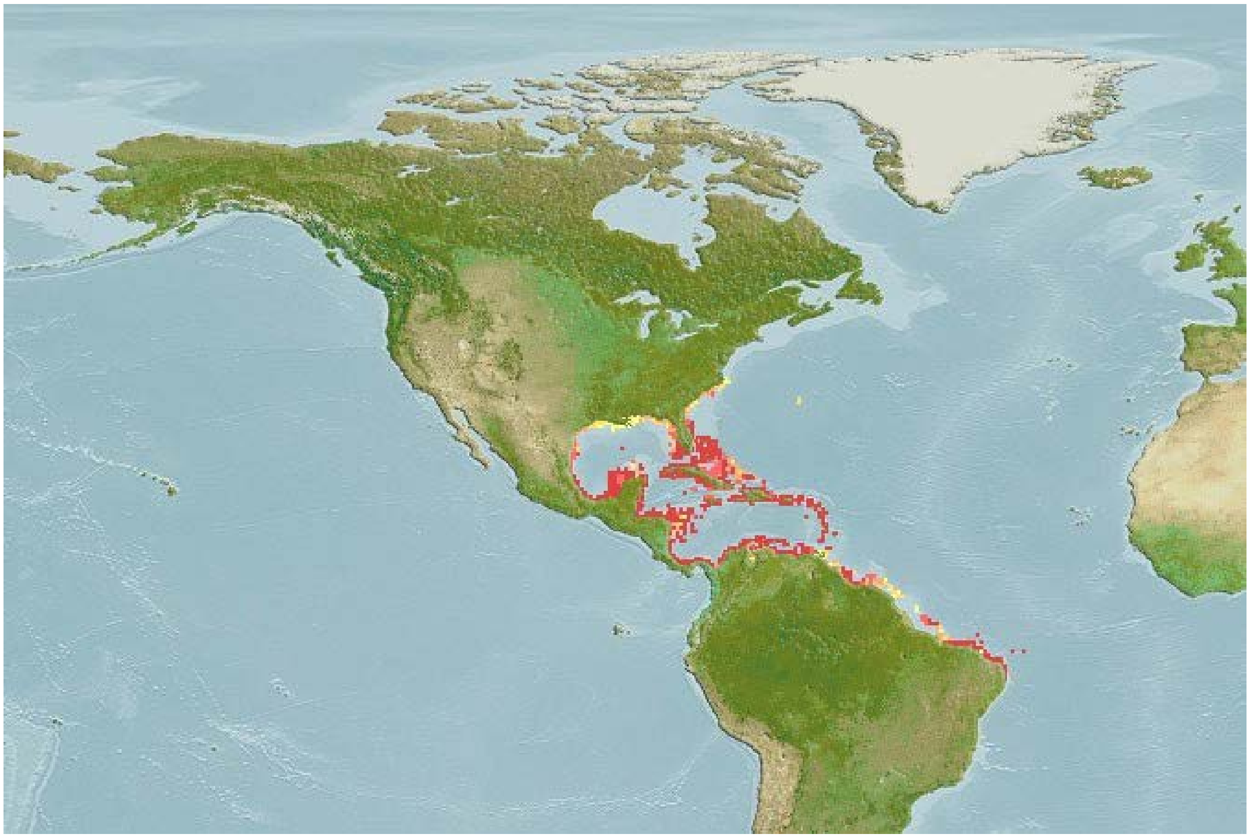

Figure 2.8.3. Geographical distribution of redtail parrotfish, *Sparisoma chrysopterum* (Froese and Pauly 2011). The relative probability of occurrence in red and pink areas is greater than 60 percent. The relative probability of occurrence in orange areas is between 40 and 59 percent and in yellow areas the relative probability of occurrence is less than 40 percent.

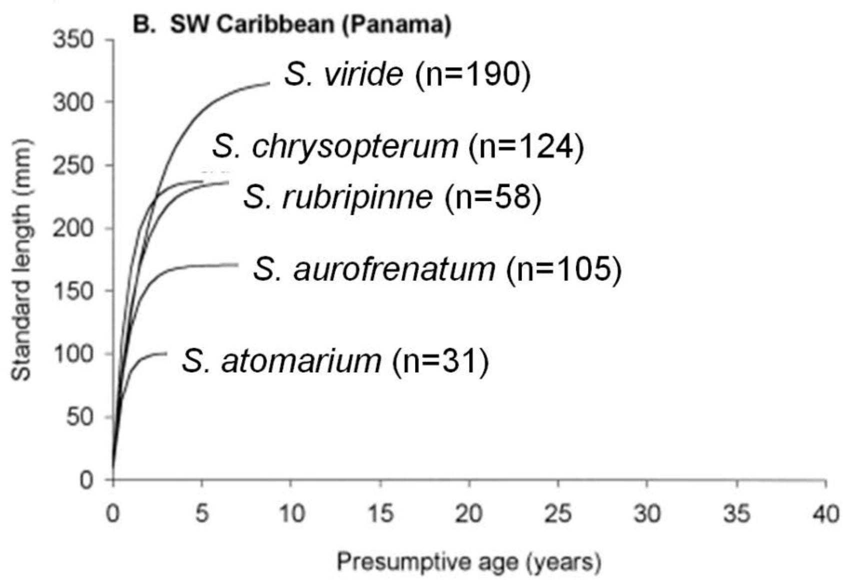

FIGURE 5 von Bertalanffy growth curves fitted to size-at-age data for 15 scarid taxa (von Bertalanffy parameters in Table 1; size-at-age data available from J. H. Choat). (A) West Pacific (northern GBR) taxa of *Bolbometopon, Chlorurus, Hipposcarus*, and *Scarus*. (B) Caribbean taxa of *Sparisoma* from the San Blas sampling locality.

Figure 2.8.4. Published von Bertalanffy growth curves, with sample sizes, for stoplight, redtail, redfin, and redband parrotfish taken from Choat and Robertson (2002).

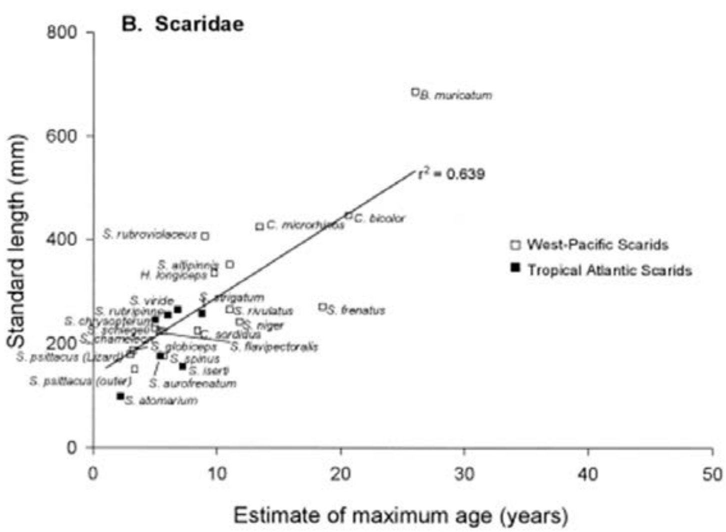

FIGURE 3 The relationship between maximum length and maximum age in 50 taxa of acanthurid and scarid fishes. Lines are least-squares regressions. (A) West Pacific and tropical Atlantic Acanthuridae. (B) West Pacific and tropical Atlantic Scaridae.

Figure 2.8.5. Published length-age relationship for west Pacific and tropical Atlantic Scarids, taken from Choat and Robertson (2002).

3. PUERTO RICO FISHERY STATISTICS

3.1. OVERVIEW

Working Group Composition:

Nancie Cummings (NMFS, SEFSC, SFD)
Daniel Matos (PR, DNER, Commercial Fisheries Statistics Program (CSP), Chief)
Luis A. Rivera (PR, DNER, CSP, port agent)
Jesus Leon (PR, DNER, CSP port agent)
Eugenio Piñeiro-Soler (PR, Rincon DWSN fisher, CFMC member)
Walter Keithly (CFMC SSC LSU)
William Tobias (St. Croix, US VI, biologist)

3.2. SILK SNAPPER COMMERCIAL FISHERY STATISTICES

3.2.1. Review of Working Papers

The Puerto Rico (PR) Fishery Statistics Work Group (WG) reviewed the working document provided by Cummings and Matos-Caraballo (SEDAR 26-DW-03) who provided a brief historical synopsis of the fisheries in Puerto Rico. Although fishing has been carried out since the late 1800's in Puerto Rico, prior to the mid 1940's mainly subsistence fishing was conducted. Sales records were obtained through voluntary reports by fishers until 1998 when reporting became mandatory through Puerto Rico Law 278 of November 29th, 1998. Commercial fishers were required to submit their landings reports to the DNER. During many of these years, the reporting was carried out through efforts of port agents to pick up the sales tickets who routinely visited fishing centers throughout the island to collect daily records of landings and carry out biological sampling activities. Data were collected by the Puerto Rico department of Natural Resources and Environment (DNER) and are submitted annually to NMFS, SEFSC for stock assessment analyses. Figure 3.10.1 provides a map of the location of fishing centers on the island. Although, statistical data collection systems have been in place since around 1967 in Puerto Rico (Suarez-Caabro 1975), electronic records documenting commercial catches exist only since 1983.

3.2.2. Commercial Landings

Records documenting the quantity of silk snapper landings as reported by fishers exist since 1983 (Table 3.9.1). Silk snapper are predominately reported from fish pot and reefish handline catches (Table 3.9.2). The historical data show that fish pots were the main gear until around 1984, thereafter reeffish hand lines have been the dominant gear used to catch silk snapper. Table 3.9.3 and Figure 3.10.2 provides the reported total commercial landings for all fish and shellfish species landed in Puerto Rico and the annual percentage that silk snapper landings contributed to the all species total.

3.2.3. Commercial Discards

Scant information is available to document the level of discards in the commercial fisheries of Puerto Rico. Matos-Caraballo (2005) provided summarized information on bycatch from a survey of 71 commercial fishing trips using beach seines, trammel nets, fish traps, and/or hand lines between 2003 and 2005. Matos-Caraballo's study did report silk snapper species occurring in any of the 71 trips surveyed over that period.

3.2.4. Commercial Effort

Information on the amount (level) of fishing effort directed at silk snapper only is not presently available for Puerto Rican commercial fisheries.

3.2.5. Biological Sampling

Information on biological sampling provided in SEDAR26-DW-04 is summarized below. Length sample data were extracted from the NMFS, SEFSC Trip Interview Program (TIP). Some bio-statistical data are available beginning in 1979 in the USVI when sporadic records, primarily on lobster, started to be recorded in St. Thomas and St. John. In 1983 the TIP program was established and interviews appear to have been performed regularly on St. Croix with a relatively high number of records. In the mid-1990's the number of records became variable in both St. Croix and St. Thomas/St. John. In Puerto Rico, data are also available starting in 1983 and appear regularly since 1983. For each interview, basic information on catch and effort is collected in addition to some biological information from a sub-sample of the catch.

3.2.5.1 Sampling Intensity Length/Age/Weight

Between 1983 and 2011, the TIP data set has nearly 26,000 records of silk snapper length observations. Of these records, some 85% were from Puerto Rico, 12% from St. Croix, and the remaining 3% from the St. Thomas/St. John locale. Table 3.9.4 provides a breakdown of the TIP length sampling by gear.

3.2.5.2 Length/Age distributions

Plots of the number of silk snapper individuals sampled by year and gear type and the average length by year and gear was provided in SEDAR26-DW-04 and is represented here as Figure 3.10.3 (sample sizes) and Figure 3.10.4 (average length).

3.2.5.3 Adequacy for characterizing catch

The overall adequacy of using the TIP samples to characterize the total catch was not evaluated at the DW however the utility of using the sample observations to characterize period changes (e.g., five year blocks) in mean length was a topic of discussion. More detailed examinations of the representativeness over a geographical scale and within year (monthly) are necessary to assess the adequacy of these data to characterize total catch at size. In addition, careful examination of the silk snapper samples by depth in relation to distributional changes in the pattern of fishing effort (i.e, fleet movement from shallow to deep) must be taken into account in any analyses using the length data to model population changes.

3.2.5.4 Alternatives for characterizing discard length/age

Characterizing discard length/age profiles was not carried out at the DW as information available suggests the level of commercial discards is not a concern.

3.2.6. Commercial Catch-at-Age/Length (directed and discards)

Estimates of catch at length/catch at age were not developed for the Puerto Rico commercial silk snapper catches.

3.2.7. Comments on adequacy of data for assessment analyses

The number of silk snapper length observations for the hand line and fish pot/trap sectors appear to be sufficient to evaluate temporal changes in length. However, a visual inspection of annual histograms and individual length observations suggests that a minimum size regulation (which was apparently never finalized) altered the size composition of the catch in the mid-1990's. This change has hampered a successful length based assessment for silk snapper in previous attempts; however, the assessment analysts are working to resolve these issues and include the most recent data in the analyses.

3.3. SILK SNAPPER RECREATIONAL FISHERY STATISTICS

3.3.1. Review of Working Papers

The Puerto Rico (PR) Fishery Statistics Work Group (WG) reviewed the working document, SEDAR26-DW-02, provided by Cummings and Matter that summarized available information on recreational fisheries in Puerto Rico. Through the Marine Recreational Information Program (MRIP) estimates of recreational harvest (AB1 catch, weight), discards (B2 catch, weight), and number of angler trips are available since 2000 by two month interval, by fishing mode (charter, private, shore mode) and area offshore. Information on the variability measured as the coefficient of variation (CV) of stratum mean estimates of catch, discards, and angler trips are also available.

3.3.2. Recreational Landings

Tables 3.9.5 and 3.9.6 and Figures 3.10.5, 3.10.6 and 3.10.7 present summarized data for estimated total fish caught (AB1) and the CV of the estimates.

3.3.3. Recreational Discards

Tables 3.9.5 and 3.9.6 and Figure 3.10.6 present summarized data for estimated total fish discarded (B2) and the CV of the estimates.

3.3.4. Recreational Effort

Information on the amount of recreational fishing effort targeted at silk snapper only is not presently available for Puerto Rican recreational fisheries however, estimates of the total number of recreational angler trips was available and is presented here. Table 3.9.7 and Figure 3.10.8 provides estimates of total number of recreational angler trips and the coefficient of variability in Puerto Rico made from 2000-2010. Table 3.9.8 presents information on the breakdown of total estimated angler trips by area (e.g., inland, state, federal waters) and also economic information relating to annual estimates of crude oil inflation and unemployment rates for Puerto Rico. Figures 3.10.9 and 3.10.10 present these data graphically.

3.3.5. Biological Sampling

No consistent, comprehensive sampling of the recreational fishery has occurred in Puerto Rico.

3.3.5.1 Sampling Intensity Length/Age/Weight

No consistent, comprehensive sampling of the recreational fishery has occurred in Puerto Rico.

3.3.5.2 Length/Age distributions

None presented at the data workshop.

3.3.5.3 Adequacy for characterizing catch

Biological sampling is not available to characterize recreational catch in Puerto Rico.

3.3.5.4 Alternatives for characterizing discard length/age

There are no accepted alternatives, nor are there any data for an alternative approach to characterizing discard length/age.

3.3.6. Recreational Catch-at-Age/Length; directed and discard

Estimates of catch at length/catch at age were not developed for the Puerto Rico recreational silk snapper catches.

3.3.7. Comments on adequacy of data for assessment analyses

Available information on recreational catch in Puerto Rico will only provide limited use in characterizing recent overall landings.

3.4. QUEEN SNAPPER COMMERCIAL FISHERY STATISTICS

3.4.1. Review of Working Papers

The Puerto Rico (PR) Fishery Statistics Work Group (WG) reviewed the working document provided by Cummings and Matos-Caraballo (SEDAR 26-DW-03) who provided a brief historical synopsis of the fisheries in Puerto Rico. Although fishing has been carried out since the late 1800's in Puerto Rico, prior to the mid 1940's mainly subsistence fishing was conducted. Sales records were obtained through voluntary reports by fishers until 1998 when reporting became mandatory through Puerto Rico Law 278 of November 29th, 1998. Commercial fishers were required to submit their landings reports to the DNER. During many of these years, the reporting was carried out through efforts of port agents to pick up the sales tickets who routinely visited fishing centers throughout the island to collect daily records of landings and carry out biological sampling activities. Figure 3.10.1 provides a map of the location of fishing centers on the island. Although, statistical data collection systems have been in place since around 1967 in Puerto Rico (Suarez-Caabro 1975), electronic records documenting commercial catches exist only since 1983.

3.4.2. Commercial Landings

Records documenting the quantity of queen snapper landings as reported by fishers exist since about 1983 with the first landings records appearing in 1987 (Table 3.9.1). Queen snapper are predominately reported from reeffish bottom line, handline, and troll catches (Table 3.9.9). The reported landings data indicate that this species was landed mainly by reefish bottom line gear with minor catches also from long lines and other line type gear. Table 3.9.3 and Figure 3.10.2 provides the reported total commercial landings for all fish and shellfish species landed in Puerto Rico and the annual percentage that queen snapper landings contributed to the all species total. Table 3.9.9. provides the percentage landings by gear for queen snapper.

3.4.3. Commercial Discards

Scant information is available to document the level of discards in the commercial fisheries of Puerto Rico. Matos-Caraballo (2005) provided summarized information on bycatch from a survey of 71 commercial fishing trips using beachseines, trammel nets, fish traps, and/or hand lines between 2003 and 2005. Matos-Caraballo's study did report queen snapper species occurring in any of the 71 trips surveyed over that period.

3.4.4. Commercial Effort

Information on commercial fishing effort targeted at queen snapper only is not presently available for Puerto Rican commercial fisheries.

3.4.5. Biological Sampling

Information on biological sampling provided in SEDAR26-DW-04 is summarized below. Length sample data were extracted from the NMFS, SEFSC Trip Interview Program (TIP). Some bio-statistical data are available beginning in 1979 in the USVI when sporadic records, primarily on lobster, started to be recorded in St. Thomas and St. John. In 1983 the TIP program was established and interviews appear to have been performed regularly on St. Croix with a relatively high number of records. In the mid-1990's the number of records became variable in both St. Croix and St. Thomas/St. John. In Puerto Rico, TIP data are also available starting in 1983 and appear regularly since 1983. For each interview, basic information on catch and effort is collected in addition to some biological information from a sub-sample of the catch.

3.4.5.1 Sampling Intensity Length/Age/Weight

Between 1983 and 2011, the TIP data set has nearly 5,000 records of queen snapper length observations. Of these records, some 85% were from Puerto Rico, 12% from St. Croix, and the remaining 3% from the St. Thomas/St. John locale. Table 3.9.10 provides a breakdown of the TIP length sampling by gear for queen snapper. As the commercial fishery for queen snapper in Puerto Rico began increasing in intensity in the late 1980's, records of length observations do not show up in the TIP database until around 1986.

3.4.5.2 Length/Age distributions

Plots of the number of queen snapper individuals sampled by year and gear type and the average length by year and gear was provided in SEDAR26-DW-04 and are represented here as Figure 3.10.11 (sample sizes) and Figure 3.10.12 (average length).

3.4.5.3 Adequacy for characterizing catch

The overall adequacy of using the TIP samples to characterize the total queen snapper commercial catch was not evaluated at the DW however the utility of using the sample observations to characterize period changes (e.g., five year blocks) in mean length was a topic of discussion. More detailed examinations of the representativeness over a geographical scale and within year (monthly) are necessary to assess the adequacy of these data to characterize total catch at size. Consideration of the sampling rates across years should be given in any subsequent population analyses incorporation the commercial length samples. In addition, the randomness of the sampling should be addressed given the schooling nature of this species.

3.4.5.4 Alternatives for characterizing discard length/age

Characterizing discard length/age profiles was not carried out at the DW as information available suggests the level of commercial discards is not a concern for this species.

3.4.6. Commercial Catch-at-Age/Length (directed and discards)

Estimates of catch at length/catch at age were not developed for the Puerto Rico recreational queen snapper catches.

3.4.7. Comments on adequacy of data for assessment analyses

The number of queen snapper length observations for the bottom handline fishery is probably sufficient to evaluate temporal changes in length. Visual inspection of the individual length observations does not suggest major outliers in the data or other types of quality control/assurance problems.

3.5. QUEEN SNAPPER RECREATIONAL FISHERY STATISTICS

3.5.1. Review of Working Papers

The Puerto Rico (PR) Fishery Statistics Work Group (WG) reviewed the working document, SEDAR26-DW-092, provided by Cummings and Matter that summarized available information on recreational fisheries in Puerto Rico. Through the Marine Recreational Information Program (MRIP) estimates of recreational harvest (AB1 catch, weight), discards (B2 catch, weight), and number of angler trips are available since 2000 by two month interval, by fishing mode (charter, private, shore mode) and area offshore. Information on the variability measured as the coefficient of variation (CV) of stratum mean estimates of catch, discards, and angler trips are also available.

3.5.2. Recreational Landings

Tables 3.9.11 and 3.9.12 and Figures 3.10.5, 3.10.6 and 3.10.7 present summarized data for estimated total fish caught (AB1) and the CV of the estimates.

3.5.3. Recreational Discards

Tables 3.9.11 and 3.9.12 and Figure 3.10.6 present summarized data for estimated total fish discarded (B2) and the CV of the estimates.

3.5.4. Recreational Effort

Information on fishing effort targeted at queen snapper only is not presently available for Puerto Rican recreational fisheries however, estimates of the total number of angler trips were available and are presented here. Table 3.9.7 and Figure 3.10.8 provides estimates of total number of recreational angler trips and the coefficient of variability in Puerto Rico made from 2000-2010. Table 3.8 presents information on the breakdown of total estimated angler trips by area (e.g., inland, state, federal waters) and also economic information relating to annual estimates of crude oil inflation and unemployment rates for Puerto Rico. Figures 3.10.9 and 3.10.10 present these data graphically.

3.5.5. Biological Sampling

No consistent, comprehensive sampling of the recreational fishery has occurred in Puerto Rico.

3.5.5.1 Sampling Intensity Length/Age/Weight

No consistent, comprehensive sampling of the recreational fishery has occurred in Puerto Rico.

3.5.5.2 Length/Age distributions

None presented at the data workshop.

3.5.5.3 Adequacy for characterizing catch

Biological sampling is not available to characterize recreational catch in Puerto Rico.

3.5.5.4. Alternatives for characterizing discard length/age

There are no accepted alternatives, nor are there any data for an alternative approach to characterizing discard length/age.

3.5.6. Recreational Catch-at-Age/Length (directed and discards)

Estimates of catch at length/catch at age were not developed for the Puerto Rico recreational queen snapper catches.

3.5.7. Comments on adequacy of data for assessment analyses

Available information on recreational catch in Puerto Rico will only provide limited use in characterizing recent overall landings.

3.6 REDTAIL PARROTFISH COMMERCIAL FISHERY STATISTICS

3.6.1. Review of Working Papers

The Puerto Rico (PR) Fishery Statistics Work Group (WG) reviewed the working document provided by Cummings and Matos-Caraballo (SEDAR 26-DW-03) who provided a brief historical synopsis of the fisheries in Puerto Rico. Although fishing has been carried out since the late 1800's in Puerto Rico, prior to the mid 1940's mainly subsistence fishing was conducted. Sales records were obtained through voluntary reports by fishers until 1998 when reporting became mandatory through Puerto Rico Law 278 of November 29th, 1998. Commercial fishers were required to submit their landings reports to the DNER. During many of these years, the reporting was carried out through efforts of port agents to pick up the sales tickets who routinely visited fishing centers throughout the island to collect daily records of landings and carry out biological sampling activities. Figure 3.1 provides a map of the location of fishing centers on the island. Although, statistical data collection systems have been in place since around 1967 in Puerto Rico (Suarez-Caabro 1975), electronic records documenting commercial catches exist only since 1983.

3.6.2. Commercial Landings

In the Puerto Rican commercial landings data, parrotfish are not recorded to species level. For the purpose of this assessment, landings are provided to family level only for Puerto Rican commercial catches. Parrotfish species are predominately reported from fish pots, gill nets, trammel nets, and dive gear (Table 3.9.13). These data suggest that four main gears were reported landings parrotfish, gillnets, fish pots, trammel nets and dive gear. Between 1983-1991, parrotfish were mainly landed by gillnets and pots. After 1991, parrotfish were landed using gillnets, fish pots, trammel nets and gear. Dive gear were mainly important after 1997. Table 3.9.3 and Figure 3.10.2 provides the reported total commercial landings for all fish and shellfish species landed in Puerto Rico and the annual percentage parrotfish landings contributed to the all species total.

The historical data show that fish pots were the main gear until around 1984, thereafter reeffish hand lines have been the dominant gear used to catch silk parrotfish.

3.6.3. Commercial Discards

Scant information is available to document the level of discards in the commercial fisheries of Puerto Rico. Matos-Caraballo (2005) provided summarized information on bycatch from a survey of 71 commercial fishing trips using beach seines, trammel nets, fish traps, and/or hand lines between 2003 and 2005. Matos-Caraballo's study reported redtail parrotfish occurring in beach seines (n=2 fish discarded of 1,284 total caught, n=6 trips surveyed) and in fish pots (n=2 fish/340 total caught, ntrips=13 surveyed) from 2003-2005. These results indicating a generally low level of redtail parrotfish discards from Puerto Rican commercial fisheries should be used with caution because of extreme low number of surveyed trips.

3.6.4. Commercial Effort

Information on the commercial effort targeted at redtail parrotfish only is not presently available for Puerto Rican commercial fisheries however; estimates of the total number of angler trips were available.

3.6.5. Biological Sampling

Information on biological sampling provided in SEDAR26-DW-04 is summarized below. Length sample data were extracted from the NMFS, SEFSC Trip Interview Program (TIP). Some bio-statistical data are available beginning in 1979 in the USVI when sporadic records, primarily on lobster, started to be recorded in St. Thomas and St. John. In 1983 the TIP program was established and interviews appear to have been performed regularly on St. Croix with a relatively high number of records. In the mid-1990's the number of records became variable in both St. Croix and St. Thomas/St. John. In Puerto Rico, data are also available starting in 1983 and appear regularly since 1983. For each interview, basic information on catch and effort is collected in addition to some biological information from a sub-sample of the catch.

3.6.5.1 Sampling Intensity Length/Age/Weight

Between 1983 and 2011, the TIP data set contains records for over 44,000 records of redtail parrotfish from the US Caribbean. Of these records, some 27% (n=12,105) records were from Puerto Rico, 69% (n=30,411) from St. Croix, and the remaining 4%(1,599) records from the St. Thomas/St. John locale. Table provides a breakdown of the TIP length sampling by gear. Table 3.9.14 provides a breakdown of the TIP length sampling by gear for redtail parrotfish. These data indicated that this species was sampled most often from gillnets, followed by fish pots and traps, with minor sample sizes from haul seines, hand lines and other miscellaneous gears.

3.6.5.2 Length/Age distributions

Plots of the number of redtail parrotfish individuals sampled by year and gear type and the average length by year and gear was provided in SEDAR26-DW-04 and is represented here as Figure 3.10.13 (sample sizes) and Figure 3.10.14 (average length).

3.6.5.3 Adequacy for characterizing catch

The number of redtail parrotfish length observations for the pots and traps (and potentially nets) is probably sufficient to evaluate temporal changes in length. Visual inspection of the individual length observations does not suggest major outliers in the data or other types of quality control/assurance problems.

3.6.5.4 Alternatives for characterizing discard length/age

Alternatives methods for characterizing discards size structure were not carried out at the SEDAR26 DW. Samples of redtail sizes from discards do not currently exist for Puerto Rican commercial fisheries.

3.6.6. Commercial Catch-at-Age/Length (directed and discards)

Estimates of catch at length/catch at age were not developed for the Puerto Rico commercial redtail parrotfish catches.

3.6.7. Comments on adequacy of data for assessment analyses

The number of redtail parrotfish length observations for the gillnet and fish pot/trap gear sectors appear to be sufficient to support further analyses of population change using these data. Visual inspection of the plotted observations do not suggest major quality control issues in the data.

3.7 REDTAIL PARROTFISH RECREATIONAL FISHERY STATISTICS

3.7.1. Review of Working Papers

The Puerto Rico (PR) Fishery Statistics Work Group (WG) reviewed the working document, SEDAR26-DW-02, provided by Cummings and Matter that summarized available information on recreational fisheries in Puerto Rico. Through the Marine Recreational Information Program (MRIP) estimates of recreational harvest (AB1 catch, weight), discards (B2 catch, weight), and number of angler trips are available since 2000 by two month interval, by fishing mode (charter, private, shore mode) and area offshore. Information on the variability measured as the coefficient of variation (CV) of stratum mean estimates of catch, discards, and angler trips are also available.

3.7.2. Recreational Landings

Table 3.9.15 and 3.9.16 and Figure 3.10.15 present summarized data for estimated total fish caught (AB1) and the CV of the estimates

3.7.3. Recreational Discards

Table 3.9.15 presents summarized data for estimated total fish landed (AB1) and discarded (B2) and the CV of the estimates.

3.7.4 Recreational Effort

Information on recreational fishing effort targeted at redtail parrotfish only is not presently available for Puerto Rican recreational fisheries however, estimates of the total number of angler trips were available and is presented here. Table 3.9.7 and Figure 3.10.8 provides estimates of total number of recreational angler trips and the coefficient of variability in Puerto Rico made from 2000-2010. Table 3.8 presents information on the breakdown of total estimated angler trips by area (e.g., inland, state, federal waters) and also economic information relating to annual estimates of crude oil inflation and unemployment rates for Puerto Rico. Figures 3.10.9 and 3.10.10 present these data graphically.

3.7.5. Biological Sampling

No consistent, comprehensive sampling of the recreational fishery has occurred in Puerto Rico.

3.7.5.1 Sampling Intensity Length/Age/Weight

No consistent, comprehensive sampling of the recreational fishery has occurred in Puerto Rico.

3.7.5.2 Length/Age distributions

None presented at the data workshop.

3.7.5.3 Adequacy for characterizing catch

Biological sampling is not available to characterize recreational catch in Puerto Rico.

3.7.5.4 Alternatives for characterizing discard length/age

There are no accepted alternatives, nor are there any data for an alternative approach to characterizing discard length/age.

3.7.6. Recreational Catch-at-Age/Length; directed and discard

Estimates of catch at length/catch at age were not developed for the Puerto Rico recreational redtail parrotfish catches.

3.7.7. Comments on adequacy of data for assessment analyses

Available information on recreational catch in Puerto Rico will only provide limited use in characterizing recent overall landings.

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3.9 TABLES

Table 3.9.1. Reported commercial landings of silk and queen snapper and parrotfish group in Puerto Rico 1983-2009, SEDAR26 focus species. Preliminary information as available from the Puerto Rico, DNER. Data presented = number reported landings observations (N) and reported pounds (whole weight). Landings are reported (not expanded).

	Parrotfishes		Queen snapper		Silk snapper		All three SEDAR 26 focus groups	
Year	**#Reports**	**Pounds**	**#Reports**	**Pounds**	**# Reports**	**Pounds**	**#Reports**	**Pounds**
1983	2,677	233,579	.	.	3,860	396,343	6,537	629,922
1984	1,698	231,387	.	.	2,713	357,156	4,411	588,543
1985	2,105	221,378	.	.	2,403	371,827	4,508	593,205
1986	1,763	105,546	.	.	2,664	356,899	4,427	462,445
1987	1,370	76,854	38	4,379	2,659	207,063	4,067	288,296
1988	265	12,208	209	14,763	2,232	170,034	2,706	197,005
1989	71	4,279	214	15,405	2,988	245,961	3,273	265,645
1990	470	36,849	220	11,390	2,303	176,884	2,993	225,123
1991	914	68,059	451	17,780	3,242	167,230	4,607	253,069
1992	1,134	91,932	492	25,285	3,004	207,966	4,630	325,183
1993	1,171	160,187	555	32,346	3,075	244,065	4,801	436,598
1994	1,549	115,750	496	27,765	3,826	338,852	5,871	482,367
1995	2,017	79,881	581	34,138	4,595	363,300	7,193	477,319
1996	2,547	102,799	575	36,685	4,340	311,324	7,462	450,808
1997	2,713	110,944	560	38,778	4,051	285,787	7,324	435,509
1998	2,433	97,503	567	46,073	3,779	209,384	6,779	352,960
1999	2,403	80,547	699	66,695	3,601	224,818	6,703	372,060
2000	3,054	74,041	761	82,869	3,493	188,270	7,308	345,180
2001	3,665	96,762	906	102,138	5,029	266,851	9,600	465,751
2002	3,172	107,485	838	110,061	4,637	198,148	8,647	415,694
2003	3,277	69,229	1,584	127,015	4,921	170,012	9,782	366,256
2004	2,488	51,152	1,068	79,553	3,634	118,997	7,190	249,702
2005	1,644	31,157	1,376	156,755	2,883	110,525	5,903	298,437
2006	1,792	31,922	1,032	102,889	2,291	83,399	5,115	218,210
2007	1,858	33,742	1,125	111,130	1,709	68,364	4,692	213,236
2008	1,740	28,134	1,290	137,292	2,185	108,634	5,215	274,060
2009	1,969	28,353	1,088	110,275	1,852	83,360	4,909	221,988
All Years	51,959	2,381,659	16,725	1,491,459	87,969	6,031,453	156,653	9,904,571

Table 3.9.2. Percentage composition of commercial silk snapper landings by gear. Landings are in units of whole weight lbs. Shaded column denotes primary gear.

YEAR	GEAR							
	Cast Nets	Combined Gears	Diving Outfits, Other	Gill Nets, Other	Haul Seines, Beach	Haul Seines, Long	Lines Hand, Other	Lines Long, Reef Fish
1983	0.0		0.1	0.6	0.2	0.3	**25.0**	0.1
1984			0.2	0.6	0.2	0.2	**22.4**	
1985	0.0		0.5	0.8	0.1	0.3	**61.5**	0.1
1986	0.0		0.2	0.5	0.0	0.1	**88.0**	0.2
1987	0.1		0.3	0.5	0.0		**78.4**	1.3
1988	0.1		0.1	0.4		0.1	**83.1**	0.1
1989	0.0		0.0	0.6		0.0	**80.6**	0.6
1990			0.5	0.1		0.1	**80.3**	0.7
1991	0.1		0.4	0.2	0.0	0.0	**74.5**	0.4
1992	0.1		0.4	0.4		0.2	**73.2**	0.1
1993	0.2		0.3	0.1	0.0	0.0	**77.0**	0.2
1994	0.0		0.3	0.2		0.5	**77.6**	0.1
1995	0.2		0.3	0.4	0.0	0.1	**83.8**	0.1
1996	0.0		0.4	0.1	0.0	0.0	**83.9**	0.2
1997	0.0		0.4	0.2	0.0	0.1	**83.3**	0.6
1998	0.0		1.5	0.5		0.2	**69.0**	3.9
1999	0.0		0.3	0.5		0.0	**74.0**	1.3
2000			0.7	0.2			**58.7**	10.7
2001	0.2		0.5	0.5		0.1	**58.0**	1.5
2002	0.1		2.1	0.5		0.2	**70.5**	1.7
2003			0.5	0.2		0.1	**67.8**	0.5
2004			1.4	0.1		0.9	**79.5**	0.2
2005			4.0	0.1		0.3	**80.4**	0.2
2006			1.9	0.0		0.7	**83.2**	0.0
2007			1.6				**89.6**	0.1
2008	0.0		5.6	2.2			**83.9**	0.4
2009		0.1	6.2	1.5			**59.6**	0.1
All	0.1	0.0	0.7	0.4	0.0	0.2	**69.4**	0.9

Table 3.9.2. (Continued). Percentage silk snapper commercial landings by gear category.

YEAR	*GEAR*							*All*
	Lines Troll, Other	*Pots And Traps, Crab, Other*	*Pots And Traps, Fish*	*Pots And Traps, Spiny Lobster*	*Rod and Reel*	*Spears*	*Trammel Nets*	
1983	0.2		**73.4**					100.0
1984	0.1		**76.3**			0.0		100.0
1985	0.2		**36.5**	0.0				100.0
1986	0.3		**10.8**					100.0
1987	0.5	0.0	**18.8**					100.0
1988	0.8		**15.0**			0.3		100.0
1989	0.9		**15.8**			0.4	0.9	100.0
1990	1.4		**16.9**			0.0		100.0
1991	0.8		**23.5**				0.0	100.0
1992	0.1		**25.5**					100.0
1993	0.1		**22.1**					100.0
1994	1.1	0.0	**20.2**	0.1			0.0	100.0
1995	0.9		**14.1**	0.0	0.0	0.0	0.0	100.0
1996	0.7	0.0	**14.6**				0.0	100.0
1997	1.7		**13.6**	0.0	0.0		0.0	100.0
1998	2.4	0.0	**22.6**	0.0				100.0
1999	0.6		**23.1**				0.2	100.0
2000	0.6		**29.1**	0.0				100.0
2001	1.9		**37.2**		0.0		0.0	100.0
2002	1.7		**23.3**					100.0
2003	0.4		**30.4**	0.0			0.0	100.0
2004	1.1		**16.8**					100.0
2005	5.5		**9.4**				0.1	100.0
2006	3.9		**9.6**				0.6	100.0
2007	2.5		**6.1**	0.0			0.1	100.0
2008	2.3	0.0	**5.4**		0.1		0.0	100.0
2009	8.8		**7.2**				16.4	100.0
All	1.1	0.0	**27.0**	0.0	0.0	0.0	0.3	100.0

Table 3.9.3. Total all species commercial landings in Puerto Rico, 1983-2009, and percentage contribution by SEDAR26 focus group.

		Percentage Contribution by Species			
Year	**All Species**	**Parrotfish Group**	**Queen Snapper**	**Silk Snapper**	**Silk+Queen+ Parrotfish_family**
1983	3,916,688	5.96		10.12	16.08
1984	3,154,298	7.34		11.32	18.66
1985	2,855,085	7.75		13.02	20.78
1986	2,535,417	4.16		14.08	18.24
1987	2,082,933	3.69	0.21	9.94	13.84
1988	2,014,697	0.61	0.73	8.44	9.78
1989	2,291,221	0.19	0.67	10.73	11.59
1990	2,180,841	1.69	0.52	8.11	10.32
1991	2,459,904	2.77	0.72	6.80	10.29
1992	2,045,294	4.49	1.24	10.17	15.90
1993	2,496,521	6.42	1.30	9.78	17.49
1994	2,710,947	4.27	1.02	12.50	17.79
1995	3,689,885	2.16	0.93	9.85	12.94
1996	3,583,128	2.87	1.02	8.69	12.58
1997	3,805,891	2.92	1.02	7.51	11.44
1998	3,455,082	2.82	1.33	6.06	10.22
1999	3,329,448	2.42	2.00	6.75	11.17
2000	3,275,083	2.26	2.53	5.75	10.54
2001	3,391,241	2.85	3.01	7.87	13.73
2002	3,274,578	3.28	3.36	6.05	12.69
2003	2,390,998	2.90	5.31	7.11	15.32
2004	1,867,511	2.74	4.26	6.37	13.37
2005	1,569,189	1.99	9.99	7.04	19.02
2006	1,341,420	2.38	7.67	6.22	16.27
2007	1,256,664	2.69	8.84	5.44	16.97
2008	1,266,232	2.22	10.84	8.58	21.64
2009	1,155,414	2.45	9.54	7.21	19.21
	69,395,610	3.43	2.15	8.69	14.27

Table 3.9.4. Number of length observations for silk snapper from the NMFS, TIP Program 1983-2011.

Sampling Location	Gear	Number Length Observations
PUERTO RICO	HAND LINE	13,360
PUERTO RICO	POTS AND TRAP	7,956
PUERTO RICO	HOOK AND LINE	351
PUERTO RICO	LONG LINES	275
PUERTO RICO	GILL NETS	54
PUERTO RICO	HAUL SEINES	52
PUERTO RICO	BY HAND	4
Puerto Rico	All Gears	22,052

Table 3.9.5. Estimated recreational AB1 and B2 Catch for silk snapper in Puerto Rico from the MRIP survey. AB1 and B2 units are numbers of fish. CV=estimate/100.

Species	YEAR	Sum of ab1	Sum of b2	CV(AB1)	CV(B2)	Angler_Trips	B2/AB1B2
silk snapper	2000	82610.95	0.00	31.61	0.00	1362703.59	0.00
	2001	65990.60	656.80	28.85	100.00	1411942.82	0.01
	2002	28167.86	919.18	49.36	100.00	1301059.11	0.03
	2003	115176.07	0.00	27.17	0.00	1111405.15	0.00
	2004	47390.27	237.81	33.34	100.00	1050298.42	0.00
	2005	27803.86	2800.90	37.97	100.00	866722.57	0.09
	2006	131780.89	0.00	54.20	0.00	955123.25	0.00
	2007	136545.63	397.23	34.35	91.97	1080096.85	0.00
	2008	93484.69	443.27	27.40	100.00	798550.71	0.00
	2009	29636.32	0.00	37.11	0.00	636150.82	0.00
	2010	18213.57	0.00	52.35	0.00	536166.86	0.00

Table 3.9.6. Estimated recreational AB1 catch (number of fish and weight in whole pounds) for the silk snapper in Puerto Rico 2 from the MRIP survey.

Species	YEAR	AB1 Numbers	AB1 Pounds (whole weight)
silk snapper	2000	82,611	210,855
	2001	65,991	47,893
	2002	28,168	34,035
	2003	115,176	132,431
	2004	47,390	35,098
	2005	27,804	30,605
	2006	131,781	252,203
	2007	136,546	132,697
	2008	93,485	112,425
	2009	29,636	35,326
	2010	18,214	32,644
silk snapper Total		776,801	1,056,212

Table 3.9.7. Estimated number of total recreational angler fishing trips in Puerto Rico, 2000-2010. Source = MRIP survey.

YEAR	Sum of ESTRIPS	Sum of CV_Estrips
2000	1,362,704	9.9
2001	1,411,943	6.9
2002	1,301,059	7.3
2003	1,111,405	7.9
2004	1,050,298	10.1
2005	866,723	8.0
2006	955,123	9.3
2007	1,080,097	8.6
2008	798,551	9.1
2009	636,151	9.4
2010	536,167	9.5
Grand Total	11,110,220	2.7

Table 3.9.8. Breakdown of estimated angler trips by area and associated annual estimates of crude oil and unemployment rates. PSE=Proportional Standard Error.

							Average Domestic		
	Inland Waters		State Waters		Federal Waters		Crude Oil Price		
Year	Number Trips	PSE	Number Trips	PSE	Number Trips	PSE	Nominal Value	Inflation Adjusted	Unemployment Rate
2000	668,090	17.1	1,230,348	10.8	132,355	15.2	$27.39	$35.76	10.3
2001	659,246	11.4	1,274,847	7.4	137,096	15.5	$23.00	$29.23	11
2002	267,876	9.9	1,113,946	8.3	187,113	11.5	$22.81	$28.50	12.2
2003	29,560	18.2	958,395	9	153,010	13.1	$27.69	$33.86	11.1
2004	36,661	16.4	928,990	11.3	121,308	14.3	$37.66	$44.81	10.7
2005	90,314	20.5	751,893	8.9	114,830	13.8	$50.04	$57.57	11.4
2006	31,730	23.6	753,394	10.8	201,729	17.8	$58.30	$65.03	10.1
2007	377,148	14.5	955,007	9.5	125,089	18.1	$64.20	$69.51	11.1
2008	110,310	16.4	704,619	10	93,932	19.3	$91.48	$95.25	13.8
2009	168,688	13.9	564,655	10.3	71,496	20	$53.48	$55.96	15
2010	127,780	16.4	481,369	10.3	54,798	20.3	$71.21	$73.44	15.7

Table 3.9.9. Reported percentage composition of queen snapper commercial landings by gear category, 1983-2009. Shaded column denotes primary gear.

	GEAR						
	Cast Nets	***Diving Outfits, Other***	***Gill Nets, Other***	***Haul Seines, Long***	***Lines Hand, Other***	***Lines Long, Reef Fish***	***Lines Troll, Other***
YEAR	0.5				**76.6**		
1987							
1988		1.5	0.8		**88.2**		**9.0**
1989		0.2	0.4		**82.2**	**11.6**	**4.5**
1990		3.5			**90.7**	**1.6**	**0.4**
1991		1.2	0.3		**96.3**	**0.7**	**0.3**
1992	0.0	0.2	0.0		**88.2**		
1993	0.0		0.2	1.3	**86.3**		**0.6**
1994	0.1	0.5	0.1	0.2	**88.7**	**0.9**	**2.1**
1995	0.2	0.1			**92.2**	**0.3**	**1.1**
1996		1.2	1.6		**83.9**		**1.1**
1997	0.1	0.7	1.3	0.3	**89.4**	**5.0**	**0.7**
1998		1.2	0.3	2.0	**68.5**	**24.4**	**1.9**
1999	0.1	0.7			**80.7**	**15.6**	**0.9**
2000	0.1	0.4	0.1		**36.1**	**60.0**	**2.8**
2001	0.5	0.2	3.2	0.1	**77.4**	**10.1**	**5.8**
2002		5.9	0.3		**88.2**	**0.6**	**2.4**
2003			0.2	0.1	**96.8**	**0.5**	**1.6**
2004			0.1		**97.4**	**0.3**	**1.8**
2005			0.0	0.0	**79.7**	**0.0**	**20.1**
2006			0.0		**82.6**		**16.9**
2007	0.0		0.3		**96.4**	**0.2**	**2.6**
2008		2.0	0.5	0.1	**95.7**	**0.0**	**1.7**
2009		0.6	0.1		**94.7**	**0.0**	**4.4**
All	0.1	0.9	0.5	0.1	**85.3**	**5.9**	**5.3**

Table 3.9.9. (Continued). Reported percentage composition of queen snapper commercial landings by gear category, 1983-2009. Shaded column denotes primary gear.

	GEAR					All
	Pots And Traps, Fish	Pots And Traps, Spiny Lobster	Rod and Reel	Spears	Trammel Nets	
YEAR						
1987	22.9					100.0
1988	0.5			0.0		100.0
1989	1.1					100.0
1990	3.8					100.0
1991	1.3					100.0
1992	11.4				0.2	100.0
1993	10.0				1.6	100.0
1994	7.4					100.0
1995	6.0					100.0
1996	12.1				0.1	100.0
1997	2.5	0.1			0.1	100.0
1998	1.6		0.0			100.0
1999	2.1					100.0
2000	0.5		0.0			100.0
2001	2.7					100.0
2002	2.6				0.0	100.0
2003	0.8					100.0
2004	0.4					100.0
2005	0.1					100.0
2006	0.5					100.0
2007	0.4					100.0
2008	0.1					100.0
2009	0.0		0.1			100.0
All	1.9	0.0	0.0	0.0	0.0	100.0

Table 3.9.10. Number of length observations for queen snapper from the NMFS, TIP Program 1983-2011.

Island Location	Gear	Number of Observations
PUERTO RICO	HAND LINE	4,456
PUERTO RICO	LONG LINES	164
PUERTO RICO	GILL NETS	61
PUERTO RICO	POTS AND TRAP	49
PUERTO RICO	HOOK AND LINE	40
PUERTO RICO	NOT CODED	6
Puerto Rico	All Gears	4,776

Table 3.9.11. Estimated recreational AB1 and B2 Catch for queen snapper in Puerto Rico from 2000-2010. Units are number of fish.

Species	YEAR	Sum of ab1	Sum of b2	CV(AB1)	CV(B2)	Angler_Trips	B2/AB1B2
queen snapper	2000	5718.07	0.00	82.37	0.00		0.00
	2001	17488.75	0.00	47.40	0.00		0.00
	2002	9536.87	0.00	53.79	0.00		0.00
	2003	6587.37	0.00	37.49	0.00		0.00
	2004	2822.05	0.00	56.93	0.00		0.00
	2005	13346.68	0.00	62.49	0.00		0.00
	2006	557.25	0.00	100.20	0.00		0.00
	2007	6823.70	0.00	85.12	0.00		0.00
	2008	26611.18	0.00	47.67	0.00		0.00
	2009	2526.09	0.00	62.90	0.00		0.00
	2010	4008.12	0.00	79.44	0.00		0.00

Table 3.9.12. Estimated recreational AB1 catch (number of fish and weight in whole pounds) for the queen snapper in Puerto Rico 2 from the MRIP survey.

Species	YEAR	AB1 Numbers	AB1 Pounds (whole weight)
queen snapper	2000	5,718	66,703
	2001	17,489	17,637
	2002	9,537	96,045
	2003	6,587	40,317
	2004	2,822	3,081
	2005	13,347	21,932
	2006	557	2,106
	2007	6,824	14,950
	2008	26,611	82,467
	2009	2,526	6,313
	2010	4,008	15,148
queen snapper Total		96,026	366,699

Table 3.9.13. Percentage composition of parrotfish family landings by gear group.

	Gear							
YEAR	***Cast Nets***	***Combined Gears***	***Diving Outfits, Other***	***Gill Nets, Other***	***Haul Seines, Beach***	***Haul Seines, Long***	***Lines Hand, Other***	***Lines Long, Reef Fish***
1983			1.1	40.2		1.3	0.4	
1984	0.0		0.6	41.2		0.4	0.6	0.0
1985	0.0		0.7	34.5		1.6	1.6	0.0
1986			1.6	40.6		0.5	2.4	
1987	0.4		2.8	46.1		2.9	1.9	
1988		1.4	1.8	59.6		0.8	10.1	
1989			1.9	62.4		7.4	0.9	
1990			6.5	51.8		1.6	0.3	0.0
1991			4.0	39.9		0.9	2.3	0.0
1992			9.4	2.0		1.7	0.4	0.0
1993	0.0		3.1	28.9		0.4	1.3	0.0
1994			9.0	50.1	0.0	0.3	5.3	0.0
1995	0.0		9.6	18.3		2.3	7.1	0.1
1996	0.1		8.1	21.8		1.7	4.4	0.1
1997	0.1		15.4	23.4		1.3	3.1	0.0
1998	0.1		15.7	16.1		0.3	4.7	0.0
1999	0.4		21.9	23.4	0.1	0.1	4.8	0.0
2000	0.0		28.6	28.3		0.2	6.1	
2001	0.4		25.1	21.8		0.8	9.1	0.0
2002	0.1		20.2	18.0	0.2	1.2	4.8	
2003	0.0		11.7	14.1	0.0	15.5	2.4	0.0
2004			10.4	19.5		8.5	2.3	0.1
2005			7.1	16.4		3.5	4.6	0.0
2006			11.1	22.9		1.9	3.7	0.0
2007			31.1	9.5		0.7	7.2	0.0
2008			28.0	12.0		4.0	16.9	0.0
2009			29.2	7.0		1.9	24.7	
All	0.1	0.0	9.1	29.6	0.0	1.7	3.4	0.0

Table 3.9.13. (Continued) Percentage composition of parrotfish family landings by gear group.

	GEAR							All
	Lines Troll, Other	Pots And Traps, Crab, Other	Pots And Traps, Fish	Pots And Traps, Spiny Lobster	Rod and Reel	Spears	Trammel Nets	
YEAR 1983	0.0		57.0	0.0				100.0
1984	0.0		57.1	0.0		0.0		100.0
1985	0.2		61.3	0.0		0.0		100.0
1986	0.1		54.4			0.4		100.0
1987	0.0		45.7					100.0
1988	0.1		22.1	0.1		3.1	0.9	100.0
1989			23.3			3.4	0.8	100.0
1990			24.2				15.6	100.0
1991	0.0	0.5	13.9				38.5	100.0
1992	0.0		9.2	0.1			77.2	100.0
1993	0.1		5.9	0.0			60.3	100.0
1994	0.1		9.3				25.8	100.0
1995	0.1		20.6	0.0			41.9	100.0
1996	0.3		19.8	0.0			43.8	100.0
1997	0.0	0.1	19.6	0.0			36.8	100.0
1998	0.1		25.3				37.8	100.0
1999	0.3		25.1	0.1			23.9	100.0
2000	0.0		26.1		0.0		10.5	100.0
2001	0.6		23.5	0.0			18.7	100.0
2002	0.0		25.6				30.0	100.0
2003			27.3				28.9	100.0
2004			29.1				30.2	100.0
2005	0.0		40.3	0.5			27.7	100.0
2006	4.2		30.7	0.0			25.5	100.0
2007	3.8		27.9	0.1		0.0	19.8	100.0
2008	1.6		22.1		0.1		15.4	100.0
2009	3.7		23.2	1.5	0.1		8.8	100.0
All	0.3	0.0	33.4	0.0	0.0	0.0	22.2	100.0

Table 3.9.14. Number of length observations of redtail parrotfish by gear type and island, 1983-2011 from the NMFS, TIP Program.

Location	Gear	Number Length Observations
PUERTO RICO	**GILL NETS**	7242
PUERTO RICO	**POTS AND TRAP**	4180
PUERTO RICO	**BY HAND**	235
PUERTO RICO	**HAUL SEINES**	210
PUERTO RICO	**HAND LINE**	190
PUERTO RICO		32
PUERTO RICO	**HOOK AND LINE**	9
PUERTO RICO	**OTHER GEARS**	5
PUERTO RICO	**SPEARS AND GI**	1
Puerto Rico	**All gears**	12,104

Table 3.9.15. Estimated recreational AB1 and B2 (releases) catch for parrotfish family in Puerto Rico from 2000-2010.

Species	YEAR	Sum of ab1	Sum of b2	CV(AB1)	CV(B2)	Angler_Trips	B2/AB1B2
parrotfish family	2001	3260.73	862.89	46.43	100.00		0.21
	2002	1153.66	0.00	100.00	0.00		0.00
	2005	4274.26	5864.68	100.00	100.00		0.58
	2006	0.00	2706.27	0.00	77.00		1.00
	2007	3967.91	190.12	59.61	100.00		0.05
	2008	936.37	579.75	100.00	69.02		0.38
	2009	22303.56	242.50	47.94	100.00		0.01
	2010	6565.94	605.70	82.15	100.00		0.08

Table 3.9.16. Estimated recreational AB1 catch (number of fish and weight in whole pounds) for redtail parrotfish in Puerto Rico 2 from the MRIP survey.

family	Species	YEAR	AB1 Numbers	AB1 Pounds (whole weight)
	redtail parrotfish	2000	772	1,703
		2001	2,584	2,464
		2002	3,187	2,423
		2003	8,782	12,040
		2004	877	946
		2007	1,261	1,359
		2009	1,015	1,287

3.10 FIGURES

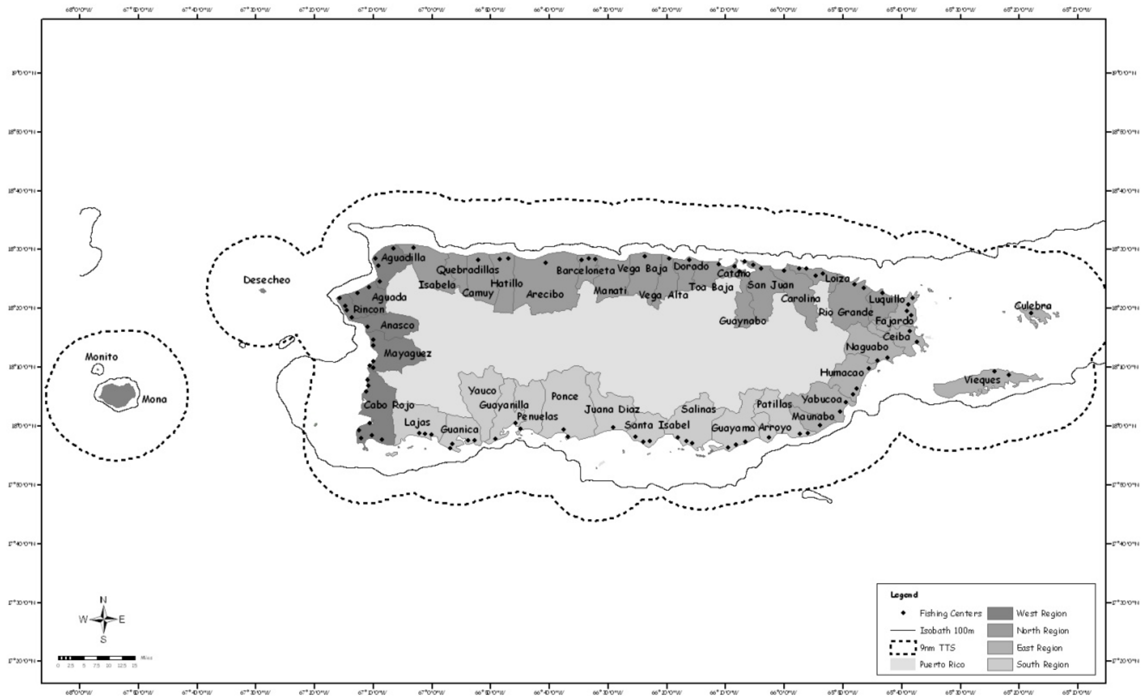


Figure 3.10.1. Map of general fishing zones around Puerto Rico and depiction of fishing centers.

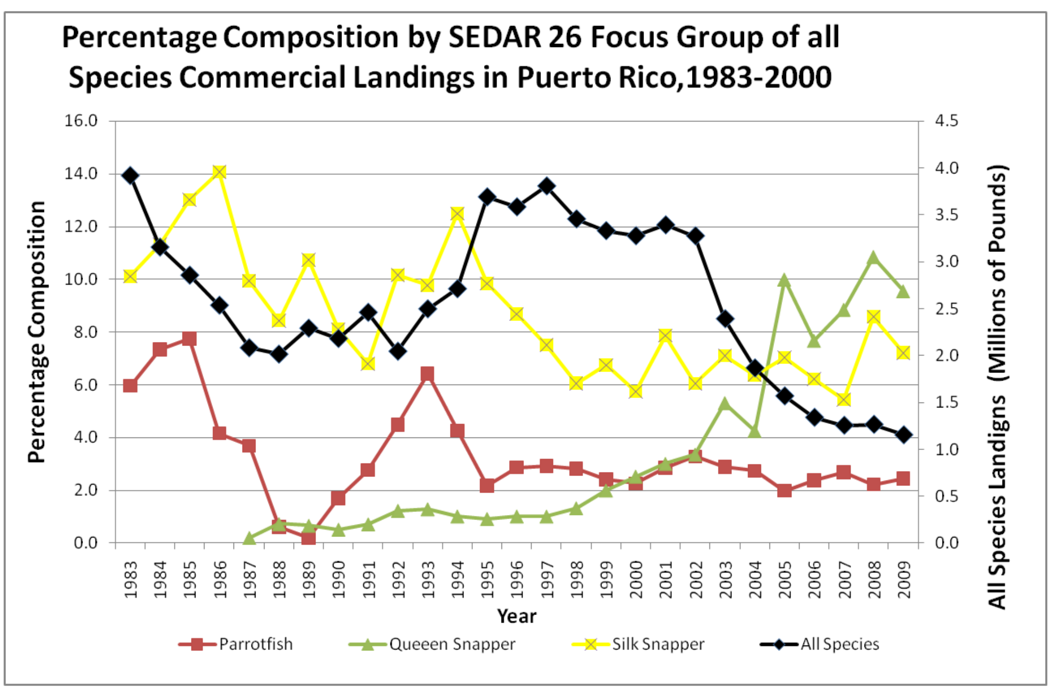


Figure 3.10.2. Percentage Composition of SEDAR 26 Focus Species (Silk and Queen Snapper and Parrotfish Family) of all Species commercial landings in Puerto Rico from 1983-2009.

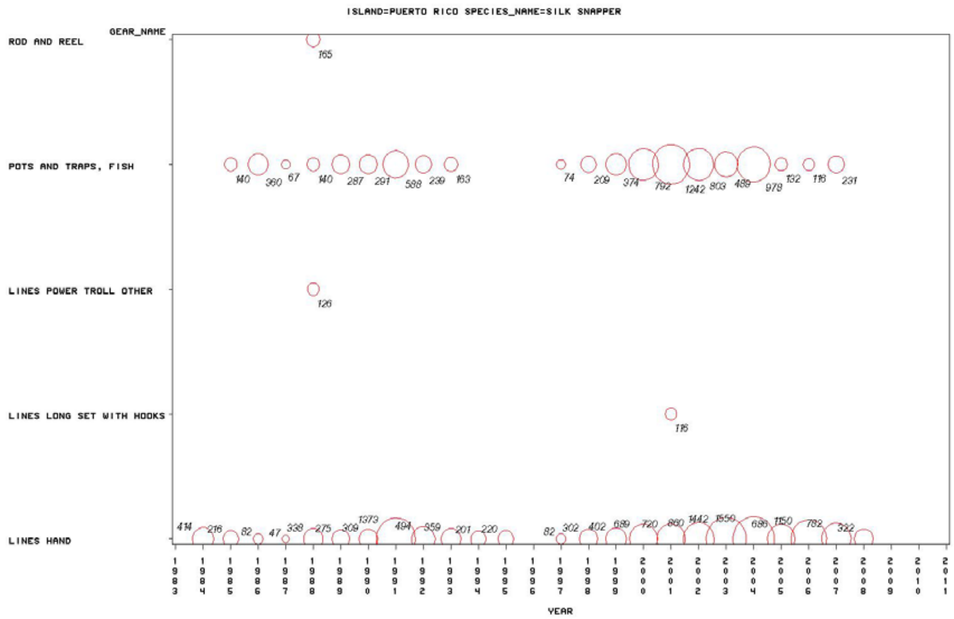


Figure 3.10.3. Number of silk snapper sampled fish by specific gear type from Puerto Rico, 1983-2011. The y-axis is average size (mm) and the x-axis is year.

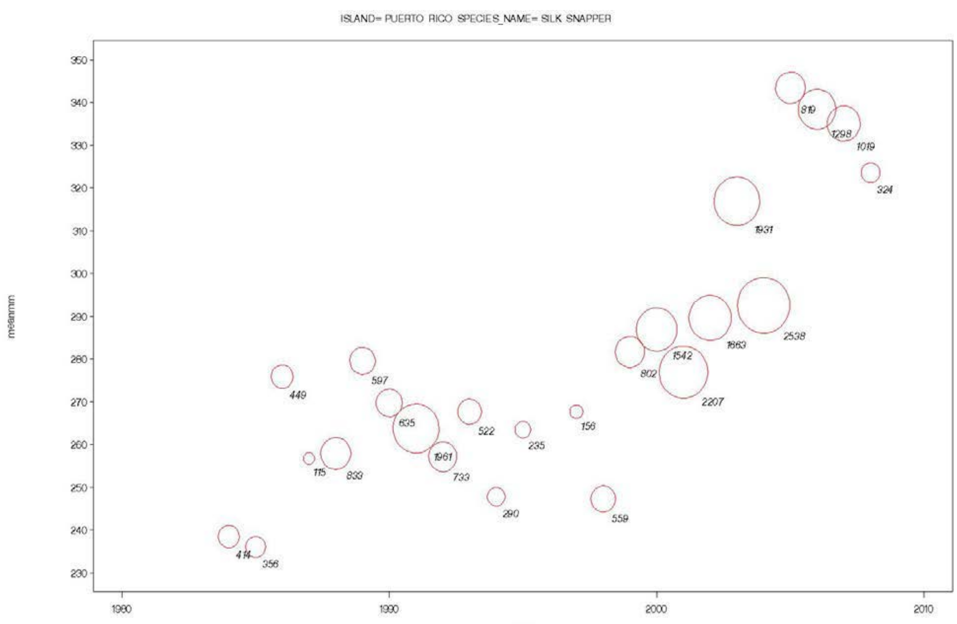


Figure 3.10.4. Silk snapper mean lengths and sample sizes from Puerto Rico, 1983-2011.

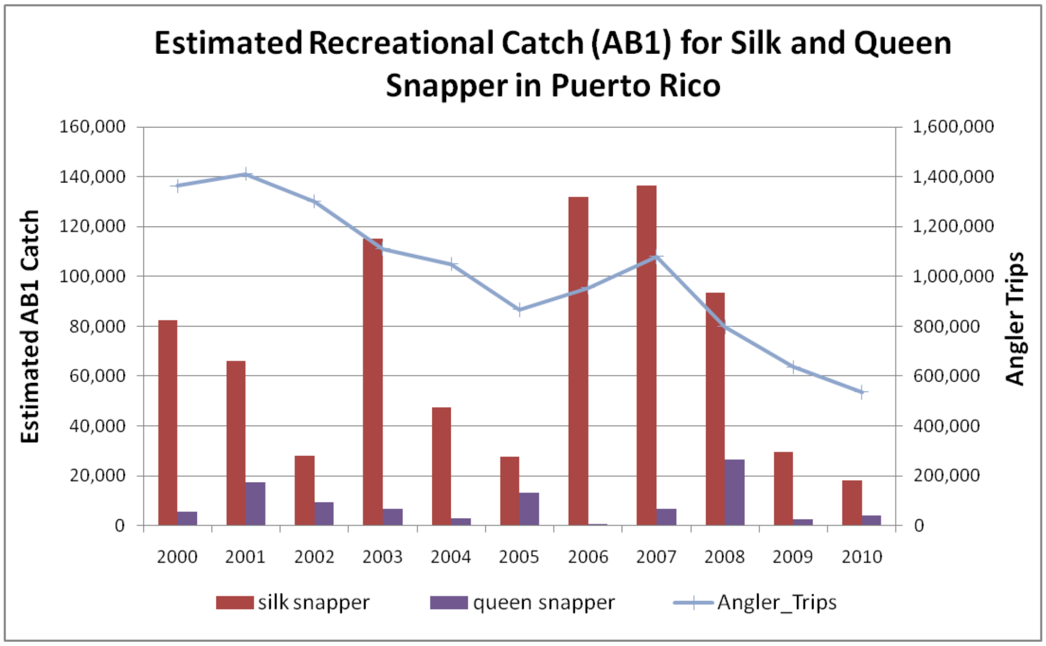


Figure 3.10.5. Estimated AB1 catch for silk and queen snapper and estimated number of recreational angler trips in Puerto Rico, 2000-2010. Units are numbers of fish. Source =MRIP survey.

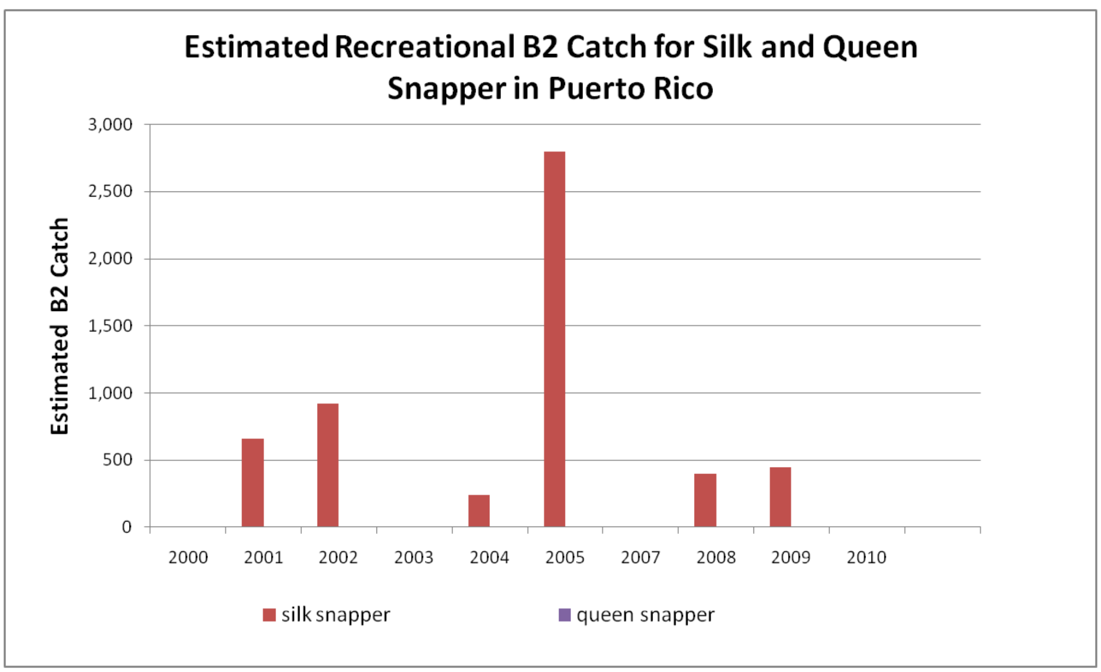


Figure 3.10.6. Estimated B2 catch by year for silk and queen snapper in Puerto Rico from 2000-2010 from the MRFSS survey. Units are numbers of fish. Source =MRIP survey. Queen snapper B2 catch was zero.

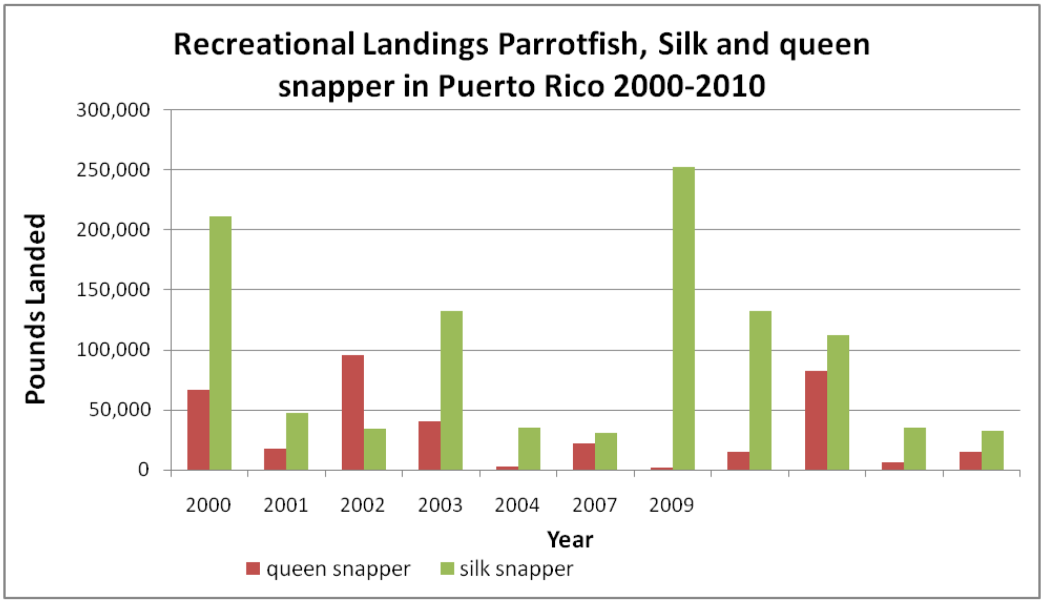


Figure 3.10.7. Estimated landings (AB1 catch in weight) silk and queen snapper in Puerto Rico from 2000-2010 from the MRFSS survey. Units are pounds whole weight. Source =MRIP survey

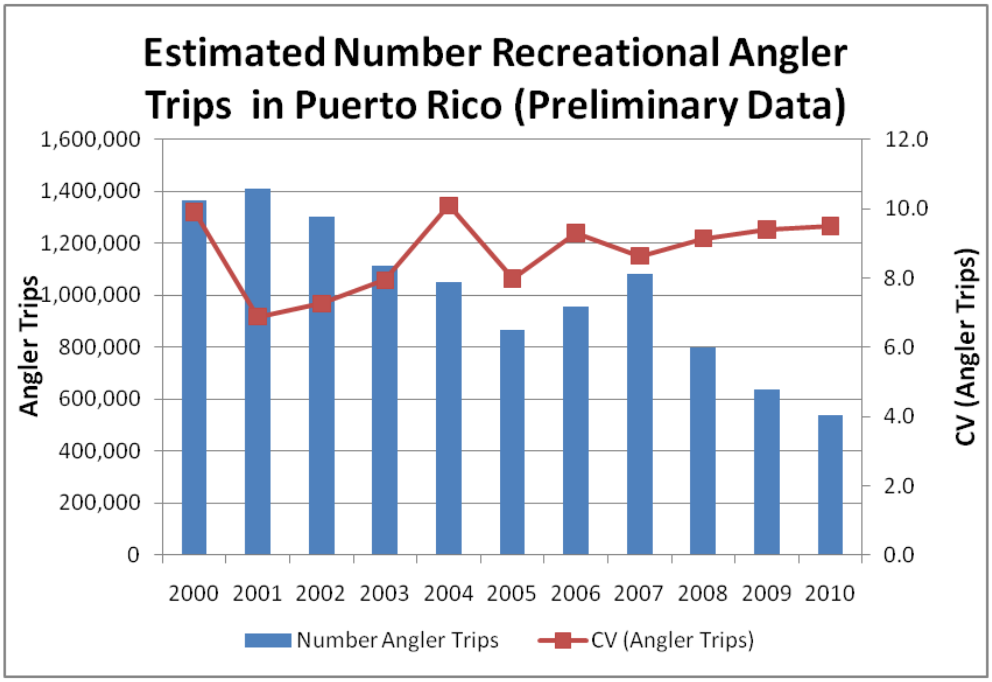


Figure 3.10.8. Profile of estimated number recreational angler trips in Puerto Rico 2000-2010. Source =MRIP survey

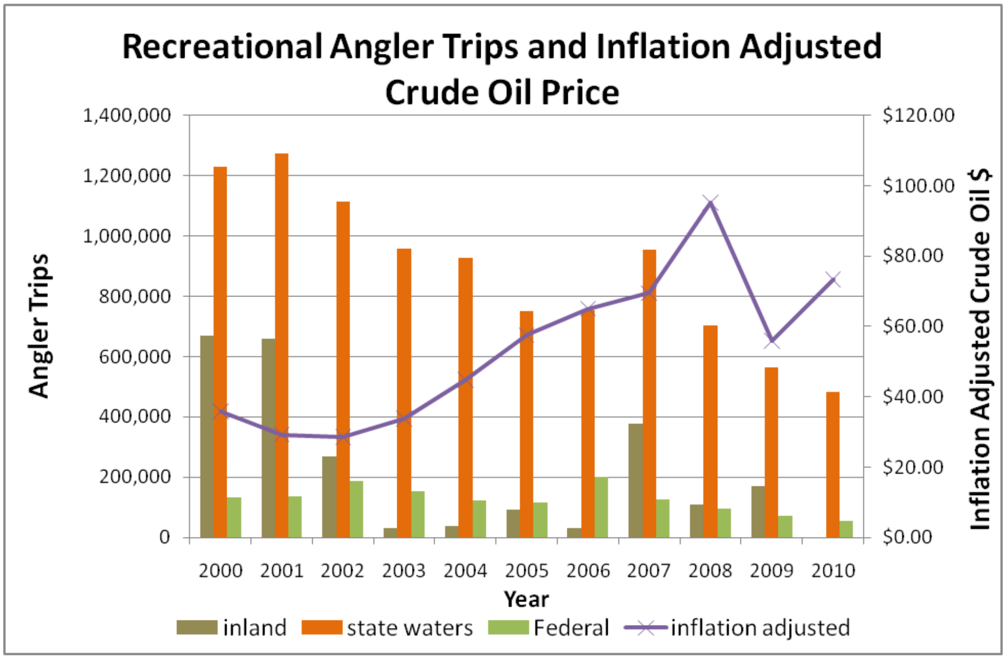


Figure 3.10.9. Estimated angler trips by area and adjusted crude oil price in U.S. Dollars.

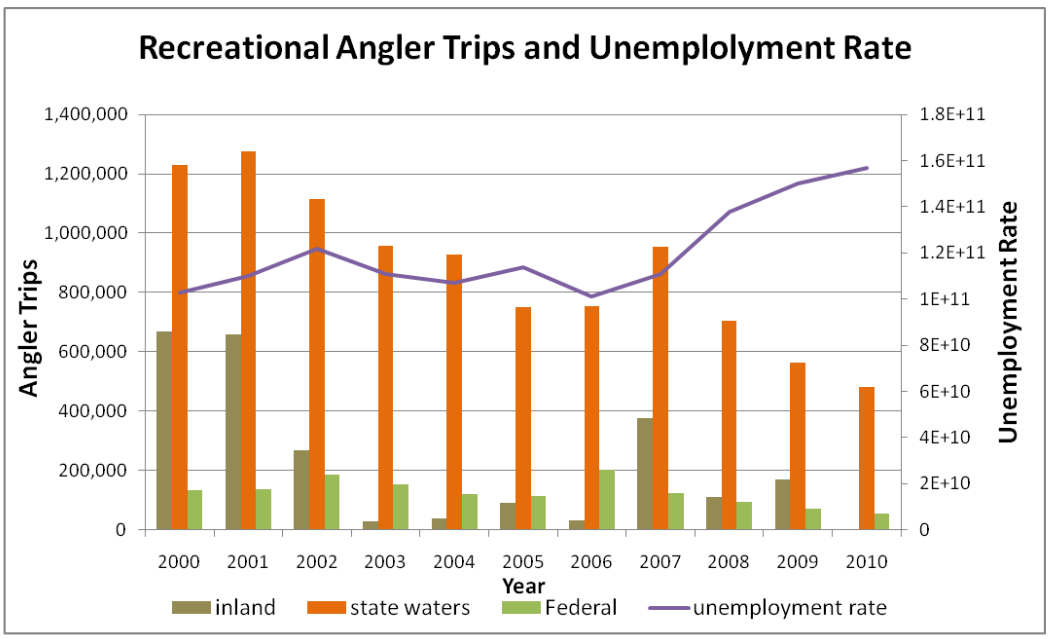


Figure 3.10.10. Estimated angler trips by area and unemployment .

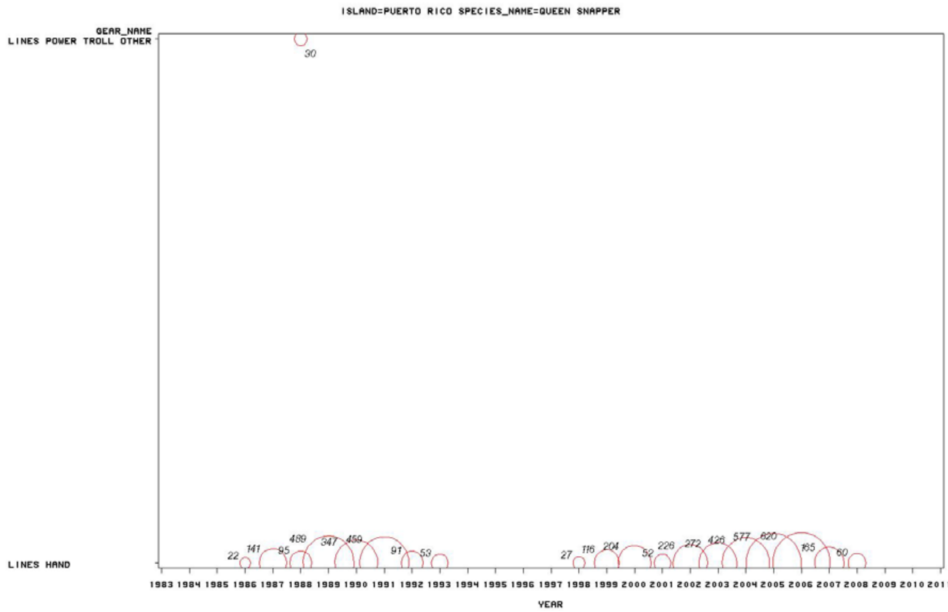


Figure 3.10.11. Queen snapper number of sampled fish by specific gear type from Puerto Rico, 1983-2011.

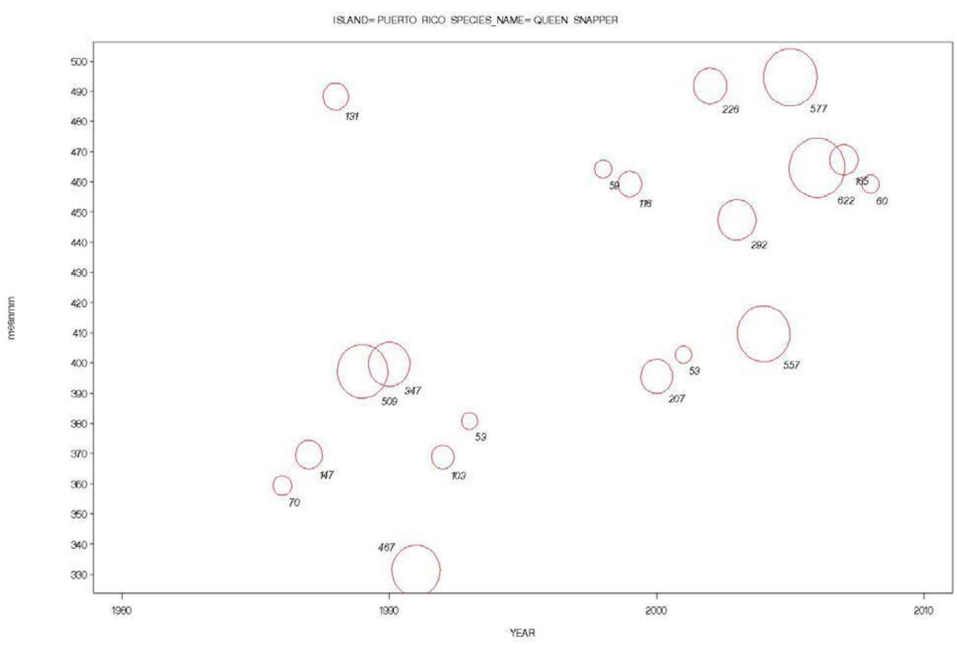


Figure 3.10.12. Queen snapper mean lengths and sample sizes from Puerto Rico, 1983-2011.

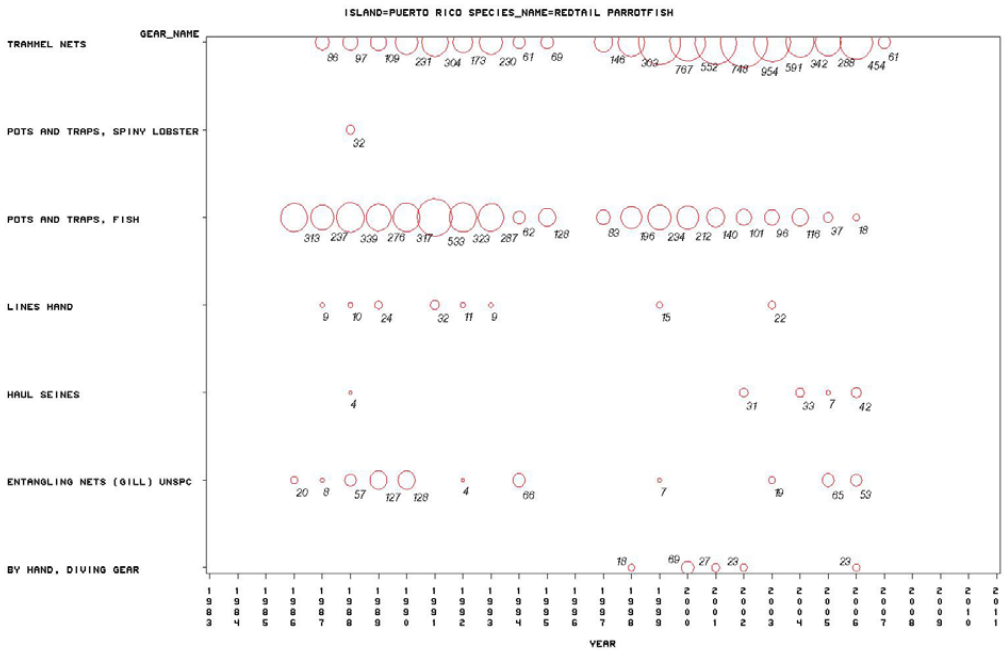


Figure 3.10.13. Redtail Parrotfish number of sampled fish by specific gear type from Puerto Rico, 1983-2011.

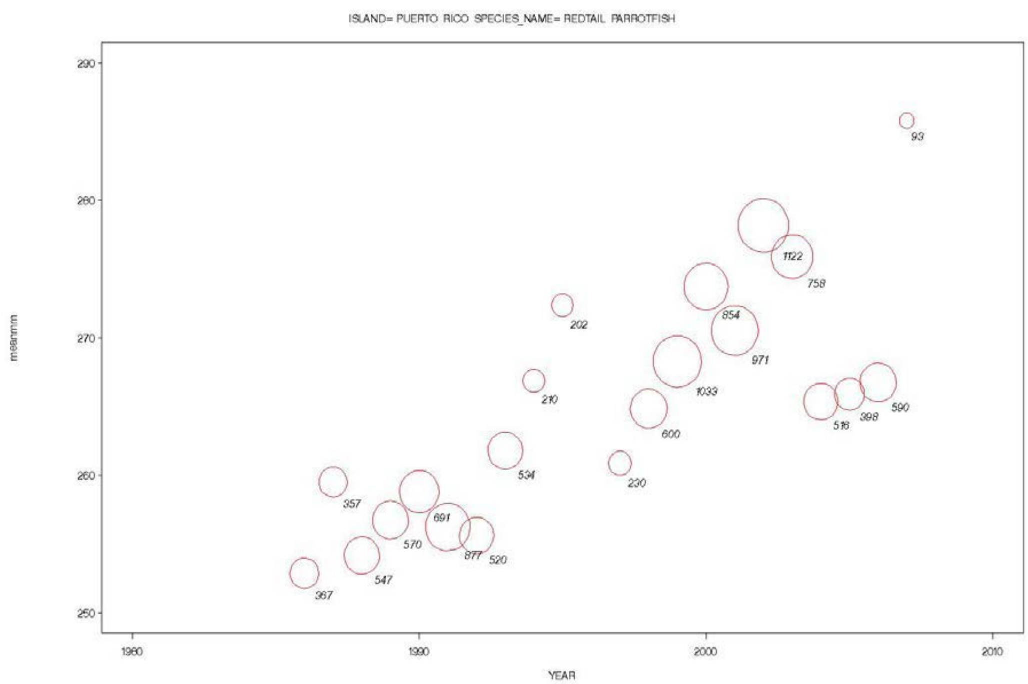


Figure 3.10.14. Redtail parrotfish mean lengths and sample sizes from Puerto Rico, 1983-2011.

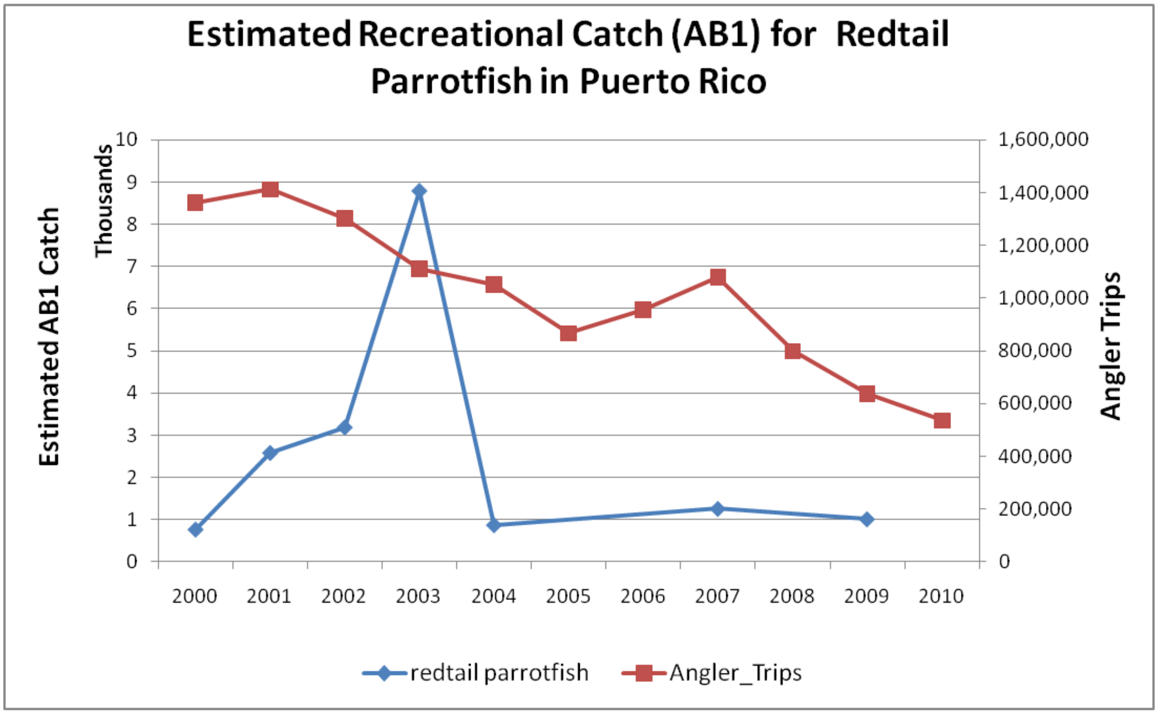


Figure 3.10.15. Estimated B2 catch by year for redtail parrotfish in Puerto Rico from 2000-2010 from the MRFSS survey. Units are numbers of fish. Source =MRIP survey

4. US VIRGIN ISLANDS FISHERY STATISTICS

4.1. OVERVIEW

The Working Group included Tom Daley, Patricia Skov, Jens Skov and William Tobias from St. Croix; Gerson Martinez from Puerto Rico; Walter Keithly from Louisiana State University; Jed Brown and Juan Cruz from the Virgin Islands DPNR Department of Fish and Wildlife; Graciela Garcia-Moliner from the Caribbean Fishery Management Council; and Todd Gedamke and Kevin McCarthy from the NOAA Fisheries Service in Miami. The group was later joined by Walter Ingram from the NOAA Fisheries Service in Pascagoula Mississippi. Kevin McCarthy was the group leader.

Issues included availability of expansion factors for landings, proper methods for developing expansion factors, and length of the landings time series. In addition, for the Trip Interview Program (TIP) data questions revolved around reporting of gears used in the fishery; specifically which gears were likely to have similar selectivities and for which cases to exclude trips which reported the use of multiple gears.

US Virgin Island fishing areas are shown in Figure 4.8.0.

4.2. SNAPPER COMMERCIAL FISHEY STATISTICS

4.2.1. Review of Working Papers

Two working papers relevant to the US Virgin Islands Fisheries Statistics working group were produced for the data workshop: SEDAR26-DW04 and SEDAR26-DW08. SEDAR26-DW04 provided a preliminary evaluation of Trip Interview Program length-frequency data. SEDAR26-DW08 provided landings of snappers in the US Virgin Islands during the period 1974-2008.

SEDAR26-DW-04: Preliminary Evaluation of available length-frequency information in the US Caribbean Trip Interview Program (TIP) data

Matthew Campbell, Todd Gedamke, Walter Ingram

Available length-frequency data from the Trip Interview Program (TIP) were summarized in tabular and visual formats in working document DW04. The intent was to present to the working group and reach decisions regarding the inclusion or exclusion of data prior to analyses. Some biostatistical data were available beginning in 1979 in the USVI when sporadic records, primarily on lobster, started to be recorded in St. Thomas and St. John. In 1983 the TIP program was established and interviews appear to have been performed regularly on St. Croix with a relatively high number of records. In the mid-1990's the number of records became variable in both St. Croix and St. Thomas/St. John. Data were excluded that could not be attributed to a single gear type or were suspect due to the relationship between length and recorded weight.

Between 1983 and 2011, the TIP data set has 35,095 records of silk and queen snapper. Due to either being landed on trips with multiple gears reported or not meeting length-weight criteria (outliers), another 3,497 snapper records were excluded from the analysis. Observations of these snapper species from the USVI were dominated by silk snapper (74%) and followed by queen snapper (26%). Of the two snapper species of interest, silk snapper was the most commonly reported species in St. Thomas – St. John (2%). In St. Croix queen snapper comprised just over half (54%) of these two measured species.

SEDAR26-DW-08: Reported commercial landings of parrotfish, snappers, groupers, and unclassified finfish in the United States Virgin Islands, 1974-2008

Kevin J. McCarthy

In the US Virgin Islands, commercial landings records are available from self-reported fisher logbook reports (i.e., commercial catch records, CCRs, collected through the US Virgin Islands Department of Planning and Natural Resources, Department of Fisheries and Wildlife) beginning in 1974. Logbook landings data from the islands of St. Thomas and St. John have been compiled separately from St. Croix landings during prior stock assessments. Finfish landings were reported by gear type (e.g., net fish, hook fish, pot fish, and spear fish) and as either snapper/grouper or as other fin fish during the period 1974-1995. Beginning in 1996 (St. Croix) and 1997 (St. Thomas/St. John) landings were reported by species group; (e.g., snappers, groupers, parrotfishes, surgeonfishes, etc.) and by gear (hook and line, gill net, SCUBA, trap, etc.).

Landings from commercial fishing vessels have been underreported in the US Virgin Islands. Expansions factors have been used to adjust the reported landings for non-reporting fishers and for fishers who reported landings for only part of a year. The complete time series of expansion factors were not available prior to the beginning of the SEDAR26 data workshop, therefore, no adjustment to the reported landings could be completed for the data workshop.

For the SEDAR 26 data workshop, available data for summing commercial landings of red tail parrotfish, queen and silk snapper were the self-reported logbook data from commercial fishers. Landings for the islands of St. Thomas and St. John were summed separately from St. Croix landings. Landings for the period 1996-2008 could only be provided as parrotfish (all species combined) and snappers (all species combined) due to the non-species specific reporting by commercial fishers in the US Virgin Islands. Landings prior to 1996 were provided as snapper/grouper and not snapper/grouper. Data were complete through 2008; 2009 data include only data from January-June. No data from 2010 had been provided prior to the data workshop. Yearly landings data, as reported, were summed by species group and fishing gear.

4.2.2. Commercial Landings

Commercial landings have been reported by species group (e.g., snapper, grouper, parrotfish) since 1998 for both St. Thomas/St. John and St. Croix. Prior to 1995, commercial landings were reported by either species group (e.g. snapper/grouper, not snapper/grouper) or by gear fished (e.g., pot fish). During the period 1995-1997, data reporting included gear fished, older species group designations (e.g., “not snapper/grouper), and the current species group designations (e.g., snapper, parrotfish).

Yearly commercial landings were summarized separately for St. Croix and St. Thomas/St. John in SEDAR document SEDAR26 DW08. As noted in earlier SEDARs (e.g., SEDAR Technical Procedures III, Caribbean Data Evaluation Workshop), landings have been underreported in the US Virgin Islands. Underreporting is due to partial reporting by individual fishermen (e.g., reporting landings during some, but not all, months), non-reporting by a portion of fishers in the fishery, and erroneous (underestimate) reports of landings. Expansion factors are needed to correct for the known underreporting. Methods for correcting US Virgin Islands landings were recommended in the SEDAR Technical Procedures III, Caribbean Data Evaluation Workshop Report. The complete time series of expansion factors was not available for use at the SEDAR 26 data workshop, therefore, only reported landings were used in the yearly landings summaries.

Landings, as reported and with no expansion factors applied, are provided in Tables 4.7.1 (St. Croix) and 4.7.2 (St. Thomas/St. John). “Calculated snapper” were determined by applying the mean proportion of snapper (weighted by the number of trips per year) during the years 1995-2008 to the “snapper-grouper” landings during 1975-1993. This approach was not recommended by the working group.

Yearly landings (1995-2008) of snappers by gear for each island are shown in Figures 4.8.1 and 4.8.2. Landings were predominantly reported from line fishing in St. Croix. St. Thomas/St. John snapper landings were reported from three predominant gears: line fishing, traps, and seine nets.

The working group recommended that the time series of landings be limited to the period 1998-2008. That period included only those landings reported to species group (snapper, grouper, parrotfish, etc.). The final complete year of landings data available at the data workshop was for 2008.

4.2.3. Commercial Discards

No comprehensive data set of commercial discards are available for the US Virgin Islands. A pilot study conducted in St. Thomas (St. Thomas Fisherman’s Association, Study of By Catch from Fishing Operations, 2008) was reviewed. Neither silk nor queen snapper bycatch were included in the report. Given the limited spatial and temporal extent of that work, the working group was not confident that the data are representative of the fishery as a whole. A second bycatch study conducted during October 2004-February 2006 in St. Croix (MRAG Americas, Final Report 2006) also reported no silk or queen snapper classified as bycatch. Sample size (number of trips) was limited, however. Further bycatch/discard studies are critical to future assessments.

4.2.4. Commercial Effort

Total commercial effort is known to be underreported in the US Virgin Islands (SEDAR Technical Procedures III, Caribbean Data Evaluation Workshop, 2009). Yearly total reported commercial fishing trips (1995-2008) are provided in Table 4.7.3. During this period landings were reported by species group (e.g., snapper, parrotfish, grouper, etc.), although during 1995-1998 some landings were reported by the older species groups (e.g., snapper-grouper, fish not snapper-grouper). More trips were reported from St. Croix than from St. Thomas/St. John, although the degree of underreporting may differ between islands. Estimates of total effort could not be completed at the time of the data workshop.

4.2.5. Biological Sampling

Biological sampling of US Virgin Islands commercial fisheries has only been consistently conducted through the Trip Interview Program (TIP). TIP data is available beginning in 1979 in the USVI when sporadic records began to be recorded in St. Thomas and St. John. By 1983-1984, interviews appear to have been conducted regularly on St. Croix with a relatively high number of records. In the mid-1990’s the number of record began to decrease in both St. Croix and St. Thomas/St. John and have remained at relatively low levels. For each interview, basic information on catch and effort (e.g., species-specific landed weight, hours fished, etc.) was recorded in addition to some biological information from a sub-sample of the catch. Number of sampled silk and queen snapper, by species and island, are provided in Table 4.7.4. Number of sampled fish by gear and island are provided in Tables 4.7.5 (silk snapper) and 4.7.6 (queen snapper). TIP sample sizes of silk snapper by gear type in St. Croix are shown in Figure 4.8.3. St. Thomas/St. John TIP sample sizes of silk snapper are shown in Figure 4.8.4. Queen snapper TIP sample sizes in St. Croix are provided in Figure 4.8.5. Confidentiality restrictions prevent presentation of St. Thomas/St. John TIP queen snapper sample sizes.

4.2.5.1 Sampling Intensity Length/Age/Weight

This analysis is not a critical component of the stock assessment, given the available information. This analysis was incomplete at the time of the data workshop, but results will facilitate the interpretation of the assessment and will be provided prior to the assessment workshop.

4.2.5.2. Length/Age distributions

Prior to the workshop basic summaries of length-frequency distributions by island and gear type were generated from the Trip Interview Program (TIP). The primary objective of the data workshop was to consult with USVI fisheries managers and fishers to more completely understand how gear types were reported and how this might affect the size composition of the catch. It was suggested that the specific gear types recorded in the data base be collapsed into four broader gear categories, which were defined according to similarities in selectivity. The following will describe the gear category grouping. Gear categories reflect similarities in gear selectivity. The suggested gear categories to be used for the up-coming assessment include: nets, pots and traps, hook and line, and divers/spear/by hand. The net category represents the following gear types: gill nets, purse seines, haul seines, fixed nets, and dip nets. The pots and traps category is self-defined. Three gear types, hook and line, long lines, and hand lines, make up the hook and line gear category. Lastly, the divers/spear/by hand category represents fishing activities that include diving, spear-fishing, or some combination thereof. Silk snapper yearly mean lengths (with sample size) are shown in Figures 4.8.6 (St. Croix) and 4.8.7 (St. Thomas/St. John). St. Croix queen snapper yearly mean lengths are shown in Figure 4.8.8. Confidentiality restrictions prevent presentation of St. Thomas/St. John TIP queen snapper data.

Ongoing analyses include the evaluation of annual length frequency distributions to determine the size at which each species become fully vulnerable to the four broad gear categories. Those analyses will be followed by an analysis of mean length to determine mortality rates for each species.

4.2.5.3. Adequacy for characterizing catch

Available information does not allow for the characterization of catch at the species level in the USVI. This issue has been examined and discussed thoroughly in pervious SEDARs, most recently at the SEDAR Data Evaluation Workshop (SEDAR Technical Procedures III, Caribbean Data Evaluation Workshop Final Report).

4.2.5.4. Alternatives for characterizing discard length/age

There are no accepted alternatives, nor are there adequate data for an alternative approach to characterizing discard length/age. For example, a bycatch study conducted during October 2004-February 2006 (MRAG Americas, 2006) observed no silk or queen snapper classified as bycatch.

4.2.6. Commercial Catch-at-Age/Length; directed and discard

Other than the TIP data described in section 4.2.5.2, no commercial catch-at-age data are available in the US Virgin Islands.

4.2.7. Comments on adequacy of data for assessment analyses

For the assessment in the USVI two primary data sources are available: commercial self-reported landing/effort (CCR) and TIP dockside port sampling of commercial landings. One critical limitation of the CCR data is that reported commercial landings may not be reflective of total commercial removals. In addition, these data have been reported at a family group level which precludes the use of species-specific classic quantitative assessment models. Inadequate TIP dockside sampling data exists to partition the aggregate landings by species (SEDAR Technical Procedures III, Caribbean Data Evaluation Workshop Final Report).

For both silk and queen snapper in the USVI, the sample sizes of the available TIP length-frequency data are limited and a time series analyses are not possible (Figures 4.8.3-4.8.5). In addition, landings have been reported as “snapper” and since silk and queen snapper comprise a small portion the “snapper” landings, it is unlikely that a catch per unit effort analysis can be conducted for either species. Some comparison of length-frequencies from samples collected in the 1980’s to those collected in the last 10 years may give insights as to changes in fishing pressure.

4.3. SNAPPER RECREATIONAL FISHERY STATISTICS

4.3.1. Review of Working Papers

None prepared

4.3.2. Recreational Landings

Unknown, unreported – no MRFSS in USVI

4.3.3. Recreational Discards

Unknown, unreported – no MRFSS in USVI

4.3.4. Recreational Effort

Unknown, unreported – no MRFSS in USVI

4.3.5. Biological Sampling

No consistent, comprehensive sampling of the recreational fishery has occurred in the US Virgin Islands.

4.3.5.1. Sampling Intensity Length/Age/Weight

No consistent, comprehensive sampling of the recreational fishery has occurred in the US Virgin Islands.

4.3.5.2. Length/Age distributions

None presented at the data workshop.

4.3.5.3. Adequacy for characterizing catch

Recreational catch in the US Virgin Islands cannot be characterized by species.

4.3.5.4. Alternatives for characterizing discard length/age

There are no accepted alternatives, nor are there any data for an alternative approach to characterizing discard length/age.

4.3.6. Recreational Catch-at-Age/Length; directed and discard

No recreational catch-at-age/length data were presented at the data workshop.

4.3.7. Comments on adequacy of data for assessment analyses

No recreational US Virgin Islands data have been presented for use in the assessment.

4.4. PARROTFISH COMMERCIAL FISHERY STATISTICS

4.4.1. Review of Working Papers

Two working papers relevant to the US Virgin Islands Fisheries Statistics working group were produced for the data workshop: SEDAR26-DW04 and SEDAR26-DW08. SEDAR26-DW04 provided a preliminary evaluation of Trip Interview Program length-frequency data. SEDAR26-DW08 provided landings of parrotfish in the US Virgin Islands during the period 1974-2008.

SEDAR26-DW-04: Preliminary Evaluation of available length-frequency information in the US Caribbean Trip Interview Program (TIP) data

Matthew Campbell, Todd Gedamke, Walter Ingram

Available length-frequency data from the Trip Interview Program (TIP) were summarized in tabular and visual formats in working document DW04. The intent was to present to the working group and reach decisions regarding the inclusion or exclusion of data prior to analyses. Some biostatistical data were available beginning in 1979 in the USVI when sporadic records, primarily on lobster, started to be recorded in St. Thomas and St. John. In 1983 the TIP program was established and interviews appear to have been performed regularly on St. Croix with a relatively high number of records. In the mid-1990's the number of records became variable in both St. Croix and St. Thomas/St. John. Data were excluded that could not be attributed to a single gear type or were suspect due to the relationship between length and recorded weight.

Although redtail parrotfish is the only species listed for this SEDAR 26 data evaluation workshop, SEFSC scientists have developed multi-species models particularly for use in data-poor situations so data from a number of parrotfish species are presented

Between 1983 and 2011, the TIP data set contains 98,829 records for 9 species of parrotfish and one aggregated parrotfish category. Due to either being landed on multiple-gear trips or not meeting length-weight criteria (outliers) another 24,954 parrotfish records were removed from the analysis. Parrotfish observations from the USVI and Puerto Rico were dominated by redtail parrotfish (44%), stoplight parrotfish (37%), redband parrotfish (7.5%), and princess parrotfish (4.1%). The majority of the parrotfish samples were from St. Croix (65%), followed by Puerto Rico (31%), and St Thomas/ St. John (3.5%). Dominance of parrotfish varied by island sampled, but in general followed the overall trend in which observations were primarily redtail and stoplight parrotfish. Of the four dominant species of parrotfish the vast majority of the individuals were captured using either a type of gill net or fish pots/traps.

SEDAR26-DW-08: Reported commercial landings of parrotfish, snappers, groupers, and unclassified finfish in the United States Virgin Islands, 1974-2008

Kevin J. McCarthy

In the US Virgin Islands, commercial landings records are available from self-reported fisher logbook reports (i.e., commercial catch records, CCRs, collected through the US Virgin Islands Department of Planning and Natural Resources, Department of Fisheries and Wildlife) beginning in 1974. Logbook landings data from the islands of St. Thomas and St. John have been compiled separately from St. Croix landings during prior stock assessments. Finfish landings were reported by gear type (e.g., net fish, hook fish, pot fish, and spear fish) and as either snapper/grouper or as other fin fish during the period 1974-1995. Beginning in 1996 (St. Croix) and 1997 (St. Thomas/St. John) landings were reported by species group; (e.g., snappers, groupers, parrotfishes, surgeonfishes, etc.) and by gear (hook and line, gill net, SCUBA, trap, etc.).

Landings from commercial fishing vessels have been underreported in the US Virgin Islands. Expansions factors have been used to adjust the reported landings for non-reporting fishers and for fishers who reported landings for only part of a year. The complete time series of expansion factors were not available prior to the beginning of the SEDAR26 data workshop, therefore, no adjustment to the reported landings could be completed for the data workshop.

For the SEDAR 26 data workshop, available data for summing commercial landings of red tail parrotfish, queen and silk snapper were the self-reported logbook data from commercial fishers. Landings for the islands of St. Thomas and St. John were summed separately from St. Croix landings. Landings for the period 1996-2008 could only be provided as parrotfish (all species combined) and snappers (all species combined) due to the non-species specific reporting by commercial fishers in the US Virgin Islands. Landings prior to 1996 were provided as snapper/grouper and not snapper/grouper. Data were complete through 2008; 2009 data include only data from January-June. No data from 2010 had been provided prior to the data workshop. Yearly landings data, as reported, were summed by species group and fishing gear.

4.4.2. Commercial Landings

Commercial landings have been reported by species group (e.g., snapper, grouper, parrotfish) since 1998 for both St. Thomas/St. John and St. Croix. Prior to 1995, commercial landings were reported by either species group (e.g. snapper/grouper, not snapper/grouper) or by gear fished (e.g., pot fish). During the period 1995-1997, data reporting included gear fished, older species group designations (e.g., “not snapper/grouper), and the current species group designations (e.g., snapper, parrotfish).

Yearly commercial landings were summarized separately for St. Croix and St. Thomas/St. John in SEDAR document SEDAR26 DW08. As noted in earlier SEDARs (e.g., SEDAR Technical Procedures III, Caribbean Data Evaluation Workshop), landings have been underreported in the US Virgin Islands. Underreporting is due to partial reporting by individual fishermen (e.g., reporting landings during some, but not all, months), non-reporting by a portion of fishers in the fishery, and erroneous (underestimate) reports of landings. Expansion factors are needed to correct for the known underreporting. Methods for correcting US Virgin Islands landings were recommended in the SEDAR Technical Procedures III, Caribbean Data Evaluation Workshop Report. The complete time series of expansion factors was not available for use at the SEDAR 26 data workshop, therefore, only reported landings were used in the yearly landings summaries.

Landings, as reported and with no expansion factors applied, are provided in Tables 4.7.1 (St. Croix) and 4.7.2 (St. Thomas/St. John). Prior to 1995 parrotfish were not reported as a separate category of commercial landings. “Fish not snapper-grouper” were included as a proxy for parrotfish for the years 1974-1993, however, the proportion of parrotfish in the “fish not snapper-grouper” is unknown and the utility of that species category is suspect.

Yearly landings (1995-2008) of parrotfish by gear for each island are shown in Figures 4.8.9 and 4.8.10. Landings were predominantly reported from SCUBA and gillnet in St. Croix prior to 2007. In 2007-08, however, the number of reported free diving landings increased such that free diving reported landings were greater than landings reported from any other gear. Further investigation by Virgin Islands DPNR

Department of Fish and Wildlife personnel during the data workshop identified those free diving trips as SCUBA trips. DPNR Department of Fish and Wildlife recommended that free diving trips/landings be combined with SCUBA trips/landings. Nearly all St. Thomas/St. John parrotfish landings were reported from traps. Yearly parrotfish landings in St. Thomas/St. John were less than 20% of the St. Croix landings.

The working group recommended that the time series of landings be limited to the period 1998-2008. That period included only those landings reported to species group (snapper, grouper, parrotfish, etc.). The final complete year of landings data available at the data workshop was for 2008.

4.4.3. Commercial Discards

No comprehensive data set of commercial discards are available for the US Virgin Islands. A pilot study conducted in St. Thomas (St. Thomas Fisherman's Association, Study of By Catch from Fishing Operations, 2008) was reviewed. Redtail parrotfish bycatch were not reported in the study. Given the limited spatial and temporal extent of that work, the working group was not confident that the data are representative of the fishery as a whole. A second bycatch study conducted during October 2004-February 2006 in St. Croix (MRAG Americas, Final Report 2006) observed only six redtail parrotfish classified as bycatch. Sample size (number of trips) was limited, however. Further bycatch/discard studies are critical to future assessments.

4.4.4. Commercial Effort

Total commercial effort is known to be underreported in the US Virgin Islands (SEDAR Technical Procedures III, Caribbean Data Evaluation Workshop, 2009). Yearly total reported commercial fishing trips (1995-2008) are provided in Table 4.7.3. During this period landings were reported by species group (e.g., snapper, parrotfish, grouper, etc.), although during 1995-1998 some landings were reported by the older species groups (e.g., snapper-grouper, fish not snapper-grouper). More trips were reported from St. Croix than from St. Thomas/St. John, although the degree of underreporting may differ between islands. Estimates of total effort could not be completed at the time of the data workshop.

4.4.5. Biological Sampling

Biological sampling of US Virgin Islands commercial fisheries has only been consistently conducted through the Trip Interview Program (TIP). TIP data is available beginning in 1979 in the USVI when sporadic records began to be recorded in St. Thomas and St. John. By 1983-1984, interviews appear to have been conducted regularly on St. Croix with a relatively high number of records. In the mid-1990's the number of record began to decrease in both St. Croix and St. Thomas/St. John and have remained at relatively low levels. For each interview, basic information on catch and effort (e.g., species-specific landed weight, hours fished, etc.) was recorded in addition to some biological information from a sub-sample of the catch. Number of sampled parrotfish by species and island are provided in Table 4.7.7. Sampled redtail parrotfish by gear and island are provided in Table 4.7.8. TIP sample sizes of redtail parrotfish by gear type in St. Croix are shown in Figure 4.8.11. St. Thomas/St. John TIP sample sizes of redtail parrotfish are shown in Figure 4.8.12.

4.4.5.1. Sampling Intensity Length/Age/Weight

This analysis is not a critical component of the stock assessment, given the available information. This analysis was incomplete at the time of the data workshop, but results will facilitate the interpretation of the assessment and will be provided prior to the assessment workshop.

4.4.5.2. Length/Age distributions

Prior to the workshop basic summaries of length-frequency distributions by island and gear type were generated from the Trip Interview Program (TIP). The primary objective of the data workshop was to consult with USVI fisheries managers and fishers to more completely understand how gear types were reported and how this might affect the size composition of the catch. It was suggested that the specific gear types recorded in the data base be collapsed into four broader gear categories, which were defined according to similarities in selectivity. The following will describe the gear category grouping. Gear categories reflect similarities in gear selectivity. The suggested gear categories to be used for the up-coming assessments include: nets, pots and traps, hook and line, and divers/spear/by hand. The net category represents the following gear types: gill nets, purse seines, haul seines, fixed nets, and dip nets. The pots and traps category is self-defined. Three gear types, hook and line, long lines, and hand lines, make up the hook and line gear category. Lastly, the divers/spear/by hand category represents fishing activities that include diving, spear-fishing, or some combination thereof. Redtail parrotfish yearly mean lengths (with sample size) are shown in Figures 4.8.13 (St. Croix) and 4.8.14 (St. Thomas/St. John).

Ongoing analyses include the evaluation of annual length frequency distributions to determine the size at which each species become fully vulnerable to the four broad gear categories. Those analyses will be followed by an analysis of mean length to determine mortality rates for each species.

4.4.5.3. Adequacy for characterizing catch

Available information does not allow for the characterization of catch at the species level in the USVI. This issue has been examined and discussed thoroughly in pervious SEDARs, most recently at the SEDAR Data Evaluation Workshop (SEDAR Technical Procedures III, Caribbean Data Evaluation Workshop Final Report).

4.4.5.4. Alternatives for characterizing discard length/age

There are no accepted alternatives, nor are there adequate data for an alternative approach to characterizing discard length/age. For example, a bycatch study conducted during October 2004-February 2006 (MRAG Americas, 2006) observed six redtail parrotfish classified as bycatch.

4.4.6. Commercial Catch-at-Age/Length; directed and discard

Other than the TIP data described in Section 4.2.5.2, no commercial catch-at-age data are available in the US Virgin Islands.

4.4.7. Comments on adequacy of data for assessment analyses

For the assessment in the USVI two primary data sources are available: commercial self-reported landings/effort (CCR) and the TIP dockside port sampling of commercial landings. One critical limitation of the CCR data is that reported commercial landings may not be reflective of total commercial removals. In addition, these data have been reported at a family group level which precludes the use of species-specific classic quantitative assessment models. Inadequate TIP dockside sampling data exists to partition the aggregate landings by species (SEDAR Technical Procedures III, Caribbean Data Evaluation Workshop Final Report).

In the US Virgin Islands, redtail parrotfish represent one of the most frequently sampled species in the TIP data base. This should allow for a time series of mean lengths to be analyzed for changes in, and estimates of, total mortality. SEFSC staff has developed specific models for application in data poor situations which can include the analysis of catch per unit effort and information from other species. Landings have been reported as "parrotfish", however, given the preponderance of redtail parrotfish in the catch, a CPUE analysis of "parrotfish" may serve as an indicator of redtail parrotfish abundance.

4.5. PARROTFISH RECREATIONAL FISHERY STATISTICS

4.5.1. Review of Working Papers

None prepared.

4.5.2. Recreational Landings

Unknown, unreported – no MRFSS in USVI

4.5.3. Recreational Discards

Unknown, unreported – no MRFSS in USVI

4.5.4. Recreational Effort

Unknown, unreported – no MRFSS in USVI

4.5.5. Biological Sampling

No consistent, comprehensive sampling of the recreational fishery has occurred in the US Virgin Islands.

4.5.5.1. Sampling Intensity Length/Age/Weight

No consistent, comprehensive sampling of the recreational fishery has occurred in the US Virgin Islands.

4.5.5.2. Length/Age distributions

None presented at the data workshop.

4.5.5.3. Adequacy for characterizing catch

Recreational catch in the US Virgin Islands cannot be characterized by species.

4.4.5.4. Alternatives for characterizing discard length/age

There are no accepted alternatives, nor are there any data for an alternative approach to characterizing discard length/age.

4.5.6. Recreational Catch-at-Age/Length; directed and discard

No recreational catch-at-age/length data were presented at the data workshop.

4.5.7. Comments on adequacy of data for assessment analyses

No recreational US Virgin Islands data have been presented for use in the assessment.

4.6. USVI LITERATURE CITED

Campbell, M.D., T. Gedamke, and W. Ingram. 2011. Preliminary Evaluation of available length-frequency information in the US Caribbean Trip Interview Program (TIP) data. SEDAR-26-DW-04. SFD-2011-012

McCarthy, K. 2011. Reported commercial landings of parrotfish, snappers, groupers, and unclassified finfish in the United States Virgin Islands, 1974-2008. SEDAR26-DW08. SFD-2011-010.

MRAG Americas. 2006. A pilot program to assess methods of collecting bycatch, discard, and biological data in the commercial fisheries of the US Caribbean. Final Report. Cooperative Research Program Grant NA04NMF4540214. pp. 78.

SEDAR Procedures Workshop III, Final Report. 2009. Caribbean Fisheries Data Evaluation. San Juan, Puerto Rico. pp. 195. http://www.sefsc.noaa.gov/sedar/download/CaribData_Final.pdf?id=DOCUMENT.

St. Thomas Fishermen's Association. 2008. Study of By Catch from Fishing Operations. MARFIN Grant NA06NMF4330052. pp. 26.

4.7. TABLES

Table 4.7.1. St. Croix reported commercial landings (no expansion factors applied) by species group (all gears combined), 1975-2008. Data for 1974 and 2010 were not available. Data for 2009 included only January-June.

Year	Fish not snapper-grouper	Snapper-grouper	Grouper	Snapper	Calculated snapper	Parrotfish
1975	11,618	4,351			3,402	
1976	41,100	4,601			3,598	
1977	42,274	8,335			6,518	
1978	35,602	19,975			15,620	
1979	34,733	35,630			27,863	
1980	29,797	10,054			7,862	
1981	63,543	23,040			18,017	
1982	122,410	28,378			22,192	
1983	204,219	23,908			18,696	
1984	270,614	15,369			12,018	
1985	165,799	6,578			5,144	
1986	21,725	1,472			1,151	
1987						
1988						
1989						
1990	176,958	62,406			48,801	
1991	353,217	137,480			107,510	
1992	174,332	76,888			60,127	
1993	10,008	5,890			4,606	
1994						
1995			488	3,743		4,717
1996			6,012	30,836		65,678
1997			17,294	59,150		181,670
1998			18,204	60,654		213,459
1999			20,561	64,099		235,343
2000			23,807	80,817		260,474
2001			29,757	123,697		290,408
2002			44,485	169,723		307,477
2003			45,908	133,620		262,473
2004			47,291	125,080		319,196
2005			39,725	150,278		376,384
2006			35,235	153,771		433,345
2007			30,301	142,127		418,097
2008			29,754	113,193		356,563
Total	**1,757,947**	**464,354**	**405,152**	**1,464,847**	**363,125**	**3,913,936**

Table 4.7.2. St. Thomas and St. John reported commercial landings (no expansion factors applied) by species group (all gears combined), 1974-2008. Data for 2010 were not available. Data for 2009 included only January-June.

Year	Fish not snapper-grouper	Snapper-grouper	Grouper	Snapper	Calculated snapper	Parrotfish
1974	36,280	18,585			13,511	
1975	190,817	65,738			47,792	
1976	163,898	53,847			39,147	
1977	175,745	57,063			41,484	
1978	315,821	82,127			59,706	
1979	353,030	88,628			64,432	
1980	359,457	131,472			95,580	
1981	330,134	147,455			107,200	
1982	311,087	125,643			91,342	
1983	491,134	35,264			25,637	
1984	546,567	18,454			13,416	
1985	569,823	14,328			10,416	
1986	265,709	6,956			5,057	
1987	263,710	3,340				
1988	251,184	3,161				
1989						
1990	141,907	85,779			62,361	
1991	381,737	150,740			109,588	
1992	203,210	56,668			41,198	
1993						
1994						
1995						
1996						
1997			1,260	12,722		3,308
1998			25,150	66,480		20,961
1999			46,608	127,551		38,188
2000			49,118	150,226		35,078
2001			54,416	176,242		50,328
2002			55,298	167,496		45,998
2003			65,444	160,736		53,315
2004			75,749	141,197		58,679
2005			66,343	153,337		50,305
2006			60,281	174,709		44,237
2007			52,683	156,472		40,372
2008			56,607	144,407		39,411
Total	**5,351,249**	**1,145,247**	**640,861**	**1,706,408**	**827,869**	**497,261**

Table 4.7.3. Number of reported US Virgin Island commercial fishing trips by island and year.

Year	St. Croix	St. Thomas/St. John
1995	414	523
1996	3,767	2,406
1997	8,568	4,572
1998	8,885	5,389
1999	8,818	6,192
2000	10,121	6,039
2001	12,596	5,656
2002	13,975	5,213
2003	12,056	4,926
2004	11,998	5,230
2005	12,204	4,784
2006	13,236	4,487
2007	12,087	2,412
2008	9,805	523
2009	5,147	2,406

Table 4.7.4. Number of TIP observations by snapper species and island for the years 1983-2011.

	All	**Puerto Rico**	**St Croix**	**St. Thomas / St John**
SILK SNAPPER	25980 (74%)	22052 (82%)	3216 (44%)	674 (78%)
QUEEN SNAPPER	9115 (26%)	4776 (18%)	4146 (56%)	193 (22%)

*** percent of column total shown in parentheses**

Table 4.7.5. Number of TIP observations of silk snapper by general gear type and island for the years 1983-2011.

ST CROIX	**HAND LINE**	1872
ST CROIX	**LONG LINES**	679
ST CROIX	**HOOK AND LINE**	510
ST CROIX	**POTS AND TRAP**	153
ST CROIX	**NOT CODED**	2
ST THOMAS/ST JOHN	**POTS AND TRAP**	263
ST THOMAS/ST JOHN	**HOOK AND LINE**	186
ST THOMAS/ST JOHN	**HAND LINE**	163
ST THOMAS/ST JOHN	**LONG LINES**	33
ST THOMAS/ST JOHN	**PURSE SEINES**	17
ST THOMAS/ST JOHN	**DIP NETS AND**	9
ST THOMAS/ST JOHN	**SPEARS AND GI**	3

Table 4.7.6. Number of TIP observations of queen snapper by general gear type and island for the years 1983-2011.

ST CROIX	**HAND LINE**	1876
ST CROIX	**LONG LINES**	1153
ST CROIX	**HOOK AND LINE**	1082
ST CROIX	**POTS AND TRAP**	32
ST CROIX	**GILL NETS**	2
ST CROIX	**FIXED NETS**	1
ST THOMAS/ST JOHN	**LONG LINES**	130
ST THOMAS/ST JOHN	**HOOK AND LINE**	34
ST THOMAS/ST JOHN	**SPEARS AND GI**	16
ST THOMAS/ST JOHN	**DIP NETS AND**	7
ST THOMAS/ST JOHN	**POTS AND TRAP**	6

Table 4.7.7. Parrotfish species total TIP observations by island for the years 1983-2011.

	All	Puerto Rico	St Croix	St Thomas/St John
Redtail parrotfish	44184 (44%)	12105 (39%)	30411 (47%)	1599 (45%)
Stoplight parrotfish	36664 (37%)	14554 (46%)	20702 (32%)	1391(39%)
Redband parrotfish	7477 (7.5%)	845 (2.7%)	6406 (10%)	226 (6.4%)
Princess parrotfish	4054 (4.1%)	1275 (4.1%)	2680 (4.1%)	96 (2.7%)
Parrotfish spp	2728 (2.7%)	838 (2.7%)	1819 (2.8%)	71 (2%)
Redfin parrotfish	1804 (1.8 %)	174 (<1%)	1544 (2.4%)	86 (2%)
Queen parrotfish	1746 (1.7%)	1073 (3.4%)	659 (1%)	12 (<1%)
Rainbow parrotfish	77 (<1%)	61 (1.9%)	1 (<1%)	15 (<1%)
Blue parrotfish	72 (<1%)	58 (1.8%)	0	14 (<1%)
Striped parrotfish	23 (<1%)	0	19 (<1%)	4 (<1%)

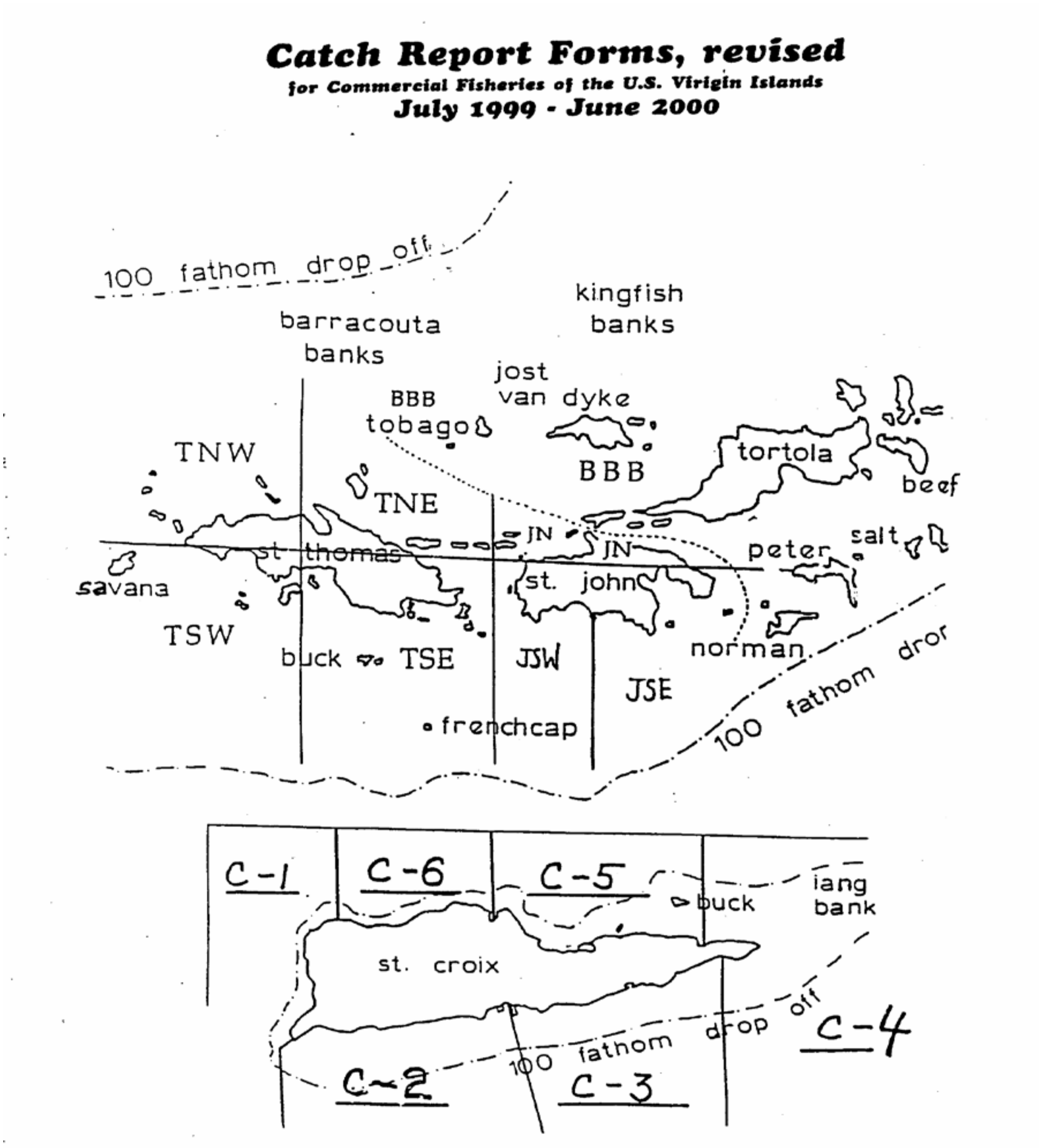
*** percent of column total shown in parentheses**

Table 4.7.8. Number of TIP observations of redtail parrotfish by gear type and island for the years 1983-2011.

ST CROIX	**POTS AND TRAP**	23439
ST CROIX	**GILL NETS**	5530
ST CROIX	**SPEARS AND GI**	730
ST CROIX	**BY HAND**	462
ST CROIX	**LONG LINES**	222
ST CROIX	**HAND LINE**	17
ST THOMAS/ST JOHN	**POTS AND TRAP**	1565
ST THOMAS/ST JOHN	**HAUL SEINES**	18
ST THOMAS/ST JOHN		15
ST THOMAS/ST JOHN	**HAND LINE**	1

4.8. FIGURES

Figure 4.8.0. US Virgin Islands fishing areas defined (from catch report forms).



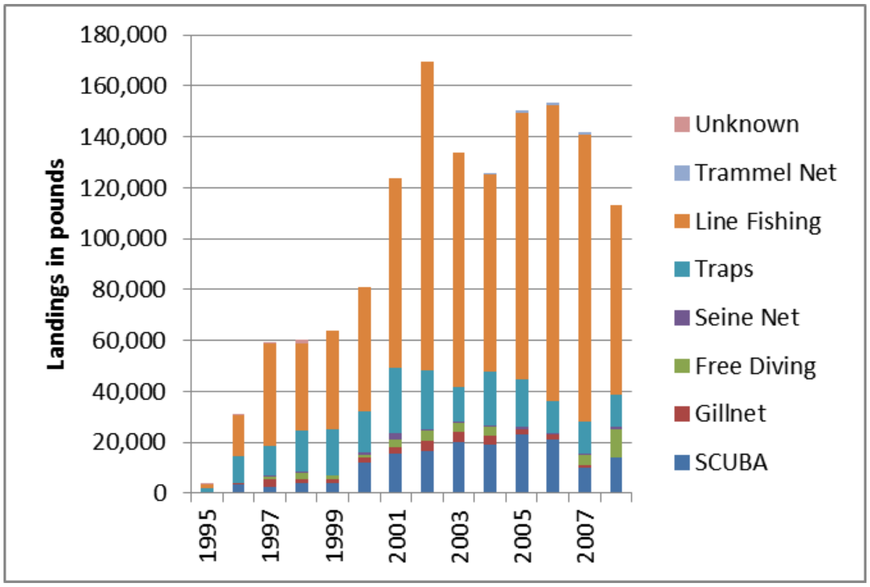


Figure 4.8.1. Yearly commercial landings of snappers by gear fished as reported (no expansion factors applied) on fisher logbooks from St. Croix.

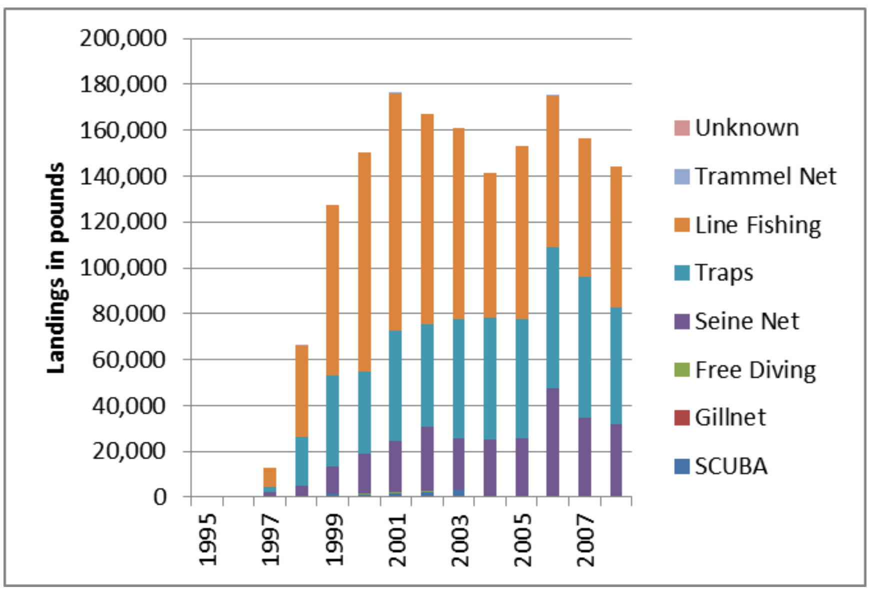


Figure 4.8.2. Yearly commercial landings of snappers by gear fished as reported (no expansion factors applied) on fisher logbooks from St. Thomas and St. John.

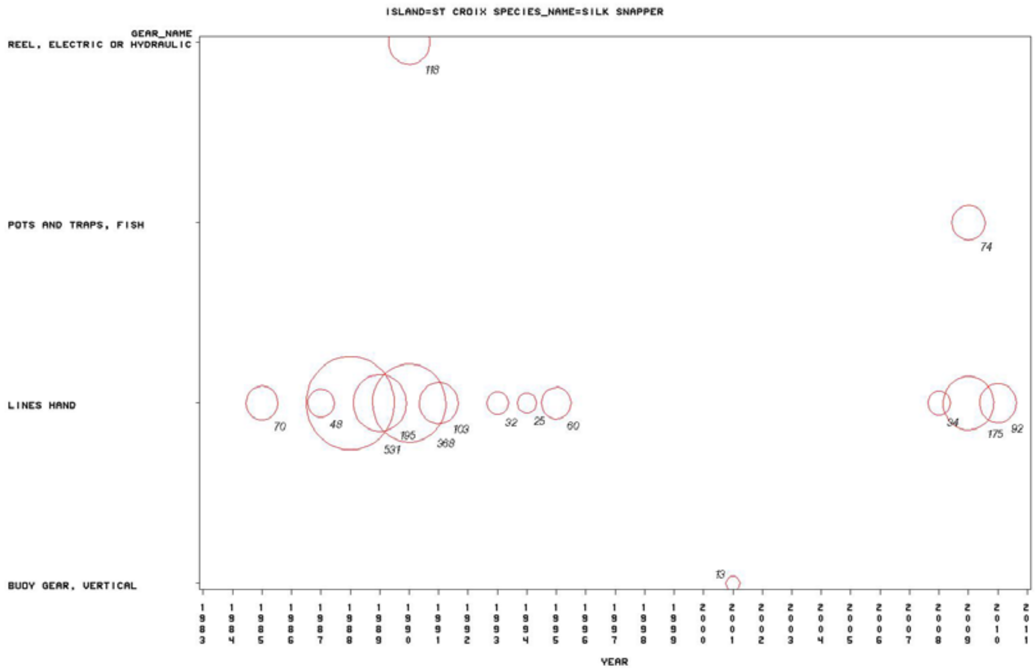


Figure 4.8.3. Silk snapper number of sampled fish by specific gear type from St. Croix, 1983-2011.

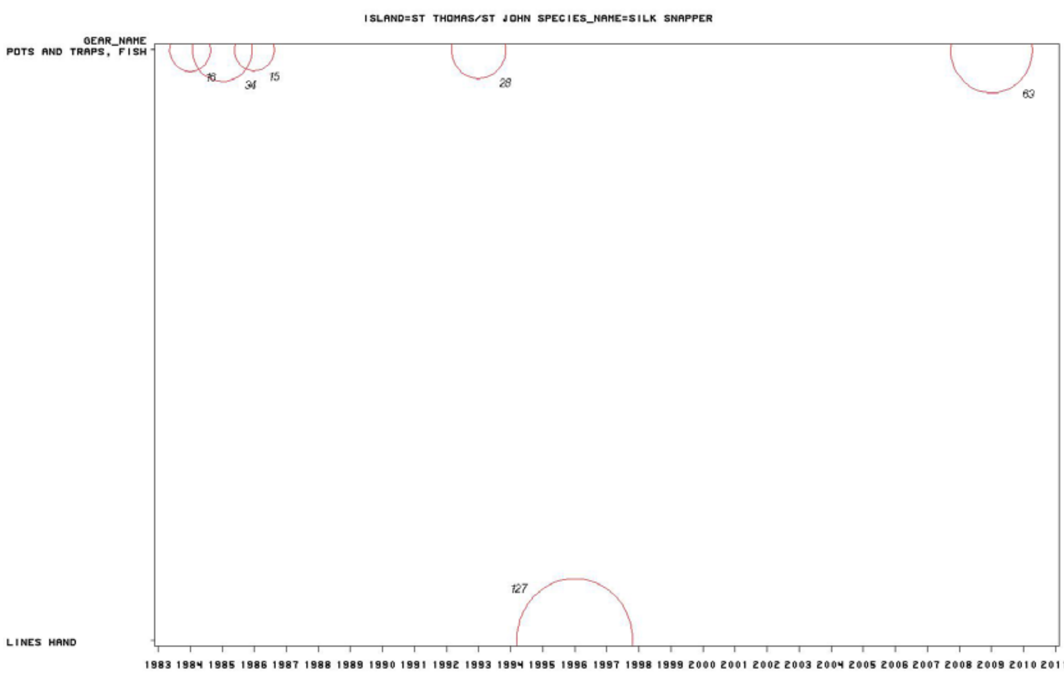


Figure 4.8.4. Silk snapper number of sampled fish by specific gear type from St. Thomas – St. John, 1983-2011.

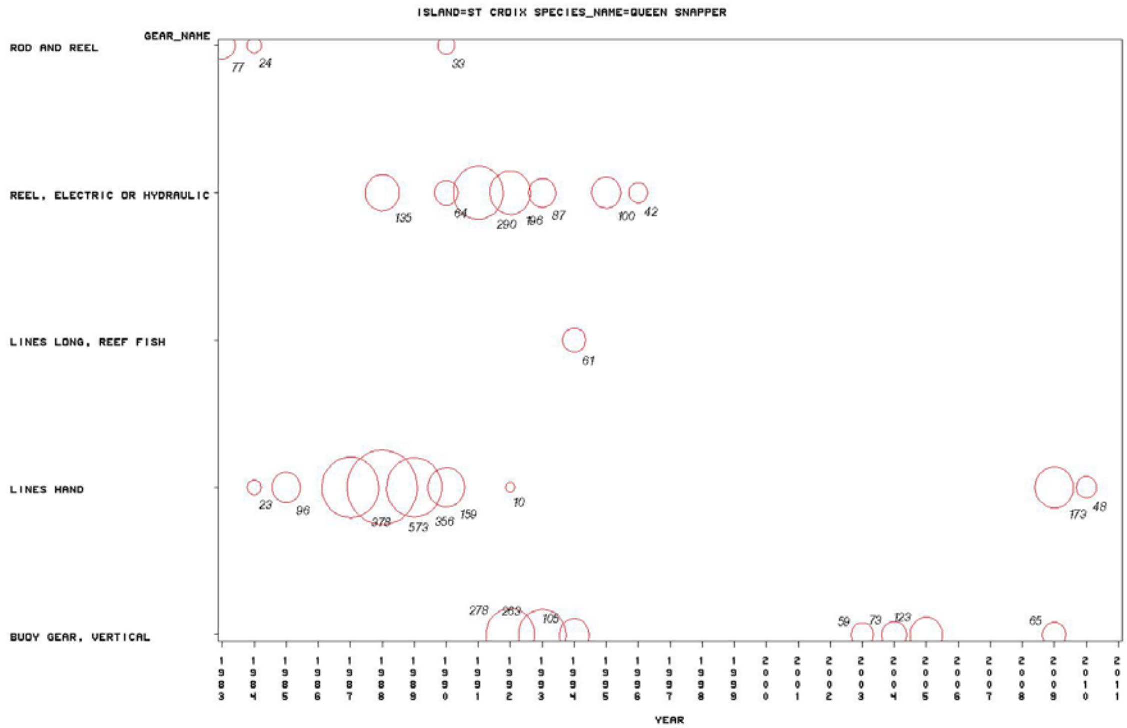


Figure 4.8.5. Queen snapper number of sampled fish by specific gear type from St. Croix, 1983-2011.

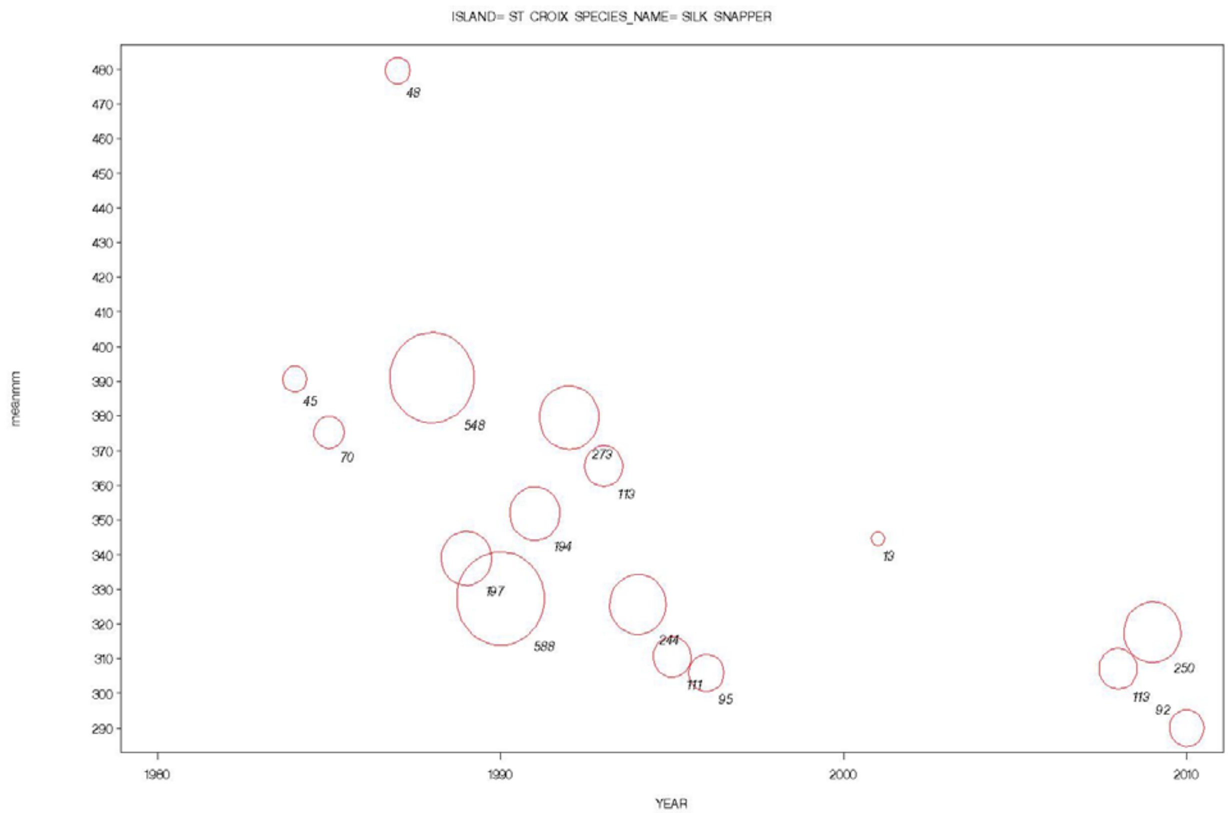


Figure 4.8.6. Silk snapper mean lengths and sample sizes from St. Croix, 1983-2011.

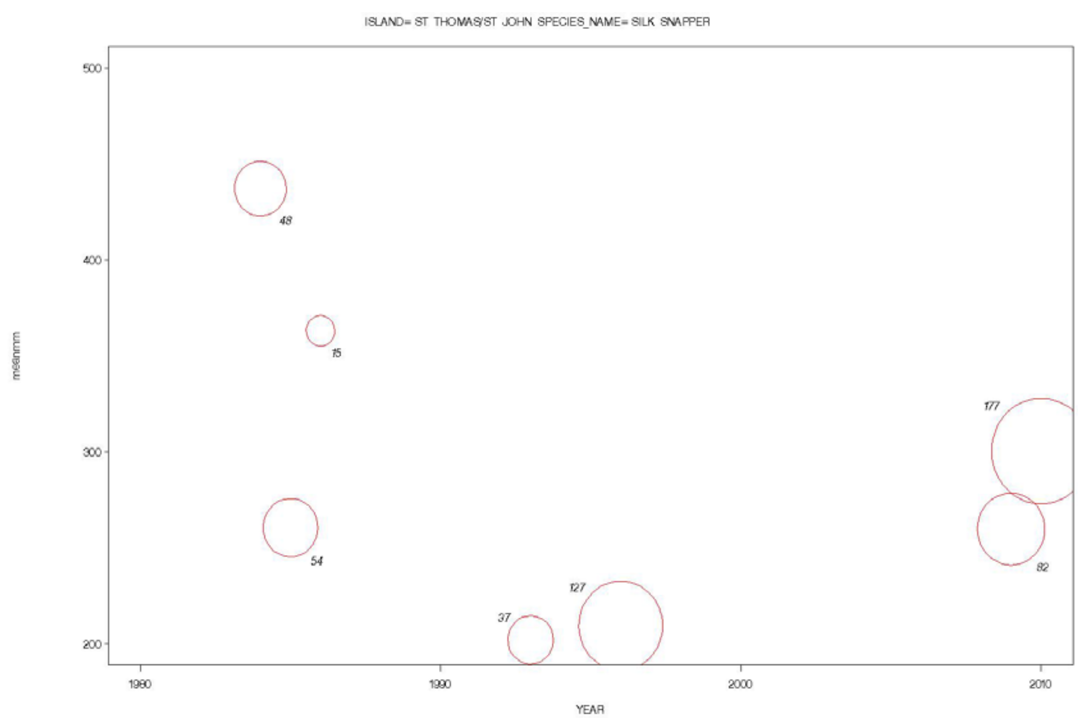


Figure 4.8.7. Silk snapper mean lengths and sample sizes from St. Thomas – St. John, 1983-2011.

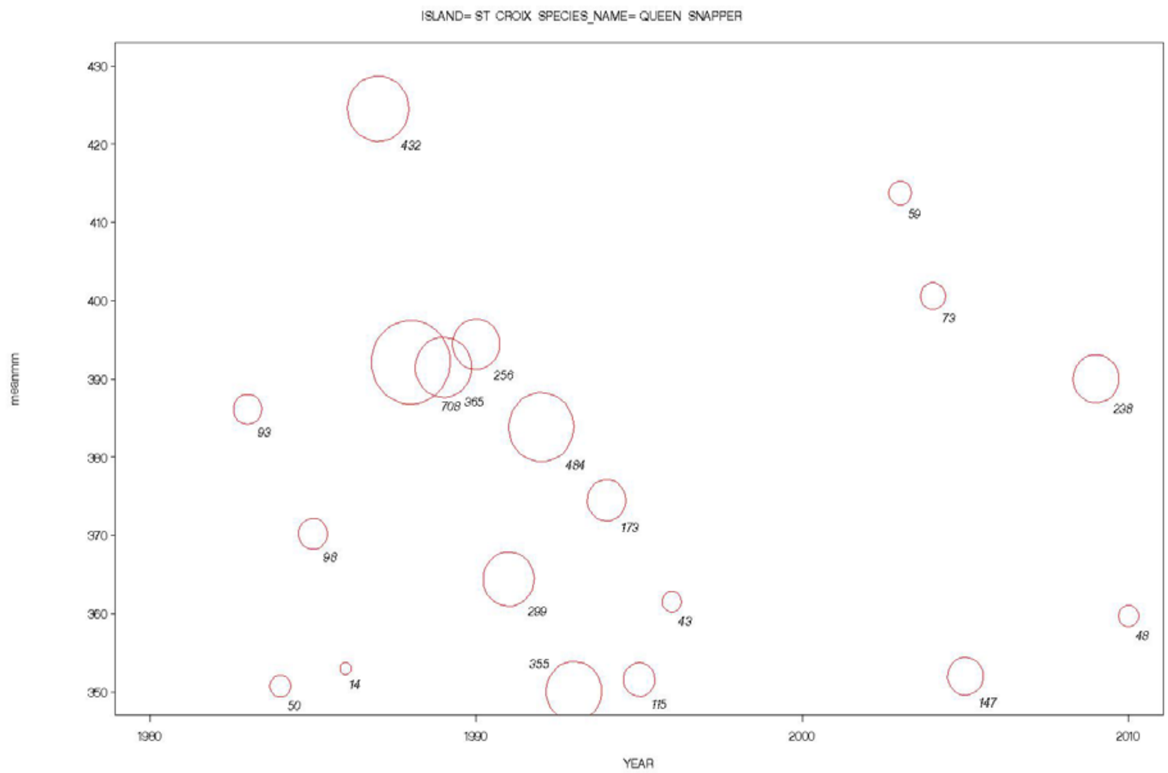


Figure 4.8.8. Queen snapper mean lengths and sample sizes from St. Croix, 1983-2011.

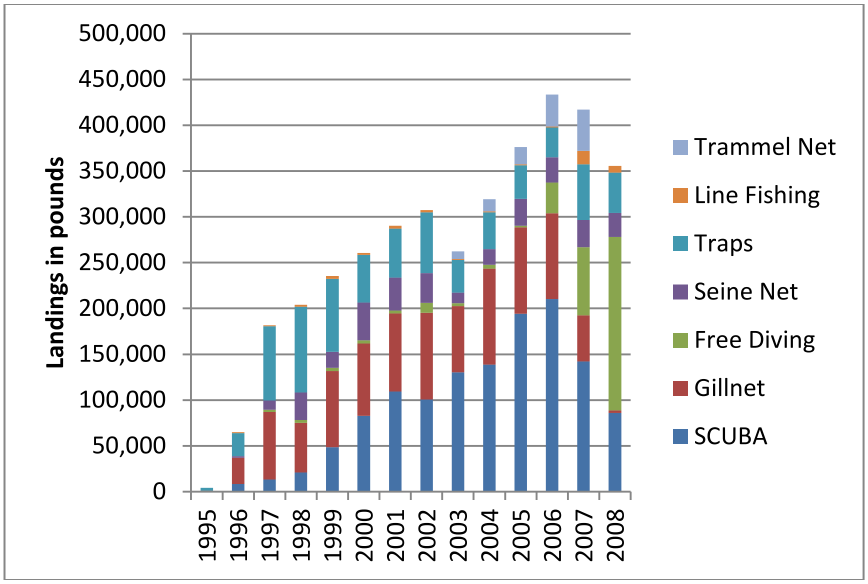


Figure 4.8.9. Yearly commercial landings of parrotfish by gear fished as reported (no expansion factors applied) on fisher logbooks from St. Croix.

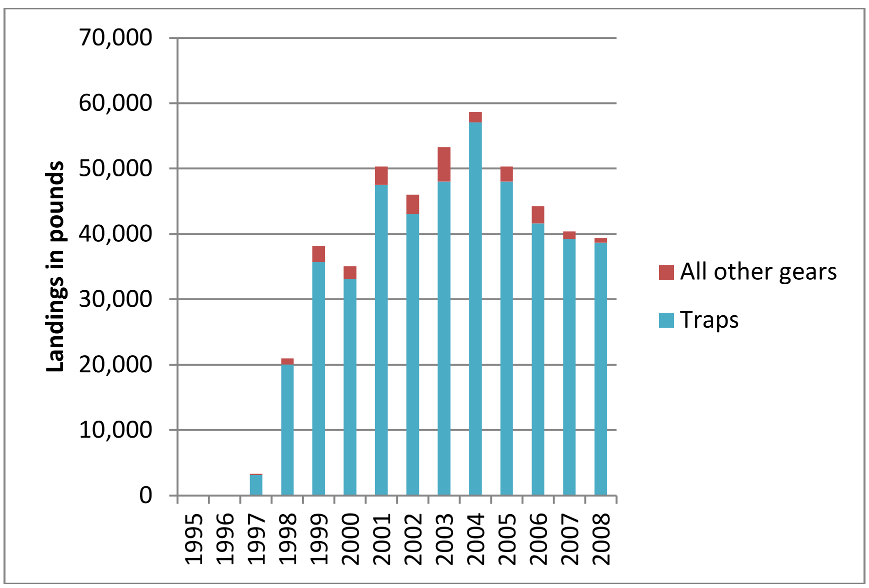


Figure 4.8.10. Yearly commercial landings of parrotfish by gear fished as reported (no expansion factors applied) on fisher logbooks from St. Thomas and St. John.

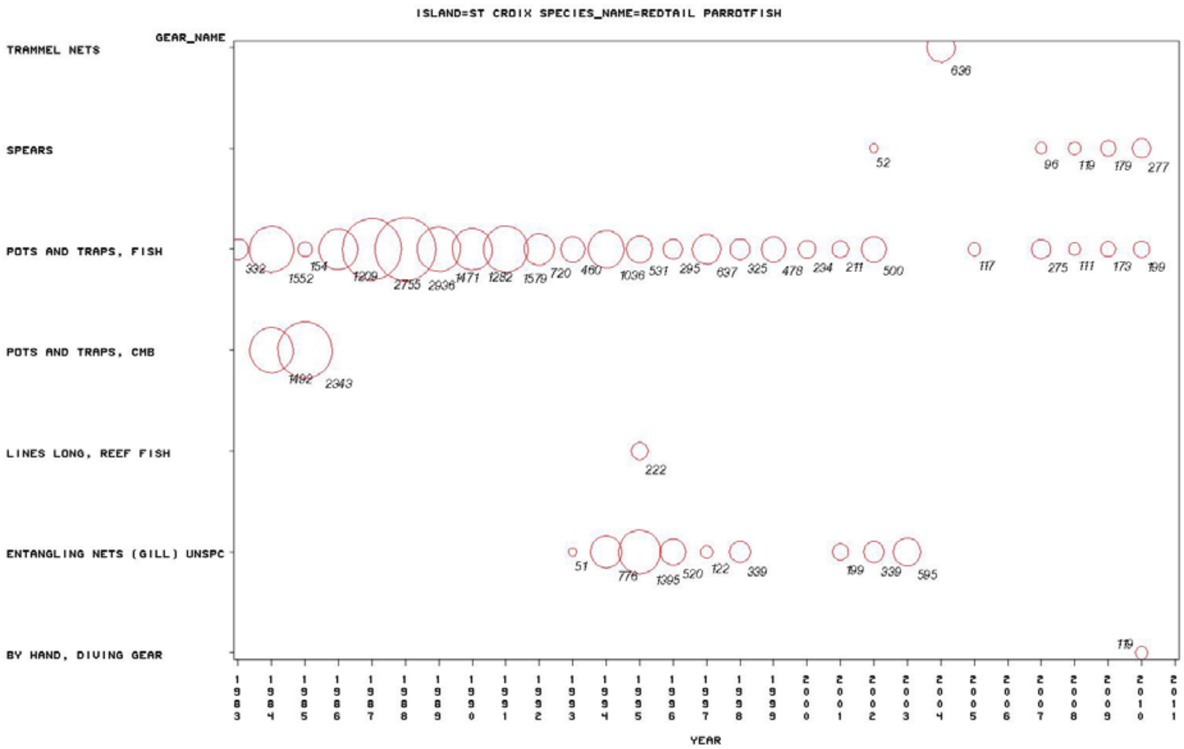


Figure 4.8.11. Redtail parrotfish number of sampled fish by specific gear type from St. Croix, 1983-2011.

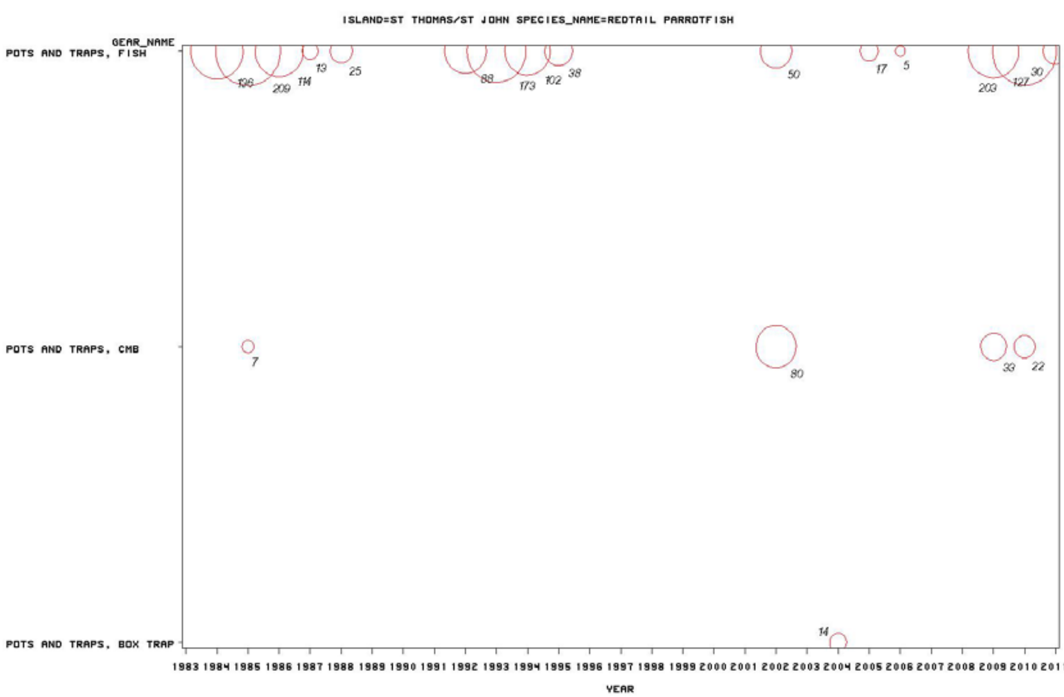


Figure 4.8.12. Redtail parrotfish number of sampled fish by specific gear type from St. Thomas/St. John, 1983-2011.

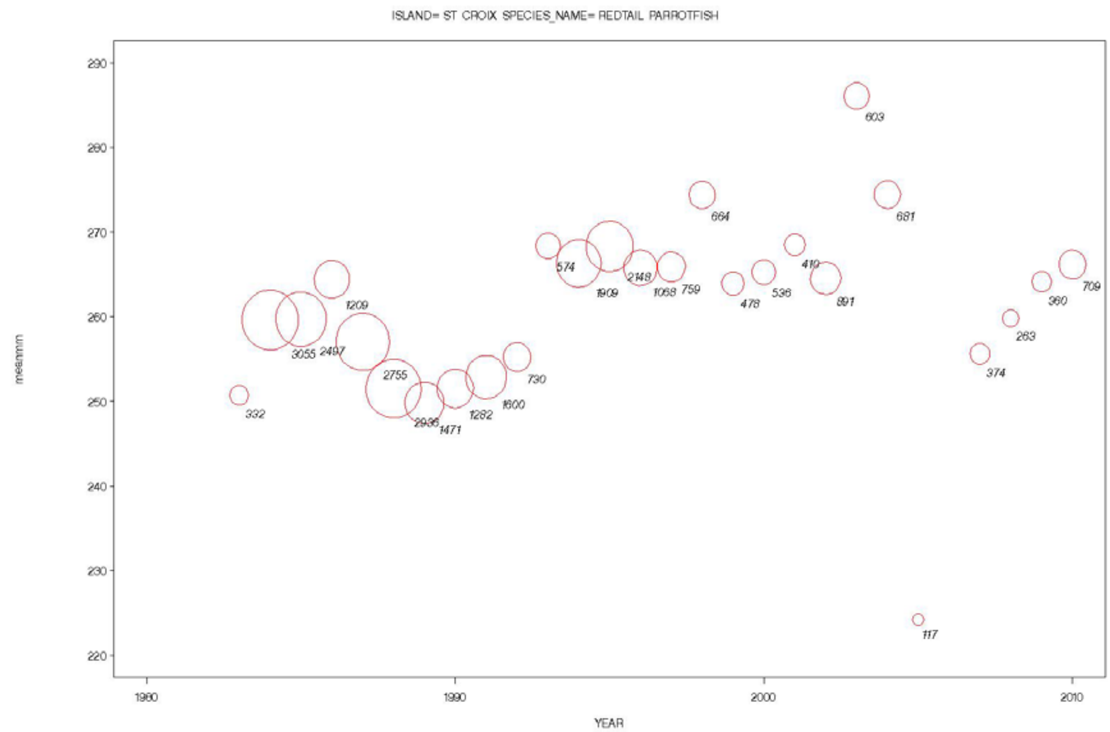


Figure 4.8.13. Redtail parrotfish mean lengths and sample sizes from St. Croix, 1983-2011.

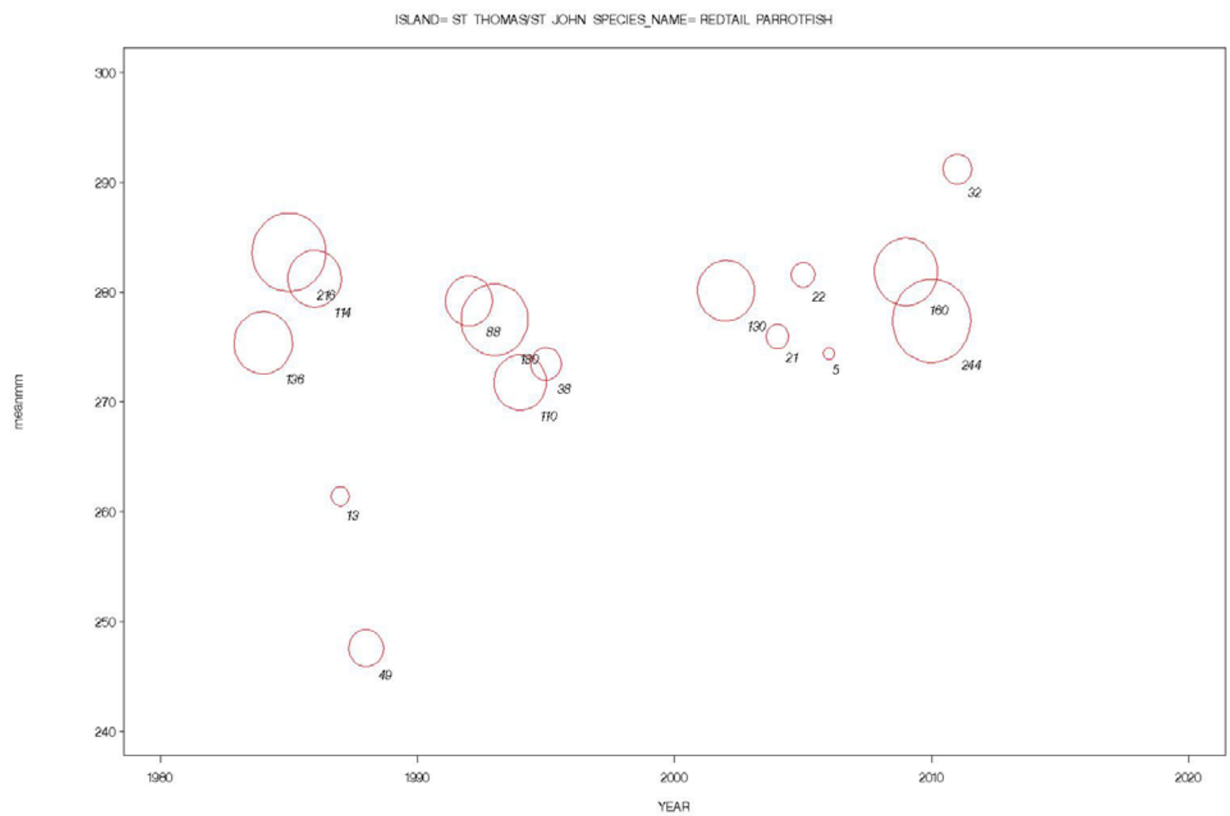


Figure 4.8.14. Redtail parrotfish mean lengths and sample sizes from St. Thomas – St. John, 1983-2011.

5. FISHERY INDEPENDENT RESEARCH

5.1. OVERVIEW

During SEDAR 26 a group of participants examined and discussed fishery-independent data that might be available for assessing the species under consideration. The group primarily consisted of Hill (leader), Ingram, McCarthy, Gedamke, and García-Molina with additional contributions from other workshop attendees. Goals were to catalogue available known projects and datasets and begin examination of data as possible. The effort was greatly aided by similar efforts at previous SEDARs and the Caribbean-Comprehensive Coral Reef Ecosystem Monitoring Project (C-CCREMP), previously funded by the NOAA Coral Reef Conservation Program. C-CCREMP, co-managed by SEFSC-Galveston and the NOS Biography Team, was an attempt to develop a database of metadata on coral reef research and monitoring projects throughout the US Caribbean. Data from that project forms the basis of this chapter and is displayed in Appendix 1. The ideal project to support conventional stock assessment modeling would be consistent sampling with a long time series over a broad geographic distribution but this does not seem to be available.

Although directed fishery-independent surveys of fishery resources have been rare in the US Caribbean, the coral reefs and reef resources of the area have been the focus of scientific study for a number of decades. Many of these research efforts have been dedicated to assessing size-structured abundances of reef fish and coral populations, often focused on documenting biological diversity or other measures of reef communities. While those research studies can provide some insight into status of the resources at the time (and locale) of the study, and may be useful in identifying "historical" environmental conditions or relative population status, few studies have been conducted over the temporal or spatial scales necessary to provide data for conventional stock assessment modeling across the US Caribbean. Only if comparable datasets can be located from past and current studies is there any strong likelihood that these research efforts could contribute to current stock assessment models although they may contribute to alternative approaches or serve as indicators of population status. Various sampling programs are identified in the following sections in order to document these efforts, their findings, the applicability of each study, and their limitations.

5.2. DEEP WATER SNAPPER RESARCH

Research into deep water fish populations present issues that are beyond those seen for shallow water reef fish studies. Depths where deep water snappers are found are beyond safe diving limits so alternative sampling means are required. Research cruises with directed sampling for deep water fishes have been conducted sporadically over the last several decades. The Oregon II cruise of 2009 and earlier research cruises have used standardized fishing techniques such as long lines, fish traps and camera sets to assess deep water species including queen and silk snapper (Pollack and Ingram, 2011).

5.3. PARROTFISH RESEARCH

Shallow-water Reef Fishes

Several fishery-independent surveys are ongoing in the Caribbean, conducted by academic researchers, territorial, commonwealth, and/or federal agencies that cover various parts of Puerto Rico and the US Virgin Islands. Two general approaches have been employed to assess status of reef resources in the US

Caribbean, those that collect and those that observe (visually sample) fish and other fishery targets. The complex and fragile coral reef habitats restrict the use of many traditional means of fishery-independent sampling (e.g., trawl surveys of the NE). Some studies are highlighted in the following sections and additional information is collated in Appendix 1.

Sampling with Fishing Gear. Only a few studies have used methods that physically collect fishery species as a means of assessing population status. Notably, the Southeast Area Monitoring and Assessment Program for the Caribbean (SEAMAP-C), or the predecessor studies on which the program was based, have sampled both conch (visually), lobster (visually and recruitment surveys), and finfish (with traps and hook and line) since the late 1970s or early 1980s. SEAMAP-C is a cooperative program between the National Marine Fisheries Service, the Dept. of Natural and Environmental Resources in Puerto Rico and the Dept. of Planning and Natural Resources, Division of Fish & Wildlife in the US Virgin Islands. SEAMAP-C is a multiyear data set, originally targeting red hind spawning areas but other species are taken as well. Sampling is conducted in random quadrants within a sample area defined for each island. Areas off St. Croix, St. Thomas/St. John, and western PR are included. Newer data should be examined, but from 1992-2002, 1098 individual fish from 39 species were captured from St. Croix; 1490 fish from 65 species were captured from St. John. Across all years, only 17 species with more than 5 individuals were captured from St. Croix; 28 species with more than 5 individuals were captured for St. Thomas/St. John. Sampling continues and methodological changes have been discussed to expand the species captured. Data are maintained by SEAMAP in Pascagoula, MS.

In 2009, with funding from the NOAA Coral Reef Conservation Program, the SEFSC began a pilot study, as a step towards developing an efficient cost-effective survey program for fisheries resources in the US Caribbean. The project, a cooperative effort between SEFSC and local fishermen, was planned to conduct fi shelf-wide sampling of reef fishes with traps in St. Croix. The survey design and stations were allocated as follows: 400 stratified random stations, 187 allocated by a newly developed geostatistical approach, 13 existing fixed long-term monitoring locations, and two that were sampled in conjunction with Kimberly Roberson of the NOAA/NOS/NCCOS/CCMA/Biogeography Branch (BIOGEO). Additional locations selected by fishermen, and not in the original survey design, were also sampled. Sampling was conducted between October 5, 2010 and November 13, 2010 with a total of 638 stations occupied. Stations were sampled using 40 identical traps, baited with frozen squid and soaked overnight.

A total of 2,860 fish from 66 species were captured. The most abundant five species captured were white grunt (n=623), queen triggerfish (n=371), blue tang (n=298), banded butterflyfish (n=218), and yellowtail snapper (n=196). Redtail parrotfish, silk and queen snapper were not captured so results from this study will not be integrated into the SEDAR 26 assessment; the three most abundant species are slated for assessment next year. This work is a step towards providing the first comprehensive spatial evaluation of fish abundance in any US Caribbean territory and provides a model for developing similar programs in other locations. It is expected to continue and provide a model for other southeast reef areas, if funding can be secured.

Visual Sampling. Many of the studies with an ecological focus use SCUBA techniques to conduct surveys of reef fish assemblages. Studies in controlled conditions have demonstrated reliability of these techniques to identify, count, and estimate lengths of reef fishes; adequate training of observers improves accuracy. These studies generally document lengths of diurnal, non-cryptic species, recording abundance per unit area or unit time. Area-based estimates can provide size structure and densities making them most useful among-study for comparisons while time-based estimates provide size structure and sighting frequency and frequently have added utility for documenting rare species. In past Caribbean SEDARs none of these studies were judged to be spatially or temporally extensive enough to serve as the basis for conventional models. There are a few studies that may provide some inputs for assessment modeling and a few that may provide some auxiliary information to contribute to assessment efforts. Some current approaches to population status assessment examine changes in mean or maximum sizes as indicators of fishing pressure (Ault et al. 2005, Gedamke 2006) and visual census of reef fishes may provide data suitable for these methods.

The SEFSC has conducted visual assessments of reef fish assemblages for approximately three decades although most of this effort has been focused in the Florida Keys and only a expenditure has taken place in the US Caribbean. More recently, beginning in about 2001, the NOAA Coral Reef Conservation Program (CRCP) has both supported reef research and provided grants to local resource agencies to conduct monitoring of coral reefs and reef resources. These projects have been in place now for nearly ten years and offer some data concerning the current status, in the form of estimates of relative abundance, of these living marine resources although there may be little data for earlier historical comparisons. The CFMC has also received CRCP support and contracted research into assessments of coral reef communities at slightly deeper depths. While this work may provide additional data since the depths are appropriate for of these species, they are spatially limited, although there are plans for additional support in the future.

Perhaps more promising are data from the monitoring efforts that have been geared towards assessing resources of the Virgin Islands National Park in St. John and Buck Island National Monument in St. Croix. These studies have included reef fishes, conch, corals, seagrasses, and other resources. They have been continued at somewhat regular intervals generally with the same methods since the 1970s with some historical information from the 1950-60s being provided by J. Randall to Dr. Jim Beets (Univ. of HI-Hilo). Dr. Beets has done some preliminary comparisons of those data with current studies and the differences may provide general trends in population status. Accessibility of the data depends on individual researchers (J. Beets and A. Friedlander) and to date has been limited.

Several of the more comprehensive programs currently underway are relatively new and provide only 9-10 years of data. Coral reef monitoring by the NOAA Oceans Biogeography Team began in 2001 and has augmented the surveys focused on the National Park and National Monument waters as well as coverage in La Parguera, Puerto Rico. Surveys of reef fish bin sizes in 5 cm categories and enumerate abundances within 100 m^2 transects. Data are available through an on-line data server and have been obtained for examination. Monitoring of western Puerto Rican reefs by SEFSC and F/HC researchers has been ongoing since 1996 (when both were students at Univ. of PR-Mayagüez) although it has been more rigorous since 2001. These surveys cover Mona, Monito, and Desecheo Islands off the west coast and reefs from Mayagüez, Boqueron, and La Parguera, although the number of samples is not extensive from some areas. The primary focus of these surveys has been examination of coral ecology and coral disease and effects on reef fish assemblages.

Jurisdictional sampling has been conducted in both the Virgin Islands (contact Tyler Smith, UVI) and Puerto Rico (contact Reni Garcia, UPR) beginning in about 2003 with CRCP grant funding. In each case sampling has occurred on a yearly basis, repeatedly sampling points spread across the jurisdictions. Numbers of samples varies but in both cases reef fishes and corals are monitored . For example, in the

USVI reef fishes are monitored in linear transects (known area) combined with roving diver surveys (known time) to quantify both common and rare species. Data has been obtained for USVI.

Of a more general nature are two activities that occur across the region that collect data from a broad range of volunteer participants conducting reef research or monitoring. REEF (the Reef Environmental Education Foundation) conducts trips and training of volunteer divers who contribute information on reef fishes throughout reef environments of the world. Based on knowledge testing and experience, divers are classified as expert or novice and data are tagged with the associated level of expertise. It is therefore possible to obtain a fairly comprehensive dataset with a presumed level of confidence. Data include categories of abundance rather than actual counts and frequencies are generally used in analyses. The program contact is Dr. Christy Pattengill-Semens. The Atlantic and Gulf Rapid Reef Assessment (AGRRA) Program is an international collaboration of scientists and mangers aimed at determining the regional condition of reefs in the Western Atlantic and Gulf of Mexico. Its participants use prescribed methods to evaluate various parameters of reef condition, covering both corals and a subset of reef fishes considered to be ecologically or economically important. The program issues periodic reports documenting results. The program contact is Dr. Robert Ginsburg (MGG-RSMAS, University of Miami).

While each of these efforts may contribute to the general knowledge of redtail parrotfish (*Sparisoma chrysopterum*), none of these programs provide a comprehensive evaluation of populations across the whole US Caribbean. This section should serve as an assessment of the datasets that are currently available and as a foundation for developing research recommendations to improve the capabilities to assess US Caribbean reef fish stocks.

5.4. DATA MANAGEMENT

There have been several efforts to compile information and analyze data about stocks in the US Caribbean (Appeldoorn et al. 1992, Jacobsen and Browder 1987) and the more recent CRCP-funded project Caribbean Comprehensive Coral Reef Ecosystem Montoring Project (C-CCREMP). C-CCREMP has been an effort to collect metadata on coral reef monitoring and research projects from the US Caribbean, beginning with NOAA funded studies. Outputs from the database are the basis for Appendix 1. Overviews of several documented studies are shown below. Data availability has been a continuing problem for SEDAR analyses. In general, projects in which individual researchers hold the data have been the most inaccessible.

In 1987, Jacobsen and Browder (SEFSC) produced a draft report entitled *The Ecological Basis of Fishery Yield of the Puerto Rico-Virgin Islands Insular Shelf*. The report was a literature review that drew together “all” available data sources for use in modeling ecosystems in PR-VI. It is a useful source for accessing documents that are not all at this point easily obtained, e.g., Boulon 1985, Clavijo et al. 1989, Gladfelter 1980, Idyll and Randall 1959, Kimmel 1985, Randall 1983, Stoner 1986). Some of these sources provide snapshots of reef fish conditions although many of the observations are published as qualitative judgments.

A sample of reef fish projects is contained below; additional projects and further information are contained in Appendix 1.

Catalogue of Fishery-Independent Data Sources included in C-CCREMP

1. SEAMAP – Caribbean: Reef Fish Sampling (USVI DFW, PR DNER, NOAA Fisheries)

Target:	Reef fish	**Duration:**	1991 to present
Coverage:	western PR, south St. John	**Contact(s):**	Aida Rosario (lipdrna@coqui.net)
Data:	SEAMAP	**Funding:**	SEAMAP

Basics: The Southeast Area Monitoring and Assessment Program for the Caribbean (SEAMAP-C) is a cooperative program between the National Marine Fisheries Service, the Dept. of Natural and Environmental Resources in Puerto Rico and the Dept. of Planning and Natural Resources, Division of Fish & Wildlife in the US Virgin Islands. Sampling is conducted in quadrants within a sample area defined for each island. Areas off St. Croix, St. Thomas, and western PR are included. From 1992-2002, 1098 individual fish from 39 species were captured from St. Croix; 1490 fish from 65 species were captured from St. John. Across all years, only 17 species with more than 5 individuals were captured from St. Croix; 28 species with more than 5 individuals were captured for St John. SEAMAP-C is a multiyear data set, originally targeting red hind spawning areas but other species are taken by trap and hook-and-line sampling.
Pros: Repeated sampling, same method across all locations, sampling deeper than divers, broad range of species, CPUE calculated as minutes of fishing time.
Cons: Interannual variability unknown, overall numbers of species other than red hind generally small, only STJ and STX sampled, not STT

2. Reef Fish Surveys (SEAMAP-like) (PR DNER)

Target:	Reef fish	**Duration:**	1988 to present
Coverage:	western PR, SE St. Thomas	**Contact:**	Aida Rosario (lipdrna@coqui.net)
Data:	DNER; SEAMAP	**Funding:**	PR DNER

Basics: Similar sampling program as SEAMAP surveys, predates SEAMAP. Multiyear data set, targeting reef fishes with trap and hook-and-line sampling.
Pros: Repeated sampling, same method across all locations, sampling deeper than divers, broad range of species, CPUE (calculated as minutes of fishing time).
Cons: same as above

3. Territorial Coral Reef Monitoring [St. Croix and St. Thomas (by Univ. of the Virgin Islands, USVI Div. Fish and Wildlife)]

Target:	Reef fish and benthos	**Duration:**	2001 to present
Coverage:	USVI (St. Thomas/Croix)	**Contact**:	Rick Nemeth (rnemeth@uvi.edu)
Data:	VI DFW	**Funding:**	NOAA CRCP

Basics: Surveys of reef fish (transects and roving diver) and benthos (coral), expected to continue long-term
Pros: Common method between STX and STT/J, repeat surveys of same site, provides density estimates, roving diver includes elusive/cryptic species
Cons: Not all data in hand, numbers only for parrotfishes, relatively short time series

4. Commonwealth Coral Reef Monitoring in Puerto Rico (PR DNER, contracted to J. Garcia of Univ. of PR-Mayagüez)

Target:	Reef fish and benthos	**Duration:**	2003 to present
Coverage:	Vieques, Desecheo, La Cordillera (others?) PR	**Contact:**	Reni Garcia (renigar@caribe.net)
Data:	UPRM; DNER	**Funding:**	NOAA CRCP

Basics: Surveys of reef fish and benthos (coral), expected to continue long-term. Some focus on deeper, shelf edge reefs. Dr. Garcia also has been involved with CariComp surveys (reef fish and benthos) of permanent stations and CFMC-funded deeper reef surveys (140-160 ft). Generally, all timed surveys rather than area-based.
Pros: Most spatially comprehensive around PR
Cons: Timed surveys, no true density measures, limited time-series.

5. PR Deep Reef Surveys (UPRM, contracted by CFMC)

A series of deep reef site assessments have been undertaken by Univ. of PR-Mayagüez (Dr. Reni Garcia) funded by the CFMC with NOAA Coral Reef Conservation Program funds. Surveys include 30, 40 and 50 m depths, replicate 10 m transects. Although the numbers from the various deep water surveys do not provide enough observations for stock assessment, they help establish preferred depth ranges and point to the need for additional deep water surveys for certain species.
Pros: Deeper reef surveys, confirms depth ranges/preferences
Cons: Spatially limited, temporally limited

6. Monitoring Reef Fish Populations in the VI National Park (DOI, National Park Service, Virgins Island National Park)

Target:	Reef fish, conch, lobster	**Duration:**	1982 to present
Coverage:	St. John; Buck Island, STX	**Contact:**	Jim Beets (beets@hawaii.edu) Alan Friedlander (Alan.Friedlander@noaa.gov)
Data:	PIs; VINPS?	**Funding:**	**VI**NPS; NOAA CRCP;NOS Biogeo

Basics: Resource monitoring by the park is probably the most temporally comprehensive of all existing or recent programs. Surveys target reef fishes, queen conch, benthic composition (e.g., corals, seagrass communities). Surveys have included intensive short-term monitoring (monthly at 2 sites from 1988-1991), annual surveys at several sites and a number of other specific survey projects. Visual surveys have been conducted in quasi-permanent sites complemented by trap surveys at various intervals. Visual surveys used consistent or calibrated methods to document all non-cryptic species in all size classes. NPS Inventory and Monitoring Program has now assumed responsibility for the monitoring efforts with monitoring conducted by NPS in collaboration with cooperators (e.g., NOAA NOS/CCMA Biogeography Team/NOAA Coral Reef Conservation Program). Datasets and field log books from J. Randall have been obtained by PI – Jim Beets and comparisons between Randall's surveys of the 1950-60s are possible.
Pros: good temporal data, spatially good for STJ, includes sites in St. Croix

Cons: mostly STJ, numbers still low, only chosen as "best" reef sites

7. Caribbean Reef Fish Surveys (NOAA Ocean Service Biogeography Team)

Target:	Reef fish and benthos	**Duration:**	2001 to present
Coverage:	La Parguera; Buck Island, St. Croix; St. John	**Contact:**	Chris Caldow (Chris.Caldow@noaa.gov)
Data:	NOS BT; web	**Funding:**	NOAA CRCP

Basics: Consists of habitat-stratified 25 x 4 m surveys for reef fish and benthic characteristics. In first five years program surveyed almost 2000 sites for fish assemblage structure and associated fine scale habitat utilization patterns. Surveys focused on La Parguera, PR, Buck Island, STX and VINPS St. John.
Pro: number of samples good, spatial coverage good in VI, uniform methodology

Con: Only La Parguera in PR, no St. Thomas, short time series

8. REEF and AGRRA surveys

Target:	Reef fish
Coverage:	All areas, potentially
Duration:	1990 to present

Basics: Trained volunteer divers (Novice to expert) submit personally collected data. AGRRA actually funds some expeditions to collect data. Other analyses have looked at frequency of occurrence as metric for abundance. Size estimates also available. Site referenced. Over 2500 survey hours for USVI and 800 hours for Puerto Rico; includes BVI sites for platform-based areal coverage.
Pro: larger area, large number of samples
Con: variability in observers, relative abundance categories

9. Monitoring Reef Ecology, Coral Disease and Restoration (NOAA Fisheries SEFSC)

Target:	Reef fish, conch, and lobster	**Duration:**	1997 to present
Coverage:	Mona and Desecheo Islands, La Parguera, PR	**Contact:**	Ron Hill (ron.hill@noaa.gov)
Data:	SEFSC (PI)	**Funding:**	NOAA CRCP

Basics: Survey both permanent sites and random locations examining changes in coral reef ecology (e.g., coral disease, bleaching) and responses of reef fish assemblages. Surveys 2-3 times per year, ~70 modified AGRRA transects (30 x 2 m) for reef fish and benthos, point count surveys, and arc surveys of coral disease. Bank, shelf and shelf edge reefs, mainly adult habitats, does not target typical nursery habitats. Numbers of these species low: 6 yellowfin grouper over 8 year time frame, no mutton snapper.
Pro: number of samples good, spatial coverage good for western PR, uniform methodology linking habitat characteristics with reef fish assemblages
Con: Only La Parguera, Mona, Desecheo in PR, no VI, medium time series, few samples in some locations

10. Coral Reef Ecosystem Studies (University of Puerto Rico-Mayagüez)

Target:	Reef fish, corals, urchins, sedimentation	**Duration:**	2001 to 2009
Coverage:	La Parguera, Culebra, St. John	**Contact:**	Richard Appeldoorn (richard.appeldoorn@uprm.edu)
Data:	UPRM; NOS web	**Funding:**	NOAA NCCOS

Basics: NOAA NCCOS-grant funded partnership with UPR as lead. Projects are studying causes of reef degradation. Reef fish and benthic composition studied in permanent replicate transects (multiple depth strata) in forereef habitats of 8 different reefs. Additional funding for Deep CRES surveys using tech diving to ~200 ft.
Pro: repeat surveys over 5-6 yr period, lots of samples
Con: only forereef habitats, numbers are low

11. AUV:

Surveys using an autonomous underwater vehicle (AUV) have been conducted along portions of the deep shelf of PR and VI (personal communication, Graciela García-Moliner). Images are being analyzed for benthic composition; video also documents various organisms.
Pros: Good spatial coverage across PR and VI
Cons: No temporal replication, data not currently analyzed for conch or finfish

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6. INDICES OF ABUNDANCE

6.1. OVERVIEW

The Index Working Group discussed the availability of data sources for Puerto Rico and the US Virgin Islands platforms. The Working Group incorporated the findings from the platform catch working groups in guiding construction of the indices. That guidance included data filtering, procedures for identifying targeting, and the selection of index standardization methods (e.g., model fitting options).

6.1.1. Group Membership

Membership of this DW working group included Nancie Cummings, Walter Ingram (leader), Kevin McCarthy, and Adam Pollack. Tom Daley, Patricia Skov, Jens Skov and William Tobias from St. Croix; Gerson Martinez from Puerto Rico; Walter Keithly from Louisiana State University; Jed Brown and Juan Cruz from the Virgin Islands DPNR Department of Fish and Wildlife; Graciela Garcia-Moliner from the Caribbean Fishery Management Council; and Todd Gedamke from NOAA also joined the working group during some of the discussions.

6.2. REVIEW OF INDICES

The working group reviewed four working papers describing index construction:

SEDAR26-DW-05 (Puerto Rico Commercial Fisheries)
SEDAR26-DW-07 (Puerto Rico Parrotfish)
SEDAR26-DW-09 (USVI Parrotfish)
SEDAR26-DW-10 (Puerto Rico and USVI Fishery Independent)

6.3. FISHERY INDEPENDENT INDICES

6.3.1. Puerto Rico and USVI Fishery Independent (SEDAR26-DW-10)

During the late 1970s and early 1980s several fishery independent surveys were undertaken to examine the deep-water stocks of snapper and grouper off of Puerto Rico and the U.S. Virgin Islands. The primary gears fished included bottom longlines, off-bottom longlines, handlines and fish traps. Other gears, such as shrimp trawls and pelagic longlines, were fished sporadically during the surveys, but excluded from summaries due to low sample number or for not targeting species of interest. In this case, the species of interest include all snappers and groupers. After an extended hiatus, in 2009, bottom longlines, fish traps and video gear was used to assess the relative abundance of reef fish along the insular shelves of Puerto Rico and the U.S. Virgin Islands. Only data from the bottom longlines and fish traps were summarized for the target species. When enough data was present to produce an index, a delta-lognormal modeling approach was used to estimate a yearly relative abundance index (I_y), as described by Lo *et al*. (1992), otherwise nominal CPUE was reported. For a complete description of the model runs and methodology see SEDAR26-DW-10.

Two indices were produced for Puerto Rico queen snapper from the fisheries independent bottom longline data (Figure 6.8.1 and Table 6.7.1) and off bottom longline data (Figure 6.8.2 and Table 6.7.2). Two indices also were produced for Puerto Rico silk snapper from the fisheries independent bottom longline data (Figure 6.8.3 and Table 6.7.3) and the fish trap data (Figure 6.8.4 and Table 6.7.4). No indices from the USVI were able to converge. Overall, there was no final consensus on the abundance indices produced, it was however noted that most model runs resulted in high CVs, in some cases due to low sample sizes. Other issues with the data included missing years and a short time series (1979-1985).

6.4. FISHERY DEPENDENT INDICES

6.4.1. Puerto Rico Commercial Fisheries (SEDAR26-DW-05)

Abundance indices for silk and queen snapper commercial fisheries in Puerto Rico were previously presented by Cummings (Unpublished Document, SEDAR Procedures III 2009). This document presents updated information on silk and queen snapper abundances through 2009. Background information relating to the commercial fisheries in Puerto Rico was presented by Cummings and Matos-Caraballo (SEDAR Procedures III, SP3) and Cummings and Matos-Caraballo (SEDAR26 DW-03) and Suarez-Caabro, (1975) and Cummings and Matos-Caraballo (SEDAR26-DW03). Figure 6.8.5 provides a depiction of where the commercial Puerto Rico fisheries are conducted.

Queen Snapper

During the SEDAR 26 Data Workshop, the Puerto Rico platform Working Group reviewed DW03 and made recommendations for trip selection for use in catch per unit of effort (CPUE) abundance analyses. The Working Group recommended considering the following stratification in subsequent exploration of the commercial landings data for development of queen snapper catch per unit of effort abundance indices. The summarized landings data indicate two primary gears of importance in the fishery (reeffish bottom line gear and troll gear) during the entire time series, 1983-2009. The Working group recommended using trips from the bottom line and troll gear only as this is the gear primarily used to target Queen Snapper. Previous examinations of queen snapper abundance indices (Cummings and Matos-Caraballo, 2009) presented indices for combined gears and combined spatial areas. Prior to further index development, detailed examination of the area and gear specific and monthly observations were reviewed by the group and deemed sufficient for CPUE analyses. The queen snapper fishery is mainly conducted off the west coast of Puerto Rico corresponding to municipalities between Cabo Rojo and Aguadilla. Table 6.7.5 presents trip selection sub-criteria relating to year, area (fishing center, municipality), and gear selection. Two alternative data sets were examined for developing Queen snapper abundance indices. These included all trips where queen snapper contributed at least 10% and at least 50% of the trip landing weight.

For each data set evaluated, standardized CPUE indices were developed using the delta-lognormal modeling approach (Lo et al. 1992). This method applies a lognormal model to the positive CPUE observations and a binomial (logistic) model to the proportion of successful (positive) observations and combines the two to obtain a yearly abundance index. For each separate data set, the delta model was applied to obtain estimates of Queen or Silk Snapper yearly abundance. Parameter estimates were obtained using the SAS GLIMMIX and MIXED procedures in SAS (v. 9.2, 2004) to develop the binomial and lognormal sub models. Similar covariates were included in both sub models: Year, Municipality (proxy for fishing area) and Month. Factor (covariate) significance was evaluated using Type 3 residual analysis and overall performance was assessed from residual analysis graphics. Residuals by year were plotted and reviewed and QQ plots of the residuals against a normal distribution were plotted. Resulting lognormal indices for the 10% and 50% Queen Snapper trip data sets were generally similar to that of the delta-lognormal thus only final results from the Base model delta lognormal model are presented here.

Table 6.7.6 presents standardized CPUE for Queen Snapper Base run. The proportion of positives was very low, about 1-2% during the first 2-3 years of the fishery, and then increased only moderately to around 4% through about 2004. After 2002, the proportion of positives, increased again but again only moderately, ranging from 8-17%. The trend of proportion of positives over time, suggests that over the time series for which landings reports are available, that possibly the targeting behavior for queen snapper changed throughout the 23 year time period. During the first 16 years of the time series, 1987-2002, the proportion of positives was very low (1-2%) and though doubling during the next 7 years, remained <20% of all the trips. Model fits were further evaluated from graphical review. Figure 6.8.6 presents standardized CPUE, 95% confidence intervals, and nominal CPUE for the Queen Snapper fishery. Estimated delta lognormal standardized Queen Snapper CPUE varies without trend until about 2000 and thereafter shows a steady increase. This point in time also corresponds to the increase in proportion of positives of queen snapper in the bottom line and troll catches, suggesting possibly a change in targeting.

<u>Silk Snapper Handline Fishery Standardized CPUE Base Model Results</u>

Fish pot accounted for on average 20%-30%. Table 1.7.7 provides updated summary of commercial landings in Puerto Rico since 1983 for the three SEDAR26 focus species (queen, snapper, silk snapper, and parrotfish). On average throughout the time period, handline landings accounted for approximately 70-80% of the silk snapper landings. Fish pot accounted for on average 20%-30%. The SEDAR26 DW Panel recommended beginning the silk snapper CPUE analyses with 1988 as previous SEDAR stock assessment evaluations considered this the first year where reliable species identification probably occurs in the landings reports. Trip selection sub-criteria relating to year, area (fishing center, municipality), and gear selection are presented in Table 6.7.5 for silk snapper handline CPUE. Two alternative data sets were examined for developing silk snapper handline fishery abundance indices. These included all trips where silk snapper contributed at least 10% and at least 50% of the trip landing weight.

Table 6.7.8 and Figure 6.8.7 presents standardized CPUE, upper and lower 95% confidence intervals and nominal CPUE for the silk snapper handline fishery base run. Standardized delta-lognormal silk snapper handline CPUE was variable without trend between 1988 and 1994, showed significant declines between hereafter through 2000, was flat from 2000 through 2008, and decline again in 2009. Resulting lognormal indices for the 10% and 50% silk snapper handline fishery trip data sets were generally similar to that of the delta-lognormal model thus only final results from the Base model delta lognormal model are presented here.

Silk Snapper Fish Pot Fishery Standardized CPUE Base Model Results

Trip selection sub-criteria relating to year, area (fishing center, municipality), and gear selection are presented in Table 6.7.5 for silk snapper fish pot CPUE. Fish pots accounted for on average 20%-30% of the time period of commercial landings for silk snapper. One alternative data set was examined for developing silk snapper fish pot fishery abundance indices. These included all trips where silk snapper contributed at least 10% of the trip landing weight.

Table 6.7.9 and Figure 6.8.8 present standardized CPUE, upper and lower 95% confidence intervals and nominal CPUE for the silk snapper fish pot fishery base run. Standardized delta-lognormal silk snapper fish pot CPUE was variable without trend between 1988 and 1994. CPUE declined significantly between 1994 and 2007, increased in 2008 and decline again in 2009. Silk snapper fish pot CPUE was much more variable than silk snapper handline CPUE. Resulting lognormal indices for the 10% alternative silk snapper fish pot trip data sets were generally similar to that of the delta-lognormal model thus only final results from the Base model delta lognormal model are presented here.

6.4.2. Puerto Rico Parrotfish (SEDAR26-DW-07)

Abundance indices were developed for parrotfish, silk snapper, and queen snapper harvested by divers, fishpots, handlines, and gill and trammel nets and reported by trip tickets in Puerto Rico using the following multinomial approach. The multinomial index of relative abundance ($I_{s,y}$) was estimated as

$$\boldsymbol{I_{s,y} = c_y p_{s,y}},$$

where c_y is the estimate of mean total catch rate (lbs per station i.d.) for year y; $p_{s,y}$ is the estimate of the mean proportion of the catch made up by species s during year y.

Both c_y and $p_{s,y}$ were estimated using generalized linear models. Data used to estimate mean total catch rates (c) and species-specific mean proportion of the catch (p_s) were assumed to have a lognormal distribution and a multinomial distribution, respectively, and modeled using the following equations:

$$\ln(\mathbf{c}) = \mathbf{X\beta} + \boldsymbol{\varepsilon}$$

and

$$\ln\left(\frac{\mathbf{p}_s}{\mathbf{p}_5}\right) = \mathbf{X\beta} + \boldsymbol{\varepsilon}$$

respectively, where $\mathbf{c}$ is a vector of the catch rate data, $\mathbf{p}_s$ is a vector of data of the proportion of catch this is made up by species s, $\mathbf{X}$ is the design matrix for main effects, $\boldsymbol{\beta}$ is the parameter vector for main effects, and $\boldsymbol{\varepsilon}$ is a vector of independent normally distributed errors with expectation zero and variance σ^2. For the multinomial model, there were five catch proportion categories: four for each species in the silk group (blackfin, silk, black and vermilion snapper) and one for all other species combined (i.e. the rest of the catch). Since the "rest of catch" category comprised the largest proportion of the catch on average, this category (p_5) was treated as the baseline category; the four logit equations then described the log-odds of the rest of the catch being made up of each of the four species in the silk group.

c_y and $p_{s,y}$ were estimated as least-squares means for each year along with their corresponding standard errors, SE(c_y) and SE($p_{s,y}$), respectively. From these estimates, $I_{s,y}$ was calculated and its variance calculated as:

$$V\left(I_{s,y}\right) \approx V\left(c_y\right) p_{s,y}^2 + c_y^2 V\left(p_{s,y}\right) + 2 c_y p_{s,y} \mathrm{Cov}\left(c, p_s\right)$$

where

$$\mathrm{Cov}\left(c, p_s\right) \approx \rho_{c,p}\left[\mathrm{SE}\left(c_y\right) \mathrm{SE}\left(p_{s,y}\right)\right]$$

and $\rho_{c,p}$ denotes correlation of c and p_s among years. A table of variables used in each model and the unit of effort is listed with the index output of each species and gear combination.

Also, delta-lognormal models were developed as described by Lo *et al.* (1992) for parrotfish, and a table of variables used in each model and the unit of effort is listed with the index output of each species and gear combination.

Initial model runs were developed for the data workshop, and the results herein represent the new model runs that the index group and the workshop as a whole agreed upon. For parrotfish and the other species the delta-lognormal approach is recommended, since the multinomial approach has not yet been through peer-review and published. Therefore, index values were only reported for the delta-lognormal runs for parrotfish with each relevant gear. Three indices were produced for Puerto Rico parrotfish using fishery dependent data from commercial dive trips (Table 6.7.10. and Figure 6.8.9), trammel nets and gillnets (Table 6.7.11 and Figure 6.8.10), and fish pots (Table 6.7.12 and .Figure 6.8.11).

6.4.3. USVI Parrotfish (SEDAR26-DW-09)

A complete description of the methods used to construct US Virgin Islands fishery dependent indices of abundance are provided in document SEDAR26-DW09.

Self-reported landings and effort data from commercial fisher catch report forms (CCR) submitted to the Virgin Islands Department of Planning and Natural Resources, Department of Fish and Wildlife were used to construct standardized abundance indices for parrotfish in the US Virgin Islands. Indices were constructed using data reported from commercial fish trap (fish pot) in St. Thomas and St. John and from commercial fish trap, SCUBA, and gillnet trips in St. Croix. Parrotfish data were sufficient to construct an index of abundance including the years 1998-2008 (the final complete year of data available prior to the SEDAR data workshop). Data were reported by species group (e.g., parrotfish, snapper, grouper, etc.) during those years. During prior years, however, species groups were less well defined (e.g., snapper and grouper, not snapper/grouper) and effort data were not reported. The working group recommended limiting the time series to 1998-2008.

Data were filtered prior to the analyses. The filtering process included: removing trips reporting multiple areas fished, multiple gears fished, and those with missing effort (hours or trap soak time) or amount of gear fished. In addition, data reported prior to 1998 were also excluded.

Fishing effort data available for fish traps included number of hauls. Trap soak time was reported for the years 2003-2008. In order to expand the time series, number of hauls was used as the effort measure for traps. SCUBA fishing effort was more problematic to quantify because some fishers reported the number of divers while other fishers reported the number of SCUBA tanks used. The number of nets fished was reported for gillnet trips. For both SCUBA and gillnet trips the duration of the trip in hours was used in the CPUE calculations.

Gillnets had been used in St. Croix primarily to target parrotfish. The fishing method included setting the gillnets then using divers to drive parrotfish into the nets. Toller (2007) recommended that those trips reporting SCUBA as the fishing gear used should be reclassified as gillnet if more than 162.5 pounds of parrotfish landings were reported for the trip. This fishing technique was specific to the St. Croix parrotfish fishery and St. Croix trips reported as SCUBA trips were reclassified following Toller's recommendation.

Species group targeted was not reported on the CCR forms, therefore, trips targeting parrotfish were identified using a data subsetting technique (modified from Stephens and MacCall, 2004). That method was intended to restrict the data set to trips with fishing effort in presumptive parrotfish habitat. Such an approach was necessary because fishing location was not reported to the CCR at a spatial scale adequate to identify targeting based upon the habitat where the fishing occurred. A very high proportion of positive trips, more than 95 percent in most years, was found for gillnet trips targeting parrotfish (as identified using the Stephens and MacCall method). The decision was made to construct an index using data from positive trips only.

For the fish trap/pot and SCUBA data the delta lognormal model approach of Lo et al. (1992) was used to construct standardized indices of abundance. Parameterization of each model was accomplished using a GLM analysis (GENMOD; Version 9.1 of the SAS System for Windows © 2002-03. SAS Institute Inc., Cary, NC, USA). For the gillnet data a lognormal model on catch rates of all trips reporting parrotfish landings from gillnets in St. Croix was used to construct a standardized index of abundance. Parameterization of the model was accomplished using a GLM procedure (GENMOD; Version 9.1 of the SAS System for Windows © 2002-03. SAS Institute Inc., Cary, NC, USA).

For each GLM analysis of proportion positive trips, a type-3 model was fit, a binomial error distribution was assumed, and the logit link was selected. The response variable was proportion successful trips. During the analysis of catch rates on successful trips, a type-3 model assuming lognormal error distribution was examined. The linking function selected was "normal", and the response variable was log(CPUE). The response variable was calculated as: log(CPUE)=ln(pounds of parrotfish/gear-specific effort). All 2-way interactions among significant main effects were examined. Higher order interaction terms were not examined.

A forward stepwise regression procedure was used to determine the set of fixed factors and interaction terms that explained a significant portion of the observed variability. Each potential factor was added to the null model sequentially and the resulting reduction in deviance per degree of freedom was examined. The factor that caused the greatest reduction in deviance per degree of freedom was added to the base model if the factor was significant based upon a Chi-Square test ($p<0.05$), and the reduction in deviance per degree of freedom was ≥1%. This model then became the base model, and the process was repeated, adding factors and interactions individually until no factor or interaction met the criteria for incorporation into the final model.

Relative nominal CPUE, number of trips, proportion positive trips, and relative abundance indices are provided in Tables 6.7.13 – 6.7.16. The abundance indices, along with 95% confidence intervals, are shown in Figures 6.8.12-6.8.15. The three St. Croix indices are plotted together in Figure 6.8.16.

Parrotfish standardized catch rates for fish trap vessels in St. Thomas and St. John were stable over most of the time series. During the final two years, however, mean yearly CPUE declined. Unfortunately, landings and effort data for the most recent years, 2009-10, were not available prior to the data workshop. It is unknown, therefore, if the trend of decreasing CPUE had continued.

Parrotfish standardized catch rates for fish trap vessels in St. Croix show no trend over the time series. Nominal CPUE was higher during the final two years of the series, however. The confidence intervals around the standardized CPUE series are sufficiently broad as to include the nominal series. With such wide confidence intervals, one could hypothesize increasing, decreasing, or stable parrotfish CPUE, and therefore population abundance, over the period.

Parrotfish standardized catch rates for SCUBA in St. Croix appear to increase over time, although the confidence intervals were broad and any increase may have been small. Nominal CPUE increased from 1998 through 2008, particularly during the final three years. The proportion of positive trips initially decreased, but has consistently increased since 2000.

Parrotfish have been targeted in St. Croix by fishers using SCUBA. Constructing indices of abundance using data from such targeted fisheries complicates the interpretation of any observed trends in CPUE. Determining whether increasing CPUE has resulted from increased population abundance or increased fisher efficiency can be problematic. An additional issue with the SCUBA data is the uncertainty in the effort reported. While some fishers reported the number of divers, others reported the number of SCUBA tanks used while fishing. Those effort measures are not equivalent and cannot be differentiated in much of the data set. As a consequence, the calculated CPUE for the SCUBA data cannot be confidently used to calculate meaningful estimates of CPUE. Additional detailed investigation of this issue may provide a mechanism for resolving the problem in the future.

Index construction using the St. Croix parrotfish gillnet data was limited to positive trips only because of the very high proportion positive trips identified as targeting parrotfish during an initial Stephens and MacCall analysis. That result is not surprising given than gillnets are specifically used to target parrotfish in St. Croix.

Parrotfish standardized catch rates for gillnet trips in St. Croix appear to have increased slightly over time, although confidence intervals were large enough that any increase in yearly mean CPUE may have been minimal. Highest mean CPUEs occurred during the years 2002-2008. Highest nominal CPUEs were also found during the final years of the period (2005-2008). Results of this analysis should be used cautiously because the data were reported from fishers actively targeting parrotfish. Yearly mean CPUE calculated from commercial gillnet data may not reflect parrotfish abundance, but rather the ability of fishers to successfully target the species.

6.5. CONSENSUS RECOMMENDATIONS AND SURVEY EVALUATIONS

Puerto Rico

The Index Working Group conducted multi-species and single-species index development analysis for silk and queen snapper; however, the Working Group recommended that results of the single species analyses be used in the assessment.

<u>Silk snapper</u>

The Working Group recommended that the silk snapper handline index be used in the assessment. The dominant component of the silk snapper landings were from the handline fishery. In addition, the estimated confidence intervals from the delta-lognormal handline index were smaller than those from the fish pot index. No consensus had been reached for the fishery independent indices.

Queen snapper

The Working Group recommended that the delta-lognormal combined bottom line and troll fishery be used in the assessment.

Parrotfish

No final recommendations have been made for the Puerto Rico parrotfish indices that have been constructed. No consensus had been reached for the fishery independent indices.

US Virgin Islands

Silk and Queen Snapper

For silk and queen snapper in the US Virgin Islands, the recommendation in plenary session at the data workshop was that indices of abundance should not be constructed because landings from the Virgin Islands commercial fishery have been reported by species group. The proportion of silk and queen snapper in the commercial landings is unknown. Indices of abundance, ostensibly of silk or queen snapper, constructed using CCR data would, therefore, have little utility.

Parrotfish

Recommendations of the working group and from plenary session were to construct indices of abundance using CCR data for US Virgin Islands parrotfish as a proxy for redtail parrotfish indices. Redtail parrotfish were believed to make up the majority of parrotfish landings. This assumption was supported by very high proportion of redtail parrotfish relative to other parrotfish species in the Trip Interview Program data.

No final recommendations have been made for the US Virgin Islands parrotfish indices that have been constructed. The methods described in SEDAR26-DW09 (data filtering, use of Stephens and MacCall, positive only analysis of St. Croix gillnet data) were approved either in plenary session at the data workshop or in a post-workshop webinar.

6.6. LITERATURE CITED

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6.7. TABLES

Table 6.7.1. Indices of abundance for queen snapper caught off Puerto Rico on bottom longlines developed using the delta-lognormal model for 1979-1985. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1979	0.16667	48	0.07675	0.45697	0.64096	0.14136	1.4773
1980	0.17708	95	0.17112	1.01879	0.44348	0.43655	2.3776
1981	0.30769	13	0.40738	2.42545	0.81451	0.58234	10.1019
1982	0.14286	98	0.16534	0.98440	0.33776	0.51013	1.8996
1983	0.06923	130	0.11723	0.69794	0.59070	0.23368	2.0846
1984	0.12048	77	0.17655	1.05113	0.45036	0.44503	2.4827
1985	0.05882	33	0.06136	0.36534	0.79572	0.09002	1.4826

Table 6.7.2. Indices of abundance for queen snapper off Puerto Rico caught on off bottom longlines developed using the delta-lognormal model for 1982-1985. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1982	0.061224	98	0.029652	0.62732	0.83229	0.14701	2.67693
1983	0.031250	128	0.022428	0.47449	1.26190	0.06737	3.34171
1984	0.094118	85	0.085791	1.81499	0.67922	0.52954	6.22090
1985	0.090909	30	0.051201	1.08320	1.15271	0.17223	6.81245

Table 6.7.3. Indices of abundance for silk snapper caught off Puerto Rico in fish traps developed using the delta-lognormal model for 1979-1985. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1979	0.33333	3	0.10699	0.05710	2.33662	0.00372	0.87699
1980	0.70000	10	4.80192	2.56254	0.46574	1.05638	6.21617
1981	0.00000	1	0				
1982	0.81250	16	2.58043	1.37704	0.30411	0.75966	2.49619
1983	0.41667	12	0.29771	0.15887	0.88316	0.03479	0.72543
1984	0.00000	1	0				
1985	0.20000	40	1.58241	0.84445	0.49121	0.33324	2.13992

Table 6.7.4. Indices of abundance for silk snapper caught off Puerto Rico on bottom longlines developed using the delta-lognormal model for 1979-1985. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1979	0.12500	48	0.012456	0.36474	2.24545	0.02495	5.33227
1980	0.11458	95	0.080798	2.36596	0.58922	0.79404	7.04979
1981	0.00000	13	0				
1982	0.05102	98	0.038255	1.12020	1.19723	0.16991	7.38559
1983	0.03077	130	0.018285	0.53544	1.84123	0.04702	6.09768
1984	0.03614	77	0.020956	0.61365	1.91438	0.05129	7.34233
1985	0.00000	33	0				

Table 6.7.5. SEDAR26 Puerto Rico Platform Commercial Fishery Statistics Working Group Recommendations for CPUE abundance data selection and analyses. Recommendations for starting year, gears included, and geographical areas (i.e., municipalities) used in CPUE standardization.

	Gear				
Species	**Handline**	**Fishpots**	**Gillnet**	**Trammel Net**	**Dive**
Silk Snapper (with vermilion snapper, blackfin snapper, and black snapper)	Start Year = 1983+ Gear = 104 + 112 + 113 + 105 Fishing Centers = 01 + 02 + 03 + 05 + 06 + 12 + 13 + 15 + 16 + 18 + 20 + 21 + 22 + 25 + 28 + 29 + 32 + 33 + 35 + 36 + 37 + 38 + 39 + 40 + 41 + 42	Start Year = 1983+ Gear = 101 Fishing Centers = 01 + 05 + 06 + 08 + 09 + 10 + 12 + 13 + 14 + 15 + 16 + 18 + 20 + 22 + 23 + 25 + 28 + 32 + 36 + 37 + 38 + 39 + 40 + 41 + 42			
Queen Snapper (with cardinal snapper)	Start Year = 1987+ Gear = 104 + 105 Fishing Centers = 01 + 05 + 06 + 12 + 13 + 15 + 16 + 28 + 32 + 35 + 36 + 37 + 38 + 39 + 40 + 41 + 42				
Parrotfish		Start Year = 1983+ Gear = 101 Fishing Centers = 18 + 19 + 20 + 21 + 22 + 23 + 24 + 25 + 27 + 28 + 29 + 31 + 36 + 37	Start Year = 1988+ Gear = 103 Fishing Centers = 23 + 27 + 35 + 36 + 37	Start Year = 1988+ Gear = 118 Fishing Centers = 23 + 27 + 35 + 36 + 37	Start Year = 1997+ Gear = 110 + 114 + 115 + 116 + 119 Fishing Centers = 14 + 18 + 19 + 20 + 21 + 24 + 25 + 27 + 33 + 34 + 35 + 36 + 37 + 38 + 40

Table 6.7.6. Puerto Rico Queen Snapper Base Model Standardized CPUE Results. STDCPUE, LCI, UCI, and obcpue = standardized index, lower and upper 95% Confidence Intervals, and nominal CPUE.

YEAR	Standard Error	obcpue	obppos	nobs	cv_i	MEANINDEX	STDCPUE	LCI	UCI	estcpue	obscpue
1988	0.2105	1.7679	0.02658	5605	0.21425	1.04583	0.93957	0.61505	1.43529	0.98262	0.29123
1989	0.09143	1.0358	0.02274	6639	0.21599	1.04583	0.40474	0.26406	0.62037	0.42329	0.17064
1990	0.07915	0.368	0.00625	2720	0.57192	1.04583	0.13233	0.04567	0.38348	0.1384	0.06062
1991	0.07628	0.5373	0.0176	3864	0.29515	1.04583	0.24714	0.13865	0.44052	0.25846	0.0885
1992	0.1496	2.647	0.06002	3482	0.19514	1.04583	0.73298	0.49794	1.07896	0.76656	0.43605
1993	0.1683	3.5579	0.07601	4447	0.16765	1.04583	0.95981	0.68799	1.33904	1.0038	0.5861
1994	0.1761	2.366	0.04973	6716	0.15677	1.04583	1.07406	0.78647	1.46681	1.12328	0.38975
1995	0.07848	1.324	0.02269	10136	0.1816	1.04583	0.41325	0.28824	0.59247	0.43219	0.2181
1996	0.1141	1.8722	0.03599	10613	0.14982	1.04583	0.72849	0.54077	0.98137	0.76187	0.30841
1997	0.1289	1.9023	0.02626	10813	0.16123	1.04583	0.76473	0.55509	1.05354	0.79977	0.31337
1998	0.1885	1.8253	0.02854	6166	0.19248	1.04583	0.93634	0.63939	1.37122	0.97925	0.30069
1999	0.1965	2.4266	0.03745	6034	0.17607	1.04583	1.06729	0.75251	1.51375	1.1162	0.39973
2000	0.1244	1.4181	0.02389	8122	0.18842	1.04583	0.63144	0.4346	0.91742	0.66037	0.23361
2001	0.1516	4.3708	0.03866	9285	0.15335	1.04583	0.94503	0.69666	1.28195	0.98834	0.72001
2002	0.1545	8.2308	0.04676	8576	0.15144	1.04583	0.97573	0.722	1.31864	1.02045	1.35586
2003	0.1262	10.2602	0.11438	10483	0.12222	1.04583	0.98766	0.77418	1.26001	1.03293	1.69018
2004	0.1379	8.4668	0.09897	8619	0.12772	1.04583	1.03222	0.80036	1.33126	1.07952	1.39474
2005	0.2513	17.2005	0.14095	8301	0.11918	1.04583	2.01577	1.58959	2.55622	2.10814	2.83344
2006	0.2475	12.9914	0.12506	6709	0.13073	1.04583	1.81022	1.39528	2.34857	1.89318	2.14007
2007	0.255	13.7191	0.13248	7465	0.12272	1.04583	1.9869	1.55591	2.53729	2.07795	2.25996
2008	0.2097	18.4581	0.16815	7071	0.12553	1.04583	1.59706	1.24369	2.05083	1.67024	3.04061
2009	0.2242	16.8052	0.15766	6330	0.13257	1.04583	1.61722	1.24199	2.10582	1.69133	2.76833

Table 6.7.7. Reported commercial landings of silk and queen snapper and parrotfish group in Puerto Rico 1983-2009, SEDAR26 focus species. Preliminary information. Data presented = number reported landings observations (N) and reported pounds (whole weight). Landings are reported (not expanded).

	Queen snapper		Silk snapper		Parrotfishes	
Year	#Reports	Pounds	# Reports	Pounds	#Reports	Pounds
1983			3,860	396,343	2,677	233,579
1984			2,713	357,156	1,698	231,387
1985			2,403	371,827	2,105	221,378
1986			2,664	356,899	1,763	105,546
1987	38	4,379	2,659	207,063	1,370	76,854
1988	209	14,763	2,232	170,034	265	12,208
1989	214	15,405	2,988	245,961	71	4,279
1990	220	11,390	2,303	176,884	470	36,849
1991	451	17,780	3,242	167,230	914	68,059
1992	492	25,285	3,004	207,966	1,134	91,932
1993	555	32,346	3,075	244,065	1,171	160,187
1994	496	27,765	3,826	338,852	1,549	115,750
1995	581	34,138	4,595	363,300	2,017	79,881
1996	575	36,685	4,340	311,324	2,547	102,799
1997	560	38,778	4,051	285,787	2,713	110,944
1998	567	46,073	3,779	209,384	2,433	97,503
1999	699	66,695	3,601	224,818	2,403	80,547
2000	761	82,869	3,493	188,270	3,054	74,041
2001	906	102,138	5,029	266,851	3,665	96,762
2002	838	110,061	4,637	198,148	3,172	107,485
2003	1,584	127,015	4,921	170,012	3,277	69,229
2004	1,068	79,553	3,634	118,997	2,488	51,152
2005	1,376	156,755	2,883	110,525	1,644	31,157
2006	1,032	102,889	2,291	83,399	1,792	31,922
2007	1,125	111,130	1,709	68,364	1,858	33,742
2008	1,290	137,292	2,185	108,634	1,740	28,134
2009	1,088	110,275	1,852	83,360	1,969	28,353
All Years	16,725	1,491,459	87,969	6,031,453	51,959	2,381,659

Table 6.7.8. Puerto Rico Silk Snapper Handline Fishery Base Model Standardized CPUE Results. STDCPUE, LCI, UCI, and obcpue = standardized index, lower and upper 95% Confidence Intervals, and nominal CPUE.

YEAR	Standard Error	obcpue	obppos	nobs	cv_i	MEANINDEX	STDCPUE	LCI	UCI	estcpue	obscpue
1988	0.4508	15.31689	0.171774	6526	0.077577	6.234501	0.932169	0.798386	1.088369	5.811607	1.321372
1989	0.4183	20.57794	0.20615	7480	0.066731	6.234501	1.005357	0.879879	1.148728	6.267896	1.775238
1990	0.8735	15.47449	0.150752	3058	0.114522	6.234501	1.22344	0.97372	1.537203	7.627539	1.334969
1991	0.5248	9.594536	0.14961	4612	0.097691	6.234501	0.86172	0.709111	1.047173	5.372393	0.827711
1992	0.6902	18.52337	0.2124	4129	0.086342	6.234501	1.282253	1.079237	1.523458	7.994206	1.597992
1993	0.4801	15.94713	0.167693	5844	0.081968	6.234501	0.939484	0.797649	1.106539	5.857213	1.375742
1994	0.4826	19.78484	0.198506	8166	0.064013	6.234501	1.209331	1.064146	1.374325	7.539578	1.706818
1995	0.3334	16.39671	0.17539	12629	0.055522	6.234501	0.963301	0.862131	1.076344	6.005702	1.414527
1996	0.3319	11.56139	0.182142	12902	0.054876	6.234501	0.970195	0.86942	1.082649	6.048679	0.997389
1997	0.3333	12.66999	0.178349	13154	0.054752	6.234501	0.976357	0.87516	1.089256	6.087102	1.093027
1998	0.3744	7.402687	0.162067	8262	0.070298	6.234501	0.854215	0.742306	0.982997	5.325607	0.638622
1999	0.3700	7.071689	0.152913	8495	0.071333	6.234501	0.831889	0.721414	0.959282	5.186414	0.610067
2000	0.2908	6.186542	0.147319	10759	0.065456	6.234501	0.712519	0.625177	0.812064	4.4422	0.533707
2001	0.3250	8.43254	0.181662	12815	0.054872	6.234501	0.950028	0.851355	1.060137	5.92295	0.727467
2002	0.3197	7.2327	0.179214	11835	0.056542	6.234501	0.906842	0.809951	1.015323	5.653706	0.623958
2003	0.2960	7.304172	0.199547	12368	0.053909	6.234501	0.880806	0.790842	0.981005	5.491387	0.630123
2004	0.3589	8.146056	0.207463	10585	0.055851	6.234501	1.030798	0.921933	1.152518	6.426511	0.702752
2005	0.3626	7.734368	0.192384	10635	0.058412	6.234501	0.995787	0.886081	1.119076	6.208237	0.667236
2006	0.4474	8.708468	0.208966	8030	0.062931	6.234501	1.140235	1.005513	1.293008	7.108799	0.751271
2007	0.4436	9.640311	0.201108	6678	0.070328	6.234501	1.011747	0.879146	1.164348	6.307738	0.83166
2008	0.5352	12.55673	0.233084	6813	0.065563	6.234501	1.309324	1.148578	1.492566	8.16298	1.083256
2009	0.4741	8.752825	0.209865	5575	0.075131	6.234501	1.012203	0.871167	1.176071	6.310579	0.755097

Table 6.7.9. Puerto Rico Silk Snapper Fish Pot Fishery Base Model Standardized CPUE Results. STDCPUE, LCI, UCI, and obcpue = standardized index, lower and upper 95% Confidence Intervals, and nominal CPUE.

YEAR	Standard Error	obcpue	obppos	nobs	cv_i	MEANINDEX	STDCPUE	LCI	UCI	estcpue	obscpue
1988	1.1106	4.880409	0.094037	2935	0.14681	9.612565	0.787012	0.587683	1.053948	7.565202	0.640696
1989	1.2302	5.993335	0.126899	3751	0.115704	9.612565	1.106064	0.878244	1.392981	10.63211	0.7868
1990	1.5509	1.755343	0.052321	2714	0.195217	9.612565	0.826466	0.561364	1.216762	7.944457	0.23044
1991	1.1538	4.724585	0.120404	2774	0.138425	9.612565	0.867097	0.658269	1.142174	8.335031	0.62024
1992	1.3246	15.19965	0.234192	1708	0.148624	9.612565	0.927185	0.689887	1.246105	8.912623	1.995397
1993	1.9915	10.67045	0.209161	2467	0.097661	9.612565	2.121402	1.74581	2.5778	20.39212	1.400808
1994	1.4772	12.81882	0.166826	3135	0.109121	9.612565	1.408275	1.132886	1.750608	13.53713	1.682844
1995	1.3981	7.169495	0.127705	4714	0.105075	9.612565	1.384224	1.122509	1.706959	13.30595	0.941205
1996	1.1080	5.952849	0.121527	3563	0.120752	9.612565	0.954529	0.750385	1.21421	9.17547	0.781485
1997	1.5021	7.261924	0.143088	3711	0.108826	9.612565	1.435917	1.155798	1.783925	13.80284	0.953339
1998	1.2690	9.096642	0.220522	2680	0.107075	9.612565	1.232914	0.995848	1.526414	11.85147	1.194199
1999	1.1234	7.380315	0.200932	3434	0.111929	9.612565	1.044099	0.835264	1.305146	10.03647	0.968881
2000	1.1238	11.60387	0.19599	2893	0.122311	9.612565	0.95585	0.74911	1.219645	9.188166	1.523346
2001	0.7552	11.9187	0.242943	4145	0.100121	9.612565	0.784644	0.642578	0.958119	7.542443	1.564676
2002	0.7059	7.896847	0.286727	4091	0.088672	9.612565	0.828132	0.693795	0.988481	7.960474	1.036691
2003	0.7486	11.9145	0.351183	3380	0.0824	9.612565	0.94515	0.801771	1.11417	9.085319	1.564125
2004	0.6111	6.210662	0.292279	2720	0.101309	9.612565	0.627469	0.51265	0.768005	6.031589	0.81533
2005	0.6695	4.343147	0.21269	1970	0.13781	9.612565	0.505361	0.384117	0.664873	4.857811	0.570165
2006	0.8285	5.463656	0.232181	1417	0.149661	9.612565	0.575875	0.427616	0.775537	5.535636	0.717264
2007	0.9941	5.239295	0.199832	1191	0.187656	9.612565	0.551124	0.379893	0.799534	5.297716	0.68781
2008	1.9049	5.652517	0.253702	1013	0.17858	9.612565	1.109708	0.778595	1.581633	10.66714	0.742058
2009	1.6911	4.434822	0.203282	1097	0.172225	9.612565	1.021503	0.72567	1.437939	9.819267	0.5822

Table 6.7.10. Indices of abundance for parrotfish caught off Puerto Rico on commercial dive trips developed using the delta-lognormal model for 1979-1985. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trip), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1997	0.13329	4194	2.49370	0.99739	0.19073	0.68340	1.45564
1998	0.09819	2536	2.20685	0.88266	0.20531	0.58790	1.32521
1999	0.07437	3523	1.55970	0.62382	0.21175	0.41035	0.94835
2000	0.12735	4476	2.98586	1.19423	0.19451	0.81228	1.75579
2001	0.11921	6451	2.18543	0.87409	0.19050	0.59919	1.27512
2002	0.11096	6074	2.21006	0.88394	0.19418	0.60162	1.29876
2003	0.09241	6623	2.04287	0.81707	0.19435	0.55593	1.20090
2004	0.05083	8125	1.87029	0.74805	0.20310	0.50038	1.11830
2005	0.03361	6813	2.77035	1.10804	0.21851	0.71940	1.70663
2006	0.09209	6374	2.85771	1.14298	0.19372	0.77861	1.67786
2007	0.09487	7136	2.26229	0.90483	0.19258	0.61776	1.32531
2008	0.12447	7480	4.34202	1.73665	0.17943	1.21645	2.47931
2009	0.08671	8096	2.71587	1.08625	0.18949	0.74609	1.58149

Table 6.7.11. Indices of abundance for parrotfish caught off Puerto Rico on commercial trammel net and gillnet trips developed using the delta-lognormal model for 1979-1985. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (length (fathoms by hours soaked), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1983	0.27374	179	0.03535	0.66478	0.15429	0.48916	0.90346
1984	0.22124	113	0.04639	0.87225	0.24510	0.53808	1.41396
1985	0.27350	117	0.02815	0.52933	0.30925	0.28922	0.96879
1986	0.19048	21	0.00979	0.18412	0.82626	0.04350	0.77929
1987	0.38462	13	0.08615	1.61996	0.52078	0.60815	4.31517
1988	0.06423	794	0.01110	0.20867	0.20656	0.13865	0.31405
1989	0.00862	580	0.00293	0.05501	0.50494	0.02121	0.14269
1990	0.12634	744	0.05478	1.03018	0.19507	0.69993	1.51626
1991	0.22111	701	0.06316	1.18766	0.11432	0.94563	1.49163
1992	0.38761	436	0.08080	1.51936	0.10100	1.24208	1.85853
1993	0.24597	496	0.07973	1.49929	0.14133	1.13172	1.98624
1994	0.32663	845	0.07960	1.49690	0.09817	1.23063	1.82077
1995	0.30577	1403	0.08926	1.67848	0.08279	1.42276	1.98015
1996	0.26392	2012	0.04200	0.78982	0.08550	0.66588	0.93683
1997	0.22949	1987	0.01573	0.29572	0.09266	0.24579	0.35580
1998	0.13947	1011	0.01066	0.20036	0.13889	0.15197	0.26417
1999	0.17083	1241	0.08536	1.60508	0.16414	1.15843	2.22394
2000	0.22021	1267	0.01801	0.33862	0.09683	0.27912	0.41079
2001	0.22810	1701	0.10733	2.01831	0.11563	1.60283	2.54150
2002	0.29473	1537	0.03080	0.57916	0.07924	0.49440	0.67845
2003	0.26229	2116	0.05226	0.98274	0.07837	0.84038	1.14923
2004	0.32381	1680	0.14626	2.75027	0.07928	2.34757	3.22206
2005	0.31088	1232	0.06692	1.25837	0.08562	1.06066	1.49294
2006	0.36164	1001	0.05387	1.01306	0.07802	0.86691	1.18386
2007	0.26502	1132	0.08971	1.68693	0.12515	1.31466	2.16462
2008	0.28032	1006	0.03719	0.69937	0.11830	0.55247	0.88533
2009	0.29925	1203	0.01256	0.23619	0.08501	0.19932	0.27988

Table 6.7.12. Indices of abundance for parrotfish caught off Puerto Rico on commercial fish pot trips developed using the delta-lognormal model for 1979-1985. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trap), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1983	0.23919	2659	0.19469	0.69559	0.07882	0.59429	0.81416
1984	0.09380	597	0.23972	0.85646	0.25370	0.51972	1.41136
1985	0.27427	649	0.41256	1.47398	0.14546	1.10359	1.96869
1986	0.19136	162	0.28365	1.01343	0.37748	0.48840	2.10287
1987	0.10811	222	0.08000	0.28582	0.36961	0.13972	0.58466
1988	0.02520	3056	0.11243	0.40168	0.23826	0.25106	0.64266
1989	0.01493	3750	0.21280	0.76029	0.25859	0.45708	1.26463
1990	0.01384	2674	0.05791	0.20691	0.29462	0.11620	0.36846
1991	0.04322	3332	0.40324	1.44070	0.16522	1.03760	2.00041
1992	0.05992	1235	0.36180	1.29265	0.24177	0.80253	2.08211
1993	0.04577	2010	0.19460	0.69526	0.21032	0.45860	1.05404
1994	0.06155	2697	0.40815	1.45823	0.15080	1.08039	1.96821
1995	0.05353	4969	0.23372	0.83504	0.12016	0.65722	1.06098
1996	0.06497	4448	0.08323	0.29737	0.11515	0.23638	0.37410
1997	0.02980	4598	0.04157	0.14853	0.16913	0.10616	0.20782
1998	0.05467	3402	0.02957	0.10563	0.14189	0.07965	0.14010
1999	0.08012	4568	0.05813	0.20770	0.10027	0.17004	0.25369
2000	0.13094	3933	0.12022	0.42951	0.09032	0.35866	0.51435
2001	0.13176	4288	0.11191	0.39984	0.08640	0.33650	0.47510
2002	0.14089	4656	0.14238	0.50870	0.07612	0.43696	0.59222
2003	0.22643	3648	0.35071	1.25301	0.06679	1.09650	1.43185
2004	0.21887	2883	0.50460	1.80283	0.07521	1.55138	2.09504
2005	0.25306	2288	1.28640	4.59605	0.07947	3.92165	5.38642
2006	0.31139	1747	0.54091	1.93257	0.07952	1.64883	2.26512
2007	0.27559	1524	0.34861	1.24552	0.08916	1.04246	1.48812
2008	0.32407	1188	0.40247	1.43795	0.09524	1.18908	1.73892
2009	0.24293	1663	0.34112	1.21876	0.09343	1.01143	1.46857

Table 6.7.13. Commercial parrotfish fish trap/pot relative nominal CPUE, number of trips, proportion positive trips, and standardized abundance index in St. Thomas/St. John.

YEAR	Normalized Nominal CPUE	Trips	Proportion positive trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1999	1.078960	847	0.880756	1.012046	0.918410	1.115229	0.048571
2000	0.879736	1,645	0.868693	0.870396	0.801568	0.945135	0.041207
2001	0.970574	1,723	0.915844	1.051859	0.980954	1.127889	0.034905
2002	0.863816	1,661	0.913305	1.005433	0.935130	1.081022	0.036256
2003	0.845747	1,603	0.941360	1.015602	0.948095	1.087916	0.034401
2004	0.979382	1,554	0.945302	1.083448	1.009466	1.162851	0.035374
2005	1.286454	1,515	0.952475	1.097917	1.026754	1.174013	0.033516
2006	1.419243	1,488	0.922715	1.076463	1.001278	1.157293	0.036214
2007	0.995032	1,399	0.909936	0.953261	0.882264	1.029970	0.038713
2008	0.681055	1,559	0.880693	0.833575	0.767118	0.905789	0.041559

Table 6.7.14. Commercial parrotfish fish trap/pot relative nominal CPUE, number of trips, proportion positive trips, and standardized abundance index in St. Croix.

YEAR	Normalized Nominal CPUE	Trips	Proportion positive trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1998	0.696008	1,688	0.907583	1.178828	0.683623	2.032752	0.277569
1999	0.837119	1,533	0.936073	1.172308	0.679037	2.023904	0.278195
2000	0.817928	1,670	0.877246	1.079182	0.609879	1.909616	0.291258
2001	0.880524	1,780	0.838202	1.135318	0.644897	1.998687	0.288538
2002	0.874237	1,855	0.851752	1.010112	0.575300	1.773554	0.287130
2003	0.718735	1,473	0.860828	0.898615	0.499344	1.617138	0.300234
2004	0.934105	1,416	0.784605	0.968530	0.519538	1.805548	0.319125
2005	1.126199	1,338	0.843049	0.929967	0.498697	1.734197	0.319292
2006	0.819054	1,250	0.820800	0.670687	0.351414	1.280030	0.331792
2007	1.663072	987	0.885512	0.905064	0.495901	1.651823	0.307750
2008	1.633020	876	0.917808	1.051389	0.591141	1.869974	0.293977

Table 6.7.15. Commercial parrotfish SCUBA relative nominal CPUE, number of trips, proportion positive trips, and standardized abundance index in St. Croix.

YEAR	Normalized Nominal CPUE	Trips	Proportion positive trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1998	0.553583	472	0.758475	0.522579	0.305573	0.893692	0.273194
1999	0.599615	558	0.707885	0.799641	0.452794	1.412178	0.290209
2000	0.682450	873	0.682703	0.829508	0.490410	1.403077	0.267399
2001	0.847550	1,144	0.689685	0.770038	0.449091	1.320353	0.274581
2002	0.875840	1,346	0.753343	0.785987	0.475541	1.299099	0.255261
2003	0.809712	1,550	0.781935	1.057284	0.639040	1.749263	0.255787
2004	0.833758	1,664	0.817308	1.027793	0.635866	1.661292	0.243593
2005	0.909510	1,439	0.820014	1.045845	0.650925	1.680367	0.240465
2006	1.089758	1,787	0.858982	1.380870	0.874429	2.180627	0.231463
2007	1.434237	1,529	0.898627	1.110119	0.716640	1.719641	0.221470
2008	2.363987	1,555	0.974920	1.670336	1.100094	2.536167	0.211112

Table 6.7.16. Commercial parrotfish gillnet relative nominal CPUE, number of trips, and standardized abundance index in St. Croix.

YEAR	Normalized Nominal CPUE	Trips	Standardized Index	Lower 95% CI (Index)	Upper 95% CI (Index)	CV (Index)
1998	0.717843	439	0.607533	0.442015	0.835031	0.160042
1999	0.774670	525	0.885971	0.651401	1.20501	0.154693
2000	0.917601	506	0.965108	0.715935	1.301002	0.150161
2001	0.952275	497	0.946476	0.70798	1.265315	0.145933
2002	1.011801	572	1.044853	0.779994	1.399648	0.146957
2003	0.931485	599	0.886987	0.664181	1.184535	0.145397
2004	0.999216	689	1.002068	0.751513	1.336158	0.144614
2005	1.268651	666	1.152142	0.864049	1.536293	0.144623
2006	1.131468	679	0.966135	0.724342	1.288641	0.14477
2007	1.127113	336	1.107605	0.82632	1.484642	0.147276
2008	1.167878	28	1.435122	0.832481	2.474019	0.277423

6.8. FIGURES

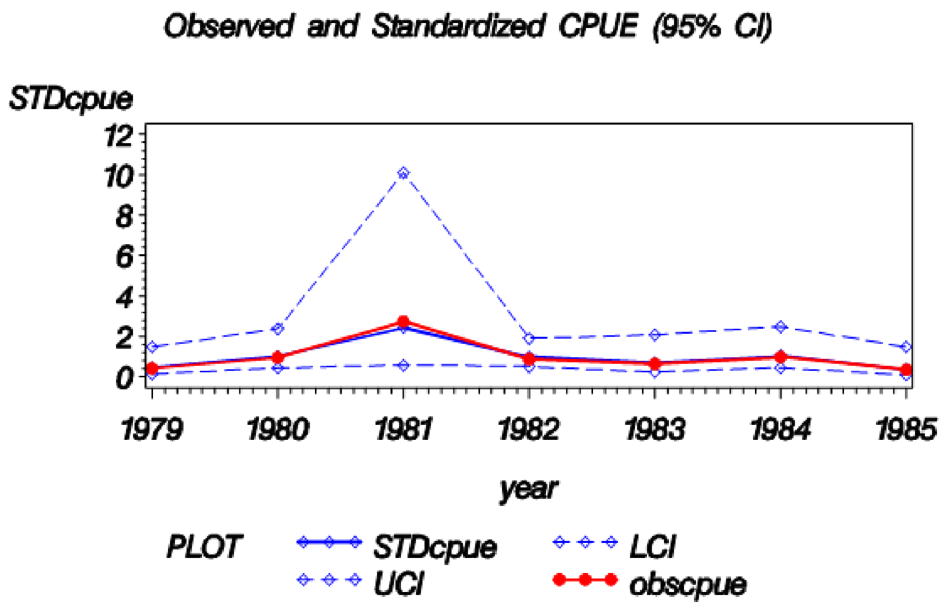

Figure 6.8.1. Queen snapper nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for fishery independent bottom longline data from Puerto Rico. CPUE = number of fish per 100 hook hour

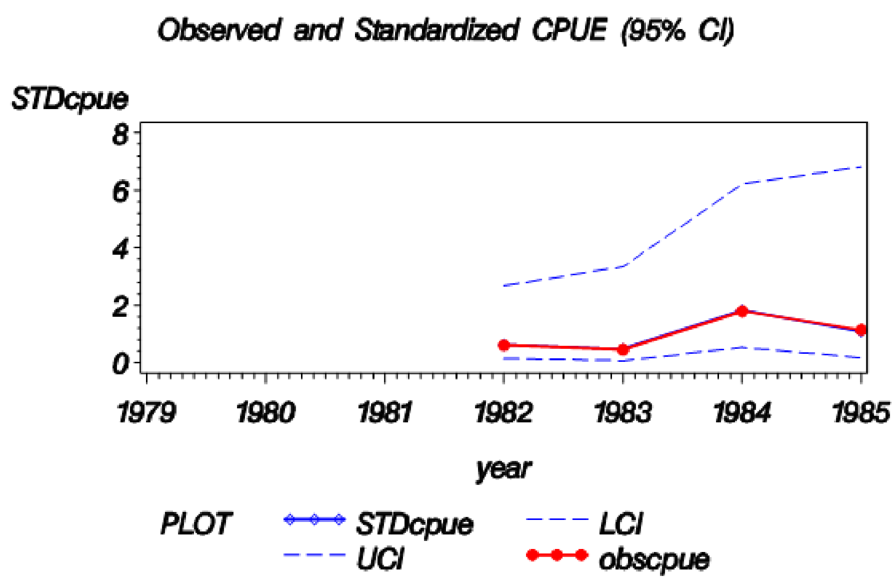

Figure 6.8.2. Queen snapper nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for fishery independent off bottom longline data from Puerto Rico. CPUE = number of fish per 100 hook hour

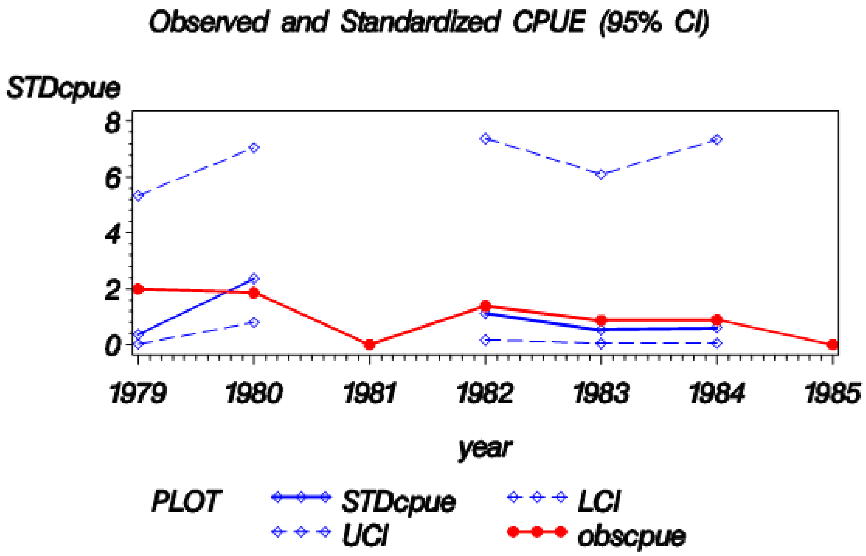

Figure 6.8.3. Silk snapper nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for fishery independent bottom longline data from Puerto Rico. CPUE = number of fish per 100 hook hour

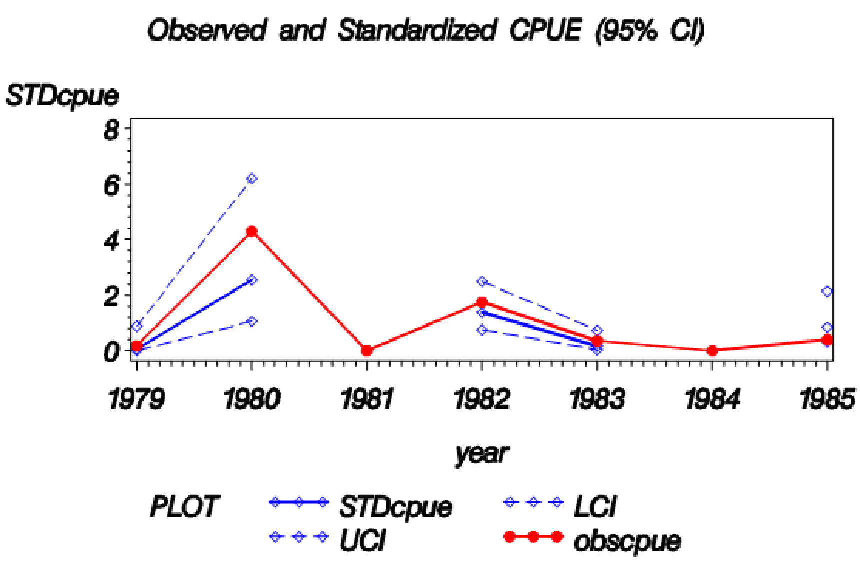

Figure 6.8.4. Silk snapper nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for fishery independent fish trap data from Puerto Rico. CPUE = number of fish per trap

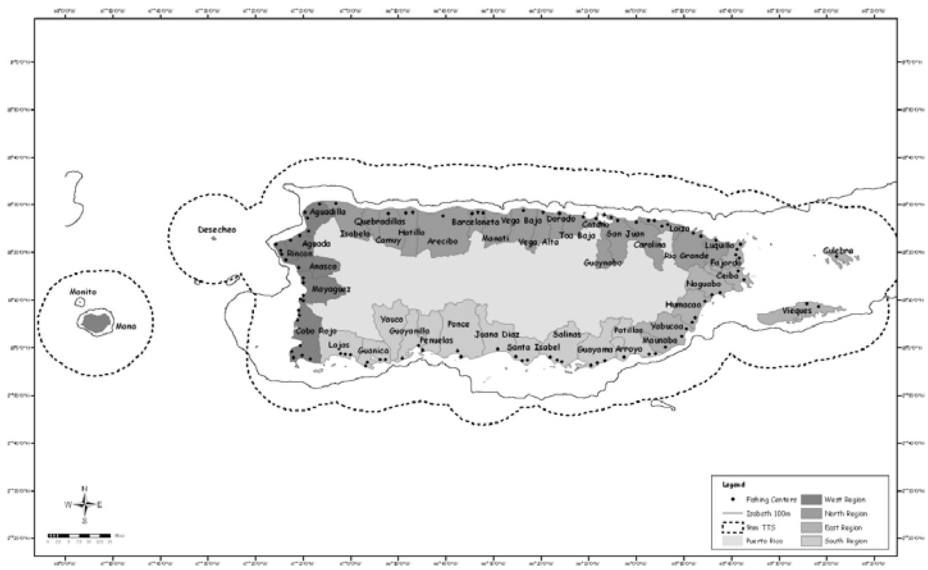

Figure 6.8.5. Map depicting fishing center (municipality) locations for the commercial fisheries in Puerto Rico.

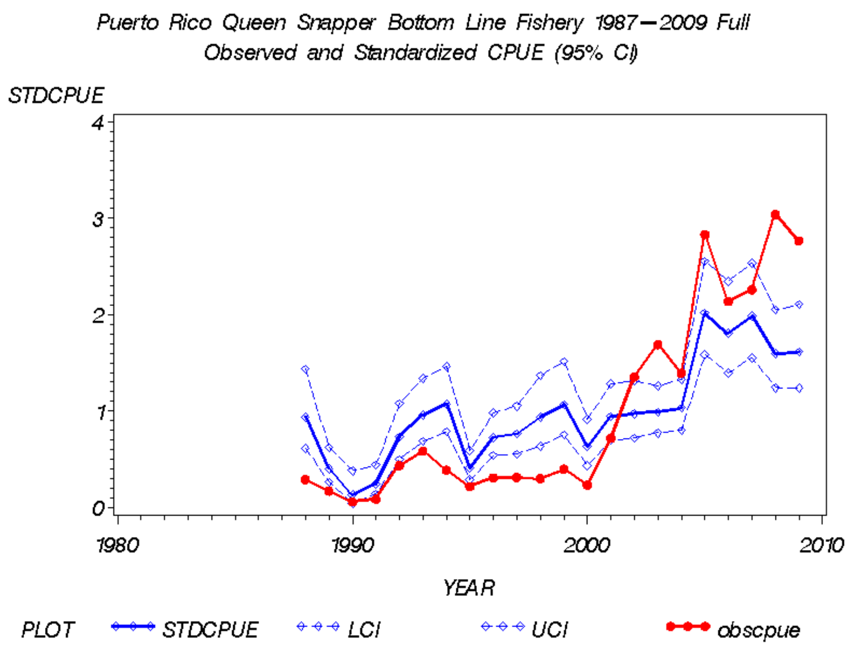

Figure 6.8.6. Queen snapper nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels fishing bottom lines in Puerto Rico. CPUE = pounds per trip

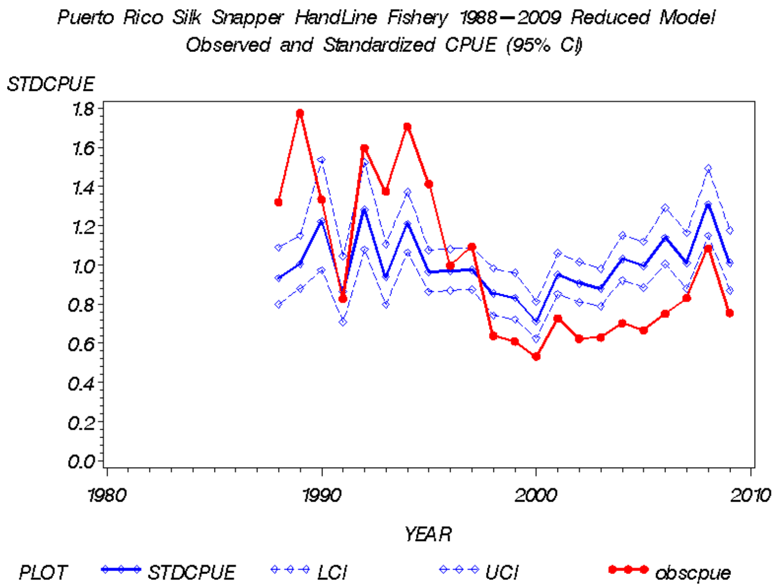

Figure 6.8.7. Silk snapper nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels fishing handlines in Puerto Rico. CPUE = pounds per trip

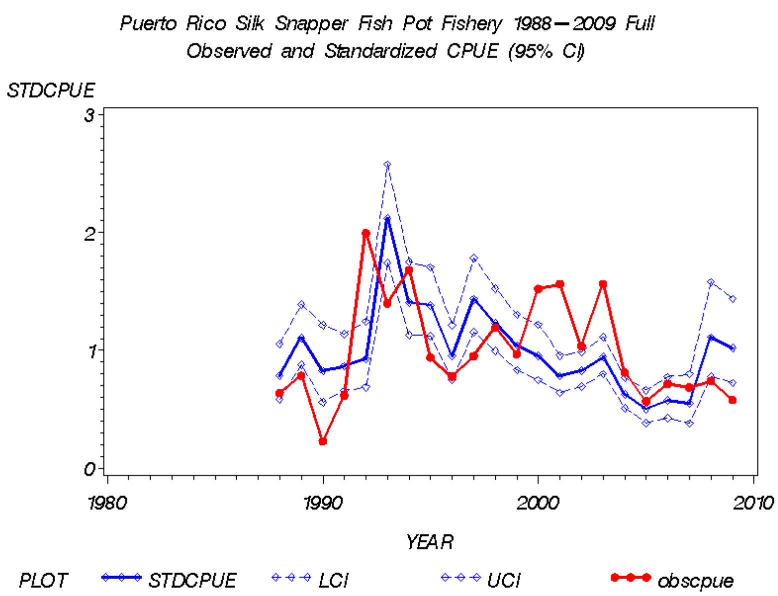

Figure 6.8.8. Silk snapper nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels fishing fish pots in Puerto Rico. CPUE = pounds per trip

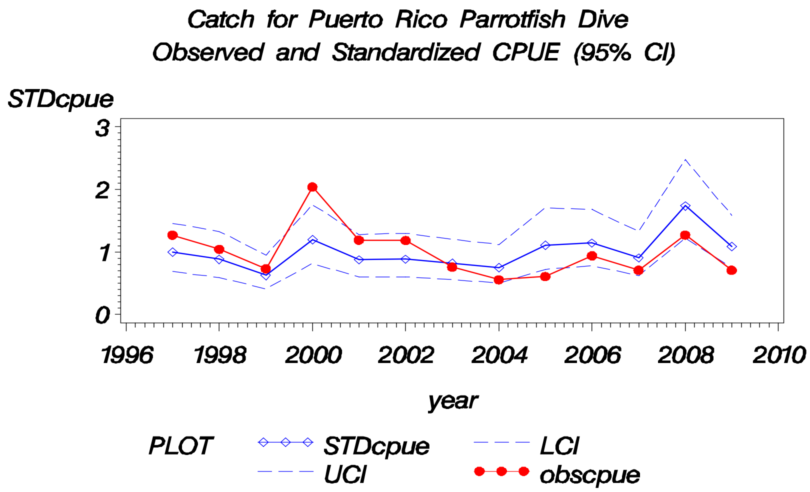

Figure 6.8.9. Parrotfish nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels diving for fish in Puerto Rico. CPUE = number of fish per trip

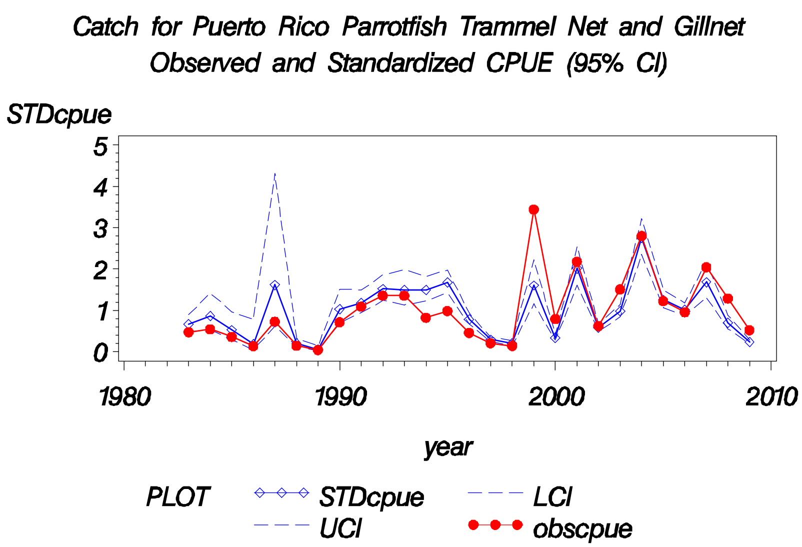

Figure 6.8.10. Parrotfish nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels using trammel and gillnets in Puerto Rico. CPUE = length (fathoms) by hours soaked

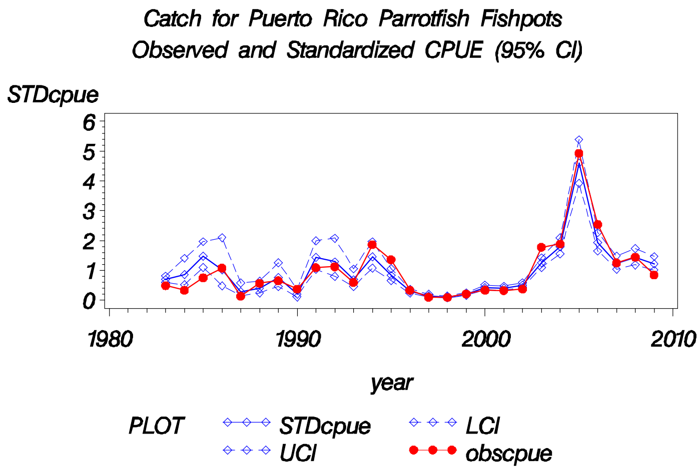

Figure 6.8.11. Parrotfish nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels using fish pots in Puerto Rico. CPUE = number of fish per fish pot

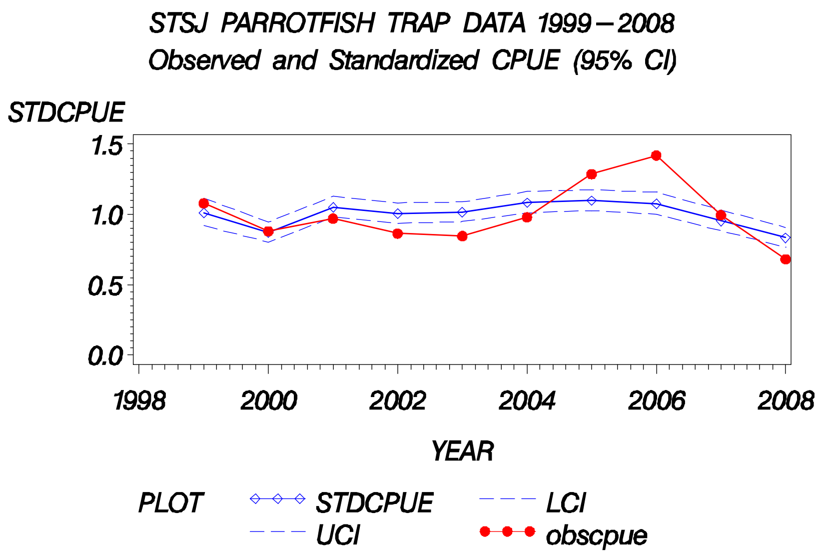

Figure 6.8.12. Parrotfish nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels fishing fish traps/pots in St. Thomas/St. John. CPUE = pounds parrotfish/trap haul/trip

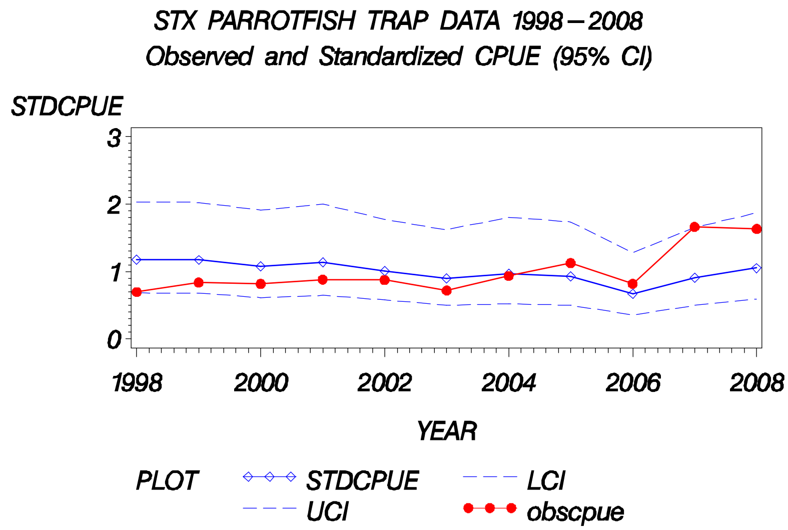

Figure 6.8.13. Parrotfish nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels fishing fish traps/pots in St. Croix. CPUE = pounds parrotfish/trap haul/trip

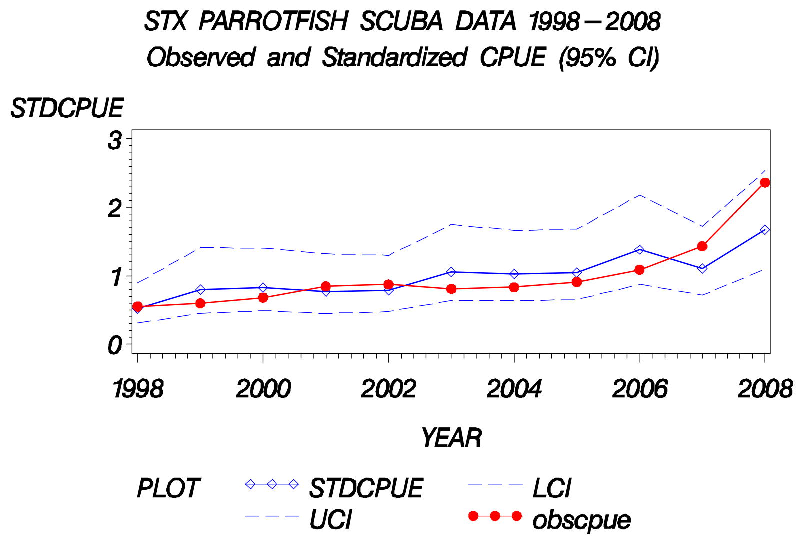

Figure 6.8.14. Parrotfish nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial fishers using SCUBA in St. Croix. CPUE = pounds parrotfish/(amount of gear*trip duration).

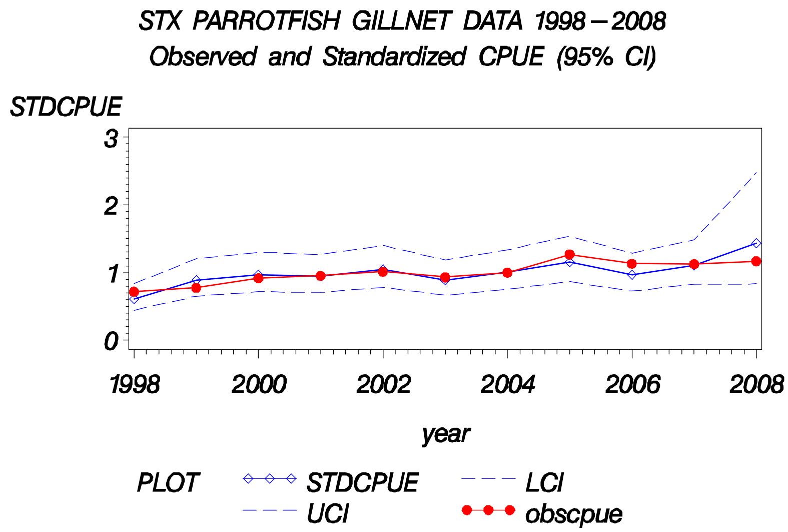

Figure 6.8.15. Parrotfish nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial gillnet vessels in St. Croix. CPUE = pounds parrotfish/(number of nets*trip duration).

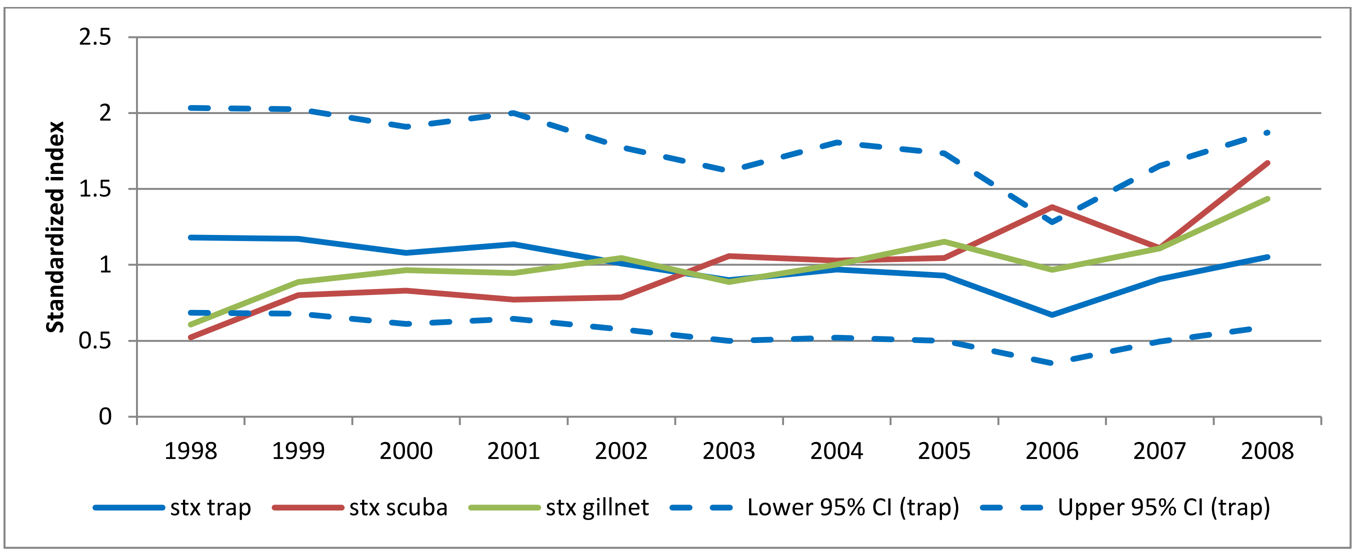

Figure 6.8.16. Parrotfish nominal standardized CPUE of commercial fishing vessels in St. Croix. Fish traps/pots CPUE = pounds parrotfish/trap haul/trip; SCUBA CPUE = pounds parrotfish/(amount of gear*trip duration); Gillnet

CPUE = pounds parrotfish/(number of nets*trip duration).

7. ANALYTIC APPROACH

During the SEDAR 26 Data Workshop, the Assessment Panel (SEDAR26 DW Panel) focused on evaluating the available data for use in carrying out benchmark stock evaluations of the three SEDAR species focus groups (silk and queen snapper and redtail parrotfish). The DW Panel evaluated the time series of catch and landings histories, discards, and considered available length observations from the TIP database. In Puerto Rico, the available time series of reported commercial landings data spans the period 1983-2009 while the corresponding time series of estimated total recreational landings data only exists since 2000. It is broadly known the commercial landings data reflect somewhere between 50-60% on average of the total commercial landings, thus the amount of uncertainly in the commercial landings time series is large, precluding the application of traditional fisheries population models that assume removals are known (e.g., production models, Virtual Population Models (VPAs)). Given the amount of uncertainty in total removals, the SEDAR26 DW Panel recommended two approaches for evaluating population status levels of silk, queen and redtail parrotfish on the Puerto Rico platform. The first included further development of catch per unit of effort (CPUE) abundance indices using both single species and multi-species models considerations. The second approach included analysis of the available time series of length observations utilizing both equilibrium (e.g. Beverton and Holt, 1957) and non-equilibrium (e.g. Gedamke and Hoenig, 2006) models.

Similarly in the USVI, two primary data sources are available: commercial self-reported landing/effort (CCR) and TIP dockside port sampling of commercial landings. The primary limitations of the USVI CCR data are that reported commercial landings may not be reflective of total commercial removals (i.e. expanding reported to actual landings can only be done utilizing the proportion of licensed fishers reporting) and lacking recreational data, there is considerable uncertainty in total removals. In addition, these data have only been reliable reported for a shorter time series than in Puerto Rico (e.g. since 1998/1999) and are reported at a family group level which precludes the use of species-specific classic quantitative assessment models. The DW group recommended a “parrotfish” CPUE analysis should be pursued given the preponderance of redtail parrotfish in the catch and reported in the TIP database. A CPUE analysis of “parrotfish” may serve as an indicator of redtail parrotfish abundance. In St. Croix, redtail parrotfish represent one of the most frequently sampled species in the TIP data base. This should allow for a time series of mean lengths to be analyzed for changes in, and estimates of, total mortality. SEFSC staff have developed specific models for application in data poor situations which can include the analysis of catch per unit effort and length frequency data from multiple species. For both snapper species in the USVI, the sample sizes of the available TIP length-frequency data are limited and may only support equilibrium based mean length mortality estimators but comparison of length-frequencies from samples collected in the 1980’s to those collected in the last 10 years may give insights as to changes in fishing pressure. In the USVI, landings have been reported as “snapper” and since silk and queen snapper comprise a small portion the “snapper” landings, it is unlikely that a catch per unit effort analysis can be conducted.

Fishery independent data are available over small spatial and temporal scales but will continue to be explored to complement both CPUE and length-frequency analysis. The spatial distribution of these catches and snapshots of mean lengths may aid in quantitative analyses and will surely serve to increase interpretive power of the assessment work.

8. RESEARCH RECOMMENDATIONS

8.1. LIFE HISTORY

- It will be important to develop regional sampling programs to collect age and growth data for silk snapper, queen snapper, and redtail parrotfish to estimate growth parameters essential to length-based analyses. Estimates of age-growth parameters are currently limited for the three species in question, therefore, it is essential to continue to build upon the existing published research.
- Regional data collection programs should also be designed to evaluate morphological conversion factors for each species. There is a lack of consistency in the units of measure for length among the studies reviewed by the LHWG. An important area of research will be to develop length-length conversion factors for the three species.
- Length-at-full vulnerability is an important input for length-based analyses. Expansion and improvement of the TIP program will be crucial for continued collection of species-specific size information, which be used to estimate length-at full vulnerability.

8.2. PUERTO RICO CATCH STATISTICS

- Commercial Landings Expansion Factor - all recommendations are in progress. Port samplers are visiting different fishing centers, collecting data of landings by trip, species and effort
- The working group also recommended that the uncertainty in the annual reported landings be characterized by computing the variance of the expansion factors and confidence intervals about the calculated total landings.
- Increasing the dockside sampling of recreational fishing trips in Puerto Rico to reduce the uncertainty in the catch estimates and 2) 20 extending / initiate MRIP's efforts in the US Virgin Islands to quantify the magnitude of recreational catches. In addition, recreational effort.
- The recreational statistics Program recommends increasing the minimum number of trip interviews to 130 for shore fishing, 200 for private boats and 90 for charter boats.
- There is an immediate need to develop sampling efforts to better identify and quantify discards in the commercial fisheries.

8.3. USVI CATACH STATISTICS

- Initiate MRIP's efforts in the US Virgin Islands to quantify the magnitude of recreational catches.
- It is important to determine the efficacy of expansion factors used to estimate total catch. The information used to calculate expansion factors by year need to be verified.
- The collection of landings statistics in the U.S.V.I. should be species-specific because analysis of the current species-groupings is not informative for stock assessments. Species composition from TIP is not appropriate, given the current sampling methodology, for estimating species-specific landings using ratio estimators.
- It is important to encourage fishermen to submit all the monthly catch reports, to submit reports for months when they do not fish, and to complete all the fields in the reports, since critical information such as effort, gear, and location fished are often missing or incomplete.

8.4. FISHERY INDEPENDENT RESEARCH

- Continuation of ongoing, long term research may provide additional information for future assessments.

8.5. INDICES OF ABUNDANCE

- 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
- 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
- Emphasis should be placed on the improvement of the TIP sampling program, as catch rate standardization, catch composition and size-frequency analyses will continue to rely upon this information. Fishery-independent surveys and the collection of other biological data, however, are extremely important to develop alternative indices of abundance.
- Need to continue efforts 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

9. APPENDIX I: Summary of Fishery-Independent Research

Project Title	Project PI	PI Contact	Project co-PI	co-PI Contact	Project Manager	Manager Contact	Project Basics	Sampling Frequency	Project Start	Project End	Data Location	Additional Methods Info
Studies of Deep water Snappers												
Reproductive Cycle and Maturation Size of Silk Snapper (Lutjanus vivanus).	Aida Rosario	lipdrna@coqui.net	Janneth Rojas, Eugenio Piñeiro, Miguel Figuerola, Noemí Peña and Wilfredo Torres		Miguel Rolón	miguel_rolon_cfmc@yahoo.com	describe, through the use of histology, the annual reproductive cycle and minimum size and age of sexual maturation of the silk snapper.	Monthly	2005	2009	Puerto Rico-DNER	25 monthly samples of gonads and otoliths covering a wide size range for a period of 12 months from Rincón deep water snappers captured with hook and line (n=300). Gonads classified according to maturity stage and maturity curve developed. Otoliths measured, weighed, sectioned to .5 mm or 500I and read. Growth curves fitted to length-at-age data by using von Bertalanffy growth model.
Reproductive Cycle of Queen Snapper (Etelis oculatus) and the Wenchman (Pristipomoides macrophthalmus) .	Aida Rosario	lipdrna@coqui.net	Janneth Rojas, Eugenio Piñeiro, Miguel Figuerola, Noemí Peña and Wilfredo Torres.		Miguel Rolón	miguel_rolon_cfmc@yahoo.com	Describe the reproductive strategy and the age and growth of the deep water snappers.	Monthly	2005	2009	Puerto Rico-DNER	Rincon deep water 425 queen snappers (Etelis oculatus) and 432 wenchman (Pristipomoides macrophthalmus) to determine the size of 50% maturation, reproductive season and age and growth. Fishes caught with line and several hooks. Otoliths were measured, weighed, mounted with silicone glue, sectioned to .5 mm or 500O and read.

Studies of Shallow water Reef fishes, including Parrotfishes

Territorial Coral Reef Monitoring (by Univ. of the Virgin Islands, USVI Div. Fish and Wildlife)]	Rick Nemeth	rnemeth@uvi.edu	Tyler Smith	tsmith@uvi.edu	Jed Brown	jed.brown@dpnr.gov.vi	Surveys of reef fish (transects and roving diver) and benthos (coral), expected to continue long-term.	Annually	2003	on-going	UVI	Common method between STX and STT/J, repeat surveys of same sites, provides density estimates, roving diver includes elusive/cryptic species
UVI-CMES Reef Coral Monitoring Program	Tyler Smith	tsmith@uvi.edu			Tyler Smith	tsmith@uvi.edu	A systematic approach employing a stratified design based upon the position of reefs along the insular platform (mid-shelf and shelf-edge) to investigate cross-shelf coral reef systems in a long-term coral reef monitoring and assessment program.	Annually	2001	on-going		This design complements other ongoing monitoring studies. Digital video and diver surveys were used to quantify coral diversity, coral recruit density, the percent cover of corals, algae and other organisms, incidence of coral bleaching and disease, sea urchin density, and fish community structure at permanent sites surrounding the islands of St. Croix and St. Thomas.

Commonwealth Coral Reef Monitoring in Puerto Rico (by Univ. of PR-Mayagüez, PR DNER)	Reni Garcia	renigar@caribe.net			Aida Rosario	lipdrna@coqui.net	Surveys of reef fish and benthos (coral), expected to continue long-term. Some focus on deeper, shelf edge reefs.	Annually	2003	on-going	PI	Dr. Garcia also has been involved with CariComp surveys (reef fish and benthos) of permanent stations and CFMC-funded deeper reef surveys (140-160 ft). Generally, all timed surveys rather than area-based.
SEAMAP–Caribbean: USVI Reef Fish Sampling	Aida Rosario	lipdrna@coqui.net					The Southeast Area Monitoring and Assessment Program for the Caribbean (SEAMAP-C) Sampling is conducted in quadrants within a sample area defined for each island. Areas off St. Croix, St. Thomas, and western PR are included.		1988	on-going		From 1992-2002, 1098 individual fish from 39 species were captured from St. Croix; 1490 fish from 65 species were captured from St. John. Across all years, only 17 species with more than 5 individuals were captured from St. Croix; 28 species with more than 5 individuals were captured for St John. SEAMAP-C is a multiyear data set, originally targeting red hind spawning areas but other species are taken by trap and hook-and-line sampling.
SEAMAP-Caribbean: PR Reef Fish Sampling	Jed Brown	jed.brown@dpnr.gov.vi					see above		1991	on-going		

Monitoring Reef Fish Populations in the VI National Park (National Park Service, Virgin Islands National Park)	Jim Beets	beets@hawaii.edu	Alan Friedlander	friedlan@hawaii.edu			Reef fish assemblages have been monitored at annual intervals, with some years including monthly sampling.		mid-1980s	on-going	PIs	Permanent stations and random sites been sampled.
NOAA Biogeography Team Caribbean Coral Reef Ecosystem Monitoring (Puerto Rico; St. Croix, and St. John)	Chris Caldow	Chris.Caldow@noaa.gov	Kimberly (Woody) Roberson	Kimberly.Roberson@noaa.gov	Mark Monaco	Mark.Monaco@noaa.gov	spatially characterizes & monitors distribution, abundance, and size of reef fishes and macro-invertebrates (conch, lobster, Diadema); relates this info to in-situ data collected on associated benthic composition parameters;	Annual/Semi-Annually	2001	on-going	NOS on-line	Belt transect fish census transect benthic composition census
Effectiveness of Coral Reef Restoration at the Fortuna Reefer Grounding Site in Mona Island, PR	Ron Hill	ron.hill@noaa.gov	Andy Bruckner	bruckner@livingoceansfoundation.org	Ron Hill	ron.hill@noaa.gov	Evaluate effectiveness of coral restoration; reef community conditions and reef fish assemblages of the site.	Quarterly	2001	2009	PIs	Tracking individual fragments (growth, reattachment, and survival), benthic composition surveys, fish transects, point count fish surveys.

Productivity of Acropora cervicornis habitat and impacts from natural and human disturbance	Ron Hill	ron.hill@noaa.gov	Andy Bruckner	bruckner@livingoceansfoundation.org	Ron Hill	ron.hill@noaa.gov	Document health, and growth of the different configurations of A. cervicornis colonies and thickets; document differences in fish assemblages using colonies through time; record disturbances and disturbance effects of coral and fish.	Semi-Annually	2006	2010	PIs	10m x 2m permanent transects are used to record coral status and health as well as fish assemblages. Photo quadrats are used to document coral cover and growth.
Prevalence and impact of coral disease in remote locations	Andy Bruckner	bruckner@livingoceansfoundation.org	Ron Hill	ron.hill@noaa.gov	Andy Bruckner	bruckner@livingoceansfoundation.org	The project is researching the prevalence of coral disease across a gradient of human impacts and the effects of disease on coral reef ecosystems (benthic communities and fish assemblages).	Semi-Annually	1996	on-going	PIs	Permanent arcs are used to measure temporal change, randomly placed 30 x 2 m transects are used to measure benthic composition and fish assemblages.

Using Hydro-Acoustic Technology for Fisheries Management: Determining the minimum size of fishery closures for protecting grouper spawning aggregations.	Rick Nemeth	rnemeth@uvi.edu			Rick Nemeth	rnemeth@uvi.edu	Four marine reserves were established to protect grouper and snapper spawning aggregations in USVI waters. This project is studying the extent and adequacy of the reserves.	Semi-Annually	2006	on-going	PIs	In 2006-2008, 18 red hind 18 Nassau grouper and 17 yellowfin grouper were tagged during the spawning season on aggregation sites within two marine reserves, the Marine Conservation District (MCD) and the Grammanik Bank. Receivers, set un overlapping patterns document migration routes in and out of the reserves as well as movement within the spawning area.
UVI-CMES Spawning Aggregation Monitoring Project	Rick Nemeth	rnemeth@uvi.edu			Rick Nemeth	rnemeth@uvi.edu	Spawning Aggregation Monitoring: determine if the MCD and Grammanik Bank closures are adequate in size and location to protect the spawning fish while on the aggregation sites.	Annually	1999	on-going		SCUBA surveys and fish traps are used to determine fish densities, size distributions and aggregation temporal dynamics. Ultrasound imaging is used to determine the gender of fish. A tag-recapture program using external dart or t-tags has been conducted since 2002 to help determine fish migration patterns across the insular shelves. Fin clips are taken for population genetics.
The effects of fish traps on benthic habitats off La Parguera, Puerto Rico.	Richard Appeldoorn		Micheal Nemeth, J Vasslides, Michelle Sharer		Miguel Rolón	miguel_rolon_cfmc@yahoo.com	Determine distribution of fish traps surrounding La Parguera, Puerto Rico, and potential impact upon benthic systems.	One time	1999	2009		Comparable surveys of traps, analyzing effects on corals and other reef organisms. Includes information on catch in different habitats

Essential fish habitat assessment for Puerto Rico aqueduct and sewer authority 301(h) waiver request					Miguel Rolón	miguel_rolon_cfmc@yahoo.com	To identify and evaluate the potential effect of 6 regional wastewater treatment plans (RWWTP) in PR on essential fish habitat (EFH), on habitat of particular concern (HAPC) and on fisheries management plans (FMP).	Quarterly	1999	2009		Basic information from quarterly monitoring of each RWWTP since 1999, and complementary fisheries habitat information, under a protocol previously approved by EPA. Modeling of treats were developed and verified with field observations. Parameters included in the model were the worse case scenario for TSS and DO. Bioassays with Champia parvula (red algae), Cyprinidon variegates (sheephead minndow) and Mysidopsis bahia (mysid shrimp) to test toxic substances such as Cu and Pb.
Inventory and atlas of corals and coral reefs, with emphasis on deep water coral reefs from the US Caribbean EEZ.	Jorge Reni Garcia	renigar@caribe.net			Miguel Rolón	miguel_rolon_cfmc@yahoo.com	Search, review and catalog information on deep reefs around PR and USVI; Build a map to 400 fathoms with acquired information; Characterize benthic and pelagic communities; Prepare a digital photo & video deep reef album for Puerto Canoas, Desecheo Island.	One time	2003	2009		Habitat information gathered from NOAA nautical charts, video recordings of the 1985 Johnson Sea-Link submersible survey at deep-snapper fishing areas (100-450m); field data from SeaBED surveys at MCD in 2003 (33-90m). It included exploratory survey of upper slope of island of Desecheo, establishing permanent stations at 30-40m along seawall. Reef and communities characterized with video-transects six 10m-long replicated. Fish characterized within belt 30m2 transects at the

												same stations, targeting the five most important commercially and recreational species (Gramma loreto, Opistognathus aurifrons, Chromis cyanea, Ophioblennius atlanticus and Holocanthus tricolor). A bathymetric survey around Desecheo island to locate reefs sites, detailed for the south section.
Characterization of benthic habitats and associated reef communities at Bajo de Sico Seamount, Mona Passage, Puerto Rico.	Jorge R. García-Sais	renigar@caribe.net	Roberto Castro, Jorge Sabater-Clavell, Milton Carlo and René Esteves		Miguel Rolón	miguel_rolon_cfmc@yahoo.com	Provide baseline quantitative and qualitative characterization of benthic habitats & fish communities; Construct georeferenced map of main reef benthic habitats; Produce detailed bathymetric map of BDS down to a maximum depth of 100 m; Provide a preliminary assessment of commercially important grouper and snapper populations; document deep reef	One time	2007	2009		

							communities with digital photos.					
Monitoring of coral reef communities at Isla Desecheo, Rincón, Mayagüez Bay, Guánica, Ponce and Caja de Muertos Island, Puerto Rico.	Jorge Reni Garcia	renigar@caribe.net	Roberto Castro, Rene Esteves, Jorge Sabater, Milton Carlo		Ernesto Diaz		monitor 12 reef stations from 6 natural reserves extending the monitoring to 6 new sites. Fish data is considered part of the reef system. The program is acquiring comprehensive digital underwater photographic documentation.	Annually	2004	2009		Sessile-benthic reef communities surveyed with intercept chain method or CARICOMP protocol. A total of five permanent 10-meter long transects. Data is percent cover and rugosityTransects recorded as underwater videos. Complementary, 12 min visual census for reef fish and motile invertebrates surveyed in 30 m2 belt-transects. Most commercially important and several recreationally fishes observed by 20 min Active Search Census (non-random, fixed-time method).
Reef and fishery assessment at Navassa Island	Margaret Miller	Margaret.W.Miller@noaa.gov			Margaret Miller	Margaret.W.Miller@noaa.gov	Periodic surveys of benthos and reef fishes	biennial	2002	on-going		
Comparison of dolphinfish (Cryphaena hippurus) commercial and recreational fisheries in PR during 2000-2003.	Grisel Rodriguez-Ferrer		Yamitza Rodriguez-Ferrer, Daniel Matos, Craig Lilyestrom		Aida Rosario	lipdrna@coqui.net	compare and analyze landings and biostatistical data for commercial and recreational dolphinfish fishers.	Every event	2000	2009		Data obtained from voluntary fishers, fishers buyer, fishing associations in 42 municipalities including Vieques and Culebra islands on biweekly or monthly basis. CPUE estimated from landings per trip and then extrapolated to monthly values. Samplers intercepted fishers at docks or boat ramps.

Bycatch Study of PR's Marine Commercial Fisheries.	Daniel Matos	matos_daniel@hotmail.com			Aida Rosario	lipdrna@coqui.net	Describe biological aspects of Puerto Rico's commercial fishery bycatch, determine magnitude & composition. Evaluate impacts of different gears; generate management recommendations.	Biweekly	2004	2009		Interviews with 12 commercial fishers contracted. 71 fishing trips interviwed, low fishers compliance. 13 with traps, 27 trammel nets, 25 hand lines.
Acoustic tracking of Reef Fishes to define species habitat utilization pattersn	Mark Monaco	Mark.Monaco@noaa.gov	Alan Friedlander		Mark Monaco	Mark.Monaco@noaa.gov	Use acoustic telemetry to define reef fish habitat utlization patterns and movements within and between management areas. Study is focused on defining ecological connectivity between the National Park and Monument in St John, USVI.	Quarterly	2007	2010	NOS Pis	Live reef fish are collected an surgery is conducted to implant an acoustic tag (pinger) into the body cavity of the fish. The fish are tracked by an underwater array of acoustic hydrophones along the south shore of St John.

An Overview of Recreational Fishing Tournaments in PR.	Grisel Rodriguez-Ferrer		Yamitza Rodriguez -Ferrer, Craig Lilyestrom		Aida Rosario	lipdrna@coqui.net	Get information about fishery aspects of marine tournaments in PR.	Every event	1999	2009		Fishermen contacted upon arrival at weight station in 124 tournaments. Size (FL)and weight information by species. Calculations of CPUE.
Blue Marlin (Makaira nigricans) Fishery in PR.	Grisel Rodriguez-Ferrer		Yamitza Rodriguez , Craig Lilyestrom		Aida Rosario	lipdrna@coqui.net	To obtain information for an important pelagic fish.	Every event	1999	2009		Fishermen contacted upon arrival at weight station in 113 tournaments, 53 of them targeted Blue Marlin. Size (FL)and weight information by species. Calculations of CPUE.
Current status of the tiger grouper (Mycteroperca tigris) fishery at Vieques island, PR.	Daniel Matos	matos_daniel@hotmail.com	Juan Posada		Aida Rosario	lipdrna@coqui.net	Monitoring program of the tiger grouper fishery in Vieques Island.	One time	1997	2009		Annual visits to landings to Isabel II and La Esperanza in Vieques island to estimate CUPE and biostatistical information on the species (length, weight and sex). Offshore tag and recapture program.
Reproduction of the coney grouper (Cephalopsis fulva) in PR.	Miguel Figuerola		Wilfredo Torres, Aida Rosario		Aida Rosario	lipdrna@coqui.net	Estimate reproductive parameters of the coney.	One time	1997	2009		987 fishes collected, 596 with histological examination. 87% of the samples were captured by hook and line in Abrir la Sierra, Bajo de Cico and Tourmarine. 579 fishes were marked to study movement patterns.
Portrait of the fishery of Sparisoma viride and Sparisoma chrysopterum in PR during 1998-2001.	Daniel Matos	matos_daniel@hotmail.com	Milagros Cartagena , Noemi Peña.		Aida Rosario	lipdrna@coqui.net	describe the fishery of these two species from the data collected by CFSP	One time	1998	2009		Data collected by port samplers but species not discriminated in the landings reports. Thus, it was necessary complement with 7,642 S. viride and 7,538 of S. chrysopterum were

												measured at the landing sites. 120 interviews to estimate CPUE.
Shallow-water reef fish monitoring SEAMAP-Caribbean Fisheries Independent Monitoring.	Aida Rosario	lipdrna@coqui.net	Miguel Figuerola, Nilda Jimenez, Richard Appeldoorn		Aida Rosario	lipdrna@coqui.net	collect, manage, and disseminate fisheries-independent data collection of shallow water reef fish resources and their environment.	One time	2000	2009		three lines with three hooks (No.6) baited with sardines and 12 traps of 1-1.5 mesh size baited with squid captures in 12 stations sampled west 67 parallel. Sampling conducted in three depth strata (0-18, 19-36, 37-90 m) in five quadrants. Total of 16 quadrants of 0.5x0.5 nm in 150 samples (trips). 4-5 hours of fishing. Data entered and stored in SEAMAP v 3.0.
Portrait of red hind (Epinephelus guttatus) in PR during 1992-1999.	Daniel Matos	matos_daniel@hotmail.com			Aida Rosario	lipdrna@coqui.net	To obtain information of the red hind fisheries using statistical data from NOAADRNA program.	One time	2001	2009		Work within the fisheries statistics state program initiated since 1967. Commercial landings collected weekly from 42 coastal municipalities and voluntarily filled by fishermen. Four port agents bring data to the laboratory.
Portrait of red hind (Epinephelus guttatus) in PR during 1998-2001.					Aida Rosario	lipdrna@coqui.net	to describe the fishery of red hind through the data collected by the CFSP (landings and biostatistics data) during 1988 - 2001.	One time	1998	2009		Work within the fisheries statistics state program initiated since 1967. Commercial landings collected weekly from 42 coastal municipalities and voluntarily filled by fishermen. Four port agents bring data to the laboratory.

Reproductive biology of the mutton snapper (Lutjanus analis) in PR with management recommendations .	Miguel Figuerola	retired	Wilfredo Torres		Aida Rosario	lipdrna@coqui.net	To obtain reproductive information of mutton snapper needed to fisheries management.	One time	2000	2009		390 gonads from 184 females and 175 males were collected around PR, most of them obtained from commercial fishers, from which 359 had histological examination.
Sexual maturity and reproductive season of the carite (Scomberomorus cavalla) and sierra (S. regalis) in PR.	Miguel Figuerola	retired	Wilfredo Torres		Aida Rosario	lipdrna@coqui.net		One time	2001	2009		357 S. regalis and 334 S. cavalla were collected to conduct gonads histological analysis and determine maturation size.

Studies of Mobile Reef Invertebrates

SEAMAP-C: USVI Queen Conch Stock Assessment	Shenell Gordon				Shenell Gordon		Collect data on population status of queen conch in a variety of critical marine habitats in USVI; provide time series information on changes in the population; monitor populations in marine reserve areas & other protected habitats; collect, analyze, manage & disseminate fisheries independent data on queen	every 5 yrs (nominally)	1981	on-going		In 1981, an initial 22 transects located around the islands of St. Thomas and St. John were surveyed to determine the density and size distribution of queen conch (St. Thomas=10 transects, St. John=12 transects). A few additional site (e.g., Saba Island) have been added since. Scooter transects: Queen conch abundance and density estimates were derived from visual surveys conducted along transects by two scuba divers using underwater scooters. Length (juvenile and adult) and age (adult) frequencies were determined, apportioned by habitat, depth, or location.

							conch resources in the USVI.					
Assessment and Monitoring of Spiny Lobster Populations at BIRNM, St. Croix, USVI (2004-07)	Carollyn Cox FFW				Ian Lundgren	Ian_Lundgren@nps.gov	Assess & monitor spiny lobster. FL Fish and Wildlife Conservation Commission was contracted by NPS to document lobster resources in BIRNM and determine effectiveness of the reserve for Caribbean spiny lobsters (Panulirus argus).	Annually	2004	2009		The sampling protocol was designed to test the hypothesis that lobsters in the reserve will be larger and more abundant than those found in the surrounding fshery. Yearly surveys have been conducted in both the reserve and surrounding fshery during April. Sampling is stratifed by habitat type in the BIRNM reserve and surrounding fshed area.
Recruitment of postlaval spiny lobster (Panulirus argus) in southwestern PR.	Aida Rosario	lipdrna@coqui.net	Miguel Figuerola		Aida Rosario	lipdrna@coqui.net	To collect and analyze data on postlarval recruitment within the territorial and contiguous EEZ to PR.	Biweekly	2003	2009		At 10 stations, 20 modified Whitman collectors were placed in different habitat types. Weather, salinity and temperature were measured biweekly. Lost collectors were replaced, but at the end only 4 of 60 collectors were still in place.
Study of juvenile recruitment of spiny lobster (Panulirus argus).	Nilda M. Jimenez				Aida Rosario	lipdrna@coqui.net	estimate spatial and temporal patterns of settlement and recruitment of juvenile lobsters.	Monthly	2003	2009		Same stations as 2002, half located on seagrass as far as 10 m off the reef, the other half on hard bottom. Two cement blocks per site used as artificial lobsters shelters. Monthly visits to open and quantify juvenile lobsters in

												shelters. Size information was also collected. Shelters removed at the end of the study.
Puerulii (Panulirus argus) monitoring.	Nilda M. Jimenez				Aida Rosario	lipdrna@coqui.net	collect post-larval lobster from Whitman collectors as part of a Caribbean wide project lead by Dr. Mark Butler and test available current models.	One time	2007	2009		Installation of Whitman collectors, three postlarvae classes: transparent, pigmented and juveniles.
Underwater queen conch resource in PR.	Richard Appeldoorn		Nilda Jimenez, Aida Rosario		Aida Rosario	lipdrna@coqui.net	Provide stock assessment information from fishery independent data needed to identify fisheries management needs, and to implement plans to protect and restore the fishery stock to support viable recreational and commercial fisheries.	One time	2001	2009		Independent fishery survey of queen conch in southwest PR in 60 stations covering a total of 890.3 km2. Random sampling of paired transects collected by visual census. Conch abundance, length and habitat was recorded and conch age was estimated.

Caribbean/NMFS Cooperative SEAMAP Program- Queen Conch, Strombus gigas, Assessment 2006.	Nilda M. Jiménez		Aida Rosario	lipdrna@coqui.net	Aida Rosario	lipdrna@coqui.net	To collect, manage, and disseminate fishery-independent data on the Queen conch, Strombus gigas; identify areas where queen conch is fished versus where it used to be fished; determine spatial & temporal variations in stock abundance within the territorial sea of Puerto Rico and the EEZ; estimate Queen conch abundance, size, age structure, and density variations due to locality, habitat type and depth.	One time	2006	2009		fishery information was obtained from the Fisheries Statistics Division in the DNER-Fisheries Research Laboratory. 42 fishers interviews asking same questionnaire from 1995. 99 stations randomly selected, within a depth limit of 90 feet, from fishermen areas, 47 in the west, 40 from the east, and 14 from the south covering a total of 46.6 ha. Trained divers using scooters measured abundances, densities, depth, and habitat type.

10. APPENDIX II: Indices of Abundance Evaluation Forms

Evaluation of Abundance Indices of Queen Snapper: Puerto Rico Commercial Handlines (SEDAR26-DW-05)

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.	✓			
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)	✓			
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)	✓			
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).	✓			
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

2. Fishery Dependent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).				✓
B. Describe any changes to reporting requirements, variables reported, etc.				✓
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.				✓

METHODS

1. Data Reduction and Exclusions

	Not Applicable	Absent	Incomplete	Complete
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?	✓			

Working Group Comments:

Methods
1. Data Reduction and Exclusion methods: SEDAR 26 DW Puerto Rico fishery platform working group identified a suite of trips to use in CPUE analyses based on expert opinion and primary areas of fishery operation. In addition, the SEDAR26 DW Panel recommended subseting the complete data set developed from the experts further by limiting the CPUE analyses to trips where Queen Snapper made up at least 10% or 50% of the total trip landed weight.
Outliers were evaluated in the initial data cleaning stage.

2. Management Regulations (for FD Indices)

	Not Applicable	Absent	Incomplete	Complete
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).	✓			
B. Describe the effects (if any) of management regulations on CPUE	✓			
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.	✓			

3. Describe Analysis Dataset (after exclusions and other treatments)

	Not Applicable	Absent	Incomplete	Complete
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.				✓
B. Include tables and/or figures of number of positive observations by factors and interaction terms.				✓
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.				✓
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.				✓
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).				✓
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓

4. Model Standardization

	Not Applicable	Absent	Incomplete	Complete
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?				✓
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.				✓

Working Group Comments:

No management measures for Queen snapper were applicable to the CPUE analyses

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

1. Binomial Component

	Not Applicable	Absent	Incomplete	Complete
A. Include plots of the chi-square residuals by factor.				✓
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)				✓
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).		✓		

2. Lognormal/Gamma Component

	Not Applicable	Absent	Incomplete	Complete
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.				✓
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.				✓
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.				✓
F. Include plots of the residuals by factor		✓		

3. Poisson Component

	Not Applicable	Absent	Incomplete	Complete
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓			
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓			
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

4. Zero-inflated model

	Not Applicable	Absent	Incomplete	Complete
A. Include ROC curve to quantify goodness of fit.	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓			
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓			

Working Group Comments:

The feasibility of this diagnostic is still under review.

MODEL DIAGNOSTICS (CONT.)

	Not Applicable	Absent	Incomplete	Complete

Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance				✓
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	*Workshop Recommendation*	*Revision Deadline ******	*Author and Rapporteur Signatures*
First Submission	7/1/2011, Webinar			
Revision				

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

Evaluation of Abundance Indices of Silk Snapper: Puerto Rico (SEDAR26-DW-05)

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.	✓			
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)	✓			
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)	✓			
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).	✓			
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

2. Fishery Dependent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).				✓
B. Describe any changes to reporting requirements, variables reported, etc.				✓
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.				✓

METHODS

1. Data Reduction and Exclusions

	Not Applicable	Absent	Incomplete	Complete
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?	✓			

Working Group Comments:

Methods
1. Data Reduction and Exclusion methods: SEDAR 26 DW Puerto Rico fishery platform working group identified a suite of trips to use in CPUE analyses based on expert opinion and primary areas of fishery operation. In addition, the SEDAR26 DW Panel recommended subseting the complete data set developed from the experts further by limiting the CPUE analyses to trips where silk snapper made up at least 10% or 50% of the total trip landed weight. Outliers were evaluated in the initial data cleaning stage.

	Not Applicable	Absent	Incomplete	Complete
2. Management Regulations (for FD Indices)				
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).				✓
B. Describe the effects (if any) of management regulations on CPUE				✓
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.				✓
3. Describe Analysis Dataset (after exclusions and other treatments)				
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.				✓
B. Include tables and/or figures of number of positive observations by factors and interaction terms.				✓
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.				✓
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.				✓
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).				✓
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓
4. Model Standardization				
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?				✓
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.				✓

Working Group Comments:

Silk snapper closed season management measure accounted for by excluding observations (trips) during the closed season.

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

	Not Applicable	Absent	Incomplete	Complete
1. Binomial Component				
A. Include plots of the chi-square residuals by factor.				✓
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)				✓
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).		✓		
2. Lognormal/Gamma Component				
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.				✓
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.				✓
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.				✓
F. Include plots of the residuals by factor		✓		
3. Poisson Component				
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓			
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓			
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			
4. Zero-inflated model				
A. Include ROC curve to quantify goodness of fit.	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓			
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓			

Working Group Comments:

The feasibility of this diagnostic is still under review.

MODEL DIAGNOSTICS (CONT.)

	Not Applicable	Absent	Incomplete	Complete

Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance				✓
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	*Workshop Recommendation*	*Revision Deadline* ***	*Author and Rapporteur Signatures*
First Submission	7/1/2011, Webinar			
Revision				

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

Evaluation of Abundance Indices of Redtail Parrotfish: St. Thomas/St. John Commercial Trap (SEDAR26-DW-09)

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.	✓			
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)	✓			
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)	✓			
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).	✓			
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

2. Fishery Dependent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).				✓
B. Describe any changes to reporting requirements, variables reported, etc.				✓
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

METHODS

1. Data Reduction and Exclusions

	Not Applicable	Absent	Incomplete	Complete
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?	✓			

Working Group Comments:

2.D. no length information were available in this data set.

1.C. outliers not identified or excluded

2. Management Regulations (for FD Indices)	Not Applicable	Absent	Incomplete	Complete
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).		✓		
B. Describe the effects (if any) of management regulations on CPUE		✓		
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.		✓		

3. Describe Analysis Dataset (after exclusions and other treatments)	Not Applicable	Absent	Incomplete	Complete
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.			✓	
B. Include tables and/or figures of number of positive observations by factors and interaction terms.			✓	
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.			✓	
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.		✓		
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).		✓		
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓

4. Model Standardization	Not Applicable	Absent	Incomplete	Complete
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?				✓
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.		✓		

Working Group Comments:

2. management history not available for use in the analysis

3. data available on request, not provided at data workshop

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

Working Group Comments:

1. Binomial Component

Item	Not Applicable	Absent	Incomplete	Complete
A. Include plots of the chi-square residuals by factor.				✓
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)	✓			
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			

2. Lognormal/Gamma Component

Item	Not Applicable	Absent	Incomplete	Complete
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.		✓		
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.		✓		
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.		✓		
F. Include plots of the residuals by factor				✓

3. Poisson Component

Item	Not Applicable	Absent	Incomplete	Complete
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓			
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓			
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

The feasibility of this diagnostic is still under review.

4. Zero-inflated model

Item	Not Applicable	Absent	Incomplete	Complete
A. Include ROC curve to quantify goodness of fit.	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓			
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓			

MODEL DIAGNOSTICS (CONT.)

Not Applicable	Absent	Incomplete	Complete

Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance	✓			
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	*Workshop Recommendation*	*Revision Deadline ****	*Author and Rapporteur Signatures*
First Submission		construct w/ revision		
Revision				

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

No final decision on recommendation.

Working group and plenary recommended constructing an index from these data including the following:

include only the years 1998-2008 (years with effort reported and includes most recent available data as of the data workshop)

use Stephens and MacCall to subset the data (identify targeted trips)

use number of trap hauls as effort measure (allows for complete 1998-08 time series)

Evaluation of Abundance Indices of Redtail Parrotfish: St. Croix Commercial Gillnet (SEDAR26-DW-09)

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

Item	Not Applicable	Absent	Incomplete	Complete
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.	✓			
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)	✓			
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)	✓			
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).	✓			
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

2. Fishery Dependent Indices

Item	Not Applicable	Absent	Incomplete	Complete
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).				✓
B. Describe any changes to reporting requirements, variables reported, etc.				✓
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

METHODS

1. Data Reduction and Exclusions

Item	Not Applicable	Absent	Incomplete	Complete
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?	✓			

Working Group Comments:

2.D. no length information were available in this data set.

1.C. outliers not identified or excluded

2. Management Regulations (for FD Indices)

	Not Applicable	Absent	Incomplete	Complete
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).		✓		
B. Describe the effects (if any) of management regulations on CPUE		✓		
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.		✓		

3. Describe Analysis Dataset (after exclusions and other treatments)

	Not Applicable	Absent	Incomplete	Complete
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.			✓	
B. Include tables and/or figures of number of positive observations by factors and interaction terms.			✓	
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.			✓	
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.		✓		
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).		✓		
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓

4. Model Standardization

	Not Applicable	Absent	Incomplete	Complete
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?				✓
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.		✓		

Working Group Comments:

2. management history not available for use in the analysis

3. data available on request, not provided at data workshop

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

1. Binomial Component

	Not Applicable	Absent	Incomplete	Complete
A. Include plots of the chi-square residuals by factor.	✓			
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)	✓			
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			

2. Lognormal/Gamma Component

	Not Applicable	Absent	Incomplete	Complete
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.		✓		
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.		✓		
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.		✓		
F. Include plots of the residuals by factor				✓

3. Poisson Component

	Not Applicable	Absent	Incomplete	Complete
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓			
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓			
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

4. Zero-inflated model

	Not Applicable	Absent	Incomplete	Complete
A. Include ROC curve to quantify goodness of fit.	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓			
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓			

Working Group Comments:

1. only positive (lognormal) model used due to high proportion positives from Stephens and MacCall subsetting

The feasibility of this diagnostic is still under review.

MODEL DIAGNOSTICS (CONT.)

Not Applicable	Absent	Incomplete	Complete	Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance	✓			
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	*Workshop Recommendation*	*Revision Deadline* ***	*Author and Rapporteur Signatures*
First Submission		construct w/ revision		
Revision				

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

No final decision on recommendation.

Working group and plenary recommended constructing an index from these data including the following:

include only the years 1998-2008 (years with effort reported and includes most recent available data as of the data workshop)

due to very high proportion positive trips after Stephens and MacCall analysis, include all gillnet trips with parrotfish landings and use a lognormal model only

use gear number of nets fished and trip hours as effort measure

categorize those trips reported as scuba trips and with >162.5 pounds of parrotfish landed as gillnet trips

Evaluation of Abundance Indices of Redtail Parrotfish: St. Croix Commercial SCUBA (SEDAR26-DW-09)

DESCRIPTION OF THE DATA SOURCE

Item	Not Applicable	Absent	Incomplete	Complete
1. Fishery Independent Indices				
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.	✓			
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)	✓			
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)	✓			
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).	✓			
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			
2. Fishery Dependent Indices				
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).				✓
B. Describe any changes to reporting requirements, variables reported, etc.				✓
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

METHODS

Item	Not Applicable	Absent	Incomplete	Complete
1. Data Reduction and Exclusions				
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).				✓
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?	✓			

Working Group Comments:

2.D. no length information were available in this data set.

1.C. outliers not identified or excluded

	Not Applicable	Absent	Incomplete	Complete
2. Management Regulations (for FD Indices)				
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).		✓		
B. Describe the effects (if any) of management regulations on CPUE		✓		
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.		✓		
3. Describe Analysis Dataset (after exclusions and other treatments)				
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.			✓	
B. Include tables and/or figures of number of positive observations by factors and interaction terms.			✓	
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.			✓	
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.		✓		
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).		✓		
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓
4. Model Standardization				
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?				✓
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.		✓		

Working Group Comments:

2. management history not available for use in the analysis

3. data available on request, not provided at data workshop

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

Item	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:
1. Binomial Component					
A. Include plots of the chi-square residuals by factor.				✓	
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)		✓			
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).		✓			
2. Lognormal/Gamma Component					
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓	
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.		✓			
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓	
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.		✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.		✓			
F. Include plots of the residuals by factor				✓	
3. Poisson Component					
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓				
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓				
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓				
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓				
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓				***The feasibility of this diagnostic is still under review.***
4. Zero-inflated model					
A. Include ROC curve to quantify goodness of fit.	✓				
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓				
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓				

MODEL DIAGNOSTICS (CONT.)

	Not Applicable	Absent	Incomplete	Complete	Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance	✓			
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	*Workshop Recommendation*	*Revision Deadline ****	*Author and Rapporteur Signatures*
First Submission		construct w/ revision		
Revision				

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

No final decision on recommendation.

Working group and plenary recommended constructing an index from these data including the following:

include only the years 1998-2008 (years with effort reported and includes most recent available data as of the data workshop)

use Stephens and MacCall to subset the data (identify targeted trips)

use gear number as effort measure (this may be either number of divers or number of dive tanks, cannot be determined which was reported in many cases)

categorize those trips reported as scuba trips and with >162.5 pounds of parrotfish landed as gillnet trips

The effort measure may differ among fishers, this is a serious problem with this index.

Evaluation of Abundance Indices of Redtail Parrotfish: St. Croix Commercial Trap (SEDAR26-DW-09)

Working Group Comments:

2.D. no length information were available in this data set.

1.C. outliers not identified or excluded

DESCRIPTION OF THE DATA SOURCE

	Not Applicable	Absent	Incomplete	Complete
1. Fishery Independent Indices				
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.	✓			
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)	✓			
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)	✓			
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).	✓			
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			
2. Fishery Dependent Indices				
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).				✓
B. Describe any changes to reporting requirements, variables reported, etc.				✓
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

METHODS

	Not Applicable	Absent	Incomplete	Complete
1. Data Reduction and Exclusions				
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.				✓
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).			✓	
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?	✓			

2. Management Regulations (for FD Indices)

	Not Applicable	Absent	Incomplete	Complete
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).		✓		
B. Describe the effects (if any) of management regulations on CPUE		✓		
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.		✓		

3. Describe Analysis Dataset (after exclusions and other treatments)

	Not Applicable	Absent	Incomplete	Complete
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.			✓	
B. Include tables and/or figures of number of positive observations by factors and interaction terms.			✓	
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.			✓	
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.		✓		
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).		✓		
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓

4. Model Standardization

	Not Applicable	Absent	Incomplete	Complete
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?				✓
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.		✓		

Working Group Comments:

2. management history not available for use in the analysis

3. data available on request, not provided at data workshop

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

Item	Not Applicable	Absent	Incomplete	Complete
1. Binomial Component				
A. Include plots of the chi-square residuals by factor.				✓
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)		✓		
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).		✓		
2. Lognormal/Gamma Component				
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.				✓
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.		✓		
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.		✓		
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.		✓		
F. Include plots of the residuals by factor				✓
3. Poisson Component				
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓			
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓			
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			
4. Zero-inflated model				
A. Include ROC curve to quantify goodness of fit.	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓			
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓			

Working Group Comments:

The feasibility of this diagnostic is still under review.

MODEL DIAGNOSTICS (CONT.)

Not Applicable	Absent	Incomplete	Complete

Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance	✓			
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	***Workshop Recommendation***	***Revision Deadline ******	***Author and Rapporteur Signatures***
First Submission		construct w/ revision		
Revision				

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

No final decision on recommendation.

Working group and plenary recommended constructing an index from these data including the following:

include only the years 1998-2008 (years with effort reported and includes most recent available data as of the data workshop)

use Stephens and MacCall to subset the data (identify targeted trips)

use number of trap hauls as effort measure (allows for complete 1998-08 time series)

Evaluation of Abundance Indices of snappers and groupers:
Fishery Independent Surveys - Puerto Rico and USVI (SEDAR26-DW-10)

DESCRIPTION OF THE DATA SOURCE

1. Fishery Independent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the survey design (e.g. fixed sampling sites, random stratified sampling), location, seasons/months and years of sampling.		✓		
B. Describe sampling methodology (e.g. gear, vessel, soak time etc.)		✓		
C. Describe any changes in sampling methodology (e.g. gear, vessel, sample design etc.)		✓		
D. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).				✓
E. What species or species assemblages are targeted by this survey (e.g. red snapper, reef fish, pelagic).				✓
F. Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.				✓

2. Fishery Dependent Indices

	Not Applicable	Absent	Incomplete	Complete
A. Describe the data source and type of fishery (e.g. commercial handline, commercial longline, recreational hook and line etc.).	✓			
B. Describe any changes to reporting requirements, variables reported, etc.	✓			
C. Describe the variables reported in the data set (e.g. location, time, temperature, catch, effort etc.).	✓			
D Describe the size/age range that the index applies to. Include supporting figures (e.g. size comp) if available.	✓			

METHODS

1. Data Reduction and Exclusions

	Not Applicable	Absent	Incomplete	Complete
A. Describe any data exclusions (e.g. gears, fishing modes, sampling areas etc.). Report the number of records removed and justify removal.			✓	
B. Describe data reduction techniques (if any) used to address targeting (e.g. Stephens and MacCall, 2004; gear configuration, species assemblage etc).	✓			
C. Discuss procedures used to identify outliers. How many were identified? Were they excluded?		✓		

Working Group Comments:

Survey design is available from cruise reports, but not summarized in paper.

Data excluded were from gears that did not catch target species.

Outliers were not identified.

2. Management Regulations (for FD Indices)

Item	Not Applicable	Absent	Incomplete	Complete
A. Provide (or cite) history of management regulations (e.g. bag limits, size limits, trip limits, closures etc.).	✓			
B. Describe the effects (if any) of management regulations on CPUE	✓			
C. Discuss methods used (if any) to minimize the effects of management measures on the CPUE series.	✓			

3. Describe Analysis Dataset (after exclusions and other treatments)

Item	Not Applicable	Absent	Incomplete	Complete
A. Provide tables and/or figures of number of observations by factors (including year, area, etc.) and interaction terms.		✓		
B. Include tables and/or figures of number of positive observations by factors and interaction terms.		✓		
C. Include tables and/or figures of the proportion positive observations by factors and interaction terms.		✓		
D. Include tables and/or figures of average (unstandardized) CPUE by factors and interaction terms.		✓		
E. Include annual maps of locations of survey sites (or fishing trips) and associated catch rates ***OR*** supply the raw data needed to construct these maps (Observation, Year, Latitude, Longitude (or statistical grid, area), Catch, Effort).				✓
F. Describe the effort variable and the units. If more than one effort variable is present in the dataset, justify selection.				✓
G. What are the units of catch (e.g. numbers or biomass, whole weight, gutted weight, kilograms, pounds).				✓

4. Model Standardization

Item	Not Applicable	Absent	Incomplete	Complete
A. Describe model structure (e.g. delta-lognormal)				✓
B. Describe construction of GLM components (e.g. forward selection from null etc.)				✓
C. Describe inclusion criteria for factors and interactions terms.				✓
D. Were YEAR*FACTOR interactions included in the model? If so, how (e.g. fixed effect, random effect)? Were random effects tested for significance using a likelihood ratio test?		✓		
E. Provide a table summarizing the construction of the GLM components.				✓
F. Summarize model statistics of the mixed model formulation(s) (e.g. log likelihood, AIC, BIC etc.)				✓
G. Report convergence statistics.				✓

Working Group Comments:

MODEL DIAGNOSTICS

Comment: Other model structures are possible and acceptable. Please provide appropriate diagnostics to the CPUE indices working group.

Working Group Comments:

1. Binomial Component

	Not Applicable	Absent	Incomplete	Complete
A. Include plots of the chi-square residuals by factor.		✓		
B. Include plots of predicted and observed proportion of positive trips by year and factor (e.g. year*area)		✓		
C. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).				✓

2. Lognormal/Gamma Component

	Not Applicable	Absent	Incomplete	Complete
A. Include histogram of log(CPUE) or a histogram of the residuals of the model on CPUE. Overlay the expected distribution.			✓	
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓			
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.				✓
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			
F. Include plots of the residuals by factor	✓			

3. Poisson Component

	Not Applicable	Absent	Incomplete	Complete
A. Report overdispersion parameter and other fit statistics (e.g. chi-square / degrees of freedom).	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor.	✓			
C. Include QQ-plot – (e.g. Student deviance residuals vs. theoretical quantiles), Overlay expected distribution.	✓			
D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

The feasibility of this diagnostic is still under review.

4. Zero-inflated model

	Not Applicable	Absent	Incomplete	Complete
A. Include ROC curve to quantify goodness of fit.	✓			
B. Include plots describing error distribution (e.g. Studentized residuals vs. linear predictor).	✓			
C. Include QQ-plot (e.g. Student dev. residuals vs. theoretical quantiles), Overlay expected distribution.	✓			

MODEL DIAGNOSTICS (CONT.)

Not Applicable	Absent	Incomplete	Complete

Working Group Comments:

D. Include diagnostic plot for variance function (e.g. square root of std residuals vs. fitted values). Overlay expected distribution.	✓			
E. Include diagnostic plot for link function (e.g. linear response variable vs. linear predictor). Overlay expected distribution.	✓			

MODEL RESULTS

A. Tables of Nominal CPUE, Standardized CPUE, Observations, Positive Observations, Proportion Positive Observations and Coefficients of Variation (CVs). Other statistics may also be appropriate to report				✓
B. Figure of Nominal and Standardized Indices with measure of variance (i.e. CVs).				✓

IF MULTIPLE MODEL STRUCTURES WERE CONSIDERED:

(***Note: this is always recommended but required when model diagnostics are poor***.)

1. Plot of resulting indices and estimates of variance	✓			
2. Table of model statistics (e.g. AIC criteria)	✓			

	Date Received	***Workshop Recommendation***	***Revision Deadline ******	***Author and Rapporteur Signatures***
First Submission				
Revision				

The revision deadline is negotiated by the author, the SEDAR coordinator and the CPUE rapporteur. The author ***DOES NOT*** *commit to any* ***LEGAL OBLIGATION*** *by agreeing to submit a manuscript before this deadline. The maximum penalty for failure to submit a revised document prior to the submission deadline is rejection of the CPUE series.*

Justification of Working Group Recommendation

No final decision on recommendation.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 26

U.S. Caribbean Queen Snapper

SECTION III: Assessment Process Report

October 2011

SEDAR
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405

Table of Contents

1. WORKSHOP PROCEEDINGS

1.1. INTRODUCTION

1.1.1. 1.1.1 Workshop time and Place

The SEDAR 26 Assessment Workshop was held July 25-29, 2011 in St. Thomas, USVI. Several additional assessment webinars were held between August and September 2011 to finalize the assessment.

1.1.2. 1.1.2 Terms of Reference

1. Review any changes in data following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model. Provide justification for any deviations from Data Workshop recommendations.
2. Develop population assessment models that are compatible with available data.
   - Consider multiple models including multispecies models if data limitations preclude single species assessments.
   - Recommend models and configurations considered most reliable or useful for providing advice
   - Document all input data, assumptions, and equations for each model
3. Evaluate feasibility and provide, if possible, estimates of stock population parameters.
   - When available, include fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, etc.
   - Include appropriate and representative measures of precision for parameter estimates.
4. Characterize uncertainty in the assessment and estimated values.
   - Consider uncertainty in input data, modeling approach, and model configuration.
   - Consider other sources as appropriate for this assessment
   - Provide appropriate measures of model performance, reliability, and ‘goodness of fit’
5. Provide evaluations of yield and productivity
   - Include yield-per-recruit, spawner-per-recruit, and stock-recruitment models
6. Provide estimates of population benchmarks or management criteria consistent with the available data, applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards.
   - Evaluating existing or proposed management criteria as specified in the management summary
   - Recommend proxy values when necessary
7. Provide declarations of stock status relative to benchmarks or alternative data-poor approach.
8. Perform a probabilistic analysis of proposed reference points, stock status, and yield.
   - Provide the probability of overfishing at various harvest or exploitation levels

- Provide a probability density function for biological reference point estimates.
- If the stock is overfished, provide the probability of rebuilding within mandated time periods as described in the management summary or applicable federal regulations.

9. Project future stock conditions (biomass, abundance, and exploitation) and develop rebuilding schedules if warranted; include estimated generation time. Stock projections shall be developed in accordance with the following:

   A) If stock is overfished:

   F=0, F=current, F=Fmsy, Ftarget (OY),

   F=Frebuild (max that rebuild in allowed time)

   B) If stock is overfishing

   F=Fcurrent, F=Fmsy, F= Ftarget (OY)

   C) If stock is neither overfished nor overfishing

   F=Fcurrent, F=Fmsy, F=Ftarget (OY)

   D) If data-limitations preclude classic projections (i.e. A, B, C above), explore alternate models to provide management advice.

10. Provide recommendations for future research and data collection.
    - Be as specific as practicable in describing sampling design and sampling intensity
    - Emphasize items which will improve future assessment capabilities and reliability
    - Consider data, monitoring, and assessment needs
11. Prepare an accessible, documented, labeled, and formatted spreadsheet containing all model parameter estimates and all relevant population information resulting from model estimates and any projection and simulation exercises. Include all data included in assessment report tables and all data that support assessment workshop figures.
12. Complete the Assessment Workshop Report for Review (Section III of the SEDAR Stock Assessment Report).

1.1.3. 1.1.3. List of Participants

Assessment Workshop Panel

Francisco Pagen ....Caribbean Coral Reef Institute
Jed Brown ....St. Croix DPNR
Kevin McCarthy..NMFS/SEFSC/Miami
Meaghan Bryan.. NMFS/SEFSC
Nancie Cummings..NMFS/SEFSC/Miami
Richard Appeldoorn.................................. SSC Representative/University of Puerto Rico
Ron Hill... NMFS/SEFSC/Galveston
Todd Gedamke..NMFS/SEFSC/Miami
Walter R. Keithly, Jr. ....SSC Rep/ LSU
William Tobias...STX Representative

Council Representation

Eugenio Pineiro-Soler...CFMC

Appointed Observers

Jose Alberto Sanchez .... STX Industry rep

Attendees

David Olsen .... STFA

Staff

Julie A. Neer ....SEDAR
Bill Arnold ....SERO
Graciela García-Moliner .... CFMC Staff
Michael Larkin...SERO
Patrick Gilles...NMFS Miami
Rachael Silvas...SEDAR

1.1.4. 1.1.4. List of Assessment Process Working and Reference Papers

Document #	Title	Authors
	Reference Documents	
SEDAR26-RD02	Inventory and Atlas of Corals and Coral Reefs, with Emphasis on Deep-Water Coral Reefs from the U. S. Caribbean EEZ	Jorge R. García Sais
SEDAR26-RD03	Estimating mutton snapper mortality rates from mean lengths and catch rates in non-equilibrium conditions (SEDAR 14 – RW- 01)	Gedamke, T. and C. Porch
SEDAR26-RD04	Estimation of mutton snapper total mortality rate from length observations	Todd Gedamke

SEDAR26-RD05	A preliminary investigation into the accuracy of commercial catch reports using information from the St. Croix net fishery	Wes Toller

1.2. PANEL RECOMMENDATIONS AND COMMENT

1.2.1. Term of Reference 1

Review any changes in data following the data workshop and any analyses suggested by the data workshop. Summarize data as used in each assessment model. Provide justification for any deviations from Data Workshop recommendations.

The primary data inputs presented and discussed during the Data Workshop (DW) were commercial landings, CPUE data, length frequency observations, and recreational catches. Catch profiles included years 2000-2010. Queen snapper landings were not available for U.S. Virgin Islands as species specific commercial landings are not reported and recreational catches are not quantified. There were no modifications made to these data inputs subsequent to the DW. Sections 2.1-2.3 characterized commercial landings, CPUE, length data and recreational catches for Puerto Rico, St. Thomas, and St. Croix respectively.

A discussion of data used and suggestions from the DW for the length frequency analysis is provided in Sections 2.1.4, 2.2.3, and 2.3.3. More details are provided in SEDAR26-DW-04.

1.2.2. Term of Reference 2

Develop population assessment models that are compatible with available data.

- *Consider multiple models including multispecies models if data limitations preclude single species assessments.*
- *Recommend models and configurations considered most reliable or useful for providing advice*
- *Document all input data, assumptions, and equations for each model*

The AW Panel recommended the use of multiple modeling approaches to evaluate the Queen snapper stock condition. These approaches included development of stock abundance CPUE indices from the dependent bottom line fishery and the application of the length based total mortality estimator (Gedamke and Hoenig, 2006) to available length frequency observations. Although, multi-species based CPUE abundance indices were discussed during the DW and preliminary results were presented at the Assessment Webinar 1 (Ingram 2011, DW07), the AW Panel recommended the traditional single species based CPUE indices as the base model.

Single species based CPUE abundance index development data inputs and model configurations are described in Section 3.1.1. Model results and associated uncertainty were discussed in Section 3.1.2.

The length based mortality model development and model configurations for both Puerto Rico and St. Croix are described in Section 3.2.1.3. Note sample sizes were insufficient to conduct additional analyses in St. Thomas.

1.2.3. Term of Reference 3

Evaluate feasibility and provide, if possible, estimates of stock population parameters.

- *When available, include fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, etc.*
- *Include appropriate and representative measures of precision for parameter estimates.*

Single species based standardized CPUE trends were constructed for the Queen snapper bottom line fishery and are presented in Section 3.1.2. The Index working group and AW Panel indicated concern that the index may not reflective of abundance but rather tracking changes in targeting preference in this fishery. Operational changes in the Queen snapper fishery particularly in the mid to late 1990's are largely supported through a consistently increasing number of successful queen snapper trips that began in the late 1990's and continued through 2008. The Queen snapper fishery is believed to have begun in the mid 1980's with reported landings first occurring in 1987 however, there is uncertainty associated with the reported landings as not all fishers report their landings.

Reliable estimates of stock population parameters are not available from the length frequency analysis due to data limitations however changes in selectivity and total mortality are presented and discussed in Sections 3.2.1.5, 3.2.2.8, 3.2.3 and 5.1.3.

1.2.4. Term of Reference 4

Characterize uncertainty in the assessment and estimated values.

- *Consider uncertainty in input data, modeling approach, and model configuration.*
- *Consider other sources as appropriate for this assessment*
- *Provide appropriate measures of model performance, reliability, and 'goodness of fit'*

Estimated 95% confidence intervals were constructed for the Queen snapper bottom line fishery CPUE indices and were presented in Section 3.1.2. The calculated coefficient of variation about the annual index ranged from 12% to 30% across the time series, 1988-2009. In general the model fits were reasonable as supported from residual analysis and inspection of QQ plots, and did not indicate any major departure from model assumptions. In addition, all factors evaluated for model inclusion were supported through fit results thus not suggesting the models were over parameterized. Future index standardization could possibly be improved if additional information on trip effort and spatial location were available. Since the Queen snapper fishery is mainly a single species fishery, use of multi-species information as covariables may not improve the fits.

Considerable uncertainty exists in the absolute estimates of total mortality from the mean length analysis so a comprehensive sensitivity analysis was conducted. This is discussed in Sections 3.2.1.5, 3.2.2.8, 3.2.3 and 5.1.3.

1.2.5. Term of Reference 5

Provide evaluations of yield and productivity

- *Include yield-per-recruit, spawner-per-recruit, and stock-recruitment models*

Calculations of yield-per-recruit, spawner-per-recruit, and stock-recruitment estimations were not addressed in SEDAR26 due to a lack of data and concerns regarding life history parameters which are discussed throughout the length frequency analyses sections.

1.2.6. Term of Reference 6

Provide estimates of population benchmarks or management criteria consistent with the available data, applicable FMPs, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards.

- *Evaluating existing or proposed management criteria as specified in the management summary*
- *Recommend proxy values when necessary*

Absolute estimates of population benchmarks are not available from this assessment, however management advice is discussed in the context of all scenarios explored (i.e. sensitivity analysis), the proposed Annual Catch Limits, and basic surplus production theory in Sections 3.2.3 and 5.3.

1.2.7. Term of Reference 7

Provide declarations of stock status relative to benchmarks or alternative data-poor approach.

Stock status is discussed in Sections 3.2.3 and 5.3.

1.2.8. Term of Reference 8

Perform a probabilistic analysis of proposed reference points, stock status, and yield.

- *Provide the probability of overfishing at various harvest or exploitation levels*
- *Provide a probability density function for biological reference point estimates.*
- *If the stock is overfished, provide the probability of rebuilding within mandated time periods as described in the management summary or applicable federal regulations.*

A probabilistic analysis of proposed reference points was not possible given data limitations.

1.2.9. Term of Reference 9

Project future stock conditions (biomass, abundance, and exploitation) and develop rebuilding schedules if warranted; include estimated generation time.

Data limitations precluded classic projections. Management advice for is discussed in the context of all scenarios explored (i.e. sensitivity analysis), the proposed Annual Catch Limits, and basic surplus production theory in Sections 3.2.3 and 5.3.

1.2.10. Term of Reference 10

Provide recommendations for future research and data collection.

- *Be as specific as practicable in describing sampling design and sampling intensity*
- *Emphasize items which will improve future assessment capabilities and reliability*
- *Consider data, monitoring, and assessment needs*

Research efforts are needed that focus on improved data collection efforts, particularly on trip based catch and effort and recording of more detailed geographical data on catch area. Surveys should be considered that will allow validation of fisher reported catch, landings, and trip effort. Surveys are needed that allow characterization of multi- species trips to allow identification of trips that split fishing effort across different gears and species groups. These surveys should be coordinated with fisher groups to enhance buy in by the industry.

The ability to utilize length-frequency data is contingent upon having reliable estimates of life history parameters (von Bertalanffy parameters in particular). Studies on basic life history (e.g. age-growth relationships and estimating natural mortality) in the US Caribbean will greatly enhance the utility of the existing length-frequency data and should provide the greatest benefit to providing management advice in the short term. This should be placed as a top priority for key species.

1.2.11. Term of Reference 11

Prepare an accessible, documented, labeled, and formatted spreadsheet containing all model parameter estimates and all relevant population information resulting from model estimates and any projection and simulation exercises. Include all data included in assessment report tables and all data that support assessment workshop figures.

Given the uncertainty in parameter inputs and the extensive sensitivities that were conducted in the length frequency analysis, the presentation of ‘all model parameter estimates’ and ‘all data’ in tabular/spreadsheet form is not a particularly accessible format for the assessment that was conducted. This information is contained in the Figures and Tables in the report and a simplified version is in preparation.

2. DATA REVIEW AND UPDATE

2.1. Puerto Rico

2.1.1. Commercial Fishery Landings Data

SEDAR26 DW-03 presented updated commercial landings data for queen snapper for the complete time series, 1983-2009. Sales records documenting landed weight by fishing center (Figure 1) and some ancillary trip effort information were obtained through voluntary reports by fishers until 2005 when reporting became mandatory through Puerto Rico Law 278 of November 29th, 1998. Since that time, commercial fishers in Puerto Rico have been required to submit landings reports to the Puerto Rico, Department of Natural Resources and Environment (DNER). During many of the early years, landings reports were accomplished through the efforts of commercial port agents who routinely visited the fishing centers to pick up the sales tickets, conduct port sampling of catches, and conduct annual censuses of fishers and fishing operations. Reported landings of queen snapper first appear in the time series in 1987. Table 2.4.1 and Figure 2.5.2 presents the reported landings from 1987-2009.

2.1.2. Single Species Commercial Catch Per Unit of Effort (CPUE) Abundance Data

Abundance indices for queen snapper commercial fisheries in Puerto Rico were previously presented by Cummings for the SEDAR Data Evaluation Workshop held in 2009 (SEDAR Procedures III, SP. For this 2011 benchmark stock assessment evaluation, commercial CPUE abundance indices were updated from SEDAR Procedures IIII to incorporate information from the commercial fisheries reported since the 2009 workshop. Updated commercial CPUE abundance indices were developed using the observations reported by commercial fishers in Puerto Rico. Although reports of commercial landings for use in developing CPUE abundance indices exist since 1967 for Puerto Rico's commercial fisheries, information is only available electronically since 1983.

As a reference to the operations of the historical commercial fisheries in Puerto Rico, background information Rico was presented by Cummings and Matos-Caraballo (SEDAR Procedures III-SP3, 2009) and Cummings and Matos-Carabalo (SEDAR26 DW-03, 2011) and Suarez-Caabro (1975).

2.1.3. Multispecies Commercial CPUE Analyses

For the 2011 SEDAR26 benchmark assessment multispecies were considered. SEDAR26-DW-07 provided details relating to the methods used to develop multispecies CPUE indices for the SEDAR26 focus species groups (silk and queen snapper and parrotfish family). The SEDAR26 Index Working group recommended that for the 2011 benchmark evaluations that results of the single species CPUE index analyses be used to characterize abundance. The Working group recommended that future stock assessment evaluations continue to explore the development of multispecies CPUE Indices.

2.1.4. Length-frequency analysis

The individual length frequency data were initially evaluated during the SEDAR 26 DW to determine island and gear combinations with sufficient data to use in subsequent length analyses.

The length-frequency histograms for each combination were evaluated over five year time periods to identify changes in selectivity and length at full vulnerability. Table 3.2.5.1 presents sample sizes for each island-gear combination. Figure 3.2.6.1 presents the length-frequency histogram for the only island-gear combination identified to have sufficient data for analysis.

The AW panel expressed an interest in evaluating the length-frequency data to identify targeting of spawning aggregations and to determine temporal changes in recruitment. Queen snapper are thought to spawn year-round with peaks in October and November in Puerto Rico and reach maturity between 233mm and 310 mm (Rosario et al. 2006). The monthly length-frequency plots in Figure 2.5.3 show that the fish measured and recorded for the TIP database mainly fall above the length at maturity. The peak of the monthly length-frequency plots are relatively stable (~400mm), however, a shift in the distribution in November and December towards larger fish (~600mm; Figure 2.5.3) may be indicative of a spawning period.

Annual length-frequency plots are shown in Figure 2.5.4. Sample size and availability of samples was variable among years. There are no obvious trends indicating changes in recruitment or targeting of spawning aggregations over time (Figure 2.5.4).

2.1.5. Recreational Catch

Information on recreational fishing in Puerto Rico is available since 2000 from the Marine Recreational Information Program (MRIP, formerly the Marine Recreational Fisheries Sampling Survey (MRFSS). SEDAR DW-02 presented information on recreational catches of queen snapper from 2000-2010 and provided estimates of total angler effort and associated coefficients of variation. Information on directed effort for queen snapper is not available. Table 2.4.1 and Figure 2.5.1 presents estimated Queen snapper recreational catches since 2000 and Table 2.4.2 and Figure 2.5.2 presents total estimated angler effort.

2.1.6. Auxiliary information from the Trip Interview Program (TIP) database

The AW panel expressed a concern about changing spatio-temporal patterns in fishing. The TIP database contains some information about fishing region and depth and as such, Figures 2.5.5 and 2.5.6 summarize this information for Puerto Rico. Figure 2.5.5 suggests that fishing overtime has been spatially concentrated in the west, northwest region of Puerto Rico. Since 1999, some fishing has also happened in the west, southwest region. The number of interviews indicating fishing depth has been variable over time, therefore, a decisive pattern is difficult to obtain (Figure 2.5.6). Fishing depth, however, has been seemingly stable over time for queen snapper in Puerto Rico (Figure 2.5.6).

2.2. St. Thomas/St. John

2.2.1. Commercial Fishery Landings Data

Commercial landings of queen snapper in St. Thomas/St. John could not be tabulated because landings have been reported by species group (e.g., snapper, grouper, etc.). No accepted, unbiased method has been identified to partition US Virgin Islands landings reported by species group to the species level (Caribbean Data Evaluation Final Report, 2009).

2.2.2. Commercial Catch Per Unit of Effort (CPUE) Abundance Data

Abundance indices could not be constructed for queen snapper in St. Thomas/St. John because commercial fishing data in the US Virgin Islands have been reported by species group (e.g., snapper, grouper, etc.). Queen snapper make up an unknown proportion of the snapper landings, therefore, a "snapper" index of abundance used as a proxy for a queen snapper cpue time series was not appropriate. In addition, the proportion of fishing effort targeting queen snapper was also unknown.

2.2.3. Length-frequency Analysis

The individual length frequency data were initially evaluated during the SEDAR 26 DW to determine island and gear combinations with sufficient data to use in subsequent length analyses. The length-frequency histograms for each combination were evaluated over five year time periods to identify changes in selectivity and length at full vulnerability. Table 3.2.5.1 presents the sample sizes for all possible island-gear combinations, note that sample sizes were insufficient for analysis and thus not included in Table 3.2.5.2. Figure 4.2.1 presents the length-frequency histogram for the St. Thomas- hook and line combination, note the overall low sample size.

2.2.4. Recreational Catch

Information on recreational catch and effort of Queen snapper was not available for St. Thomas/St. John.

2.2.5. Auxiliary information from the TIP database

Sample size was insufficient to evaluate changes in spatio-temporal patterns in fishing for St. Thomas/St. John.

2.3. St. Croix

2.3.1. Commercial Fishery Landings Data

Commercial landings of queen snapper in St. Croix could not be tabulated because landings have been reported by species group (e.g., snapper, grouper, etc.). No accepted, unbiased method has been identified to partition US Virgin Islands landings reported by species group to the species level (Caribbean Data Evaluation Final Report, 2009).

2.3.2. Commercial Catch Per Unit of Effort (CPUE) Abundance Data

As in St. Thomas/St. John, abundance indices could not be constructed for queen snapper in St. Croix. See Section 2.2.2 for explanation.

2.3.3. Length-frequency Analysis

The individual length frequency data were initially evaluated during the SEDAR 26 DW to determine island and gear combinations with sufficient data to use in subsequent length analyses. The length-frequency histograms for each combination were evaluated over five year time periods to identify changes in selectivity and length at full vulnerability. Table 3.2.5.1 presents sample sizes for each island-gear combination. Figure 3.2.6.1 presents the length-frequency histogram for the only island-gear combination identified to have sufficient data for analysis, (i.e., St. Croix-hook and line).

As was mentioned in Section 2.1.4, the AW panel expressed an interest in evaluating the length-frequency data identify targeting of spawning aggregations and to determine temporal changes in recruitment. Figure 2.5.7 suggests that length-frequency is quite stable from a monthly perspective for queen snapper caught in waters surrounding St. Croix. Therefore, there is no indication from the data contained in the TIP database that fishers are targeting spawning aggregations.

Annual length-frequency plots are shown in Figure 2.5.8. Availability of samples and sample size varied over time. The years with well-defined histograms have relatively stable peaks across time (Figure 2.5.8). The data from the TIP database does not indicate a changing trend in recruitment over time.

2.3.4. Recreational Catch

Information on recreational catch and effort of Queen snapper was not available for St. Croix.

2.3.5. Auxiliary information from the TIP database

As was mention in Section 2.1.6, the AW panel was interested in evaluating the spatio-temporal trends in fishing. Limited information exists however the TIP database contains some information about fishing region and depth Figures 2.5.9 and 2.5.10 summarize this information for St. Croix. Figure 2.5.9 suggests that the fishing has mainly been in the eastern region of St. Croix (please note small sample size indicated in the figure). The number of interviews including information about fishing depth has been variable over time, therefore, strong conclusions about a discernible pattern in fishing depth is difficult to obtain (Figure 2.5.10). Figure 2.5.10 suggests a potential increase in fishing depth over time however sample size is much lower in recent years (2000 – present).

2.4. Tables

Table 2.4.1. Estimated recreational AB1 and B2 Catch for seven reefish species in Puerto Rico from the MRIP survey. AB1 and B2 units are numbers of fish. CV=estimate/100.

Species	YEAR	Sum of ab1	Sum of b2	CV(AB1)	CV(B2)	B2/AB1B2
queen snapper	2000	5718.07	0.00	82.37	0.00	0.00
	2001	17488.75	0.00	47.40	0.00	0.00
	2002	9536.87	0.00	53.79	0.00	0.00
	2003	6587.37	0.00	37.49	0.00	0.00
	2004	2822.05	0.00	56.93	0.00	0.00
	2005	13346.68	0.00	62.49	0.00	0.00
	2006	557.25	0.00	100.20	0.00	0.00
	2007	6823.70	0.00	85.12	0.00	0.00
	2008	26611.18	0.00	47.67	0.00	0.00
	2009	2526.09	0.00	62.90	0.00	0.00
	2010	4008.12	0.00	79.44	0.00	0.00

Table 2.4.2. Estimated number recreational angler trips in Puerto Rico, 2000-2010. Source = MRIP survey.

YEAR	Estimated # Angler Trips	Coefficient of Variation of # Angler Trips
2000	1,362,704	9.9
2001	1,411,943	6.9
2002	1,301,059	7.3
2003	1,111,405	7.9
2004	1,050,298	10.1
2005	866,723	8.0
2006	955,123	9.3
2007	1,080,097	8.6
2008	798,551	9.1
2009	636,151	9.4
2010	536,167	9.5
Grand Total	11,110,220	2.7

2.5. Figures

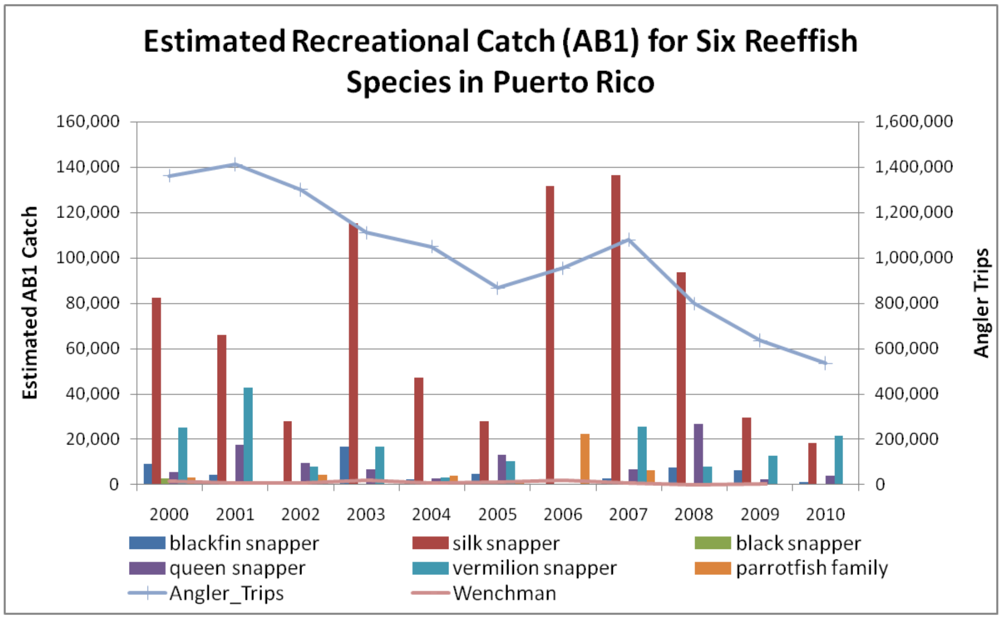

Figure 2.5.1. Estimated AB1 catch for six Reeffish species and number recreational angler trips in Puerto Rico, 2000-2010. Units are numbers of fish. Source =MRIP survey.

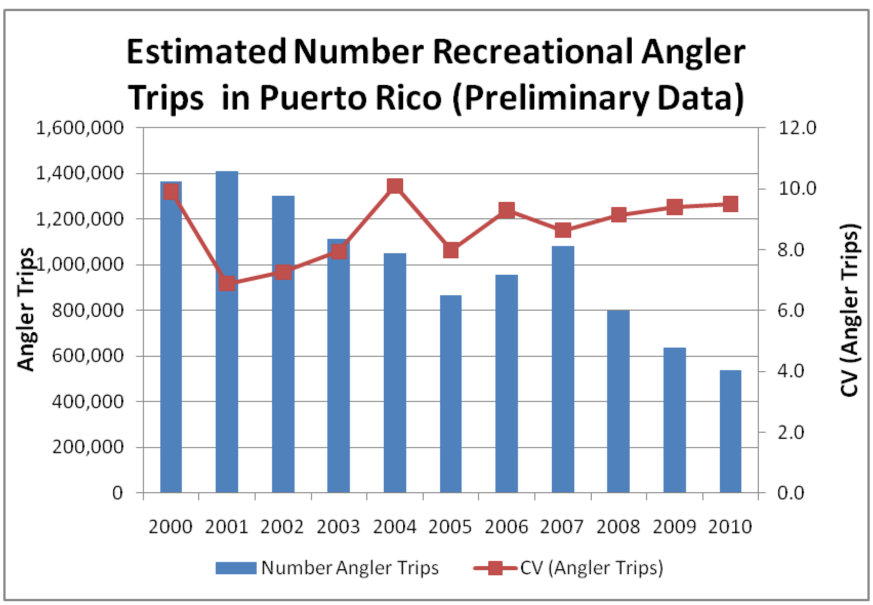

Figure 2.5.2. Profile of estimated number recreational angler trips in Puerto Rico 2000-2010. Source =MRIP survey.

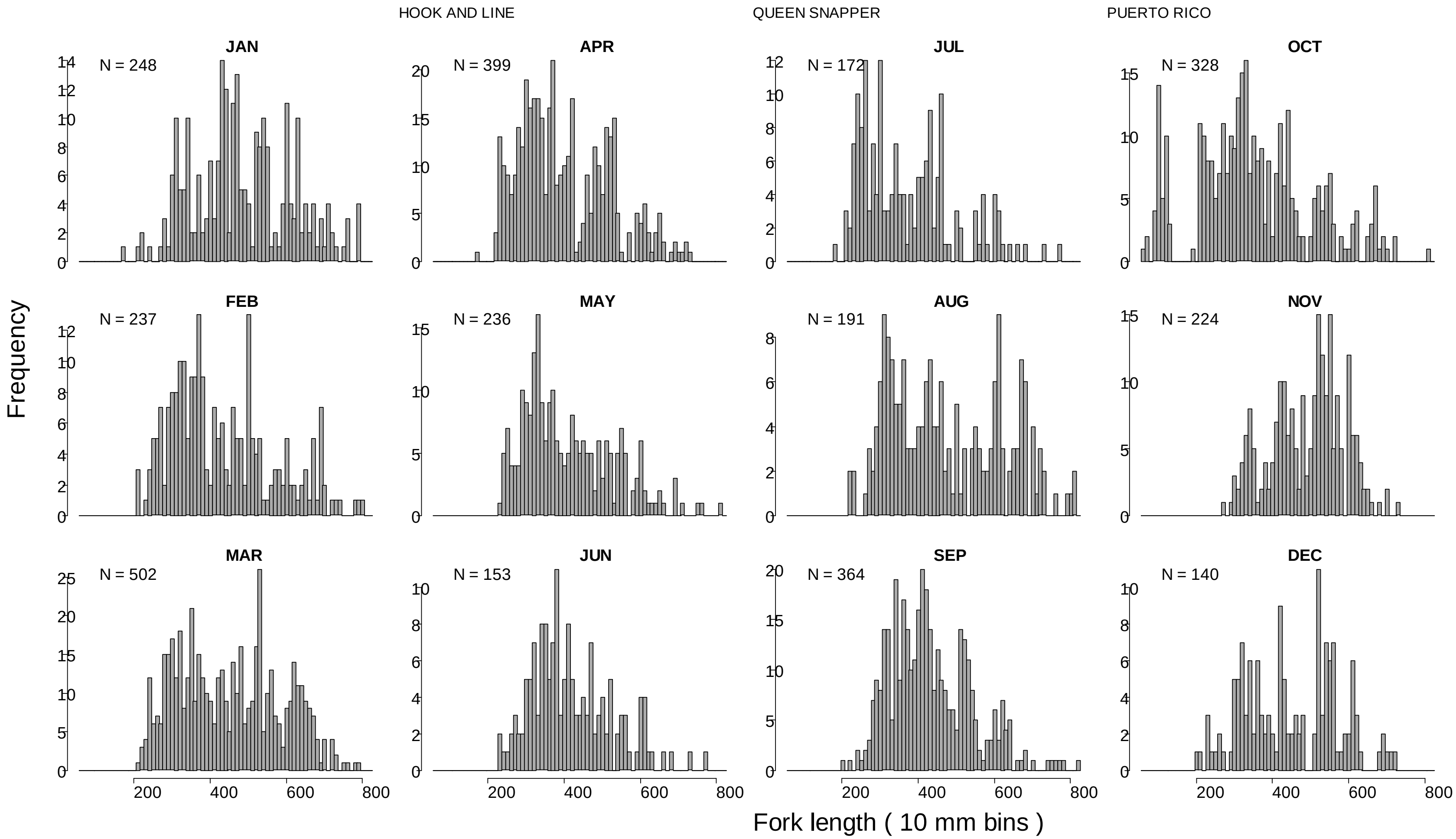

Figure 2.5.3. Monthly length-frequency histograms, where the length data was aggregated over years, for queen snapper caught by hook and line in Puerto Rico. N represents the sample size.

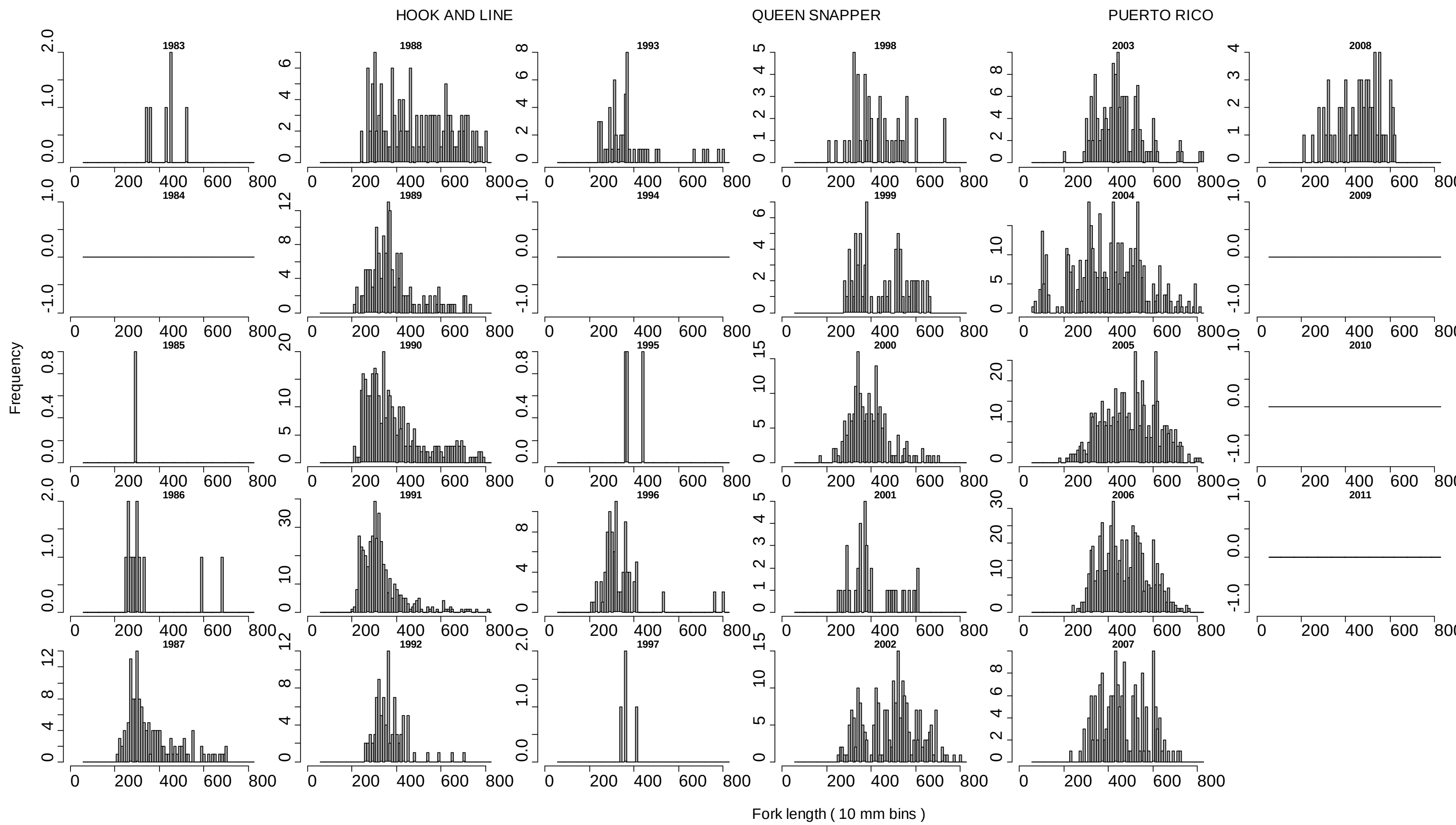

Figure 2.5.4. Annual length-frequency histograms for queen snapper caught by hook and line in Puerto Rico. Flat lines at zero indicate length-data was not collected in those years. Please note that the y-axis differs for each panel.

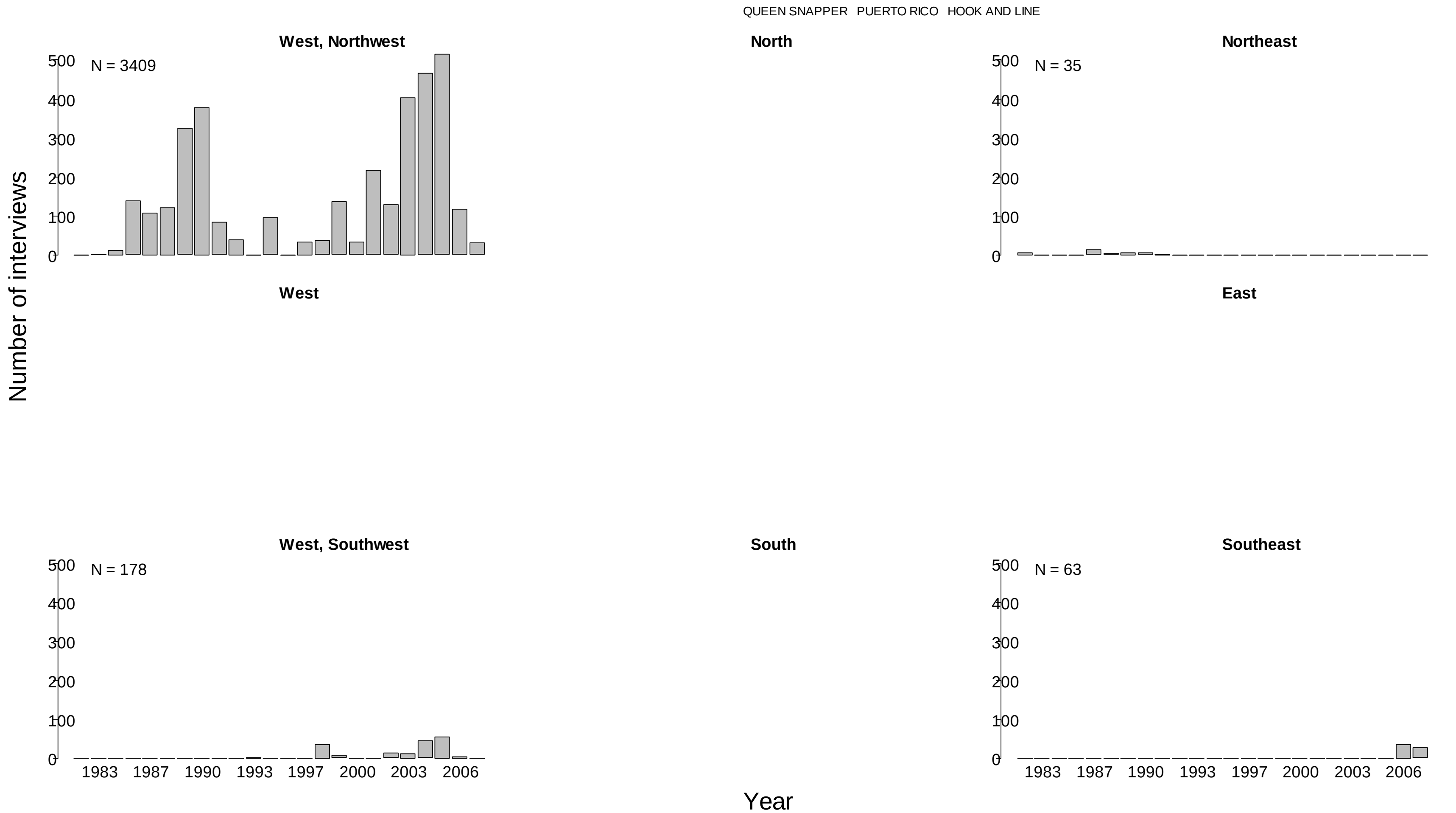

Figure 2.5.5. Number of interviews indicating fishing in a particular region around Puerto Rico where queen snapper was caught by hook and line. N is the total number of interviews indicating fishing within a given region.

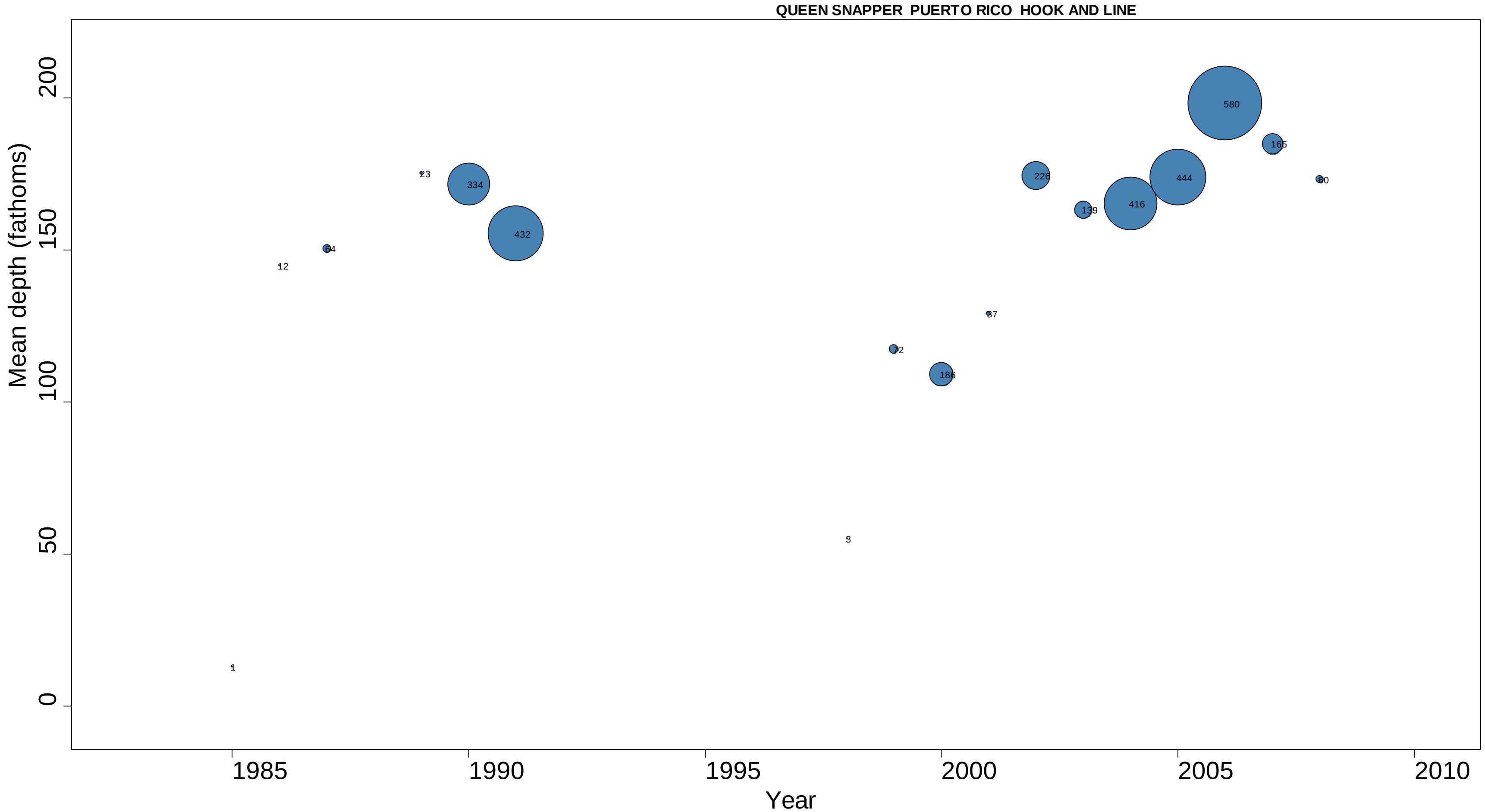

Figure 2.5.6. Mean depth (measured in fathoms) of fishing and capture of queen snapper using hook and line in Puerto Rico. Bubble size indicates the number of interviews from the TIP database for a given year that were used to calculate the mean and is scaled with respect to other years. The numbers plotted within the figure represent the number of interviews per bubble.

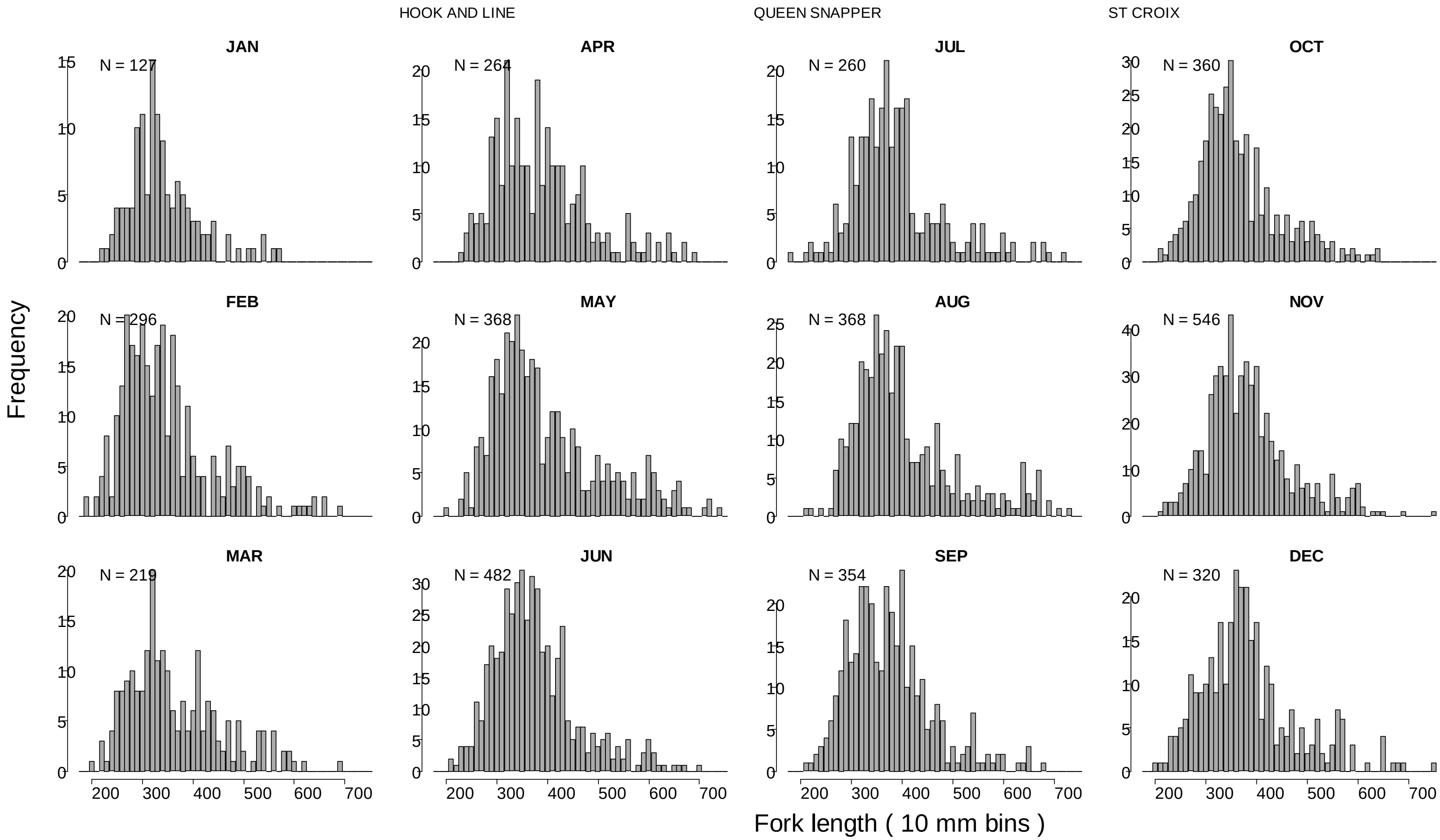

Figure 2.5.7. Monthly length-frequency histograms, where the length data was aggregated over years, for queen snapper caught by hook and line in St. Croix. N represents the sample size.

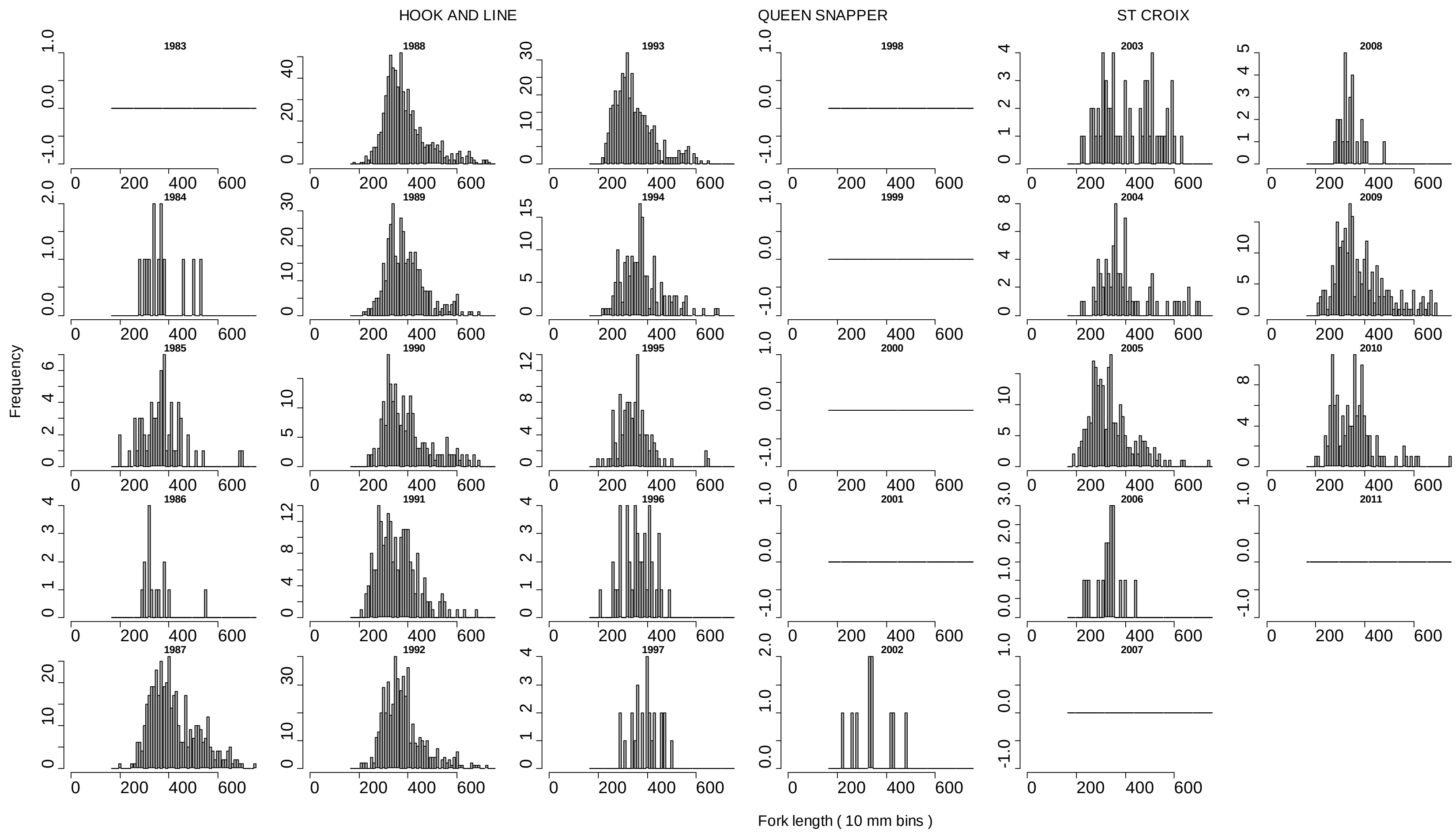

Figure 2.5.8. Annual length-frequency histograms for queen snapper caught by hook and line in St. Croix. Flat lines at zero indicate length-data was not collected in those years. Please note that the y-axis differs for each panel.

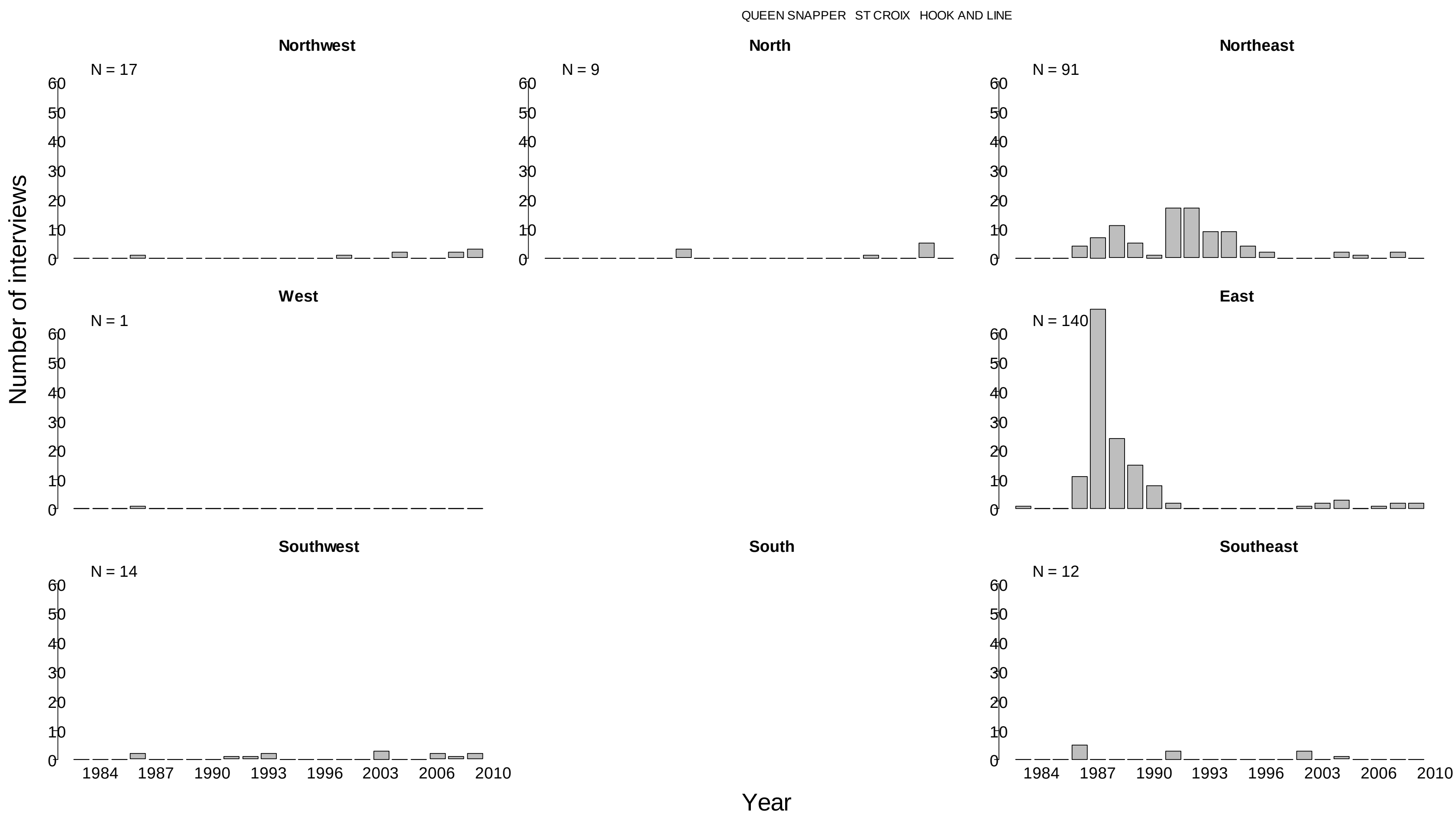

Figure 2.5.9. Number of interviews indicating fishing in a particular region around St. Croix where queen snapper was caught by hook and line. N is the total number of interviews indicating fishing within a given region.

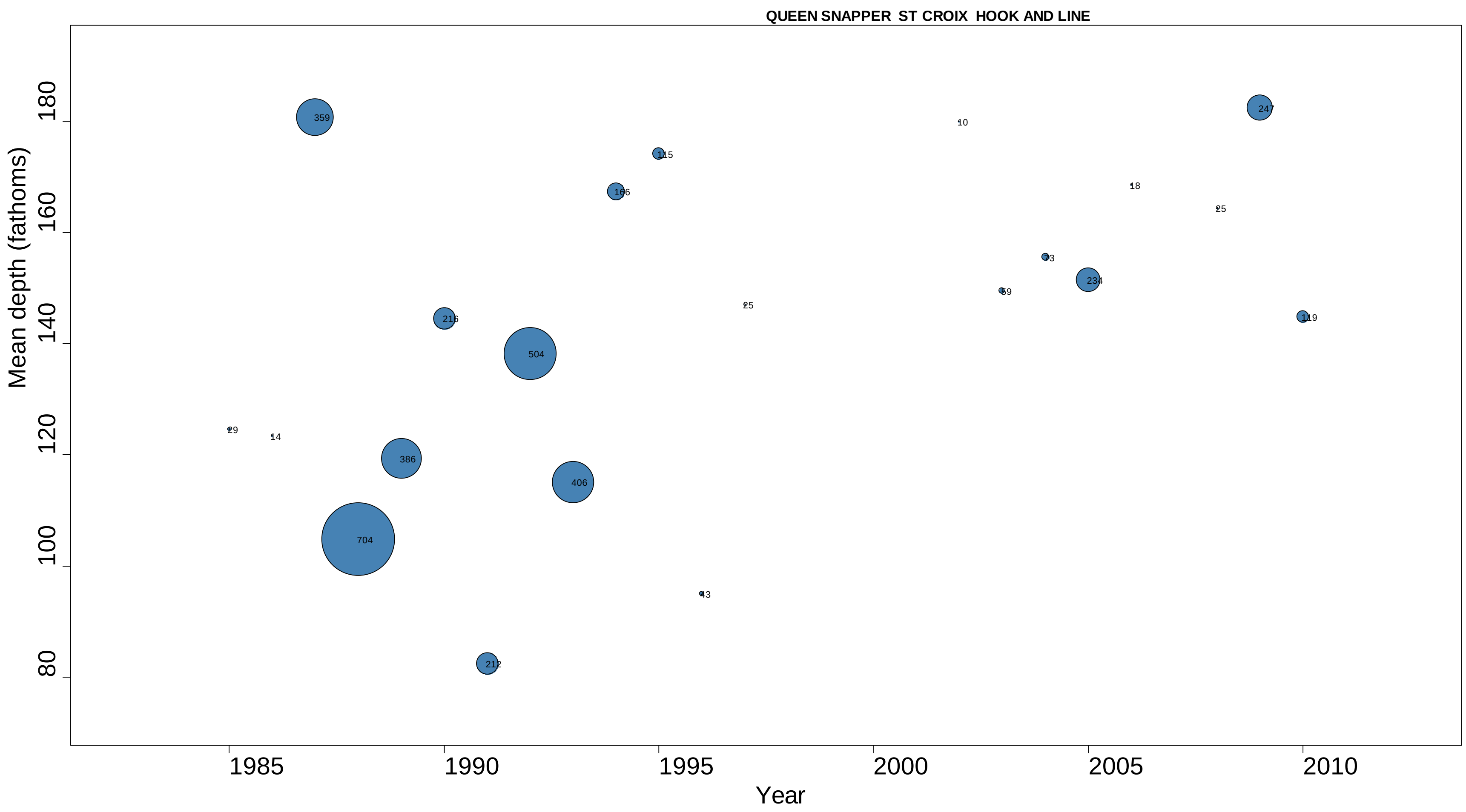

Figure 2.5.10. Mean depth (measured in fathoms) of fishing and capture of queen snapper using hook and line in St. Croix. Bubble size indicates the number of interviews from the TIP database for a given year that were used to calculate the mean and is scaled with respect to other years. The numbers plotted within the figure represent the number of interviews per bubble.

3. Puerto Rico Queen Snapper Stock Assessment Models and Results

3.1. Model 1 – Commercial CPUE Abundance Indices

3.1.1. Model 1 Methods

3.1.1.1 Overview

For the SEDAR26 2011 benchmark evaluations a combination of model approaches were used to investigate stock status of queen snapper resources for the Puerto Rican platform. These involved development of commercial single species CPUE abundance indices and also an evaluation of changes in stock status using port sampling collections of length samples.

3.1.1.2 Data Sources

Commercial single species CPUE abundance indices were developed from the historical collection of commercial landings and effort data reported from 1983-2009 for the Puerto Rican commercial fisheries. Table 3.1.5.1 presents a summary of the commercial landings and number of CPUE observations for queen snapper in Puerto Rico.

3.1.1.3 Model Configuration and Equations

Commercial CPUE Indices Base Case

During the SEDAR 26 Data Workshop, the Puerto Rico platform Working Group reviewed DW03 and DW 05 and made recommendations for trip selection for use in CPUE abundance analyses. The Working group noted that pervious SEDARs had also considered the Stephens and MacCall (2004) approach for data sub setting, however, the Panel felt that in input of the local experts in identifying the geographical areas and time periods where queen snapper catches were likely to occur was important to consider. The Working Group recommended considering the following stratifications of time (year, month), geographical region (fishing center), and fishery (gear) in subsequent exploration of the landings data for development of queen snapper catch per unit of effort abundance indices. Inspection of the summarized landings data from DW03 indicated two primary gears used for queen snapper in the fishery, reef fish bottom line gear and troll gear, during the entire time series, 1983-2009 with queen snapper landings occurring since 1987 in the data set. These two gears on average contributed about 90% of the annual queen snapper landings over the time series. The Working group recommended using trips from the bottom line gear only for the Base Case CPUE set as this is the gear primarily used to target queen Snapper in Puerto Rico. Previous examinations of queen snapper abundance indices (Cummings and Matos-Caraballo, 2009) presented indices for combined gears and combined spatial areas however the Working group felt that further partitioning of the observation could help to reduce the overall variation in the annual index. Prior to index development, detailed summaries of the area and gear specific and monthly observations were reviewed by the group and deemed sufficient for CPUE analyses. The queen snapper fishery is mainly conducted off the west coast of Puerto Rico corresponding to municipalities between Cabo Rojo and Aguadilla. Table 3.1.5.2 presents trip selection sub-criteria relating to year, area (fishing center, municipality), and gear selection for the SEDAR26 benchmark CPUE evaluations.

Commercial CPUE Alternative Cases

In addition to the Base case data set, the Working Group suggested as an alternative data reduction approach to set a minimum level (percentage) that queen snapper contributed to each catch. Percentage cutoff levels of 10%, 25% and 50% that queen snapper represented of each landing were recommended.

3.1.1.4 Parameters Estimated

For each CPUE data set evaluated (Base Case and Alternative), standardized CPUE indices were developed using the standard delta-lognormal modeling approach (Lo et al. 1992). This method applies a lognormal model to the positive CPUE observations and a binomial (logistic) model to the proportion of successful (positive) observations and combines the two to obtain a yearly abundance index. The delta lognormal model was applied to each separate CPUE set (Base Case and Alternatives) to obtain estimates of yearly abundance. Parameter estimates were obtained using the SAS GLIMMIX and MIXED procedures in SAS (v. 9.2, 2004) to develop the binomial and lognormal sub models. Similar covariates were included in both sub models: year, municipality (proxy for fishing area) and month. Factor (covariate) significance was evaluated using Type 3 residual analysis.

3.1.1.5 Uncertainty and Measures of Precision

Overall performance was assessed for each of the CPUE data sets examined (Base Case and Alternatives) from residual analysis graphics and QQ plots. Residuals by year were plotted and reviewed and QQ plots of the residuals against a normal distribution were plotted. For each CPUE data set evaluated 95% Confidence interval estimates were estimated around the yearly estimates of abundance.

3.1.1.6 Benchmark / Reference points methods

Reference points were not developed for the queen Snapper CPUE Abundance Indices.

3.1.1.7 Projection methods

Projection analyses were not relevant for the queen snapper CPUE analyses.

3.1.2. Model 1 (CPUE Abundance Indices) Results

3.1.2.1. Measures of Overall Model Fit

Base Case Model Results

Table 3.1.5.3 and 3.1.5.4 present Type 3 tests of factor effects for the Queen Snapper fishery Base run. All fixed factors included in the model (year, fishing center, month, and gear) were significant. Table 5 presents standardized CPUE for Queen Snapper Base run. Figures 3.1.6.3 and 3.1.6.4 presents nominal CPUE and observed proportion of positives for the Base Run. The proportion of positive queen snapper observations in the data set was very low in all years, about 1-2% during the first 2-3 years of the fishery, and then increased only moderately to around 4% through about 2004. After 2002, the proportion of positives, increased again but again only moderately, ranging from 8-17%. The trend of proportion of positives over time, suggests that over the time series for which landings reports are available, that possibly the targeting behavior for queen snapper changed throughout the 23 year time period. During the first 16 years of the time series, 1987-2002, the proportion of positives was very low (1-2%) and though doubling during the next 7 years, remained <20% of all the trips. Model fits were further evaluated from graphical review. Figures 3.1.6.5 and 3.1.6.6 present plotted residual distribution of expected CPUE for the lognormal and binomial model fits for the base run.

Alternative CPUE Models using 10% and 50% Queen Snapper Trip Weight Selection Criterion

Fit results for the two alternative CPUE runs considering 10% and 50% trip landing weights as cutoff criteria for trip selection were also considered. Tables 6 and 7 presents standardized CPUE for Queen Snapper Base alternative runs at the 10 and 50% cutoff levels. Estimates of the annual standardized CPUE from the two alternative runs were not dissimilar to that of the Base run.

3.1.2.2 Parameter estimates & associated measures of uncertainty

Base Case:

Tables 3.1.5.5-3.1.5.7 presented standardized indices for the Base Case and 95% upper and lower confidence intervals and the two alternative runs. Figure 3.1.6.7 presents QQ plots for the Base case run. There was a slight tendency of trending in the overall residual pattern with increasing year; however the pattern in residuals for both the lognormal and binomial fits and the QQ plots did not suggest problems in normality or in the overall fitting of the data. Figure 3.1.6.8 presents standardized CPUE, 95% confidence intervals, and nominal CPUE for the Base run. Estimated delta lognormal standardized Queen Snapper CPUE varies without trend until about 2000 and thereafter shows a steady increase. This point in time also corresponds to the increase in proportion of positives of queen snapper in the bottom line and troll catches, suggesting possibly a change in targeting.

Alternative Model Results:

Figures 3.1.6.9 and 3.1.6.10 present standardized CPUE, 95% confidence intervals, and nominal CPUE for the two alternative data set runs, the 10% and 50% queen snapper trip proportion cutoff levels. Estimated lognormal Queen Snapper CPUE was similar for both cutoff cases (10%, 50% trip landing cutoff levels), suggesting only a slight increase in lognormal CPUE over the 22 year time period.

3.1.2.3 Stock Abundance and Recruitment

NA

3.1.2.4 Stock Biomass (total and spawning stock)

NA

3.1.2.5 Fishery Selectivity

NA

3.1.2.6 Fishing Mortality

NA

3.1.2.7 Stock-Recruitment Parameters

NA

3.1.2.8 Evaluation of Uncertainty (*Broader than 3.1.2.2; evaluation of assumptions, model configurations etc. May include retrospective analyses, sensitivities)*

NA

3.1.2.9 Benchmarks / Reference Points / ABC values

NA

3.1.2.10 Projections

NA

3.1.3. Discussion

The AW Panel discussed the index standardization results presented in DW-05 particularly as to the potential for reflecting a trend in stock abundance for the Queen snapper resource in Puerto Rico. It was noted that this fishery was a relatively new emerging fishery as of the mid 1980's, with the first recorded landings occurring in 1987. Recorded landings remained at less than 50,000 pounds through 1998, thereafter showing significant increases and nearly threefold increases by 2008. There is additional uncertainty in the landings history as not all fishers report in Puerto Rico with expansion factors having large variation and in additional regional expansion factors not available until around 2006. Even with these concerns, it is generally believed that the Queen snapper fishery was lightly exploited in the mid to late 1980's.

The standardized index from the base bottom line fishery run and the alternative runs similarly shows a flat trend through 2000, thereafter significantly increasing through 2007. Interpretation of the standardized CPUE trends, particularly in the more recent years, as being representative of stock abundance is difficult for several reasons. The CPUE analyses presented in DW-05 show an annually increasing trend in the number of successful Queen snapper catches in the bottom line fishery landings data. Background information provided by the local fishers at the DW and AW workshops support increasing number of technological improvements in the fishery that included hull design changes from yolas to fiber glass, increased horsepower (from 25-40hp to 60hp), use of color fathometers, switches in line type and hook type (circle vs J). These operational changes occurred in the late 1990's through about 2003 and could have been factors associated with increased number of successful trips as well as increasing landings, changes in trip duration (fishing time), and fishing area (distance traveled). Additional information at the trip level is needed to better characterize the abundance trend.

3.1.4. References

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Cummings, N.J. 2009. Notes Relating to the Commercial Fisheries in Puerto Rico. SEDAR Caribbean Procedures Report (SP-09), 39pp.

Ingram, Jr. G.W. 2011. Delta-lognormal and multinomial approaches to index development for parrotfish, silk snapper, and queen snapper from Puerto Rican Trip Tickets. SEDAR26-DW-07.

Lo N.C.H., Jacobson L.D., Squire J.L., 1992, Indices of relative abundance from fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. 49, 1515–1526.

Matos-Caraballo, Daniel. 2008. Lessons learned from the Puerto Rico's Commercial fishery, 1988-2008 Proc. Gulf Caribbean Fish. Inst. 61st . Annual Session.

Suarez-Caabro, Jose a. Pueroto Rico's fishery statistics 1968-1969. Agricultural and fisheries contributions. Vol. II (1) April 1975.

3.1.5. Tables

Table 3.1.5.1. Reported commercial landings of queen snapper Puerto Rico 1983-2009. 2009 = preliminary information. Data presented = number reported landings observations (N) and reported pounds (whole weight). Landings are reported (not expanded).

Year	**#Landings Reports**	**Pounds (Whole Weight)**
1987	38	4,379
1988	209	14,763
1989	214	15,405
1990	220	11,390
1991	451	17,780
1992	492	25,285
1993	555	32,346
1994	496	27,765
1995	581	34,138
1996	575	36,685
1997	560	38,778
1998	567	46,073
1999	699	66,695
2000	761	82,869
2001	906	102,138
2002	838	110,061
2003	1,584	127,015
2004	1,068	79,553
2005	1,376	156,755
2006	1,032	102,889
2007	1,125	111,130
2008	1,290	137,292
2009	1,088	110,275
All Years	16,725	1,491,459

Table 3.1.5.2. SEDAR26 Puerto Rico Platform Commercial Fishery Statistics Working Group Recommendations for CPUE abundance data selection and analyses. Recommendations for starting year, gears included, and geographical areas (i.e., municipalities) used in CPUE standardization.

	Gear				
Species	**Handline**	**Fishpots**	**Gillnet**	**Trammel Net**	**Dive**
Silk Snapper (with vermilion snapper, blackfin snapper, and black snapper)	Start Year = 1983+ Gear = 104 + 112 + 113 + 105 Fishing Centers = 01 + 02 + 03 + 05 + 06 + 12 + 13 + 15 + 16 + 18 + 20 + 21 + 22 + 25 + 28 + 29 + 32 + 33 + 35 + 36 + 37 + 38 + 39 + 40 + 41 + 42	Start Year = 1983+ Gear = 101 Fishing Centers = 01 + 05 + 06 + 08 + 09 + 10 + 12 + 13 + 14 + 15 + 16 + 18 + 20 + 22 + 23 + 25 + 28 + 32 + 36 + 37 + 38 + 39 + 40 + 41 + 42			
Queen Snapper (with cardinal snapper)	Start Year = 1987+ Gear = 104 + 105 Fishing Centers = 01 + 05 + 06 + 12 + 13 + 15 + 16 + 28 + 32 + 35 + 36 + 37 + 38 + 39 + 40 + 41 + 42				

Parrotfish		Start Year = 1983+ Gear = 101 Fishing Centers = 18 + 19 + 20 + 21 + 22 + 23 + 24 + 25 + 27 + 28 + 29 + 31 + 36 + 37	Start Year = 1988+ Gear = 103 Fishing Centers = 23 + 27 + 35 + 36 + 37	Start Year = 1988+ Gear = 118 Fishing Centers = 23 + 27 + 35 + 36 + 37	Start Year = 1997+ Gear = 110 + 114 + 115 + 116 + 119 Fishing Centers = 14 + 18 + 19 + 20 + 21 + 24 + 25 + 27 + 33 + 34 + 35 + 36 + 37 + 38 + 40

Table 3.1.5.3. Type 3 Tests for Factor Effects for binomial mode Queen Snapper Base Mode.

Type 3 Tests of Fixed Effects						
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr>Chi Sq*	*Pr>F*
Year	21	11E3	252.70	12.03	<.0001	<.0001
Fishing center	16	11E3	2406.16	150.38	<.0001	<.0001
Month	11	11E3	37.71	3.43	<.0001	<.0001
PR_GEAR_CODE	1	11E3	21.68	21.68	<.0001	<.0001

Table 3.1.5.4. Type 3 Test of Factors for lognormal fit to positive observations for Queen Snapper Base Model.

Type 3 Tests of Fixed Effects						
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr>ChiSq*	*Pr>F*
Year	21	6160	242.02	11.52	<.0001	<.0001
Fishing center	16	6160	4395.10	274.69	<.0001	<.0001
Month	11	6160	23.09	2.10	0.0172	0.0173
PR_GEAR_CODE	1	6160	391.52	391.52	<.0001	<.0001

Table 3.1.5.5. Queen Snapper Base Model Standardized CPUE Results. STDCPUE, LCI, UCI, and obcpue = standardized index, lower and upper 95% Confidence Intervals, and nominal CPUE. Annual standardized index = STDCPUE.

YEAR	Standard Error	obcpue	obppos	nobs	cv_i	MEANINDEX	STDCPUE	LCI	UCI	estcpue	obscpue
1988	0.2105	1.7679	0.02658	5605	0.21425	1.04583	0.93957	0.61505	1.43529	0.98262	0.29123
1989	0.09143	1.0358	0.02274	6639	0.21599	1.04583	0.40474	0.26406	0.62037	0.42329	0.17064
1990	0.07915	0.368	0.00625	2720	0.57192	1.04583	0.13233	0.04567	0.38348	0.1384	0.06062
1991	0.07628	0.5373	0.0176	3864	0.29515	1.04583	0.24714	0.13865	0.44052	0.25846	0.0885
1992	0.1496	2.647	0.06002	3482	0.19514	1.04583	0.73298	0.49794	1.07896	0.76656	0.43605
1993	0.1683	3.5579	0.07601	4447	0.16765	1.04583	0.95981	0.68799	1.33904	1.0038	0.5861
1994	0.1761	2.366	0.04973	6716	0.15677	1.04583	1.07406	0.78647	1.46681	1.12328	0.38975
1995	0.07848	1.324	0.02269	10136	0.1816	1.04583	0.41325	0.28824	0.59247	0.43219	0.2181
1996	0.1141	1.8722	0.03599	10613	0.14982	1.04583	0.72849	0.54077	0.98137	0.76187	0.30841
1997	0.1289	1.9023	0.02626	10813	0.16123	1.04583	0.76473	0.55509	1.05354	0.79977	0.31337
1998	0.1885	1.8253	0.02854	6166	0.19248	1.04583	0.93634	0.63939	1.37122	0.97925	0.30069
1999	0.1965	2.4266	0.03745	6034	0.17607	1.04583	1.06729	0.75251	1.51375	1.1162	0.39973
2000	0.1244	1.4181	0.02389	8122	0.18842	1.04583	0.63144	0.4346	0.91742	0.66037	0.23361
2001	0.1516	4.3708	0.03866	9285	0.15335	1.04583	0.94503	0.69666	1.28195	0.98834	0.72001
2002	0.1545	8.2308	0.04676	8576	0.15144	1.04583	0.97573	0.722	1.31864	1.02045	1.35586
2003	0.1262	10.2602	0.11438	10483	0.12222	1.04583	0.98766	0.77418	1.26001	1.03293	1.69018
2004	0.1379	8.4668	0.09897	8619	0.12772	1.04583	1.03222	0.80036	1.33126	1.07952	1.39474
2005	0.2513	17.2005	0.14095	8301	0.11918	1.04583	2.01577	1.58959	2.55622	2.10814	2.83344
2006	0.2475	12.9914	0.12506	6709	0.13073	1.04583	1.81022	1.39528	2.34857	1.89318	2.14007
2007	0.255	13.7191	0.13248	7465	0.12272	1.04583	1.9869	1.55591	2.53729	2.07795	2.25996
2008	0.2097	18.4581	0.16815	7071	0.12553	1.04583	1.59706	1.24369	2.05083	1.67024	3.04061
2009	0.2242	16.8052	0.15766	6330	0.13257	1.04583	1.61722	1.24199	2.10582	1.69133	2.76833

Table 3.1.5.6. Standardized CPUE, Upper and Lower 95% CI intervals and Nominal CPUE for Queen Snapper Fishery lognormal model fit for the 10% queen snapper cutoff trip weight case. Annual standardized index = STDCPUE.

YEAR	Standard Error	obcpue	obppos	nobs	cv_i	MEANINDEX	STDCPUE	LCI	UCI	estcpue	obscpue
1988	5.2036	67.575	1	146	0.08093	53.2226	1.20803	1.02777	1.41991	64.2947	0.85361
1989	3.2954	46.291	1	148	0.07866	53.2226	0.78718	0.67276	0.92106	41.8958	0.58474
1990	10.7431	58.882	1	17	0.20706	53.2226	0.97483	0.64709	1.46858	51.8832	0.7438
1991	3.8825	31.348	1	66	0.11122	53.2226	0.65592	0.52547	0.81876	34.9096	0.39599
1992	2.6049	44.878	1	205	0.06943	53.2226	0.70496	0.61366	0.80983	37.5196	0.5669
1993	2.6044	49.065	1	321	0.06304	53.2226	0.77617	0.68431	0.88037	41.3098	0.61979
1994	2.8788	48.36	1	328	0.05849	53.2226	0.92483	0.82282	1.03949	49.2219	0.61088
1995	3.2643	58.982	1	227	0.065	53.2226	0.94366	0.82875	1.07451	50.2243	0.74507
1996	2.6689	52.332	1	379	0.05581	53.2226	0.89847	0.80365	1.00449	47.8191	0.66106
1997	3.5843	73.798	1	277	0.06073	53.2226	1.10899	0.98227	1.25207	59.0235	0.93221
1998	3.825	64.143	1	175	0.07203	53.2226	0.99774	0.86404	1.15213	53.1022	0.81025
1999	3.3289	65.761	1	222	0.06616	53.2226	0.94537	0.82832	1.07896	50.3151	0.8307
2000	3.7773	59.653	1	193	0.0702	53.2226	1.01097	0.8787	1.16317	53.8067	0.75354
2001	3.3354	114.071	1	353	0.05485	53.2226	1.14253	1.02391	1.2749	60.8085	1.44094
2002	3.2413	178.018	1	396	0.05277	53.2226	1.15407	1.03856	1.28244	61.4228	2.24872
2003	2.0344	90.186	1	1190	0.04151	53.2226	0.92094	0.84761	1.00062	49.0151	1.13923
2004	2.1168	86.026	1	848	0.04272	53.2226	0.9309	0.8547	1.01391	49.5451	1.08668
2005	2.7183	122.241	1	1168	0.04021	53.2226	1.27029	1.17218	1.37662	67.6084	1.54414
2006	2.7867	105.803	1	822	0.04323	53.2226	1.21114	1.11087	1.32047	64.4602	1.3365
2007	2.4493	104.688	1	976	0.04139	53.2226	1.1118	1.0235	1.20771	59.1729	1.32241
2008	2.4857	111.607	1	1166	0.04172	53.2226	1.11948	1.02989	1.21685	59.5814	1.40982
2009	2.7354	107.899	1	985	0.04277	53.2226	1.20169	1.10322	1.30896	63.9573	1.36299

Table 3.1.5.7. Standardized CPUE, Upper and Lower 95% CI intervals and Nominal CPUE for Queen Snapper Fishery lognormal model fit for the 50% queen snapper cutoff trip weight case. Annual standardized index = STDCPUE.

YEAR	Standard Error	obcpue	obppos	nobs	cv_i	MEANINDEX	STDCPUE	LCI	UCI	estcpue	obscpue
1988	5.6834	64.3672	1	128	0.08637	63.25957768	1.040231	0.87549	1.23597	65.8046	0.73576
1989	3.9284	49.8769	1	130	0.08393	63.25957768	0.739874	0.62573	0.87485	46.8041	0.57013
1990	9.6430	59.0667	1	15	0.20988	63.25957768	0.726284	0.47947	1.10014	45.9444	0.67518
1991	3.8213	32.75	1	60	0.1141	63.25957768	0.529407	0.4217	0.66463	33.4901	0.37436
1992	3.8080	54.56	1	150	0.07921	63.25957768	0.759969	0.64879	0.8902	48.0753	0.62366
1993	3.7708	59.9916	1	239	0.07171	63.25957768	0.831207	0.72028	0.95922	52.5818	0.68575
1994	3.5866	50.88	1	275	0.06618	63.25957768	0.856745	0.75064	0.97784	54.1973	0.5816
1995	3.7538	61.8812	1	202	0.07032	63.25957768	0.843868	0.73328	0.97113	53.3827	0.70735
1996	3.2504	55.4062	1	325	0.06305	63.25957768	0.814976	0.71852	0.92438	51.5551	0.63333
1997	4.3539	78.5697	1	244	0.06706	63.25957768	1.026347	0.89766	1.17348	64.9263	0.89811
1998	4.1806	63.1395	1	129	0.08295	63.25957768	0.796698	0.6751	0.9402	50.3988	0.72173
1999	3.9919	51.8539	1	178	0.07433	63.25957768	0.848988	0.73186	0.98486	53.7066	0.59273
2000	5.7941	70.7829	1	129	0.08344	63.25957768	1.097724	0.92928	1.2967	69.4416	0.8091
2001	5.7145	141.696	1	230	0.0674	63.25957768	1.340236	1.17139	1.53341	84.7827	1.61969
2002	5.2815	223.834	1	302	0.06203	63.25957768	1.346051	1.18916	1.52365	85.1506	2.55859
2003	3.1699	98.8139	1	1037	0.05122	63.25957768	0.978345	0.88315	1.0838	61.8897	1.12952
2004	3.3062	96.0907	1	717	0.05176	63.25957768	1.009768	0.91053	1.11982	63.8775	1.09839
2005	4.1135	130.372	1	1051	0.04932	63.25957768	1.318321	1.19455	1.45492	83.3965	1.49025
2006	4.6125	119.273	1	578	0.05415	63.25957768	1.346595	1.20848	1.50049	85.1851	1.36338
2007	3.8403	116.996	1	737	0.05204	63.25957768	1.166458	1.05122	1.29432	73.7896	1.33735
2008	4.2631	128.543	1	860	0.05198	63.25957768	1.29658	1.16865	1.43851	82.0211	1.46934
2009	4.2120	115.891	1	872	0.0518	63.25957768	1.285329	1.15891	1.42554	81.3094	1.32472

3.1.6. Figures

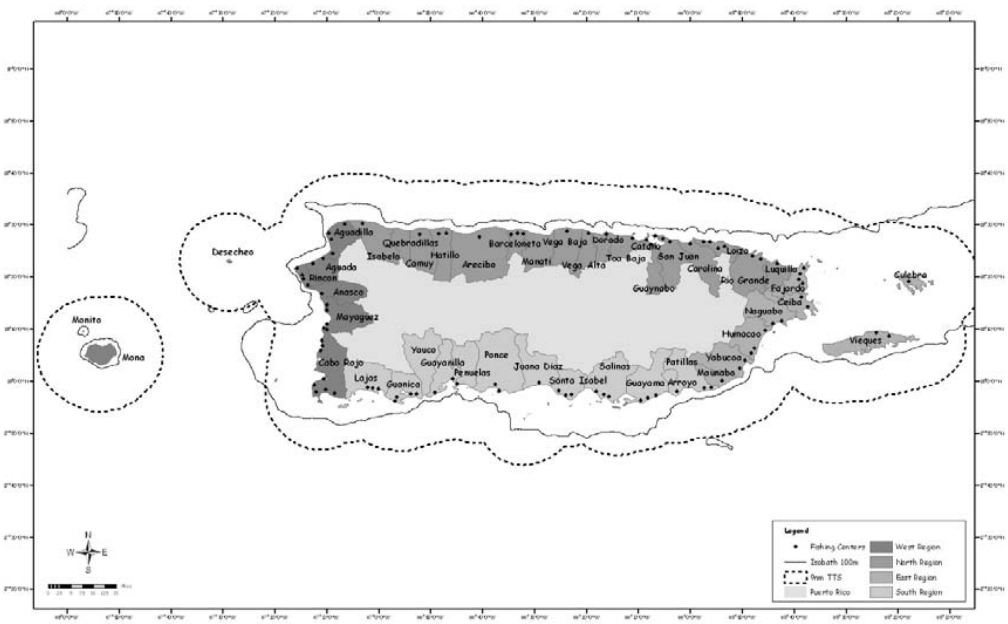

Figure 3.1.6.1. Map depicting fishing center (municipality) locations for the commercial fisheries in Puerto Rico.

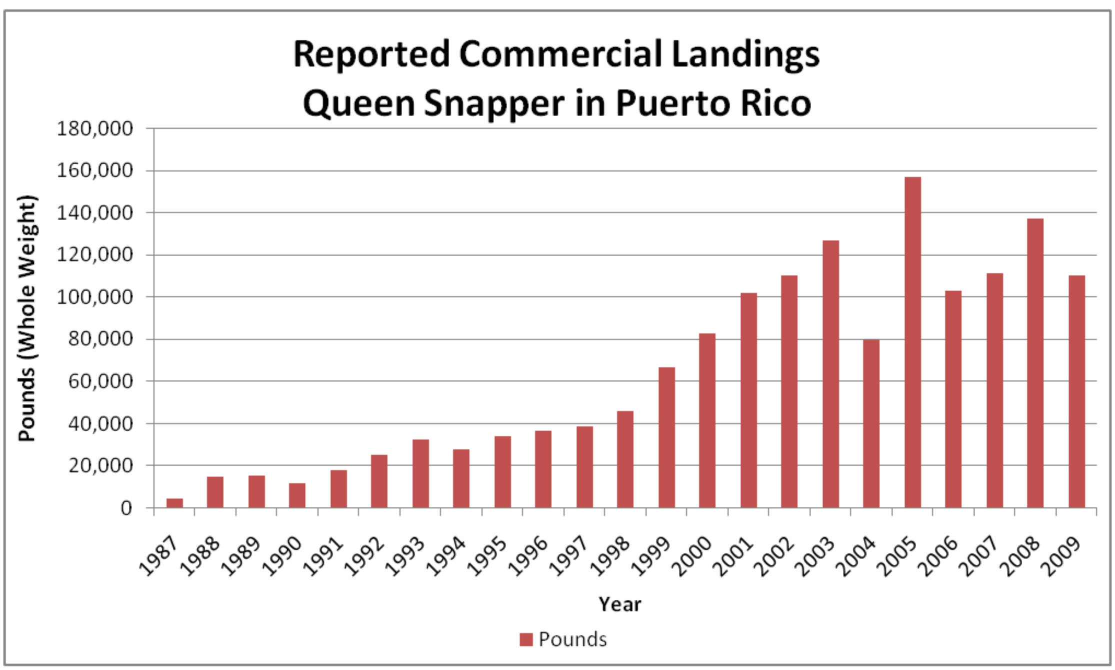

Figure 3.1.6.2. Reported commercial landings of queen snapper in Puerto Rico 1987-2009. 2009 data are preliminary.

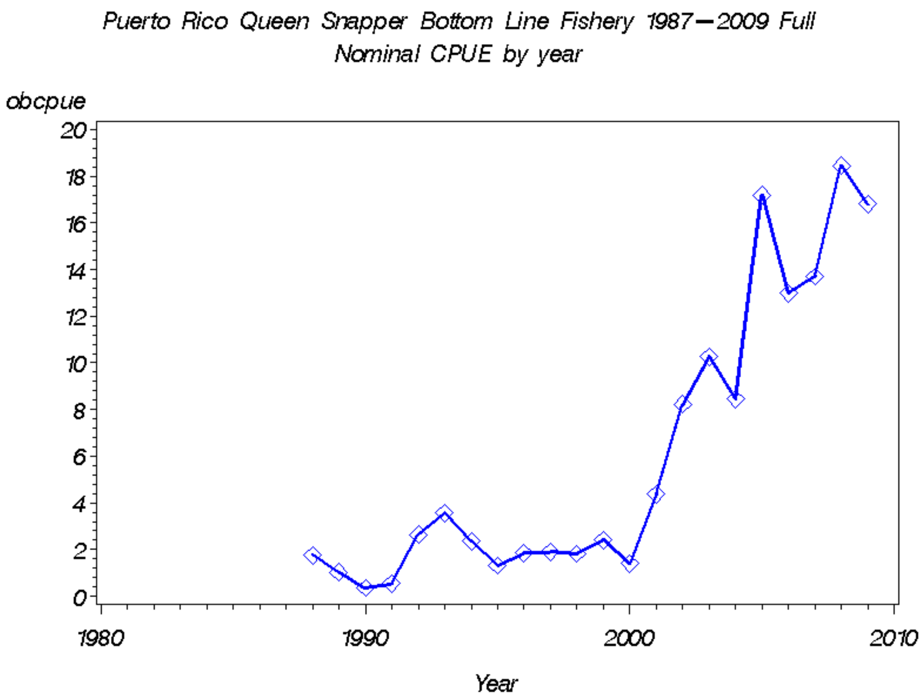

Figure 3.1.6.3. Queen Snapper fishery Base Run Nominal CPUE.

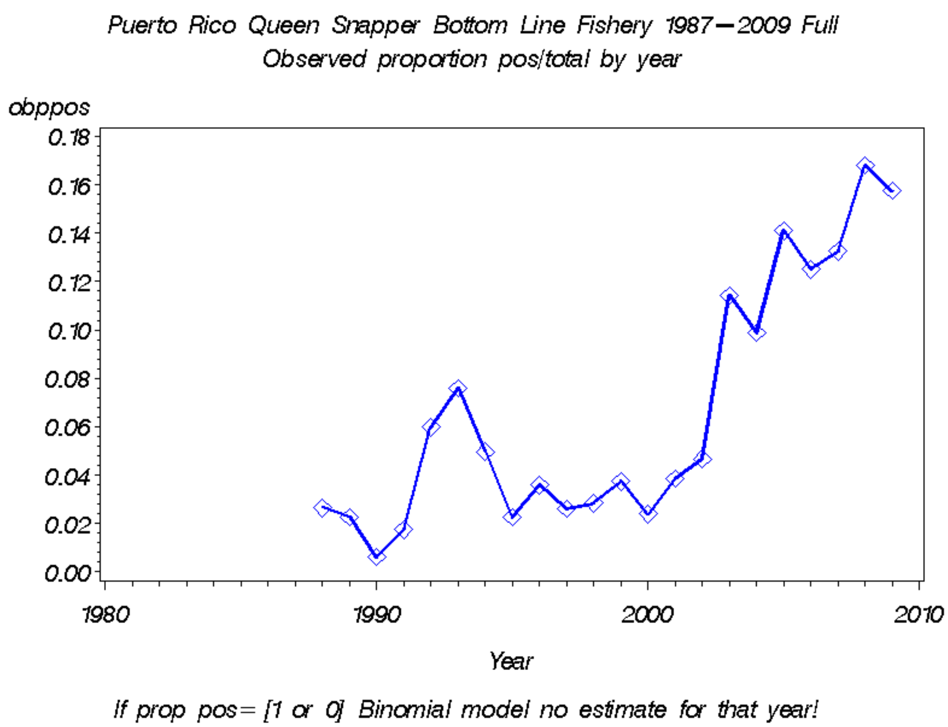

Figure 3.1.6.4. Queen Snapper Fishery Base Model Run for observed proportion of positives

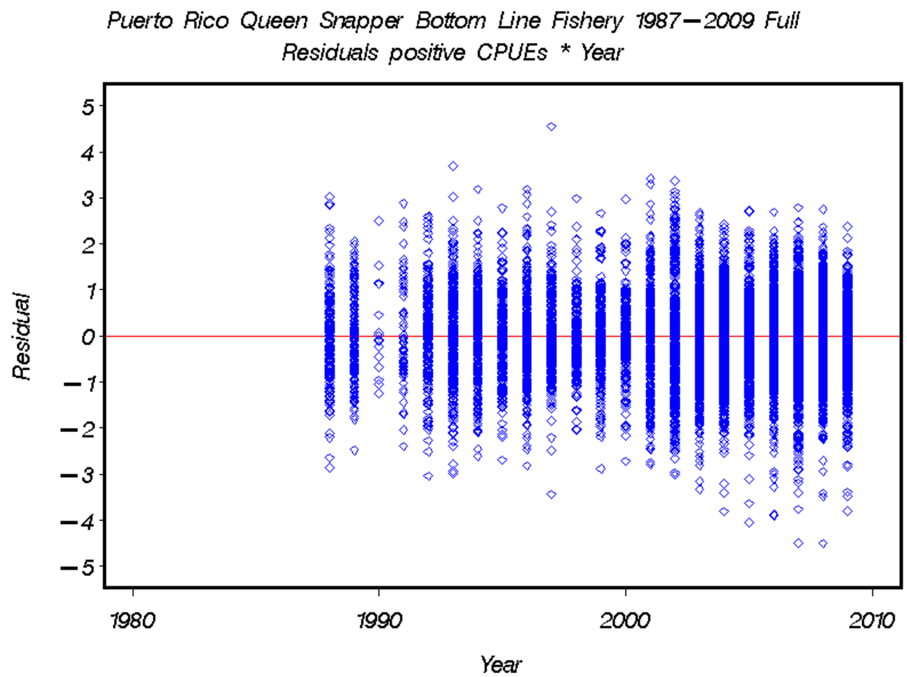

Figure 3.1.6.5. Plotted residual distribution for lognormal model fit for Queen Snapper Fishery Base Run.

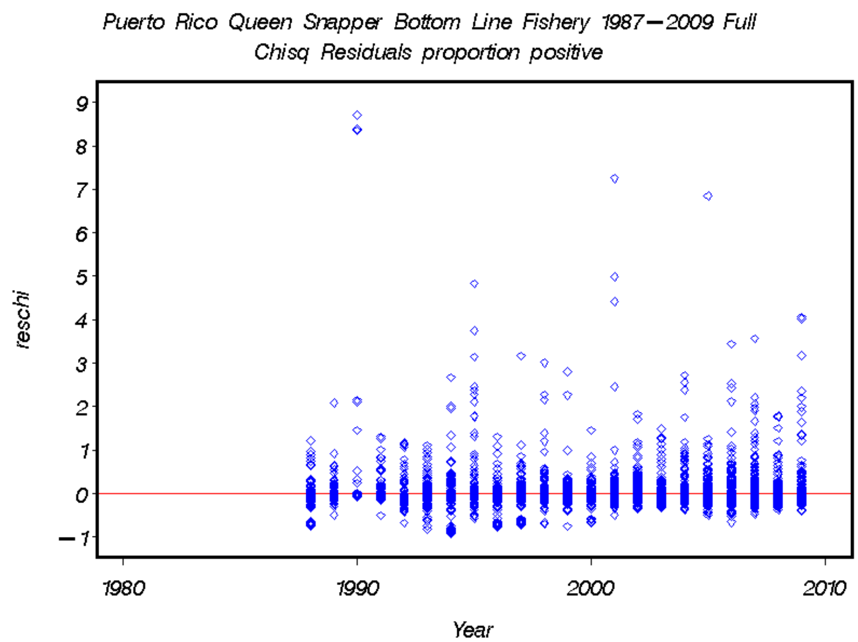

Figure 3.1.6.6. Plotted residual distribution for binomial model fit for Queen Snapper Fishery Base run.

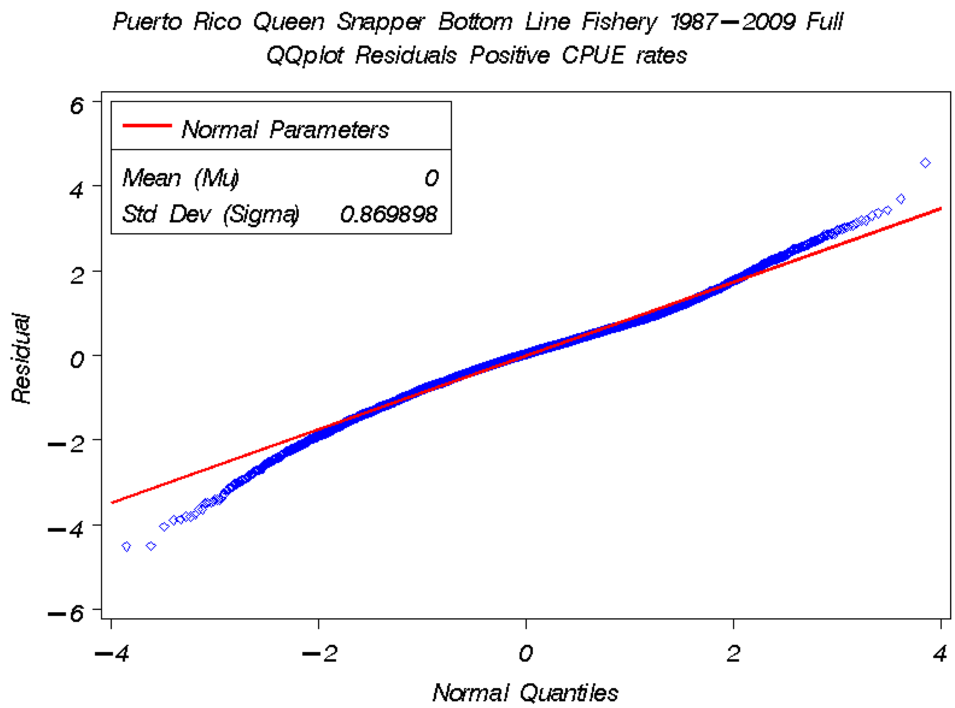

Figure 3.1.6.7. QQ plot for the lognormal model for Queen Snapper Base run.

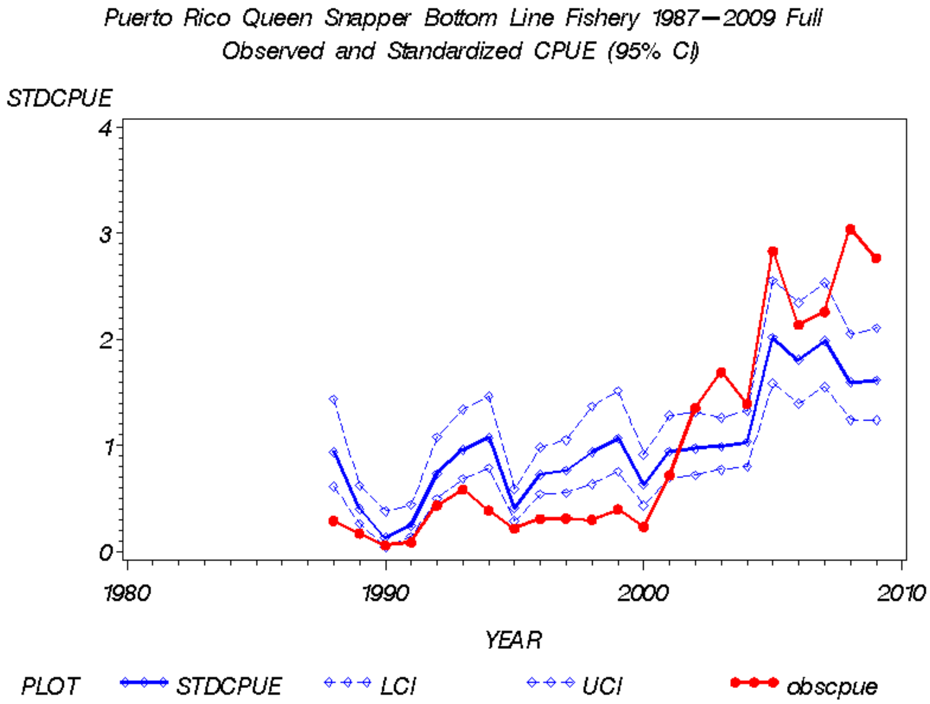

Figure 3.1.6.8. Standardized Delta –Lognormal CPUE, Upper and Lower 95% CI intervals and Nominal CPUE for Queen Snapper fishery Base Run.

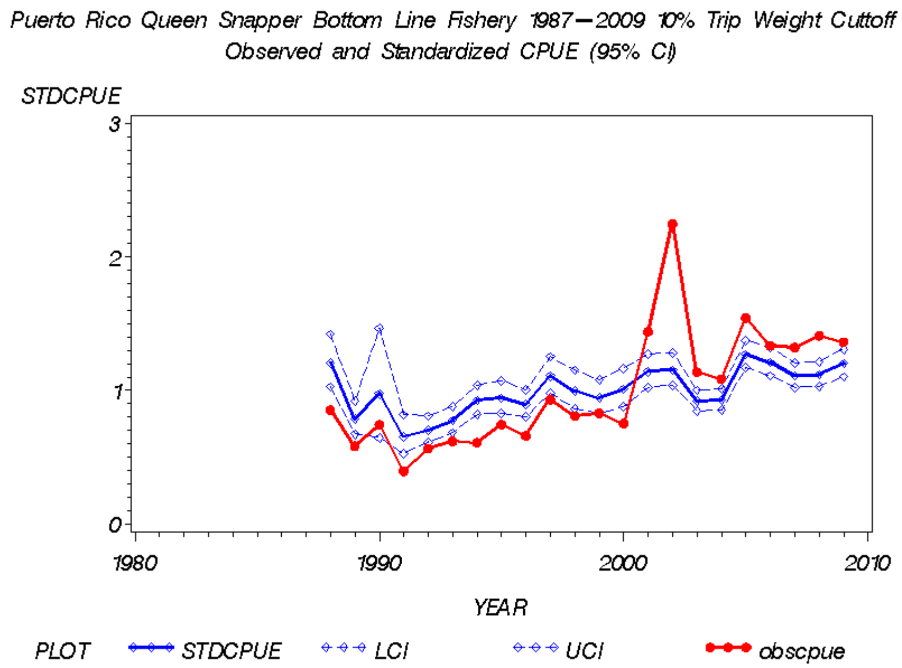

Figure 3.1.6.9. Standardized CPUE, Upper and Lower 95% CI intervals and Nominal CPUE for Queen Snapper Fishery lognormal model fit for the 10% queen snapper cutoff trip weight case.

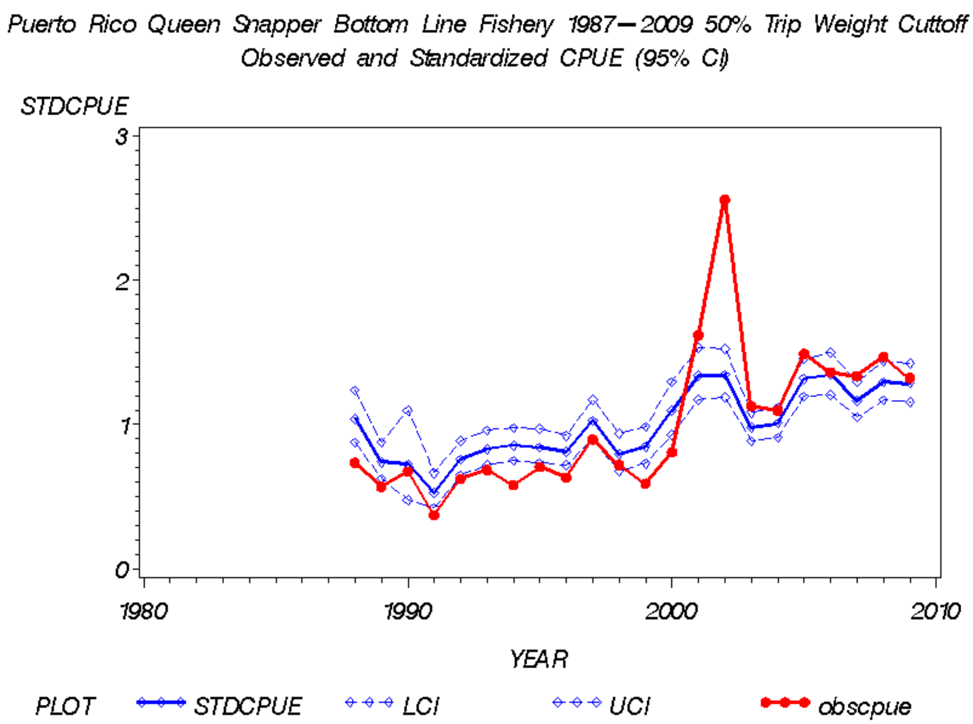

Figure 3.1.6.10. Standardized CPUE, Upper and Lower 95% CI intervals and Nominal CPUE for Queen Snapper Fishery lognormal model fit for the 50% queen snapper cutoff trip weight case.

3.2. Model 2 – Length frequency analysis of TIP data

3.2.1. Model 2 Methods

3.2.1.1. Overview

A review of the length frequency data available from the NMFS Trip Interview Program (TIP) database indicated that sample sizes were sufficient to conduct a comprehensive time-series length analysis for a limited number of species, island, and gear combinations (see SEDAR-DW-04 paper; Table 3.2.5.1). Our analysis focused on time series analyses and relative differences in total mortality estimates rather than on absolute values of total mortality due to considerable uncertainty in age-growth parameters. Total mortality (Z) estimates and the ability to detect changes in mortality were explored using a variant of the Beverton-Holt length-based mortality estimator (Beverton and Holt 1956, 1957).

3.2.1.2. Data Sources

The only source of length data for this analysis was the TIP database (detailed evaluation is presented in SEDAR-DW-04 paper). Input values for other the parameters populating the model were gathered from available literature (Table 3.2.5.2). The SEDAR 26 DW and AW panels noted considerable uncertainty about the existing values of von Bertalanffy growth parameters. Information from comparable species and expert opinion were used to develop the sensitivity range for the input parameters.

3.2.1.3. Model Configuration and Equations

The Beverton-Holt mortality estimator has received widespread use, especially in data-limited situations, owing mainly to the minimal parameter inputs, which are the von Bertalanffy growth parameters K and L_∞, the so-called length of first capture (smallest size at which animals are fully vulnerable to the fishery and to the sampling gear), L_c, and the mean length of the animals ($\bar{L}$) above the length L_c:

$$Z = \frac{K(L_\infty - \bar{L})}{\bar{L} - L_c}$$

There are six assumptions behind this method.

1) Asymptotic growth with known parameters K and L_∞ which are constant over time.
2) No individual variability in growth.
3) Constant and continuous recruitment over time.
4) Mortality rate is constant with age for all ages $t > t_c$.
5) Mortality rate is constant over time.
6) Population is in equilibrium (i.e., enough time has passed following any change in mortality that mean length now reflects the new mortality level).

The method has been criticized, however because the assumption of equilibrium (6) is very difficult to meet in the real world situations where any change in fishing pressure disrupts the equilibrium stable age distribution. In the case of increased fishing pressure, it simply takes time for the larger and older animals to be removed from the population and the mean length to decrease and reflect the current mortality rate. When fishing pressure is decreased, equilibrium takes even longer to achieve as only time will allow the smaller/ younger animals to grow and the mean length to increase and reflect the current mortality rate.

Gedamke and Hoenig (2006) developed an extension of the Beverton-Holt length-based mortality estimator for use in non-equilibrium situations. This method is attractive quantitatively because it still only requires minimal data that are commonly available and it does not require the assumption that catch rate is proportional to abundance. It allows for the broader application of a mean length analysis approach by removing an equilibrium assumption that is typically difficult to meet in real world situations. In addition, the transitional form of the model allows mortality estimates to be made within a few years of a change rather than having to wait for the mean lengths to stabilize at their new equilibrium level. In other words, as soon as a decline in mean lengths is detected, this model can be applied and the trajectory of decline can be used to estimate the new Z and how mean lengths will change over time.

The method is described in detail in Gedamke and Hoenig (2006) and will only be described briefly here. Like the Beverton and Holt estimator this extension requires only a series of mean length above a user defined minimum size and the von Bertalanffy growth parameters, so it can be applied in many data poor situations. Gedamke and Hoenig (2006) demonstrated the utility of this approach using both simulated data and an application to data for goosefish caught in the NEFSC fall groundfish survey.

The mean length in a population can be calculated *d* years after a single permanent change in total mortality from Z_1 to Z_2 yr^{-1} by the following equation:

$$\bar{L} = L_\infty - \frac{Z_1 Z_2 (L_\infty - L_c)\{Z_1 + K + (Z_2 - Z_1)\exp(-(Z_2 + K)d)\}}{(Z_1 + K)(Z_2 + K)(Z_1 + (Z_2 - Z_1)\exp(-Z_2 d))}$$

This equation has been generalized to allow for multiple changes in mortality rate over time (e.g. one change, two changes, three changes etc.). The algorithm was programmed in AD Model Builder in a maximum likelihood framework and used to estimate mortality rates from the observed mean lengths. A shell program was written in R to conduct a grid search of potential year(s) of change and also to conduct a sensitivity analysis to input parameters.

Models were run starting with the simplest (i.e. no change in mortality) and then sequentially by adding an additional years of change and therefore increasing complexity (i.e. each year of change adds two parameters). Akaike information criterion with a correction for small sample size (AIC_c) was calculated for each scenario and will be referred to simply as AIC throughout the rest of this document. When comparing models, an AIC value that improved by 5 or more was deemed as providing 'strong' support for the more complex (i.e. additional year of change and additional parameters) model (Burnham and Anderson, 2002).

The first step in the application of this mean-length approach is to determine the length at which animals become fully vulnerable to the gear, L_c. Histograms from five year periods (see Figure 1 for example) and a cumulative plot of all individuals captured during the time series were constructed for island gear combinations for which sufficient sample sizes were available. For the base case, the length at full vulnerability L_c was selected both visually (Thorson and Prager, 2011) and by an automated selection evaluation of the 10 mm length bin which contained the largest number of individuals in each 5 year period. The evaluation of five-year periods avoids situations where selectivity may have changed over time. For example, a regulation which requires increased mesh size in traps would result in fewer small individuals being captured and an increase in mean length. Using the highest L_c value from each time period avoids the violating model assumptions and the confounding of selectivity and mortality in the calculation of annual mean lengths. While visual inspection of histograms is a common and accepted approach we evaluated model results over a range of values.

3.2.1.4. Parameters Estimated

The parameters estimated by the non-equilibrium length method as described in 3.2.1.3 above are total mortality rates and the year(s) of change. For the rest of this document, $Z_{current}$ is defined as the total mortality in the most recent time periods.

3.2.1.5. Uncertainty and Measures of Precision

The panel at the SEDAR 26 DW and AW, recognized considerable uncertainty in the von Bertalanffy growth parameters and some hesitation as to the selection of length-at-full vulnerability (L_c) was expressed. As such, a comprehensive sensitivity analysis was conducted. The range of the von Bertalanffy growth parameter (VBK) explored was 0.25 - 0.75. The base value was 0.45, which is the mean of the two published estimates of Murray and Moore (1992) and Murray et al. (1992). For all other sensitivity analyses the range of VBK inputs were set to a value 60% above and below the base value. The base value for all queen snapper sensitivity runs was 0.45, for the reasons explained above. The range used for queen snapper caught by hook and line in Puerto Rico encompasses the two estimates of the von Bertalanffy growth parameter from Murray and Moore (1992) and Murray et al. (1992), 0.29 and 0.61. The range of the asymptotic growth parameter (L_∞) explored was 846mm-906mm. The upper bound was either 1) the maximum observed length, 2) 10% above the base value when the maximum observed is less than the base value or 3) 15% above the base value when the maximum observed length was questionable (e.g., one observation that appeared to be an outlier).

The accepted method for determining L_c is by visual inspection of the length frequency histogram (Thorson and Prager 2011). This approach was used for this analysis, however, to satisfy the concerns of the AW panel a wide range of L_c values were explored. Note that the lowest L_c values used in the sensitivity analysis were clearly below the actual length at full vulnerability and included only to demonstrate model behavior.

3.2.1.6. Benchmark / Reference points methods

The calculation of traditional benchmarks based on MSY theory using the mean length mortality estimation method was not possible due to considerable uncertainty in the available life-history parameters.

3.2.1.7. Projection methods

NA

3.2.2. Model 2 Results

3.2.2.1. Measures of Overall Model Fit

The AIC results provided strong support for the model indicating a change in the estimate of total mortality (Z) in 1996 (Table 3.2.5.3). The initial estimate of total mortality rate prior to 1996 was estimated to be 0.87 and in recent years 1.4 (Table 3.2.5.3, Figure 3.2.6.2).

3.2.2.2. Parameter estimates & associated measures of uncertainty

Section 3.2.2.8 provides further explanation of results from sensitivity analysis.

3.2.2.3. Stock Abundance and Recruitment

NA

3.2.2.4. Stock Biomass

NA

3.2.2.5. Fishery Selectivity

NA

3.2.2.6. Fishing Mortality

Estimates of total mortality can be translated to fishing mortality (F) by subtracting natural mortality. Lacking direct estimates of natural mortality, life history invariant relationships would have to be used and given the uncertainty in the von Bertalanffy growth parameters this was not pursued.

3.2.2.7. Stock-Recruitment Parameters

NA

3.2.2.8. Evaluation of Uncertainty

Table 3.2.5.4 summarizes the ranges of the input parameters explored in the sensitivity analysis. Variability in von Bertalanffy growth parameters had no effect on whether a change in mortality was supported, however, length at full vulnerability (L_c) was the determining factor (compare left and right panels of Figure 3.2.6.3). As expected, and potentially confounded by possible changes in selectivity, values well below the base case for length at full vulnerability, the more complex models which predict a change in total mortality were not supported. Models that predicted a change in total mortality and were strongly supported by AIC selection predicted an increase in total mortality.

Absolute estimates of total mortality were directly related to the von Bertalanffy growth parameter and as expected increased with an increased input value of VBK (Figure 3.2.6.3 and 3.2.6.4). As a result, the overall range in total mortality was 0.5 to 2.0 for the most recent time period. However, when proportional change in total mortality (i.e., $\Delta Z/Z_1$) is calculated all model results fall within the range of 0.55-0.85 (i.e., a 55%-85% change in total mortality; Figure 3.2.6.5). The resulting range in the proportional change of total mortality is directly related to the relationship of L_c and L_∞ (Figure 3.2.6.6).

3.2.2.9. Benchmarks / Reference Points / ABC values

NA

3.2.2.10. Projections

NA

3.2.3. Discussion

The queen snapper fishery in Puerto Rico is a relatively new fishery since the early 1980s and changes in the size structure of the population indicates an increase in total mortality as the fishery has developed over the time series. The length frequency analysis presented here suggests this change in mortality happened in the mid-1990s. While the base case indicates that mortality increased from 0.87 to 1.4, there is no measure of uncertainty associated with these values. The sensitivity analysis was designed to evaluate all possible sources of uncertainty in parameter inputs. The resulting total mortality estimates from the sensitivity analysis were highly variable due to the input range of parameters explored.

The range of input parameters for the von Bertalanffy growth coefficient was centered on values derived from the literature. Published values from the literature had a range of 0.29-0.61. The SEDAR 26 AW panel noted that the base case input value of 0.45 was high. Given this uncertainty, a range of 0.25-0.75 was explored. Similarly, questions regarding published L_∞ values were also discussed and a wide range of inputs were explored. From this aspect of the sensitivity analysis, the variability in the total mortality estimates were a direct result of the range of the von Bertalanffy growth inputs explored (i.e., L_∞ was less influential). It should also be noted that the negative correlation between VBK and L_∞ was implicitly accounted for, however, values paired at the lower bounds or the upper bounds of both parameters are unlikely.

The selection of L_c is a critical component of the mean length mortality estimation approach and is commonly chosen by visually inspecting length frequency plots (Thorson and Prager 2011). The exploration of a wide range of L_cs was conducted to address concerns expressed regarding this approach at the AW. It should be noted that unlike the sensitivity analysis to von Bertalanffy growth parameters the lower range of the L_c values will lead to violations of the core assumptions of the model. Specifically, values that are lower than full selectivity at any point during the time series will confound changes in selectivity and the estimate of mortality. The lower portion of the L_c range was explored to illustrate model behavior and the corresponding mortality rates are likely to be confounded with selectivity and are not likely to be valid. Conversely, as L_c is increased above the base case, the number of fish included in the analysis declines and the possibility of detecting a change decreases. Given the length frequency histograms presented in Figure 3.2.5.1, L_c values between 456 and 526 are most appropriate.

The total mortality estimates of queen snapper resulting from the sensitivity analysis were variable and alone are difficult to use for developing management advice. When looking at proportional change in mortality the effect of VBK inputs is reduced. Even with the comprehensive sensitivity analysis, all results fall within the range of a 55%-85% increase in total mortality. This may not be informative for many situations, however, given the fact that this fishery developed during the time range explored additional conclusions may be discerned. There are no reported landings between 1983 and 1986 and since that time reported landings have increased to over 100 thousand pounds. If it is assumed from this information that the fishery was un- or lightly-exploited at the start of the time series, the estimates of initial total mortality should be close to the natural mortality (M). A general rule of thumb, given surplus production theory, is that FMSY is twice the natural mortality rate (Gulland, 1971; Garcia et al. 1989). In this analysis and given the situation, a doubling of the initial mortality rate would be at or near F_{MSY}. The results presented here suggest that regardless of the input parameters total mortality has increased at most by 85% and therefore as long as the fishery was unexploited or very lightly exploited at the beginning part of the time series and the assumption that Fmsy = M, the current fishing mortality rate (F) should theoretically be below F_{MSY}. These results in combination with the recent Annual Catch Limit (ACL) amendment which proposes to reduce landings by at least 15% suggests that the stock is not likely to experience overfishing once management is in place.

3.2.4. References

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Murray, P.A. and E.A. Moore, 1992. Some morphometric relationships in *Etelis oculatus* Valenciennes (Queen snapper), landed in St. Lucia, W.I.. Proc. Gulf Caribb. Fish. Institut. 41:416-421.

Thorson, J. T., and M. H. Prager. 2011. Better catch curves: Incorporating age-specific natural mortality and logistic selectivity. Transactions of the American Fisheries Society 140: 356–366.

3.2.5. Tables

Table 3.2.5.1. Summary of the sample sizes for island and gear combinations. Sample numbers (i.e., number of measured fish) for each combination are reported, as well as the analysis type (described in more detail in methods section). TS indicates a length-based time-series analysis was done and ID indicates insufficient data for analysis. Data were obtained from the Trip Interview Program (TIP) database

SPECIES NAME	ISLAND	GEAR NAME	SAMPLES	ANALYSIS
QUEEN SNAPPER	PUERTO RICO	HOOK AND LINE	3901	TS
QUEEN SNAPPER	PUERTO RICO	NETS	61	ID
QUEEN SNAPPER	PUERTO RICO	POTS AND TRAPS	9	ID
QUEEN SNAPPER	ST CROIX	HOOK AND LINE	4089	TS
QUEEN SNAPPER	ST CROIX	NETS	3	ID
QUEEN SNAPPER	ST CROIX	POTS AND TRAPS	24	ID
QUEEN SNAPPER	ST THOMAS	DIVERS	17	ID
QUEEN SNAPPER	ST THOMAS	HOOK AND LINE	176	ID
QUEEN SNAPPER	ST THOMAS	NETS	8	ID

Table 3.2.5.2. Parameter values for base case scenario. $L_{C:}$ length at full vulnerability, VBK: von Bertalanffy growth parameter, and L_{∞}: the asymptotic length.

SPECIES NAME	ISLAND	GEAR NAME	Lc	VBK	$L\infty$
QUEEN SNAPPER	PUERTO RICO	HOOK AND LINE	486	0.45	888
QUEEN SNAPPER	ST CROIX	HOOK AND LINE	365	0.45	888

Table 3.2.5.3. Summary of time-series analysis results for the base case for Queen snapper caught by hook and line in Puerto Rico.

Npar	AIC	LLIKE	Lc	VBK	L_Inf	Z	Z1	ΔYear1	Z2	ΔYear2	Z3	ΔYear3	Z4
2	213.81	104.57	486	0.45	888	1.26755	-	-	-	-	-	-	-
4	207.40	98.45	486	0.45	888	-	0.870	1996	1.404	-	-	-	-
6	210.02	96.01	486	0.45	888	-	0.873	1996	1.294	2005	1.887	-	-
8	214.88	93.44	486	0.45	888	-	0.912	1991	0.001	1994	1.287	2005	1.893

Table3.2.5.4. Input parameter ranges for sensitivity analysis.

Parameter	Lower bound	Base	Upper bound
L_c	366mm	486mm	546mm
VBK	0.25	0.45	0.65
L_∞	846mm	888mm	906mm

3.2.6. Figures

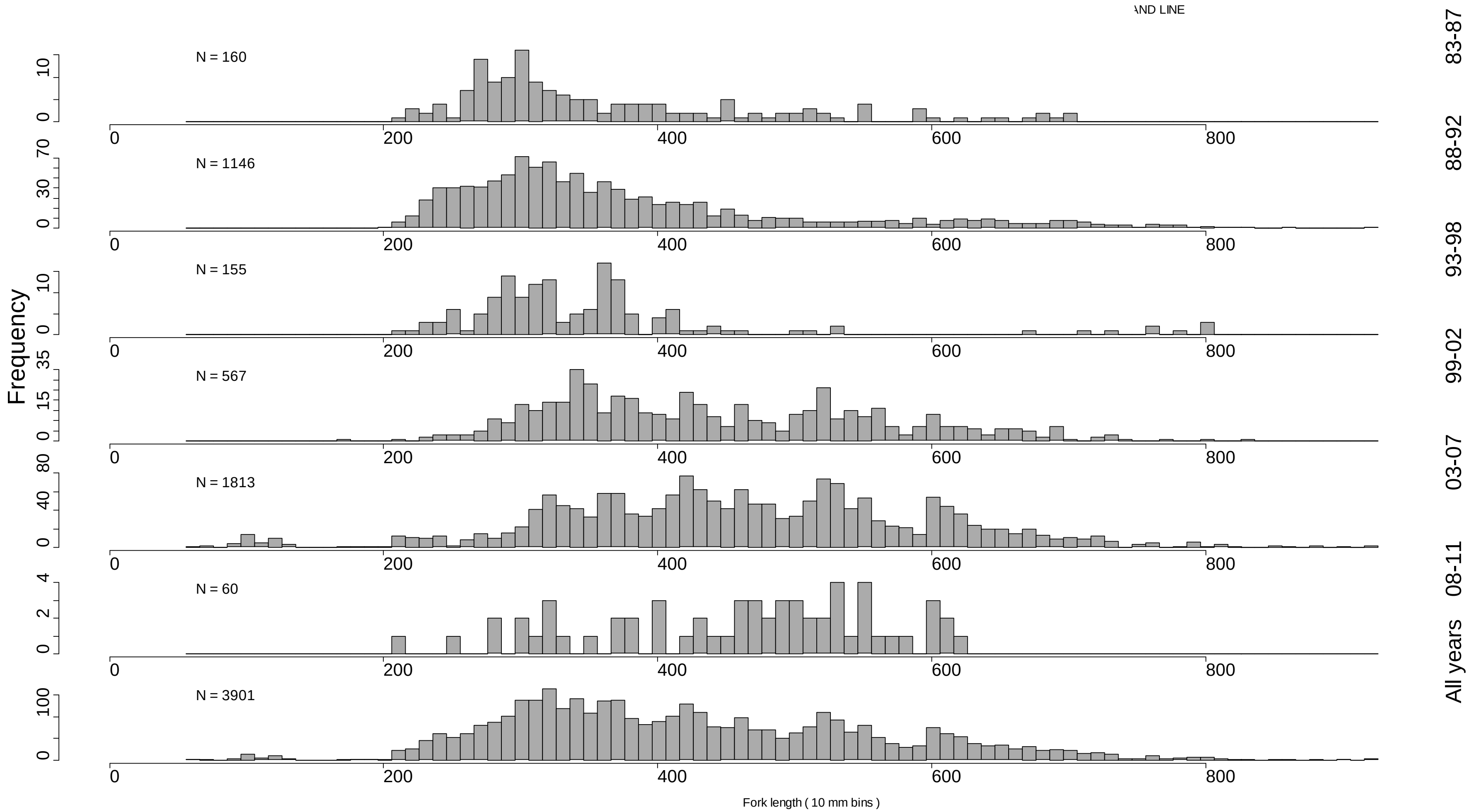

Figure 3.2.6.1. Length-frequency histograms for Queen snapper caught by hook and line in Puerto Rico. Each panel includes data from a five-year time period, which is indicated at the right side of each panel. The bottom panel includes data from all years. Sample numbers (N) are indicated in each panel.

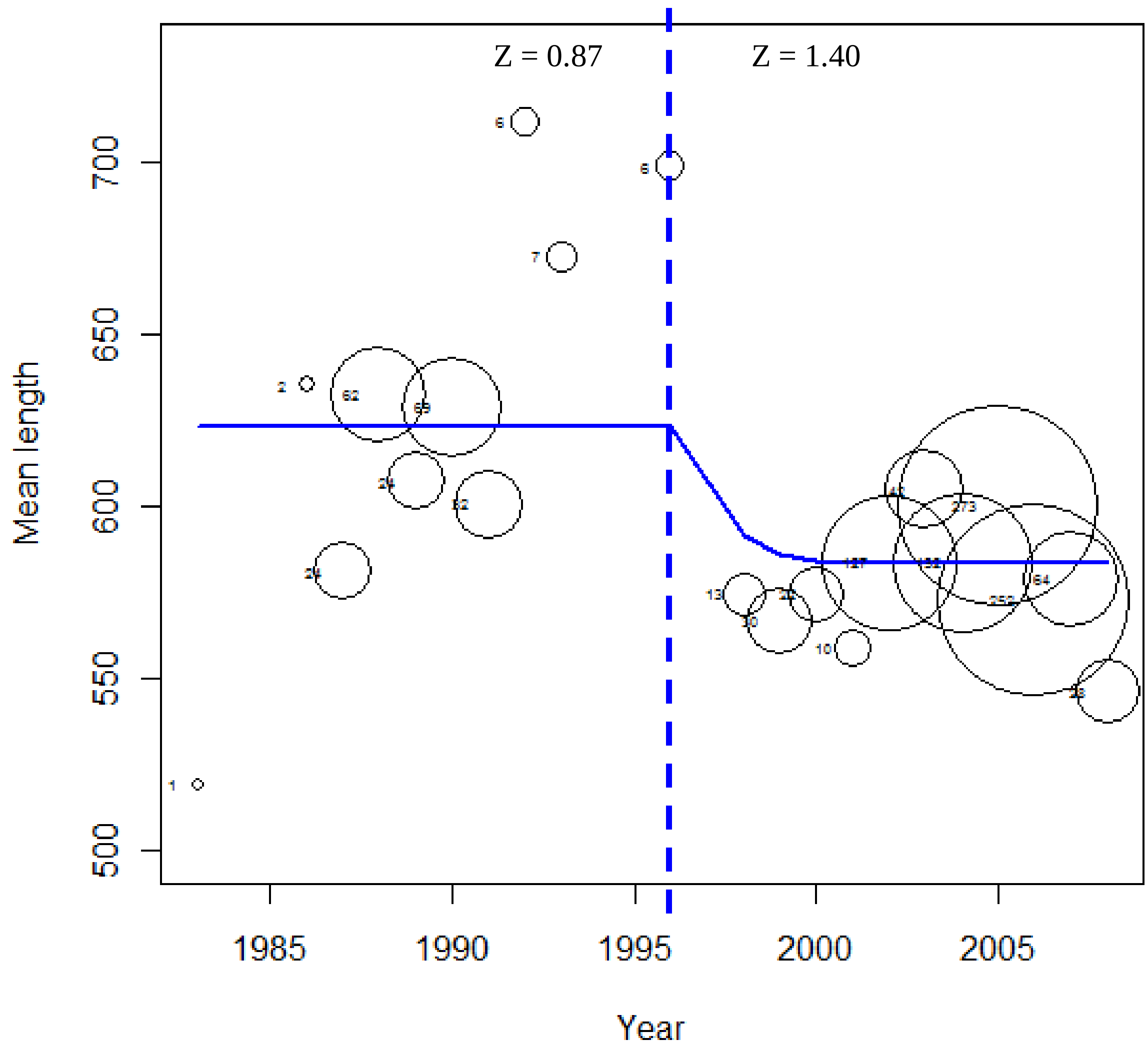

Figure 3.2.6.2. Mean length of fully-vulnerable individuals over time for the base-case time-series analysis. Bubble size indicates annual sample size relative to other years, the solid blue line represents the line of best fit, and the dashed blue line marks the year of change.

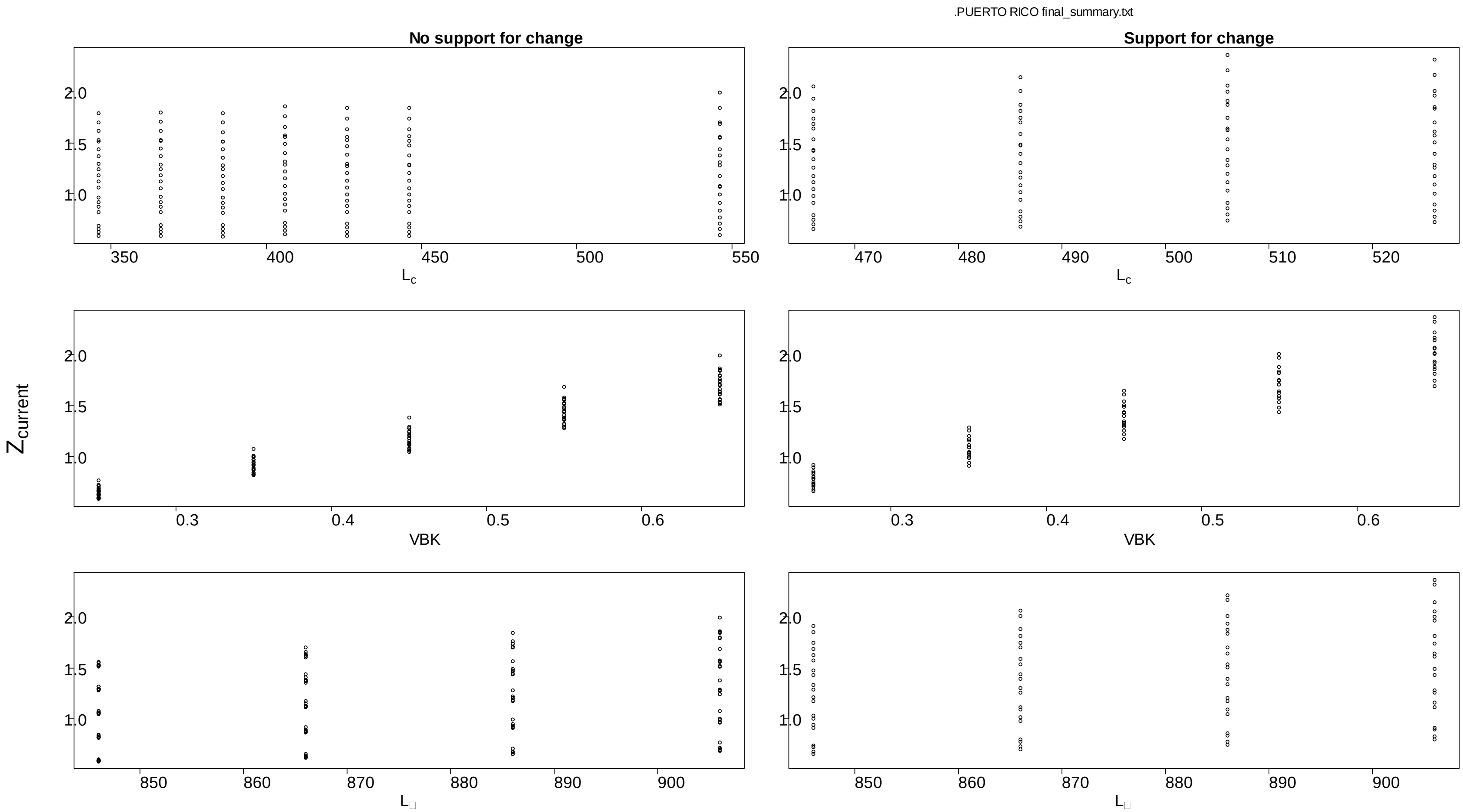

Figure 3.2.6.3. Current estimates of total mortality ($Z_{current}$) as a function of length at full vulnerability (L_c, top panels), the von Bertalanffy growth parameter (VBK, middle panels), and asymptotic length (L_∞, bottom panels) when there was no support for change (left panels) and a support for change (right panels) from the time-series analysis for Queen snapper caught by hook and line in Puerto Rico. The base case parameter combination was 486mm for L_c, 0.45 for the von Bertalanffy growth parameter, and 888mm for L_∞. Strong support delta AIC>5.

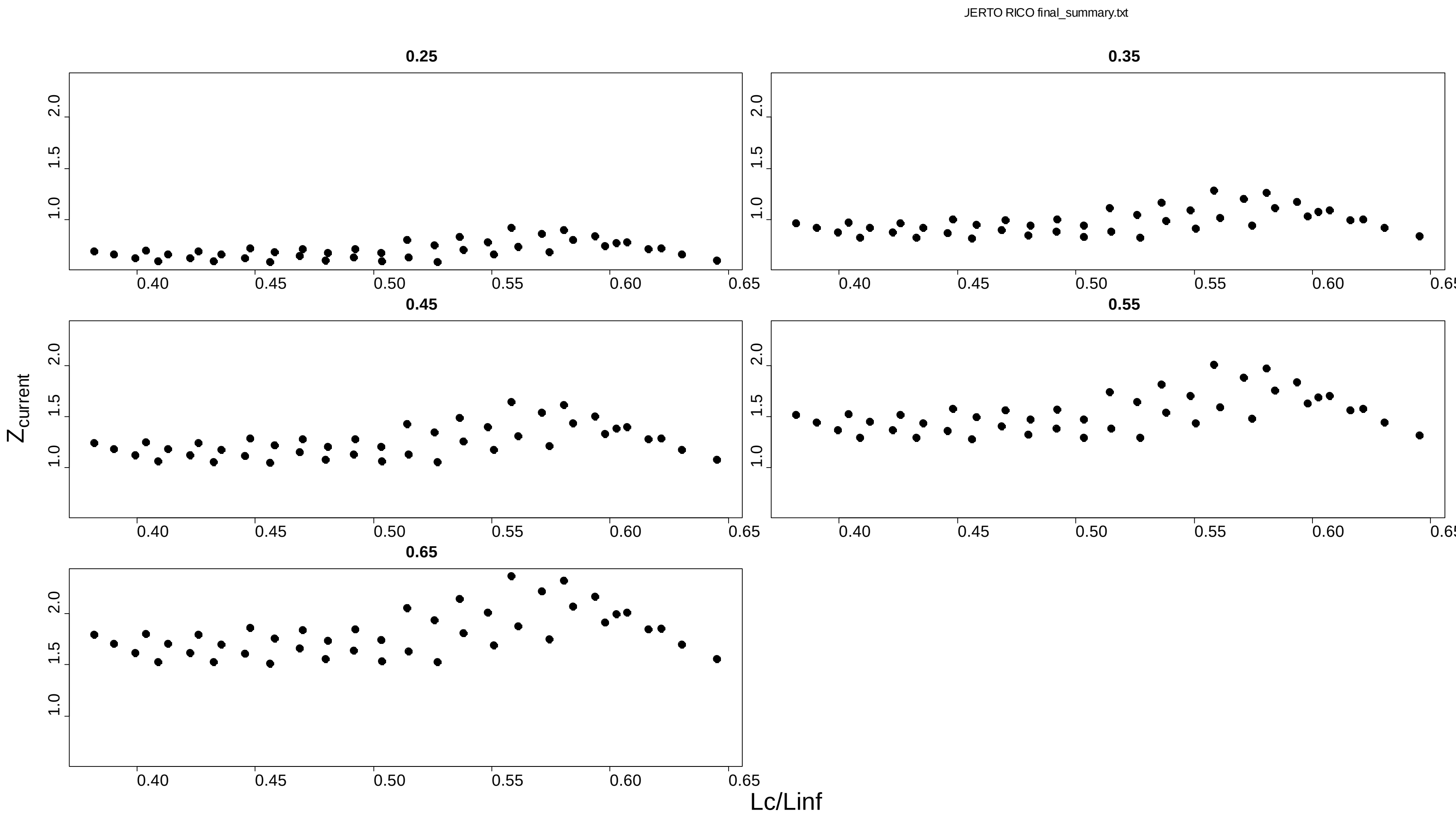

Figure 3.2.6.4. Estimates of current total mortality ($Z_{current}$) as a function of the von Bertalanffy growth parameter and the ratio between length at full vulnerability (L_c) and the asymptotic length (L_∞) for Queen snapper caught by hook and line in Puerto Rico. Each panel represents a unique value of the von Bertalanffy growth parameter. Low values of the length ratio indicates either a small value of L_c or a large value of L_∞ and high values of the ratio indicate a high value of L_c and a small value of L_∞. Strong support delta AIC>5.

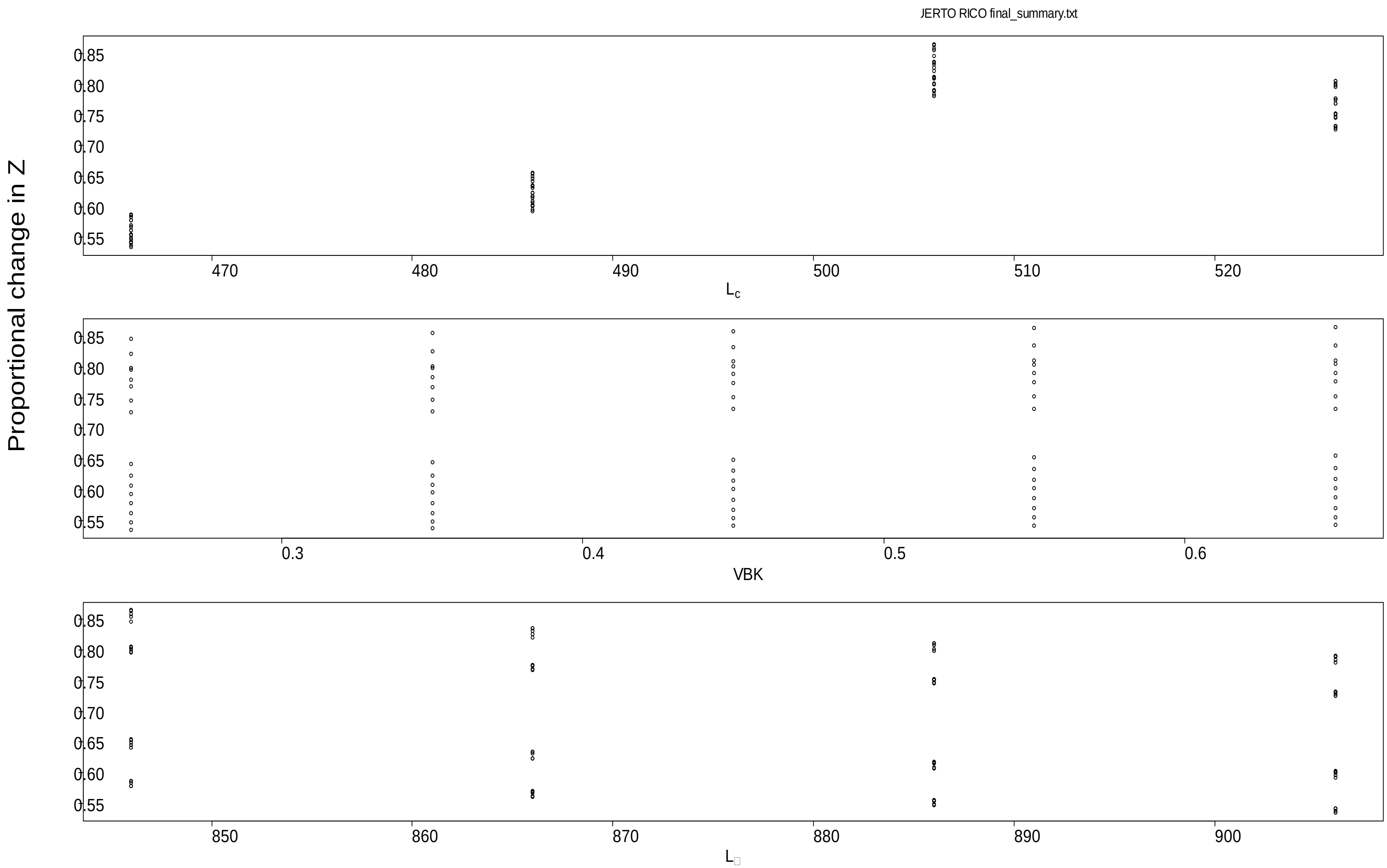

Figure 3.2.6.5. Proportion change in total mortality (Z) as a function of length at full vulnerability (Lc), the von Bertalanffy growth parameter (VBK) and asymptotic length (L_∞) for Queen snapper caught by hook and line in Puerto Rico. Strong support delta AIC>5.

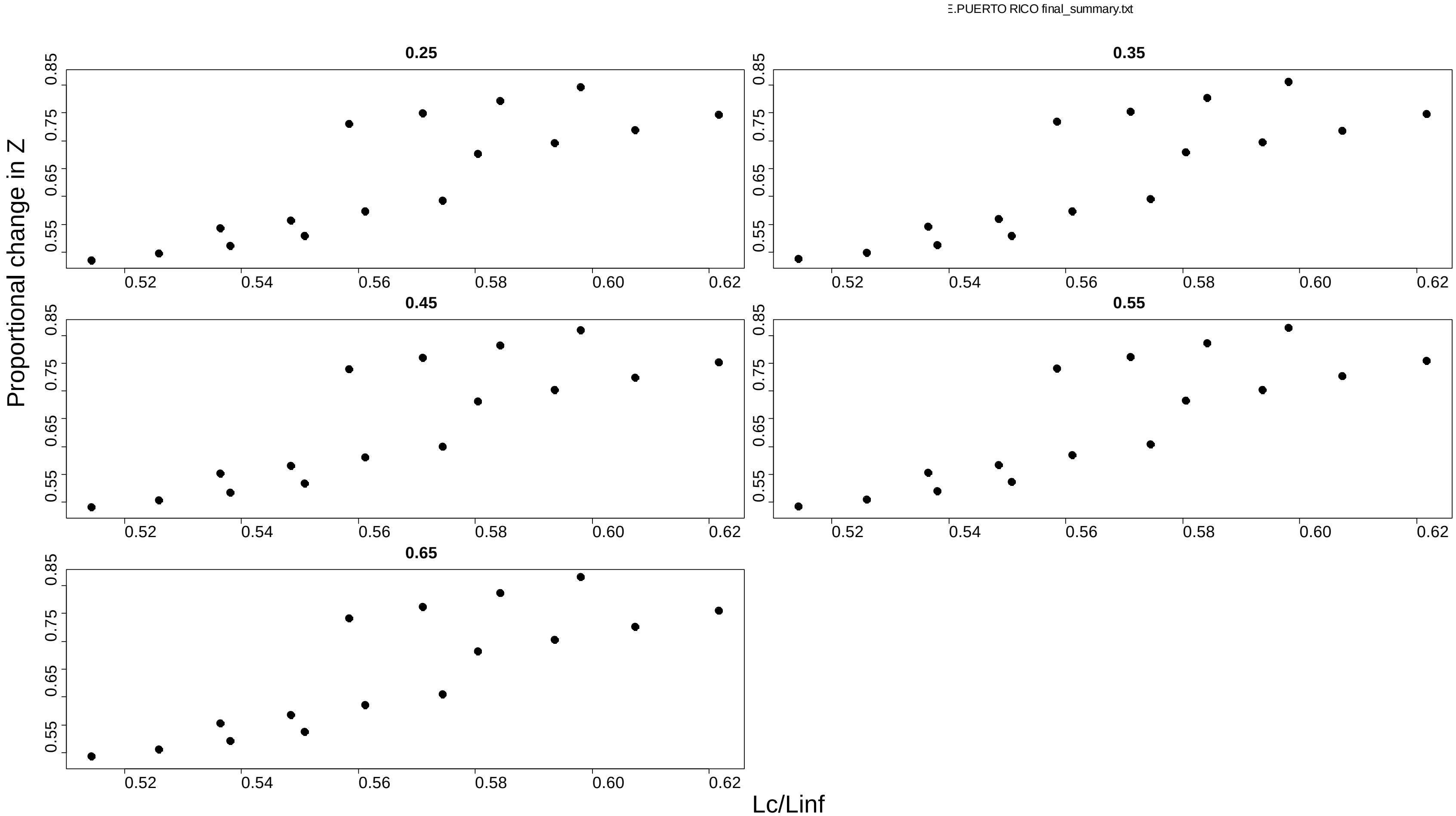

Figure 3.2.6.6. Proportional change in total mortality as a function of the von Bertalanffy growth parameter and the ratio between length at full vulnerability (L_c) and the asymptotic length (L_∞) for Queen snapper caught by hook and line in Puerto Rico. Each panel represents a unique value of the von Bertalanffy growth parameter. Low values of the length ratio indicates either a small value of L_c or a large value of L_∞ and high values of the ratio indicate a high value of L_c and a small value of L_∞. Strong support delta AIC>5.

4. St. Thomas/St. John Queen Snapper Stock Assessment Models and Results

4.1. Overview

Sample sizes were insufficient to conduct analyses using the length data. Table 3.2.4.1 above presents the sample sizes for this island and all possible gear combinations. Figure 1 presents the length-frequency histogram for the St. Thomas- hook and line combination; hook and line was the only gear type with even a limited number of samples. It should also be noted that no samples were available since 1997.

4.2. Figures

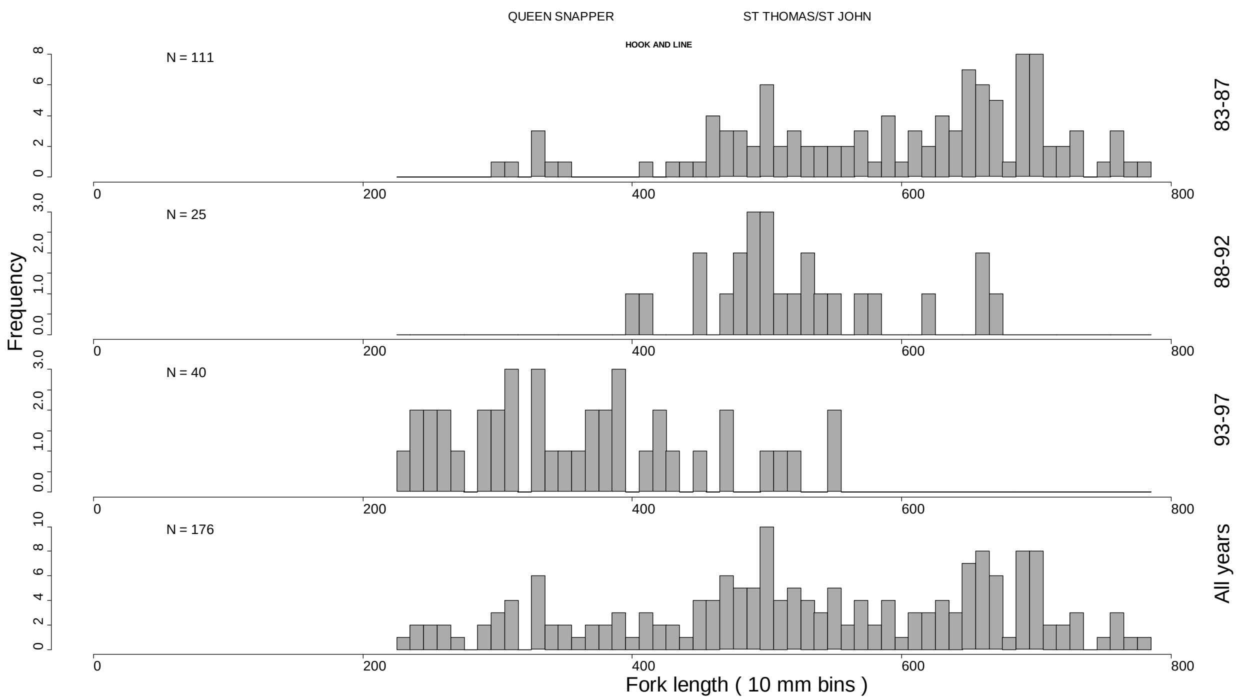

Figure 4.2.1. Length-frequency histograms for Queen snapper caught by hook and line in St. Thomas. Each panel includes data from a five-year time period, which is indicated at the right side of each panel. The bottom panel includes data from all years. Sample numbers (N) are indicated in each panel.

5. St. Croix Queen Snapper Stock Assessment Models and Results

5.1. Model 1: Length-Frequency Analysis Methods

5.1.1. Overview

Although 4089 samples were available from the TIP length database, most (~80%) were sampled prior to 1992. As a result, strong support through AIC criteria was not present for detecting a change in total mortality through the time-series analysis. Closer evaluation of length-frequency plots suggest size structure has remained stable and there is no evidence to suggest that mortality rates have changed (Figures 5.5.1 and 5.5.2).

5.1.2. Data Sources

See section 3.2.1.2

5.1.3. Model Configuration and Equations

See section 3.2.1.3

5.1.4. Parameters Estimated

NA

5.1.5. Uncertainty and Measures of Precision

At the SEDAR 26 DW and SEDAR 26 AW, the panel noted considerable uncertainty in the von Bertalanffy growth parameters and some hesitation as to the selection of length-at-full vulnerability (L_c) was expressed. As such, a comprehensive sensitivity analysis was conducted. The range of the von Bertalanffy growth parameter explored was 0.18-0.68, which represents 60% above and below the base value (0.45, which is the mean of the two published estimates in Murray and Moore 1992 and Murray et al. 1992). This range encompasses the two estimates of the von Bertalanffy growth parameter from Murray and Moore (1992) and Murray et al. (1992), 0.29 and 0.61. The range of the asymptotic growth parameter explored was 799mm-899mm. The upper bound was either 1) the maximum observed length, 2) 10% above the base value when the maximum observed is less than the base value or 3) 15% above the base value when the maximum observed length was questionable (e.g., one observation that appeared to be an outlier).

The accepted method for determining Lc is by visual inspection of the length frequency histogram (Thorson and Prager 2011). This approach was used for this analysis, but to satisfy the concerns of the AW panel we explored a wide range of L_c values. Note that the lowest Lc values used in the sensitivity analysis were clearly below the actual length at full vulnerability and included only to demonstrate model behavior.

5.1.6. Benchmark / Reference points methods

NA

5.1.7. Projection methods (Describe methods, including assumptions)

NA

5.2. Model 1 Results

5.2.1. Measures of Overall Model Fit

The AIC values do not provide strong support for the more complex model and therefore a change in mortality could not be detected (see Table 5.4.1, Figure 5.5.3). The resulting total mortality estimate for the base case was 2.34 (Table 5.4.1).

5.2.2. Parameter estimates & associated measures of uncertainty

See section 5.2.8 for explanation of results from sensitivity analysis.

5.2.3. Stock Abundance and Recruitment

NA

5.2.4. Stock Biomass (total and spawning stock)

NA

5.2.5. Fishery Selectivity

NA

5.2.6. Fishing Mortality

NA

5.2.7. Stock-Recruitment Parameters

NA

5.2.8. Evaluation of Uncertainty

Table 5.4.2 summarizes the ranges for the input parameters used in the sensitivity analysis. The sensitivity results indicate that a change was not detected in total mortality for any combination of the input parameters when using an AIC threshold that provides strong support for model selection. In other words, the sensitivity analysis did not provide strong support for the more complex models that predict a change in total mortality.

The total mortality estimates from the sensitivity analysis ranged between 0.5 to ~3.5 (Figures 5.5.4 and 5.5.5). Total mortality estimates are strongly correlated with the von Bertalanffy growth parameter input values (see second panel of Figure 5.5.4).

5.2.9. Benchmarks / Reference Points / ABC values

NA

5.2.10. Projections

NA

5.3. Discussion

Overall, the size structure of Queen snapper in St. Croix has not exhibited dramatic changes over the time series investigated. Additionally, lack of change in size structure has led to an inability to detect a change in total mortality with the available data and strong AIC criteria. Some change can be detected when AIC criteria are weakened, analysts are still investigating this. The results suggest that fishing has been occurring at rates that are sustainable, however, given data limitations we cannot interpret results in relation to stock status. A cautious interpretation of the absolute values of total mortality indicates that the exploitation rates appear to be higher than in Puerto Rico.

5.4. Tables

Table 5.4.1. Summary of time-series analysis results for the base case for Queen snapper caught by hook and line in St. Croix.

Npar	AIC	LLIKE	Lc	VBK	L_Inf	Z	Z1	ΔYear1	Z2	ΔYear2	Z3	ΔYear3	Z4
2	207.277	101.323	365	0.45	888	2.338	-	-	-	-	-	-	-
4	209.171	99.409	365	0.45	888	-	1.948	1987	2.474	-	-	-	-
6	208.65	95.525	365	0.45	888	-	1.921	1987	2.648	1997	1.935	-	-
8	213.888	93.406	365	0.45	888	-	3.142	1985	1.738	1987	2.666	1997	1.935

Table 5.4.2. Input parameter ranges for sensitivity analysis.

Parameter	Lower bound	Base	Upper bound
L_c	335mm	365mm	465mm
VBK	0.18	0.45	0.68
L_∞	799mm	888mm	899mm

5.5. Figures

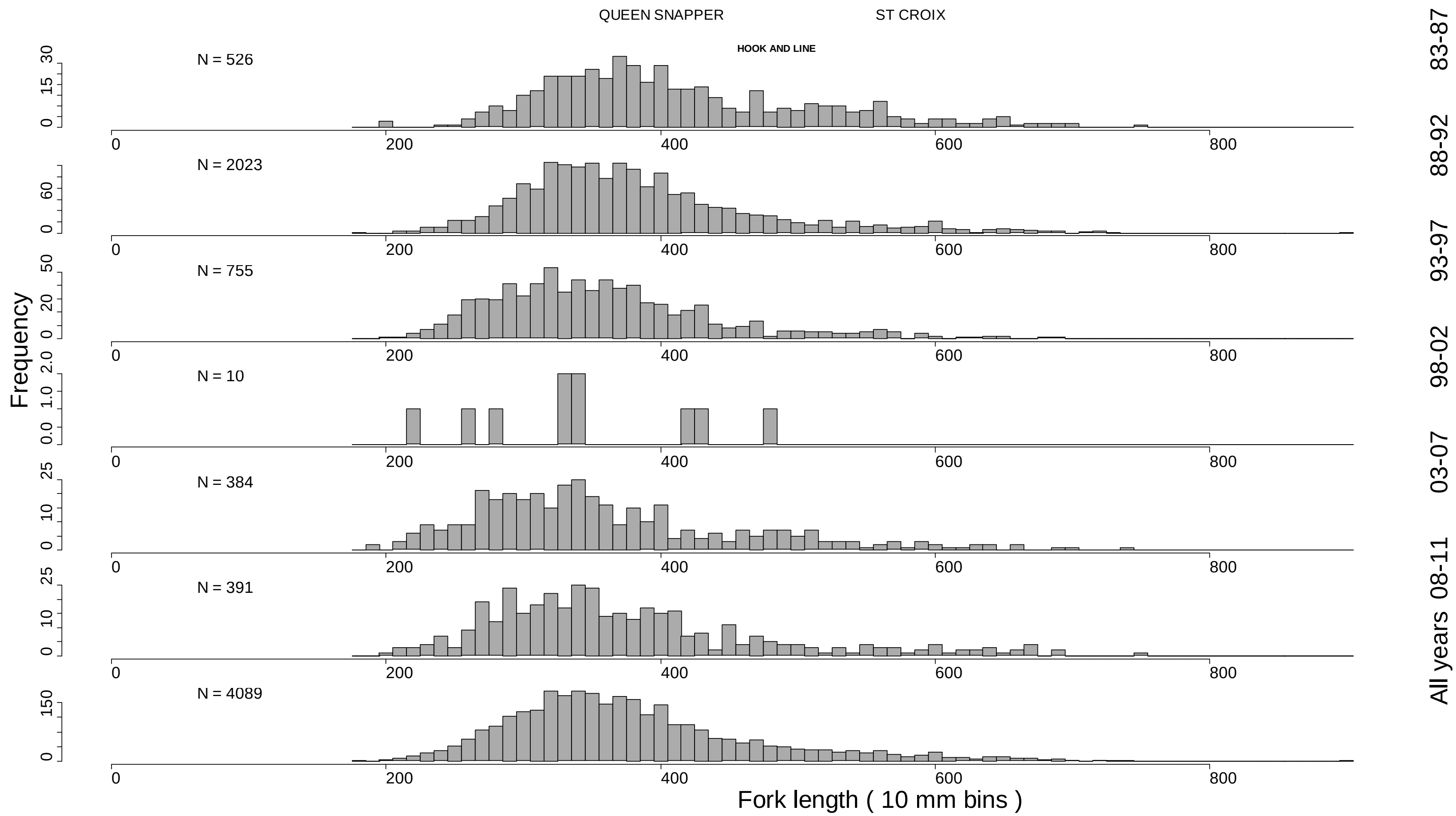

Figure 5.5.1. Length frequency distribution for Queen snapper caught by hook and line in St. Croix. Each panel includes data from a five-year time period, which is indicated at the right side of each panel. The bottom panel includes data from all years. Sample numbers (N) are indicated in each panel.

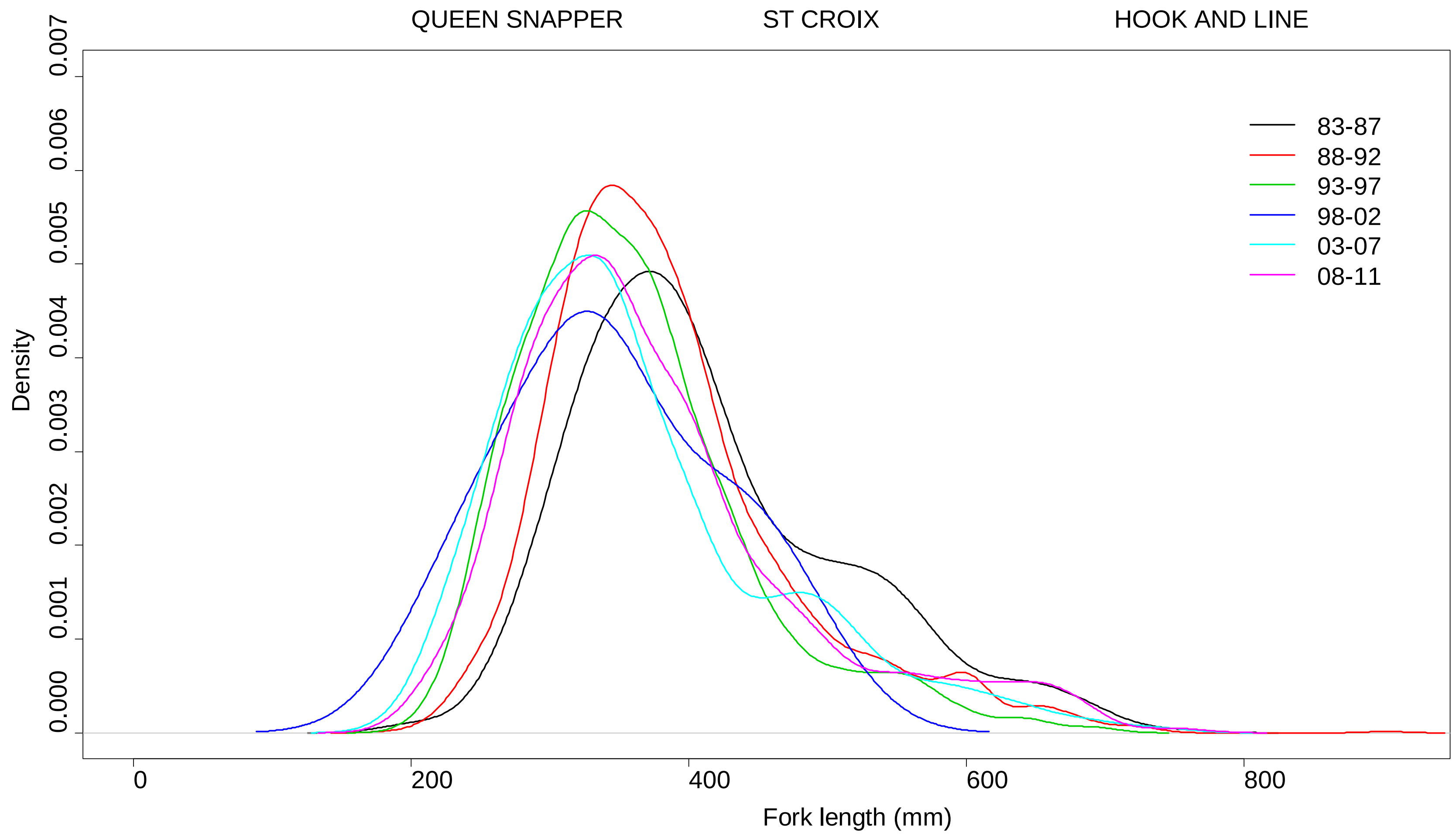

Figure 5.5.2. Density plot of the observed length distribution from the TIP database for Queen snapper caught by hook and line in St. Croix. Each curve represents a five-year period of time.

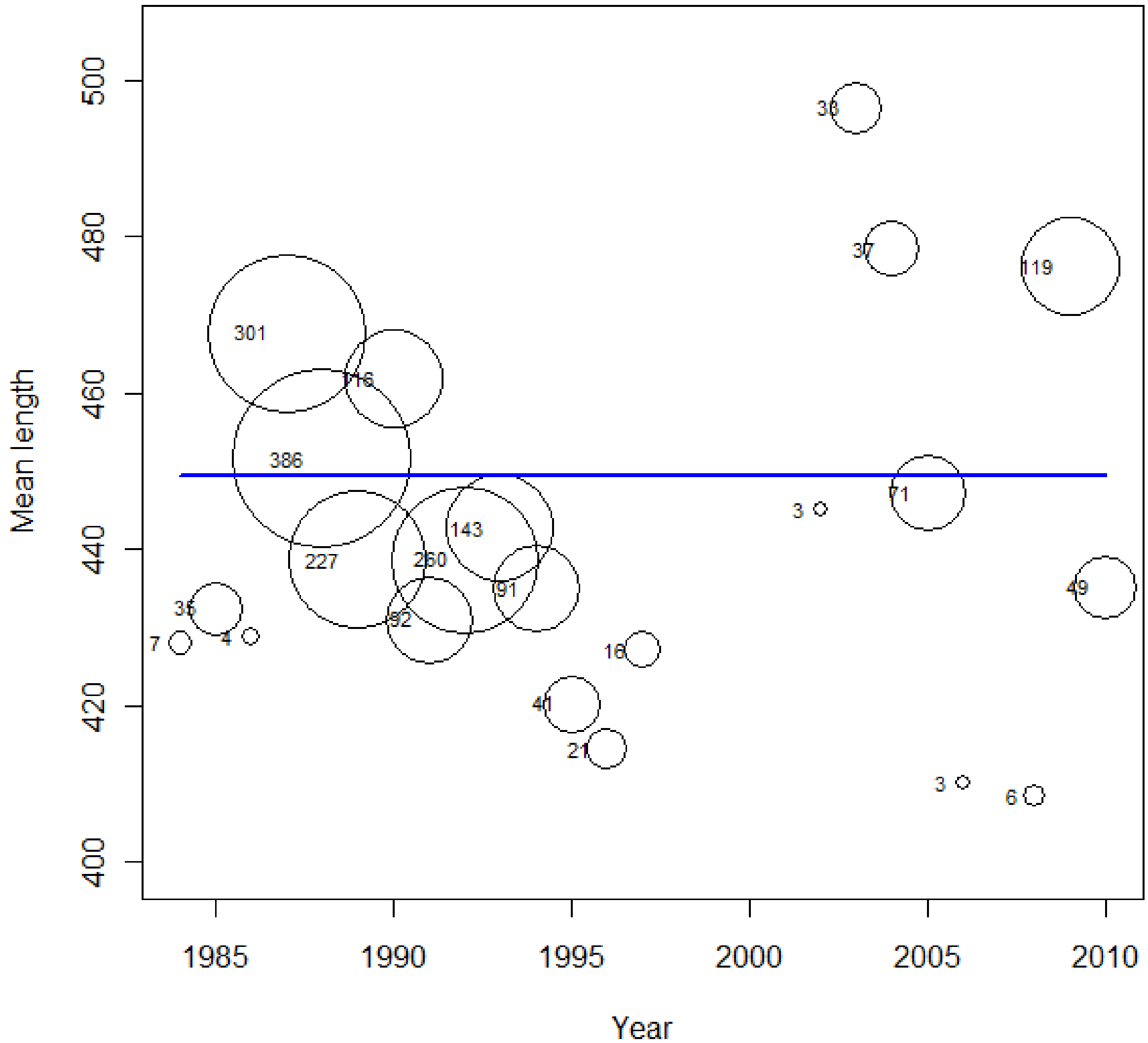

Figure 5.5.3. Mean length of fully-vulnerable individuals over time for the base-case time-series analysis. Bubble size indicates annual sample size relative to other years, the solid blue line represents the line of best fit.

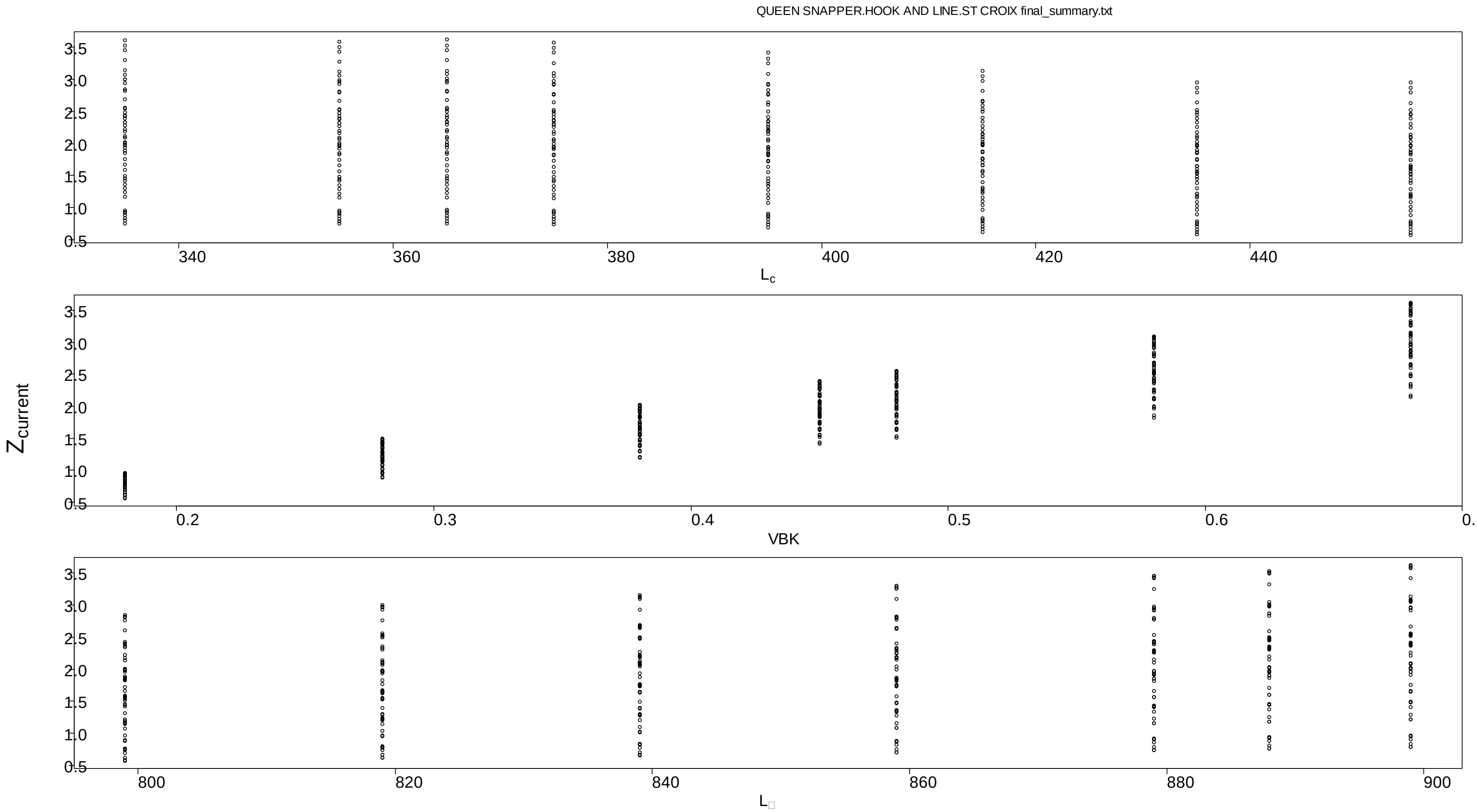

Figure 5.5.4. Current estimates of total mortality ($Z_{current}$) as a function of length at full vulnerability (L_c, top panel), the von Bertalanffy growth parameter (VBK, middle panel), and asymptotic length (L_∞, bottom panel) all runs resulted in no support for a predicted change in total mortality from the time-series analysis for Queen snapper caught by hook and line in St. Croix. The base case parameter combination was 365mm for L_c, 0.45 for the von Bertalanffy growth parameter, and 888mm for L_∞. Strong support delta AIC>5.

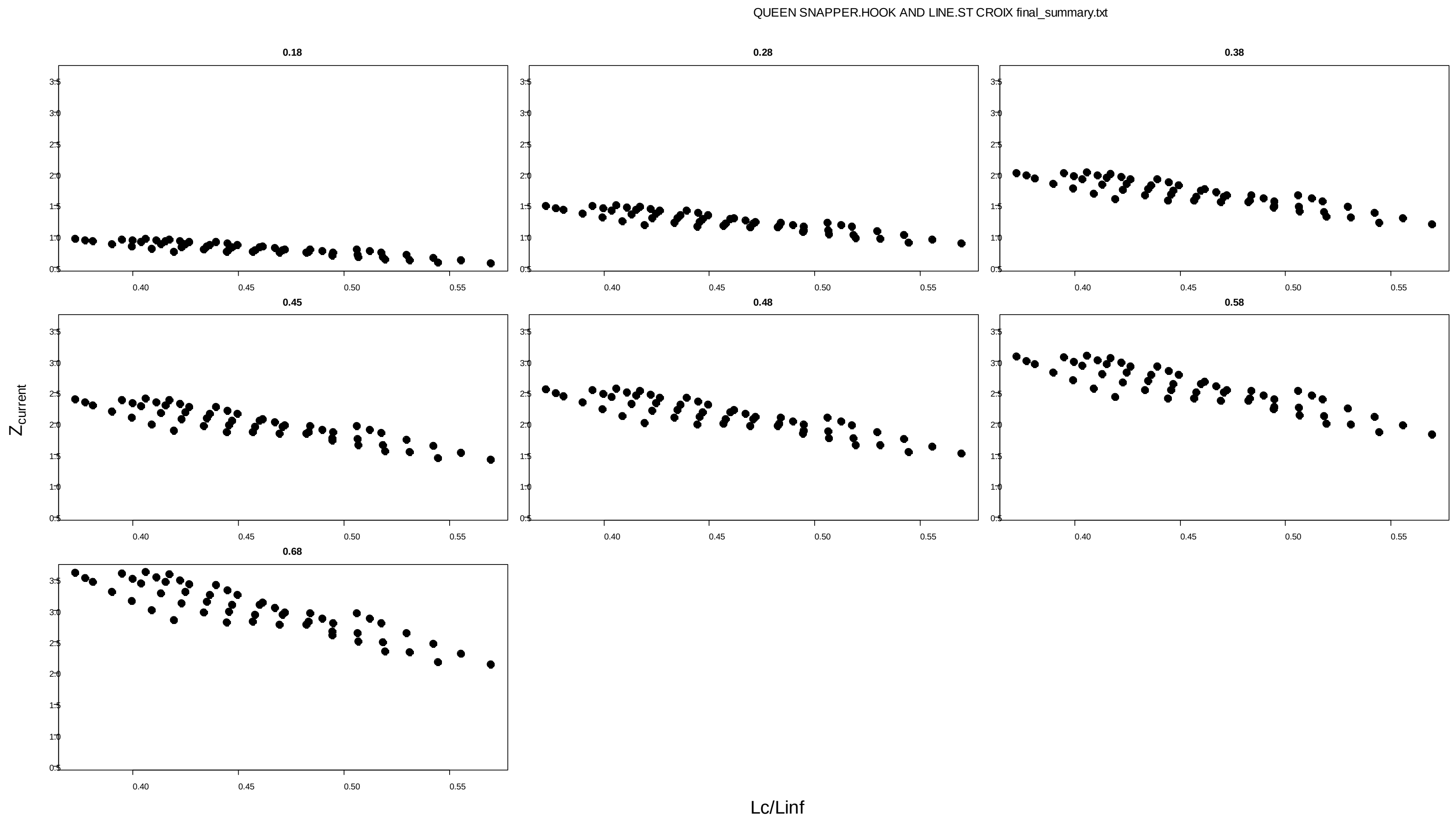

Figure 5.5.5. Estimates of current total mortality ($Z_{current}$) as a function of the von Bertalanffy growth parameter and the ratio between length at full vulnerability (L_c) and the asymptotic length (L_∞) for Queen snapper caught by hook and line in St. Croix. Each panel represents a unique value of the von Bertalanffy growth parameter. Low values of the length ratio indicates either a small value of L_c or a large value of L_∞ and high values of the ratio indicate a high value of L_c and a small value of L_∞. Strong support delta AIC>5.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 26

U.S. Caribbean Queen Snapper

SECTION IV: Research Recommendations

SEDAR
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405

1. DATA WORKSHOP RESEARCH RECOMMENDATIONS

1.1 LIFE HISTORY WORKING GROUP

- It will be important to develop regional sampling programs to collect age and growth data for silk snapper, queen snapper, and redtail parrotfish to estimate growth parameters essential to length-based analyses. Estimates of age-growth parameters are currently limited for the three species in question, therefore, it is essential to continue to build upon the existing published research.
- Regional data collection programs should also be designed to evaluate morphological conversion factors for each species. There is a lack of consistency in the units of measure for length among the studies reviewed by the LHWG. An important area of research will be to develop length-length conversion factors for the three species.
- Length-at-full vulnerability is an important input for length-based analyses. Expansion and improvement of the TIP program will be crucial for continued collection of species-specific size information, which be used to estimate length-at full vulnerability.

1.2 PUERTO RICO CATCH STATISTICS WORKING GROUP

- Commercial Landings Expansion Factor - all recommendations are in progress. Port samplers are visiting different fishing centers, collecting data of landings by trip, species and effort
- The working group also recommended that the uncertainty in the annual reported landings be characterized by computing the variance of the expansion factors and confidence intervals about the calculated total landings.
- Increasing the dockside sampling of recreational fishing trips in Puerto Rico to reduce the uncertainty in the catch estimates and 2) 20 extending / initiate MRIP's efforts in the US Virgin Islands to quantify the magnitude of recreational catches. In addition, recreational effort.
- The recreational statistics Program recommends increasing the minimum number of trip interviews to 130 for shore fishing, 200 for private boats and 90 for charter boats.
- There is an immediate need to develop sampling efforts to better identify and quantify discards in the commercial fisheries.

1.3 USVI CATCH STATISTICS WORKING GROUP

- Initiate MRIP's efforts in the US Virgin Islands to quantify the magnitude of recreational catches.
- It is important to determine the efficacy of expansion factors used to estimate total catch. The information used to calculate expansion factors by year need to be verified.

- The collection of landings statistics in the U.S.V.I. should be species-specific because analysis of the current species-groupings is not informative for stock assessments. Species composition from TIP is not appropriate, given the current sampling methodology, for estimating species-specific landings using ratio estimators.
- It is important to encourage fishermen to submit all the monthly catch reports, to submit reports for months when they do not fish, and to complete all the fields in the reports, since critical information such as effort, gear, and location fished are often missing or incomplete.

1.4 FISHERY INDEPENDENT RESEARCH

- Continuation of ongoing, long term research may provide additional information for future assessments.

1.5 INDICES OF ABUNDANCE WORKING GROUP

- 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
- 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
- Emphasis should be placed on the improvement of the TIP sampling program, as catch rate standardization, catch composition and size-frequency analyses will continue to rely upon this information. Fishery-independent surveys and the collection of other biological data, however, are extremely important to develop alternative indices of abundance.
- Need to continue efforts 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

2. ASSESSMENT WORKSHOP RESEARCH RECOMMENDATIONS

Research efforts are needed that focus on improved data collection efforts, particularly on trip based catch and effort and recording of more detailed geographical data on catch area. Surveys should be considered that will allow validation of fisher reported catch, landings, and trip effort. Surveys are needed that allow characterization of multi- species trips to allow identification of trips that split fishing effort across different gears and species groups. These surveys should be coordinated with fisher groups to enhance buy in by the industry.

The ability to utilize length-frequency data is contingent upon having reliable estimates of life history parameters (von Bertalanffy parameters in particular). Studies on basic life history (e.g. age-growth relationships and estimating natural mortality) in the US Caribbean will greatly enhance the utility of the existing length-frequency data and should provide the greatest benefit to providing management advice in the short term. This should be placed as a top priority for key species.

3. REVIEW PANEL RESEARCH RECOMMENDATIONS

3.1 Major priorities

1. There is large degree of uncertainty in the assessment due to the data poor nature of this fishery. In the short to medium terms, the key data set is likely to remain size frequency distributions. The ability to utilize length-frequency data is contingent upon having reliable estimates of life history parameters (von Bertalanffy parameters in particular), therefore the highest priority for future research are:
    a. Studies on basic life history (e.g. age-growth relationships and estimating natural mortality) are essential in the US Caribbean and will greatly enhance the utility of the existing length-frequency data. This information should provide the greatest benefit to providing management advice in the short term. This should be placed as a top priority for key species.
    b. At present, the TIP size frequency data provides the only source of information on stock status and benchmarks and it is therefore essential that this program be at least continued. However, expansion (for example, to USVI) and improvement of the TIP program will be recommended for continued collection of species-specific size information.
    c. Focus should be on developing more complete and accurate data sets into the future, particularly on trip based catch and effort and recording of more geographical data on catch location.
    d. The recreational catch and effort is an important data set and should be continued. Expanding this system to the USVI may also be useful. Furthermore, this source of mortality should be included in the analyses.
    e. Emphasis should be placed on extension, as compliance and unreporting is likely to increase when more data is required of fishers. Given the present low rate of reporting in Puerto Rico, this would be of great concern.
    f. Validation of fisher reported catch, landings and trip effort should be undertaken.
    g. The collection of landings statistics in the USVI should be species-specific because analysis of the current species-groupings is not informative for stock assessments, unless future assessments and management action focus on logical clusters of species.

h. Characterization of multi- species trips to allow identification of trips that split fishing effort across different gears and species groups. This work should be coordinated with fisher groups to enhance buy-in by the industry.

i. It is important to encourage fishermen to submit all the monthly catch reports (USVI), to submit reports for months when they do not fish, and to complete all the fields in the reports, since critical information such as effort, gear, and location fished are often missing or incomplete.

2. All sources of mortality should be considered in the analyses especially for the recreational fishery catch in Puerto Rico for Silk and Queen Snapper.
3. Given the importance of the SEINE method and that extensions of this method are likely to be used into the near future, the following additional modification are required:

   a. When the full likelihood surface for the SEINE analyses were shown in session, it was clear that unnecessary combinations are sampled and that the surface is reasonably flat near the optimal likelihood, which means more sampling needs to be undertaken within this range.

   b. The SEINE method should be extended to apply a Bayesian hierarchical model that draws on species with more information (Punt *et al*., 2011, although this method is not Bayesian). This method would integrate across all the different forms of uncertainty and also allow more data rich species' information to be drawn from for the data poor species.

   c. The SEINE method should be extended to include the estimate of M for those species where this information is available. . This directly acknowledged the correlation between growth, maximum length and natural mortality.

   d. The SEINE method should be tested in a simulation study using a simulated population with known parameters, recruitment, and size frequency and including variability in key parameters. Furthermore, these results should then be converted to a guideline on how to apply this information in a data poor situation.

   e. Some preliminary analyses were undertaken during the Review that should be further investigated.

3.2 Medium priority

1. For all landings series, a more appropriate method would be to present median estimates of landings with confidence intervals for all regions. All sources of uncertainty should be included in this analysis.
2. The CPUE standardisation methods needs much more extensive investigation, including:

   a. The feasibility of including additional factors or variables either as offsets or ratios of catch to relevant species total catch should be undertaken in the future. An overall Redtailed Parrotfish index from the catch rate standardisation is developed in the future.

   b. Developing an overall Redtailed Parrotfish index from the catch rate standardisation be developed in the future

3. Given the uncertainty in the data, any future FIS should be designed in such a way as to be aligned with the earlier surveys. This would be extremely useful for comparison.

3.3 Lower priority

1. There is some question whether changing the commercial catch expansion method during the series produces biases. Therefore, the effect of the two different methods over the time series to develop the expansion factors should be tested.
2. There is a need to develop sampling efforts to better identify and quantify discards in the commercial fisheries.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 26

U.S. Caribbean Silk Snapper, Queen Snapper, and Redtail Parrotfish

SECTION V: Review Workshop Report

December 2011

SEDAR
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405

Table of Contents

1. INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 26 Review Workshop was held October 17-21, 2011 in San Juan, Puerto Rico.

1.2 TERMS OF REFERENCE

1. Evaluate the adequacy, appropriateness, and application of data used in the assessment.
2. Evaluate the adequacy, appropriateness, and application of methods used to assess the stock taking into consideration the data-poor nature of the fisheries.
3. Recommend appropriate estimates, when available, of stock abundance, biomass, and exploitation. When data-limitations preclude estimates, provide summary of conclusions that can be drawn from data-poor methodologies that were used in assessment.
4. Evaluate the methods used to estimate population benchmarks and management parameters (*e.g., MSY, Fmsy, Bmsy, MSST, MFMT, or their proxies*); recommend appropriate management benchmarks, provide estimated values for management benchmarks, and provide declarations of stock status.
5. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status taking into consideration the data limitations and proposed alternatives; recommend appropriate estimates of future stock condition (e.g., exploitation, abundance, biomass).
6. Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty in estimated parameters. Provide, if available, measures of uncertainty for estimated parameters. Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty. Ensure that the implications of uncertainty in technical conclusions are clearly stated.
7. Ensure that stock assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations.[*]

8. Evaluate the SEDAR Process as applied to the reviewed assessment and identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops.
9. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted. Clearly denote research and monitoring needs that could improve the reliability of future assessments. Recommend an appropriate interval for the next assessment, and whether a benchmark or update assessment is warranted.
10. Prepare a Peer Review Summary Report summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference.

The panel shall ensure that corrected estimates are provided by addenda to the assessment report in the event corrections are made in the assessment, alternative model configurations are recommended, or additional analyses are prepared as a result of review panel findings regarding the TORs above.

1.3 LIST OF PARTICIPANTS

Workshop Panel

Walter Keithly, Chair....LSU/CFMC SSC
Cathy Dichmont....CIE Reviewer
Panayiota Apostolaki....CIE Reviewer
Vivian Haist....CIE Reviewer
Jorge Garcia-Sais....CFMC SSC

Analytic Representation

Todd Gedamke....NMFS SEFSC Miami
Meaghan Bryan....NMFS SEFSC Miami
Nancie Cummings....NMFS SEFSC Miami
Kevin McCarthy....NMFS SEFSC Miami

Council Representation

Carlos Farchette....CFMC

Appointed Observers

Jose Alberto Sanchez....Industry Representative/St. Croix

Staff

Graciela Garcia-Moliner....CFMC Staff
Julie Neer....SEDAR
Michael Larkin....SERO
Rachael Silvas....SEDAR
Tyree Davis....NMFS SEFSC Miami

2. REVIEW PANEL REPORT

Review Panel Summary Report

U.S. Caribbean Queen Snapper, Silk Snapper, and Redtail Parrotfish

Prepared by the SEDAR 26 Review Panel

Executive Summary

The 26th South East Data, Assessment, and Review (SEDAR 26) meeting aimed to review the assessments for the U.S. Caribbean Queen Snapper, Silk Snapper, and Redtail Parrotfish. The assessment reports for these three species across the different islands (Puerto Rico, St. Thomas/St. John, and St. Croix) were provided to the review panel members prior to the SEDAR 26 meeting. In addition, the other reports from the Data and Assessment meetings were available from https://grunt.sefsc.noaa.gov/sedar/Sedar_Documents.jsp?WorkshopNum=26&FolderType=Assessment. The meeting was held at the El Convento Hotel in Old San Juan, Puerto Rico from Monday, October 17 through Thursday October 20, 2011. Assessments were presented to the panel and informative discussion continued through and following the presentations. The SEDAR process (and Terms of Reference) is relatively prescriptive so the Panel is able to pursue the review by focusing on the adequacy and appropriateness of the available data and the assessment processes used.

Background

South East Data, Assessment, and Review (SEDAR) is a process for stock assessment development and review conducted by the South Atlantic, Gulf of Mexico, and Caribbean Fishery Management Councils; NOAA Fisheries, SEFSC and SERO; and the Atlantic and Gulf States Marine Fisheries Commissions. SEDAR is organized around three workshops: data, assessment, and review. Input data are compiled during the data workshop, analysis is conducted during the assessment workshop, and results are considered during the review workshop by independent reviewers. SEDAR documents include a data report(s) produced by the data workshop; a stock assessment report(s) produced by the assessment workshop; and a peer review consensus report(s) which provides an evaluation of the assessment reports and recommendations.

SEDAR is a public process. All workshops, including the review, are open to the public with notices of the workshops being given in the Federal Register. All documents are freely distributed to the public upon request and posed on the SEDAR website.

The review workshop is an independent peer review of the stock assessment. The term “review” is applied broadly, as the review panel may request limited additional analyses, correction of errors, and sensitivity runs of the assessment model(s) provided by the Assessment Workshop. The review panel is ultimately responsible for ensuring that the best possible assessment is provided through the SEDAR process. The review panel task is specified in Terms of Reference.

Summary of Findings

The report by the Review Panel for Queen Snapper, Silk Snapper, and Redtail Parrotfish, as well as an overview of findings associated with these three species is given in the next section. The Review Panel was in agreement that data poor methods to assess the status of these three stocks across the different regions (Puerto Rico, St. Thomas/St. John, and St. Croix) was appropriate given the substantial uncertainty in virtually all of the data and input parameters. There was also agreement that, in general, appropriate methods were applied to ascertain status of the stocks given the data poor situation. Given that a time-series analysis of size frequency distributions of the three stocks across the three regions is the primary information available for assessing relative total mortality estimates, the consensus of the review panel is that the Trip Interview Program (TIP) be continued and, if feasible, enhanced. Basic life history information from the US Caribbean is also considered to be extremely important to more fully assess the status of the stocks and it is the opinion of the review panel that further investments in this research will provide, over time, substantial benefits. Other recommendations of the panel are provided below.

SEDAR 26: Overview for Queen Snapper, Silk Snapper, and Redtail Parrotfish

- The panel agrees that there has been a very thorough process of mining the data, investigating all sources of data and their related uncertainty. Similarly, a meta-analysis was undertaken of all relevant sources in the literature to inform sensitivity tests, rather than use of single values.
- There is very large uncertainty in almost all the data and input parameters, which correctly, therefore, requires applications of data poor methods.
- The Assessment team extensively applied methods appropriate for data poor fisheries and also undertook a very good extension and application of the SEINE (Survival Estimation in Non Equilibrium Situations) (Gedamke and Hoenig, 2006) method.
- The panel supports the position that the most valuable information for assessing the status of the considered stocks, at this stage, is the size frequency information and that continued investment in this data set is essential.
- Uncertainty in the analyses is well presented. However, uncertainty was not well presented in the landings data especially through endeavouring to provide only a single expanded landings data set in Puerto Rico. The need for expansion factors in USVI is much reduced given that returns were mandatory. For all landings series, a more appropriate method would be to present median estimates of landings with confidence intervals being provided for all regions. All sources of uncertainty should be included in this analysis. Further modifications with regard to the SEINE analysis could be undertaken (see detailed comments below).

- The catch per unit effort (CPUE) standardisation methods were appropriately applied given the low information base of key factors including, but not limited to, gear information (e.g. GPS), depth fished, and species targeted. The panel agrees with the conclusions that the standardised catch rate indices do not reflect abundance trends. Much more extensive investigation of the feasibility of including additional factors or variables, either as offsets or ratios of catch to relevant species total catch, should be undertaken in the future. However, it is acknowledged that the data themselves have such serious gaps that it is unlikely that the conclusions will change.
- The panel suggests that the SEINE method has not been tested enough in a simulation study to assess its strength with regard to developing overfishing proxies. The simulation studies should be tested on a simulated population with known parameters, recruitment and size frequency. Despite this view, the method shows the greatest promise in these data poor situations.

TOR 1: Evaluate the adequacy, appropriateness, and application of data used in the assessment.

Population parameters

During the Review Workshop, the assessment team produced an addendum to the Data Review Report providing a compilation of all population biology information. One of the greatest sources of uncertainty is appropriate population dynamic parameters. Most of the parameters are derived from studies not undertaken within the Puerto Rico or USVI area. In addition, the meta-analysis has shown that this suite of species has large parameter variability between regions thereby adding to the uncertainty of applying them to this region. The level of uncertainty restricts the type of modelling that could be applied and increases the uncertainty in the results and therefore the conclusions. ***Population studies should therefore concentrate on collecting growth data specific to the region.***

Data

Several data sets are available for Puerto Rico and the USVI (the latter divided into St Thomas/St. John and St Croix areas) and these are described in an Addendum to the Assessment Review report produced during the Review Workshop. However, the core data used by the Assessment Team are a) Trip interview program (TIP) (mainly commercial) data for both Puerto Rico and US Virgin Islands, b) Puerto Rico commercial sales/trip ticket data c) US Virgin Islands commercial landings reports and d) MRFSS observations of recreational catch and effort since 2000 for Puerto Rico. Although several other data sets, such as fisheries independent surveys (FIS) are available, these were not used and reasons are provided in the Addendum. ***Given the uncertainty in the data, any future FIS should be designed in such a way as to be aligned with earlier surveys. This would be extremely useful for comparison purposes.***

There are several gaps and large uncertainties in all the data. After all the in-depth analysis undertaken by the Data Review and Assessment teams, ***much of the key available information that could be extracted from the data has been mined.***

Landings and effort

Overall landings are highly uncertain due to a) the unknown frequency and quantum of misreporting (over and under) and unreporting, particularly for Puerto Rico(under), b) the amount of illegal fishing due to, for example, unlicensed fishing, c) the unknown recreational catch especially in USVI and d) the unknown amount of discarding by both commercial and recreational fishers. This means that the landing and effort dataset suffers from the full spectrum of illegal, unregulated and unreported uncertainty. Much work by the different teams has been undertaken in trying to address these issues and the final conclusions with regard to the usefulness of the data are generally appropriate.

In Puerto Rico, from 1967 to 2004, sales records were collected from voluntary reports by fishers, co-operatives and dealers. From 2005, these were mandatory. Landings by species are available in electronic format since 1983. On the other hand, species-specific commercial catch data are not available for USVI. Logbooks for St. Thomas/St. John and St. Croix are available since 1974 by gear type and were mandatory throughout this period. From 1996, fishers further stratified their data by gear and species group (e.g. snapper, parrotfish). The records of the number of licences per year, and the level of reporting by island, year and month, are known to a reasonable level of confidence given that reporting was mandatory. For the key period in which the data are applied, reporting rates are reasonably high.

Compared to USVI, the Puerto Rico data require higher and less confidently known expansion factors, but benefit from the data being species specific. The USVI data benefit from requiring smaller or no expansion factors, but suffer from not being species specific.

One can draw the following conclusions:

1. Much of the landings data for Puerto Rico cover a period in which data provision was voluntary. When the data became mandatory, there seems to be a short period in which the data reporting rate became slightly higher, but may not have been as accurate due to biases in the individual records. However, reporting rates subsequently worsened again. Annual reporting rates have varied from around 60% to 75%, with recent reporting rates about 50%. These data therefore suffer from large unreporting, especially in the early part of the series. A current data project is investigating these issues in depth. The Data Review workshop has attempted to reconstruct this data set using several different methods and discussion with different stakeholders including fishers. It therefore seems likely that data collected in the past will remain uncertain.

2. Focus should therefore be on developing more complete and accurate data sets into the future. A current project is working on developing new data sheets. These require greater detail from fishers than previous returns. ***Emphasis should be placed on extension, as compliance and unreporting could increase when more data is required of fishers. Given the present low rate of reporting in Puerto Rico, this would be of great concern.***

3. In order to create a total landings data set, expansion factors are used for the Puerto Rico) landings data. Until 2003, expansion factors adjust for non-reporting fishers using the ratio of reporting to non-reporting fishers (based on licences issued). Post 2003,

validation port sampling occurred and therefore the expansion factors are based on the ratio by weight of reported landings to port sampler observed landings. The expanded landings data were used to calculate the OFL catch. Given the uncertainty with respect to total effort, developing expansion factors is difficult. The expansion factors produce a single expanded series. There is some question whether changing the method during the time series introduces bias. ***Therefore, the effect of the two different methods over the time series to develop the expansion factors should be tested.*** This indicates the use of expansion factors in this region is appropriate and appropriately applied.

4. Given the uncertainty in the expansion factors and consequently the actual landings, producing a single landings series mis-represents the uncertainty. ***It is much more appropriate to include all the uncertainty and therefore, either produce a high, middle and low series or a single series with confidence intervals.*** Discards occur for certain species with ciguatera, but for these species the issue is more likely it is only likely to involve the discards of smaller fish. ***Discards are not considered and should be included in the uncertainty calculations.***

Recreational catch and effort

The collection of recreational catch data was initiated in Puerto Rico in 2000 for the shore, private boat, and for-hire components of the recreational fishery. These data are not collected in the USVI. Generally, the recreational catches are high enough that they should not be ignored. This is an important data set and ***should be continued. Expanding this system to the USVI may also be useful. Furthermore, this source of mortality should be included in the analyses. Length frequency data from the recreational catch would be useful and should be collected.***

Catch per unit effort

Catch rate data are potentially useful to provide an index of abundance over time. However, a key assumption is that the index is proportional to biomass (see ToR section on comments regarding the standardisation process). Given the uncertainty in both the total landings and effort data, these data are also highly uncertain. However, these data can, of course, be divided into subsets for abundance calculations which can often reduce uncertainty. However, this does not seem to be the case here. For example, a) the data contain an unknown degree of multiple trips on one ticket (Puerto Rico), b) the data do not follow a fisher or licence over the whole time series and c) little is known specifically about the kind of gear (beyond broad categories) that was applied.

Commercial size data

Trip interview data are collected by port samplers and provide the length frequency of sampled catch. These data are available since 1983 and provide essential information on catch composition, landing verification and, most importantly, size frequency of the catch. However, a very small fraction of the landings are sampled – about 3-5% for Puerto Rico and 1-2% for USVI. Although there is a survey design behind the sampling, it is unclear whether it is applied. For the USVI, these data were not deemed useful to divide the commercial landings data into species. ***However, the size data are a crucial information source as these are the only data that have led to the relative total***

mortality estimates. The analytical methods used to develop the size frequency distributions are appropriate for the purposes of the data poor analyses applied.

TOR 2: Evaluate the adequacy, appropriateness, and application of methods used to assess the stock taking into consideration the data-poor nature of the fisheries.

Three major methods to assess the stock were undertaken: a) developing standardised catch rate indices of abundance, b) equilibrium Beverton and Holt estimates of total mortality based on size frequency data and c) the non equilibrium SEINE method developed in Gedamke and Hoenig (2006) and modifications described in the Assessment report.

CPUE standardisation

The catch rate standardisation uses a delta lognormal generalised linear modelling approach. Presence or absence of catch used a binomial distribution and the positive catch used a lognormal distribution. This method is a standard approach for zero inflated data as appears to be the case here. For both Queen and Silk Snapper in Puerto Rico, a single catch rate index by region is provided, whereas an index is produced by gear type for Redtail Parrotfish. No catch rate standardisation was undertaken for USVI as catch reporting is by species group only and a species aggregate CPUE index could not be disaggregated to inform specific species stock assessments. The latter seems inappropriate given that the different gear still fish the same population, so therefore an overall index is required. This is likely to require a reformulation of the standardisation method. As a result, ***the panel recommends that an overall Redtailed Parrotfish index be developed in the future, recognizing that species specific inferences can not be drawn from the indices.***

The standardisation methods were appropriately applied given the low information base of key factors such as gear information (e.g. GPS). ***The panel agrees with the conclusions that the standardised catch rate indices do not reflect indices proportional to abundance.*** More extensive investigation of including additional factors or variables either as offsets or ratios of catch relative to relevant species total catch should be undertaken in the future. ***However, it is acknowledged that the data themselves have such serious gaps that it is unlikely that the conclusions will change.***

Spawning aggregation

The size data by month over all years were investigated for indications that spawning aggregations are fished at certain periods of the year. ***Given that much of the catch is comprised of mature animals anyway, the panel recommends that these data are unlikely to suggest whether spawning aggregations are targeted.***

Size selectivity

Combining length frequency data in 5-year blocks to assess changes in selectivity over time was considered an acceptable approach

Visually inspecting length frequency graphs to identify the part of the population that is fully selected for each gear is an acceptable approach in this case.

Estimating total mortality (and in some cases a proxy for F_{MSY})

Two methods were employed to calculate total mortality or relative changes in total mortality. The first uses the classic equilibrium size method developed by Beverton and Holt that is applied to fully selected size classes in the early period. The second approach uses the SEINE method to test whether the mean size has changed over time.

The assessment report appropriately advises caution with regard to the use of equilibrium methods to estimate total mortality. In the case of Queen Snapper, an F_{MSY} proxy is also provided for the SEINE method, assuming F_{MSY} is about twice natural mortality (M).

The second method extends the SEINE method from Gedamke and Hoenig (2006).

The SEINE method models the change in mean size over time and is an appropriate method to apply given the available information and data. These tests have correctly tested across a range of growth parameters (Kappa and L_inf). The model also was tested to establish whether 0, 1 or n number of changes in mean size occurred over the period. Akakie information critera (AIC) is used to test the number of Z changes that are "strongly" supported by the data. This extensive testing of uncertainty should be applauded. ***However, when the full likelihood surface was shown in session, it was clear that unnecessary combinations are sampled and that the surface is reasonably flat near the maximum likelihood, which suggests more sampling should be undertaken within this range.***

In cases where there is high uncertainty in von Bertalanffy growth parameters, the SEINE method could be extended to include approaches that assume a relationship between M and Kappa and use these directly to estimate F rather than Z, although this approach requires substantial simulation testing. This would directly acknowledge the correlation between growth, maximum length and natural mortality.

The SEINE method has been simulation tested using data from a number of fisheries. However, ***this method should be tested in a simulation study using a simulated population with known parameters, recruitment, and size frequency and including variability in key parameters.*** Furthermore, these results should then be converted to a guideline on how to apply this information in a data poor situation.

TOR 3: Recommend appropriate estimates, when available, of stock abundance, biomass, and exploitation. When data-limitations preclude estimates, provide summary of conclusions that can be drawn from data-poor methodologies that were used in assessment.

Given the uncertainty in the data and biological parameters, only the SEINE (non-equilibrium) method applied to size frequency data provided any form of information on fishing mortality trends. ***The panel agrees that the total mortality estimates are highly uncertain. The panel also supports the view that the proportional change in total mortality is likely to be more robust than absolute estimates of total mortality.*** The new tests undertaken during the review on Queen Snapper, removing the years for which very few data are available, provides appropriate estimates of proportional change in mortality[1]. This version did not provide “strong” support for a change in mortality over time using the AIC criterion.

TOR 4: Evaluate the methods used to estimate population benchmarks and management parameters (e.g., MSY, Fmsy, Bmsy, MSST, MFMT, or their proxies); recommend appropriate management benchmarks, provide estimated values for management benchmarks, and provide declarations of stock status.

The panel members strongly support the summary statements provided during the Review.

TOR 5: Evaluate the adequacy, appropriateness, and application of the methods used to project future population status taking into consideration the data limitations and proposed alternatives; recommend appropriate estimates of future stock condition (e.g., exploitation, abundance, biomass).

Given the data available and the methods applied, there is limited ability to accurately predict future population status.

TOR 6: Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty in estimated parameters. Provide, if available, measures of uncertainty for estimated parameters. Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty. Ensure that the implications of uncertainty in technical conclusions are clearly stated.

Uncertainty in the analyses is well presented in the Data and Assessment Review reports. Furthermore, many of the methods were applied using extensive sensitivity tests or data/information mining.

However, uncertainty was not well presented in the landings data especially as a consequence of endeavouring to provide only a single data landings set per region. ***A more appropriate method would be to present median estimates of landings with confidence intervals for all regions. All sources of uncertainty should be included in this analysis.***

Further modifications with regard to the SEINE analysis can be undertaken (as described in ToR 2). These changes would narrow the focus of the analysis to a more appropriate range of parameter combinations and would better sample the likelihood surface in the area of interest. ***Suggested future research would be to apply a Bayesian hierarchical model*** that draws on species with more information (Punt *et al.*, 2011, although this method is not Bayesian). This method would integrate across all the different forms of uncertainty and also allow more data rich species’ information to be drawn from for the data poor species.

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[1]These tests have not been checked and are therefore preliminary

TOR 7: Ensure that stock assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations.

Extensive documentation was provided to the panel and the panel acknowledges the work that this must have required. These documents included two workshop (Data and Assessment) review reports, Assessment Review reports for the three species being reviewed, and several background documents. The Assessment Report provided a large amount of detail and is set out providing much of the information required. However, it was difficult to glean from the report the following:

1. The Assessment reports are incomplete in that they do not fully describe the data that were not used and why that is the case. This relies on other documentation, which is inappropriate given that the Assessment Report should logically progress the reader through the whole process from data, analysis to conclusions.
2. The major summary per species and region did not provide a comprehensive review of the process and conclusions, such that the reader is able to clearly understand the appropriateness of the methods and conclusions. This is especially important given that the fisheries are data poor and a combination of results is used to provide conclusions. The review team asked the Assessment team to develop such a statement during the review, as this provides clearer information to address the key Terms of Reference.
3. The report should include a description of how the fishery is managed. This puts the analysis in better context.

TOR 8: Evaluate the SEDAR Process as applied to the reviewed assessment and identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops.

The panel recommends that the annual process of attempting to develop data poor assessments for all the major target species should be reviewed. In the panel's opinion, it would be more appropriate to investigate a more strategic approach to progress management of these fisheries without necessarily applying these techniques to all the species. This is especially the case, as the three species reviewed here were some of the best species in terms of data within the region. Therefore subsequent species (except lobster and Queen Conch) are more likely to be even more uncertain. Possible methods would be to use a mixture of risk assessment techniques and clustering species together in a logical manner, for example through being exposed to similar fishing mortality pressure trends. Another approach would be to select key species based on importance to the different fisheries and the ecosystem that is likely to be the first to reflect when there are management issues.

TOR 9: Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted. Clearly denote research and monitoring needs that could improve the reliability of future assessments. Recommend an appropriate interval for the next assessment, and whether a benchmark or update assessment is warranted.

Major priorities

1. There is large degree of uncertainty in the assessment due to the data poor nature of this fishery. In the short to medium terms, the key data set is likely to remain size frequency distributions. The ability to utilize length-frequency data is contingent upon having reliable estimates of life history parameters (von Bertalanffy parameters in particular), therefore the highest priority for future research are:
    a. Studies on basic life history (e.g. age-growth relationships and estimating natural mortality) are essential in the US Caribbean and will greatly enhance the utility of the existing length-frequency data. This information should provide the greatest benefit to providing management advice in the short term. This should be placed as a top priority for key species.
    b. At present, the TIP size frequency data provides the only source of information on stock status and benchmarks and it is therefore essential that this program be at least continued. However, expansion (for example, to USVI) and improvement of the TIP program will be recommended for continued collection of species-specific size information.
    c. Focus should be on developing more complete and accurate data sets into the future, particularly on trip based catch and effort and recording of more geographical data on catch location.
    d. The recreational catch and effort is an important data set and should be continued. Expanding this system to the USVI may also be useful. Furthermore, this source of mortality should be included in the analyses.
    e. Emphasis should be placed on extension, as compliance and unreporting is likely to increase when more data is required of fishers. Given the present low rate of reporting in Puerto Rico, this would be of great concern.
    f. Validation of fisher reported catch, landings and trip effort should be undertaken.
    g. The collection of landings statistics in the USVI should be species-specific because analysis of the current species-groupings is not informative for stock assessments, unless future assessments and management action focus on logical clusters of species.
    h. Characterization of multi- species trips to allow identification of trips that split fishing effort across different gears and species groups. This work should be coordinated with fisher groups to enhance buy-in by the industry.
    i. It is important to encourage fishermen to submit all the monthly catch reports (USVI), to submit reports for months when they do not fish, and to complete all the fields in the reports, since critical information such as effort, gear, and location fished are often missing or incomplete.
2. All sources of mortality should be considered in the analyses especially for the recreational fishery catch in Puerto Rico for Silk and Queen Snapper.

3. Given the importance of the SEINE method and that extensions of this method are likely to be used into the near future, the following additional modification are required:
    a. When the full likelihood surface for the SEINE analyses were shown in session, it was clear that unnecessary combinations are sampled and that the surface is reasonably flat near the optimal likelihood, which means more sampling needs to be undertaken within this range.
    b. The SEINE method should be extended to apply a Bayesian hierarchical model that draws on species with more information (Punt *et al*., 2011, although this method is not Bayesian). This method would integrate across all the different forms of uncertainty and also allow more data rich species' information to be drawn from for the data poor species.
    c. The SEINE method should be extended to include the estimate of M for those species where this information is available. . This directly acknowledged the correlation between growth, maximum length and natural mortality.
    d. The SEINE method should be tested in a simulation study using a simulated population with known parameters, recruitment, and size frequency and including variability in key parameters. Furthermore, these results should then be converted to a guideline on how to apply this information in a data poor situation.
    e. Some preliminary analyses were undertaken during the Review that should be further investigated.

Medium priority

1. For all landings series, a more appropriate method would be to present median estimates of landings with confidence intervals for all regions. All sources of uncertainty should be included in this analysis.
2. The CPUE standardisation methods needs much more extensive investigation, including:
    a. The feasibility of including additional factors or variables either as offsets or ratios of catch to relevant species total catch should be undertaken in the future. An overall Redtailed Parrotfish index from the catch rate standardisation is developed in the future.
    b. Developing an overall Redtailed Parrotfish index from the catch rate standardisation be developed in the future
3. Given the uncertainty in the data, any future FIS should be designed in such a way as to be aligned with the earlier surveys. This would be extremely useful for comparison.

Lower priority

1. There is some question whether changing the commercial catch expansion method during the series produces biases. Therefore, the effect of the two

different methods over the time series to develop the expansion factors should be tested.

2. There is a need to develop sampling efforts to better identify and quantify discards in the commercial fisheries.

SEDAR 26, Review workshop: US Caribbean Queen Snapper

TOR 1: Evaluate the adequacy, appropriateness, and application of data used in the assessment.

The SEDAR 26 Data Workshop conducted a thorough and comprehensive review of all available data and information that might be useful for the assessment of the U.S. Caribbean Queen Snapper resource. This included evaluation of: life history information; fisheries statistics; fisheries independent surveys; and commercial fishery CPUE standardization. The SEDAR 26 Assessment Workshop adhered to the data recommendations from the Data Workshop, including trip selection criteria for conducting the commercial fishery CPUE analysis.

Data limitations preclude the use of standard stock assessment methods that are generally applied in more data rich situations. The simplest types of population dynamics models require, at minimum, a time series of catch and an abundance index. For the U.S. Caribbean Queen Snapper resource these data are either not available or not reliable. The primary analytical method used for the Queen Snapper assessments was application of the length frequency based SEINE model, an appropriate approach in this data-limited situation. The SEINE model requires reliable estimates of von Bertalanffy growth parameters and time series of length frequency data from a source where selectivity is asymptotic and relatively constant (or minimally, that a size at full vulnerability applicable across the times series can be determined).

For Queen Snapper, estimates of von Bertalanffy growth parameters were taken from two St. Lucia studies. Estimates of L_∞ were consistent between the two studies (1020 mm and 1030 mm) and consistent with the length frequency distributions sampled from U.S. Caribbean fisheries. Estimates of the growth rate parameter *K*, differed significantly between the two studies (0.29 and 0.61) as did estimates of natural mortality (0.33 and 0.76 - Note: the 0.76 value was rejected by the Data Workshop because it could not be independently verified). The analysts appropriately dealt with this by conducting a broad range of sensitivity analyses for the SEINE model, covering the range of uncertainty in *K*.

Length frequency data, available from the TIP program, were evaluated to determine gear/island combinations with sufficient data for use in the SEINE analyses. Where sufficient data existed (Puerto Rico hook and line fishery and St. Croix hook and line fishery), these were investigated to ensure there were no obvious changes in selectivity over the time series or other features (e.g. strong year class signals) that might preclude their use in the SEINE analyses. The selected length frequency data sets were adequate and appropriated applied in the assessment.

The Queen Snapper fishery in Puerto Rico is somewhat unique in that it is a relatively recent fishery, occurring in deeper waters along the slope edge. As such, the historical record of commercial landings is thought to be relatively complete. Landings data presented in the Assessment Workshop Report are reported landings, however expanded landings estimates (adjusted for non-reporting and mis-reporting) are available and would provide a more accurate record of the commercial fishery.

Estimates of recreational catch, available since 2000, indicate this mortality source may be moderate relative to the commercial fishery. Information provided in the Data Workshop Report indicates that between 2000 and 2009 the recreational landings averaged about 30% of the reported commercial landings (but will be lower relative to expanded landings).

For the two USVI regions, species specific commercial landings data are not available, and there is no objective basis for partitioning landings by species group to individual species. There are no agreed methods to calculate expansion factors, so under-reporting is not accounted for. Additionally, there are no recreational catch estimates, although anecdotal information suggests this fishery is small relative to commercial landings.

Landings data were not explicitly used in the stock assessments, however they can be useful to interpret trends in other data sources. For example, an increasing trend in landings in conjunction with a decrease in mean size of the catch is often a signal of overfishing.

Single species CPUE standardizations to develop annual indices were conducted as recommended by the SEDAR 26 Data Workshop. The recommended trip selection protocol was based on area and gear combinations that had a reasonable probability of catching the species of interest. For Queen Snapper there are a number of reasons, *a priori*, that suggest the available commercial fishery CPUE data is not likely to be an index of abundance. These include: Queen Snapper is a targeted species but information on effort directed to specific species is not available; technology advances, including electric reels and GPS, have influenced the catchability of this species; and the fishery developed and expanded over the history of the catch and effort data.

Although considerable fishery-independent survey data exist for the U.S. Caribbean, the majority of studies are spatially and/or temporally limited precluding any value for stock assessment. A series of cruises with directed sampling of deep water fishes were conducted in U.S. Caribbean waters (primarily around Puerto Rico) annually between 1979 and 1985 and again in 2009. Bottom longline gear was used both in the earlier time series and again in 2009, however there was only partial overlap in the locations fished. During the earlier time series Queen Snapper was the second most abundant species caught, but in 2009 no Queen Snapper were caught. In addition to little overlap in the locations fished by bottom longline, it seems likely that the depth distribution also differed between the earlier surveys and the 2009 survey. This is extremely unfortunate. If the 2009 survey had followed a design similar to the earlier surveys, it could have produced an estimate of stock depletion (assuming little or no exploitation of Queen Snapper prior to the 1979 – 1985 surveys).

Best possible use was made of the limited data available for Caribbean Queen Snapper. Analyses conducted for the stock assessment focussed on the commercial fishery length frequency data, which is the most reliable and consistent of the data sets. A commercial fishery CPUE standardization was conducted for the Puerto Rico platform, but as discussed above, this analysis was unlikely to provide a useful contribution to the assessment.

TOR 2: Evaluate the adequacy, appropriateness, and application of methods used to assess the stock taking into consideration the data-poor nature of the fisheries.

The approach to assessing Queen Snapper using the SEINE method was appropriate given the data limitations for this resource. High uncertainty in the von Bertalanffy K parameter and in the length that Queen Snapper are fully selected (L_c) required sensitivity analyses over a broad parameter space and resulted in high uncertainty in Z estimates. An innovative extension to the SEINE analysis was developed, using a Z ratio estimator, which resulted in reasonably precise estimates of current Z relative to Z in the early years of the Puerto Rico fishery. The analysts made the most of the limited data available, conducting a comprehensive set of analyses to extract as much information as possible from the length frequency data.

The approach adopted for both the Puerto Rico and St. Croix SEINE analyses was to conduct a suite of sensitivity runs across the major axes of uncertainty – the von Bertalanffy$K$ parameter and the length of full vulnerability, L_c. The Queen Snapper length frequency data (hook and line fishery) has a broad and relatively flat right limb, so the length of full vulnerability is not readily determined by visual inspection of the data.

For the Puerto Rico SEINE analysis, the Akakie information criterion (AIC) provided support for an increase in Z beginning in 1996 (an ΔAIC of 5 was taken as indicating "strong" support for a higher parameter model over a lower parameter model and accepting an additional change in Z). Many of the Z estimates were quite high with Z ranging from $\sim$0.3 to $\sim$ 2.5 over the sensitivity range investigated. Z estimates were highly correlated with the assumed K, with higher K values resulting in higher Z estimates. The ratio of Z in the later period relative to that in the earlier period was less variable, ranging from 0.55 to 0.85, and indicating an increase in fishing pressure over the history of the fishery.

During the review process it was noted that 3 data points in the Puerto Rico SEINE analysis (1992, 1993 and 1995 - years with little data) were potentially highly influential in providing "strong" support for the hypothesis of a change in Z over the history of the fishery. An additional set of analyses were conducted that excluded these three data points, and while the AIC criterion still favoured the model with a change in Z, the "support" for that model was no longer "strong" (the ΔAIC was approximately 2).

Also, during the review process it was suggested that analysis of the early years' Puerto Rico length frequency data, a period when the fishery was developing and exploitation rates would be relatively low, may provide an estimate of M for Queen Snapper. The analyst calculated the Beverton-Holt equilibrium-based Z, using the first 2000 fish sampled. As for the non-equilibrium Z analyses, the high uncertainty in the growth K parameter precluded any conclusion about M.

For the St. Croix Seine analysis, the AIC criterion did not provide the requisite "strong" support for a change in Z over the period of the analysis. Again, Z estimates were high, ranging from 0.5 to $\sim$3.5 over the sensitivity range investigated, with Z estimates strongly correlated with the von Bertalanffy growth parameter.

The Puerto Rico commercial fishery CPUE standardization indicated a relatively flat trend through 2000 followed by increasing annual indices through 2007. This followed the trend in the proportion of trips with positive Queen Snapper landings. Given concerns that CPUE is not likely to be proportional to stock abundance for this species and that the fishery at the start of the data series was likely to have been small, the Assessment Working Group appropriately did not consider this index in determining stock status.

TOR3: Recommend appropriate estimates, when available, of stock abundance, biomass, and exploitation. When data-limitations preclude estimates, provide summary of conclusions that can be drawn from data-poor methodologies that were used in assessment.

It is not possible to estimate stock biomass or abundance trends, given the limited data available for these assessments. The non-equilibrium SEINE method used to analyze the length frequency data could potentially provide information about total mortality (Z) and exploitation trends, however high uncertainty in von Bertalanffy K, natural mortality (M), and appropriate values for L_c limit conclusions that can be drawn from the analyses.

For Puerto Rico Queen Snapper, the SEINE analyses provided support for an increase in Z between the earlier and later periods of the fishery (pre- and post-1996). Although absolute estimates of Z were poorly determined, the proportional change Z was better determined with estimates ranging from 0.55 to 0.85.

Given the data and information poor situation for Caribbean Queen Snapper the ability to make definitive conclusions about stock status is limited.

TOR4: Evaluate the methods used to estimate population benchmarks and management parameters (e.g., MSY, Fmsy, Bmsy, MSST, MFMT, or their proxies): recommend appropriate management benchmarks, provide estimated values for management benchmarks, and provide declaration of stock status.

No direct estimates of management parameters or population benchmarks could be derived given data limitations, the data-poor methodologies employed, and uncertainty in basic life-history parameters (e.g. von Bertalanffy growth parameters).

For Puerto Rico Queen Snapper, however, the SEINE analysis was used indirectly to make inferences about stock status relative to overfishing. This Queen Snapper stock was unexploited (or very lightly exploited) at the start of the time series so total mortality at that time should be very close to the natural mortality rate. Across the sensitivity scenarios considered, the SEINE analyses indicated a proportional increase in Z from the early to the later period of the fishery ranging from 0.55 to 0.85. Adopting a common assumption used in fisheries population dynamics, that F_{msy} is twice the natural mortality rate, allows the conclusion that the current fishing mortality rate is below F_{msy}. **The assumptions in this approach for determining status relative to overfishing should be relatively robust to the uncertainties in the assessment, assuming the fishery was only lightly exploited at the beginning of the time series.**

Analysts present at the SEDAR 26 Review Workshop produced a Queen Snapper stock status summary based on the data-poor methodologies used, fundamental principles of population dynamics and overall interpretation of basic data. The summary states that “there is no evidence to suggest that overfishing is occurring on Queen Snapper in the

US Caribbean”. **The Review Panel endorses the conclusions in that summary, and the premises upon which they are based.**

TOR 5: Evaluate the adequacy, appropriateness, and application of methods used to project future population status taking into consideration the data limitations and proposed alternatives; recommend appropriate estimates of future stock condition (e.g., exploitation, abundance, biomass).

Given data limitation and resultant restrictions on analytical methods, it is not possible to project future stock status for the Caribbean Queen Snapper resource.

TOR 6: Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty in estimated parameters. Provide, if available, measures of uncertainty for estimated parameters. Comment on the degree to which methods used to evaluate uncertainty reflect and capture significant sources of uncertainty. Ensure that the implications of uncertainty in technical conclusions are clearly stated.

The principal parameters estimated in the Queen Snapper stock assessments are estimates of total mortality, Z. These parameters are highly sensitive to the values of the von Bertalanffy growth parameter K and to the assumed value for the length at full vulnerability L_c. A broad range of sensitivity analyses were conducted across the plausible range of K and L_c. These sensitivity analyses are useful to present the potential range in Z, however they should not be interpreted as representing a probability distribution for Z. Developing a probability distribution for Z would entail weighting each of the Z estimates by the likelihood of the Z (or Zs) given the data, and the probability of the associated K and L_c (which is unknown).

The so-called *base case* should not be taken as the most likely: rather it is a central point of the sensitivity test values. The Queen Snapper growth parameters came from two St. Lucia studies that had similar L_{inf} (1020mm and 1030mm)but differed in their K estimates and the maximum observed age (t_{max}). In one study, K was estimated at 0.29 with a t_{max} of 10 and in the other study K was estimated at 0.61 with a t_{max} of 5. It seems likely that different ageing criteria were used in the two studies and that one of the studies is more likely to be correct than a set of ageing criteria mid-way between the two. Thus, the base case K, which was the mid-point between the estimates from these two studies is less likely than the K estimates from either study.

Conclusions presented in the stock assessment summary included as an Addendum to this report are robust to the uncertainty in the Z estimates.

TOR 7: Ensure the stock assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations.

A summary of Queen Snapper stock status in the U.S. Caribbean was prepared by the members of the Assessment Team present at the Review Workshop and is included as and Addendum to this report. The summary statement was reviewed by the Review Panel who endorsed the statement as an appropriate encapsulation of the information and analyses presented. The conclusions made in the Queen Snapper summary provide the strongest statements possible about stock status given the data limitations.

TOR 8: Evaluate the SEDAR Process as applied to the reviewed assessment and identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops.

The review panel consensus on this term of reference is provided in the Overview section.

TOR 9: Consider the research recommendation provided by the Data and Assessment workshops and make any additional recommendation or prioritizations warranted. Clearly denote research and monitoring needs that could improve the reliability of future assessments. Recommend an appropriate interval for the next assessment, and whether a benchmark or update assessment is warranted.

The review panel consensus on this term of reference is provided in the Overview section of this report.

SEDAR 26, Review workshop: US Caribbean Silk Snapper

TOR 1: Evaluate the adequacy, appropriateness, and application of data used in the assessment.

The data and assessment workshops compiled and used information on natural mortality, Von Bertalanffy growth parameters, reproduction, and length frequency data and information about changes in the behaviour of the fishery, and proportion of fishers that report catches. ***The data are appropriate and have been used correctly in the analysis.*** A wide range of material was used for the calculation and there was very good coverage of literature and other sources of information for Silk Snapper. ***The data obtained from the literature review are appropriate and used correctly.***

They have also compiled information on recreational and commercial catches, discards, and fishing effort. Comments on those data are provided below:

Landings

For Puerto Rico, ***the commercial landings used are appropriate for the calculation***. However, expanded catches should have been reported in the Assessment Report as well to provide a more complete picture of the level of exploitation that this stock might have experienced and its associated stock status. Information on the uncertainty in the data is also needed.

No species-specific data were available for the other areas. Only landings by species group were available.

Recreational

For Puerto Rico, estimates of recreational catches starting from 2000 were available. However, information about directed effort for this species was not available so the data were not used. ***Recreational data were appropriate for the analysis, but were not used. Further work to explore how this set of information could be incorporated into the analysis is recommended.*** That could include use of existing length frequency information, design of data collection programmes, etc.

Data were not available for the other areas.

Discards

The group noted that scant information was available to document the level of discards in the commercial fisheries of Puerto Rico. Closed seasons and the introduction of minimum size limits during certain years could have led to discarding. ***Therefore, it is recommended that more work be done to assess whether discarding is (has been) significant.***

Effort

For Puerto Rico, information on the number of trips undertaken every year and proportion of those that caught Silk were used to describe fishing effort. ***The data are***

appropriate and have been used correctly. No effort data were used for the other areas

Length data

Length information from the NMFS Trip Interview Programme (TIP) was used in the calculations. This is a valuable source of information and ***has been used extensively and adequately to inform the analysis***.

TOR 2. Evaluate the adequacy, appropriateness, and application of methods used to assess the stock taking into consideration the data-poor nature of the fisheries.

All species evaluated in the analysis were species for which limited information exist. Given the paucity of information on biology and exploitation the choice of methods used in the Assessment workshop is appropriate and the team has gone to length to meet the challenges and make the best use of data. ***The consideration of the Beverton and Holt mortality estimator and SEINE method was appropriate and has also helped highlight the challenges and limitations in the data.*** Details on the individual methods and specific comments are provided below

CPUE standardisation

Due to data limitations, species specific CPUE series could only be developed for the fishery in Puerto Rico. A standard delta-lognormal approach was used for the standardisation of the data. A binomial model was used to describe the proportion of successful observations in that approach. The assessment report stated that operational changes could have taken place during the time period covered by the CPUE series for both the fish pot and handline fishery. A switch in targeting might have taken place during that period. The parameterisation used to describe the proportion of successful trips (binomial model) does not allow for such behaviour to be captured and accounted for effectively. ***Therefore, alternative statistical approaches or ways to parameterise the model to incorporate information about the change in the proportion of successful trips (e.g. offsets) need to be explored.*** In its current form, ***the panel agrees with the assessment team that the CPUE series cannot be considered to provide reliable information about the change in the stock size over the years.***

Targeting fishing (spawning aggregations)

For Puerto Rico and St. Croix, length frequency plots were examined to assess whether the fishery targets spawning aggregations. ***We consider that the length frequency graphs used to provide information on targeting are not adequate to do so.*** Given that the fishery is catching mainly mature fish anyway, any targeting behaviour is unlikely to change the length distribution enough to provide such information.

For St. Thomas/St. John, insufficient data precluded such evaluation.

Spatio-temporal patterns in fishing

For Puerto Rico, the use of the TIP information to explore changes in the area and depth where fishing is taking place is reasonable and provides additional information about fisher behaviour. ***However, it is not possible to assess whether conclusions about the behaviour of the fishery are biased due, for example, to the way sampling was conducted. It is important to address such concerns when designing future sampling.***

Similar analysis was conducted for St. Croix except that data on depth were insufficient to support any depth specific analysis. The comments provided above for the analysis of the data from Puerto Rico are applicable to this case, too.

For St. Thomas/St. John, insufficient data were available for such evaluation

Change in selectivity over the years

The AW combined length-frequency data from 5-year blocks to produce graphs that they then used to examine whether there have been changes in selectivity over the years. ***We consider this approach to be an acceptable one.***

Length at full vulnerability

Visual inspection of length frequency graphs to identify the part of the population that is fully selected for each gear is an acceptable approach in this case.

Change in total mortality (Z)

The Beverton and Holt mortality estimator analysis and SEINE were not used for the fisheries in Puerto Rico. This was considered an appropriate decision given changes in the size range of fish landed by fishermen which indicates that selectivity could have changed over the years. It was also not used for St. Thomas/St. John because of insufficient data. The SEINE analysis was used for St. Croix and estimated a single total mortality value for the whole time period used in the calculations. ***We consider that the application of the model was appropriate and made the best use of the data available.***

TOR 3. ***Recommend appropriate estimates, when available, of stock abundance, biomass, and exploitation. When data-limitations preclude estimates, provide summary of conclusions that can be drawn from data-poor methodologies that were used in assessment.***

We agree with the conclusion of the Assessment workshop that without additional information it is not possible to provide estimates of stock size or change in stock size. We also agree that the stability in stock structure (based on length frequency information) suggests that fishing appears to be sustainable.

TOR 4. ***Evaluate the methods used to estimate population benchmarks and management parameters (e.g., MSY, Fmsy, Bmsy, MSST, MFMT, or their proxies); recommend appropriate management benchmarks, provide estimated values for management benchmarks, and provide declarations of stock status.***

It was not possible to calculate benchmarks due to paucity of data

TOR 5. ***Evaluate the adequacy, appropriateness, and application of the methods used to project future population status taking into consideration the data limitations and proposed alternatives; recommend appropriate estimates of future stock condition (e.g., exploitation, abundance, biomass).***

The Assessment workshop did not do any projections because data were not available to support such calculations.

TOR 6. ***Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty in estimated parameters. Provide, if available, measures of uncertainty for estimated parameters. Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty. Ensure that the implications of uncertainty in technical conclusions are clearly stated.***

The Assessment workshop explored the uncertainty in their estimates of the CPUE for Puerto Rico. CPUE standardisation was the only quantitative method used for that area. ***The sensitivity runs using different sub-sets of the catch data is a logical extension of the base case.*** However, the uncertainty in the catch data was not adequately described and that influenced the choice of sensitivity runs. ***Further work on the latter (e.g. use of expanded catches) will support a more comprehensive characterisation of the uncertainty in CPUE series.*** The implications of uncertainty are explained in the report.

For St. Croix the SEINE analysis was run for range of values for the parameters of the Von Bertalanffy equation (K and L_{inf}) and L_c to test the sensitivity of the model predictions to changes in the values of those parameters. A base case set of parameter values was also chosen which corresponded to the mean of the values of each parameter that were found in the literature. This was not the most plausible set of parameter values. ***The sensitivity analysis was appropriate*** but it probably covered some combinations of parameter values that were not realistic. However, that did not reduce the validity of the analysis. The sensitivity analysis did not support change in the total mortality except in one case. ***We agree with the conclusion of the assessment team that the change in total mortality that the model estimated in that case reflected a change in selectivity rather than a change in mortality***.

TOR 7. ***Ensure that stock assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations.***

A separate report that described the work undertaken by the analysts on Silk Snapper was available. It covered most of the relevant aspects adequately. A brief description of the fishery management as part of this report would be useful and would be recommended for the future. The Beverton and Holt total mortality estimator method is mentioned in the section that describes the analysis of the data from the Puerto Rico fishery to explain why it was not used. A brief reference to that method and what it calculates needs to be included in that section (alternatively, a reference to section 5.1.3 could be added). The review panel felt that a more concise description of the findings was needed and asked the analysts to provide one. The summary of findings is provided separately.

TOR 8. ***Evaluate the SEDAR Process as applied to the reviewed assessment and identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops.***

The Terms of Reference were adequately addressed.

TOR 9. ***Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted. Clearly denote research and monitoring needs that could improve the reliability of future assessments. Recommend an appropriate interval for the next assessment, and whether a benchmark or update assessment is warranted.***

The list of research recommendations is included in the Overview section.

SEDAR 26, Review workshop: US Caribbean Redtail Parrotfish

TOR1. ***Evaluate the adequacy, appropriateness and application of the data used in the assessment.***

Puerto Rico

The available data on Redtail Parrotfish includes commercial landings for the period extending from 1983 to2009. Expanded landings that account for underreporting are reported as available, but were not included in the assessment report. Recreational catch data is available for the period 2000-10. Information on directed effort on Redtail Parrotfish is not available. Length frequency analyses are presented for the pot and fish trap fishery. Spatio-temporal auxiliary information on the fishery of Redtail Parrotfish is based on fishermen interviews. Catch per unit effort (CPUE) data are not available for the Redtail Parrotfish, since parrotfish are not identified to spp level in the reported landings. Since CPUE data for Redtail Parrotfish are not available for the commercial fishery of Puerto Rico, the stock assessment is primarily based on the length frequency data from the NMFS Trip Interview Program (TIP).

The lack of information on fishing effort limits the ability to conduct the stock assessment of Redtail Parrotfish. The adequacy of effort data is compromised due to a variety of factors including, but not limited to, (a) the variability of effort associated with seasonal closures, (b) changes in climatological conditions, (c)changes in socioeconomic factors, and (d) changes in reporting attitudes by fishermen. The length-frequency data from the TIP is appropriate for the assessment of Redtail Parrotfish. It encompasses a reasonably long period (1983-2007) with a total of 3,693 individual fish measurements. The panel agreed that application of length frequency data was the most effective approach for providing inferences about the status of the redtail population in the Puerto Rico fishery.

USVI

For St. Thomas, St. John and St. Croix the commercial landings data covers the period from 1998 to2008. Previous data did not include any specific parrotfish information. Recreational fisheries data is not available for the USVI. Length frequency analyses are presented for the pot and fish trap fishery. Spatio-temporal auxiliary information on the fishery of Redtail Parrotfish is based on fishermen interviews. Catch per unit effort (CPUE) data are not available for the Redtail Parrotfish since parrotfish are not identified to spp level in the reported landings for the USVI. The stock assessment is primarily based on the length frequency data from the NMFS Trip Interview Program (TIP).

As in the case of Puerto Rico, the lack of information on directed fishing effort limits the ability to conduct the stock assessment of Redtail Parrotfish. The adequacy of the effort data is compromised by a number of factors including, but not limited to: (a) variability in effort associated with seasonal closures, (b) changes in climatological conditions, (c) changes in socioeconomic conditions, and (d) changes in reporting attitudes by fishermen. The length-frequency data from the TIP is appropriate for the assessment of Redtail Parrotfish from the USVI. It encompasses an extended period of time (1983-present) with a total of 1,481 individuals for St. Thomas/St. John and 3,111 individuals for St. Croix. The length frequency data was the main source of information from which the redtail stock assessment was derived. As such, it is considered that application of such data was the most effective in providing inferences about the status of the redtail population in the USVI.

TOR 2. ***Evaluate the adequacy, appropriateness and application of the methods used to assess the stock taking into consideration the data-poor nature of the fisheries.***

The lack of fishing effort data and species-specific information on commercial landings of Redtail Parrotfish makes the TIP length frequency data the most appropriate for stock assessment. Analyses based on the time series of size frequency data and relative differences in total mortality estimates by application of a variant of the Beverton-Holt length-based mortality estimator (SEINE model) were attempted for both Puerto Rico and the USVI.

With respect to model application, there is considerable uncertainty in the von Bertanlanffy growth parameters for Redtail Parrotfish. Information on comparable species was applied. Sensitivity analyses were conducted for a range of K values (VBert growth parameter):60% above and below a central value taken from the literature. Convergence problems were encountered for the Puerto Rico model. . It was concluded that without ancillary information and given the uncertainty (and high variability in VBert growth parameters), the resulting estimates of total mortality were unreliable and not useful for stock assessment purposes. The relatively stable size distribution of redtail snapper in the TIP data from Puerto Rico lends confidence in the Lc chosen from visual inspection of the length frequency graphs. Essentially, with smaller sample size constraints the same analysis was drawn for the St. Thomas/St. John fishery of Redtail Parrotfish. For St. Croix, where Redtail Parrotfish is a targeted species, it was considered that as for Puerto Rico and the ST. Thomas/St. John fishery the uncertainty associated with the VBF parameter assumptions and resultant comprehensive sensitivity analyses, the absolute estimate of total mortality is unreliable and not useful for management purposes.

Given the constraints of the Beverton-Holt length-based mortality estimator associated with the uncertainty of Von Bertanlanffy species specific growth parameters, evaluation of the Redtail Parrotfish stock based on visual inspection of size distributions was the only realistic alternative for inferences of stock status. Confidence in the use of a visually estimated Lc is supported by the stable size distributions of Redtail Parrotfish in Puerto Rico and the USVI.

TOR 3. *Recommend appropriate estimates, when available, of stock abundance, biomass, and exploitation. When data-limitations preclude estimates, provide summary of conclusions that can be drawn from data-poor methodologies used in the assessment.*

Data poor conditions apply for the Redtail Parrotfish fisheries in Puerto Rico and the USVI. Inferences from length-frequency data suggest that there is no detectable change in Z estimates for Redtail Parrotfish over the time series investigated. Also, the majority of fish measured in the TIP are above the reported size at maturity.

TOR 4. Evaluate the methods used to estimate population benchmarks and management parameters (e.g. MSY, Fmsy, MSST, MFMT, or their proxies)

With respect to Redtail Parrotfish, species specific data from the commercial fisheries is unavailable. CPUE data is unavailable and the average of commercial landings is used as a proxy of MSY and OFL for species groups and several particular species.

TOR 5. ***Evaluate the adequacy, appropriateness, and application of the methods used to project future population status taking into account the data limitations and proposed alternatives; recommend appropriate estimates of future stock condition (e.g. exploitation, abundance, biomass)***

Future population status projections for Redtail Parrotfish were not addressed in the stock assessment report. Such an undertaking is constrained by the lack of reliable CPUE indices from the commercial fishery and uncertainty in species-specific Von Bertanlanffy growth parameters. Inferences derived from the size frequency data time series allows for conservative (risk averse) recommendations of stock exploitation.

TOR 6. ***Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty in estimated parameters. Provide, if available, measures of uncertainty for estimated parameters. Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty. Ensure that the implications of uncertainty in technical conclusions are clearly stated.***

Data limitations in the US Caribbean preclude the use of advanced quantitative analyses that provide measures of uncertainty.

TOR 7. ***Ensure that stock assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations.***

A separate report that described the work undertaken by the analysts on Redtail Parrotfish was available. It covered most of the relevant aspects adequately. A brief description of the fishery management as part of this report would be useful and would be recommended for the future. The review panel felt that a more concise description of the findings was needed and asked the analysts to provide one. The summary of findings is provided in the Addendum to this report.

TOR 8. ***Evaluate the SEDAR Process as applied to the reviewed assessment and identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops.***

The Terms of Reference were adequately addressed.

TOR 9. ***Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted. Clearly denote research and monitoring needs that could improve the reliability of future assessments. Recommend an appropriate interval for the next assessment, and whether a benchmark or update assessment is warranted.***

The consensus list of research recommendations is included in the Overview section.

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SEDAR 26 Review Workshop Participants

Workshop Panel

Walter Keithly, Chair .... LSU/CFMC SSC

Cathy Dichmont .... CIE Reviewer

Panayiota Apostolaki .... CIE Reviewer

Vivian Haist .... CIE Reviewer

Jorge Garcia-Sais .... CFMC SSC

Analytic Representation

Todd Gedamke .... NMFS SEFSC Miami
Meaghan Bryan .... NMFS SEFSC Miami
Nancie Cummings .... NMFS SEFSC Miami
Kevin McCarthy .... NMFS SEFSC Miami

Council Representation

Carlos Farchette .... CFMC

Appointed Observers

Jose Alberto Sanchez .... Industry Representative/St. Croix

Staff

Graciela Garcia-Moliner.. CFMC Staff
Julie Neer.. SEDAR
Michael Larkin... SERO
Rachael Silvas .... SEDAR
Tyree Davis... NMFS SEFSC Miami

SEDAR

Southeast Data, Assessment, and Review

SEDAR 26

U.S. Caribbean Queen Snapper

Section VI: Addenda and Post-Review Updates

October 2011

SEDAR
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405

This addendum documents analyses requested from by the Review Panel during the Review Workshop. The Review Panel requested that the analytic team produce a table summarizing the data available for consideration in the assessment, and a summary statement addressing the assessment.

1) Summary of Data Inputs

Table 1 summarizes the available data inputs for all species considered during SEDAR 26 and provides an indication of how the data were used for analysis.

Table 1. SEDAR 26 Available Landings, Effort, and Length-frequency Data

	St. Croix	St. Thomas/ St. John	Puerto Rico
Landings			
Recreational	• catch/effort/length time series unavailable	• catch/effort/length time series unavailable	• MRFSS/MRIP only recreational landings and effort data – 2000-2010 • no queen snapper discards reported; landings provided at data workshop • landings and discards of silk snapper and redtail parrotfish were provided at the data workshop • estimated queen snapper landings averaged 33,000 pounds/year • estimated silk snapper landings averaged 96,000 pounds/year • estimated redtail parrotfish landings averaged 3,200 pounds/year • used to determine the relative proportion of recreational landings and discards to total removals • data were not used in quantitative or qualitative analyses to determine overfishing status
Commercial	• Commercial Catch Records (CCR) self reported commercial data • no species-specific data, species groups reported • 1998 first year of landings by species group and with effort data reported • 2008 last year of data available for this assessment • Assessment workshop panel recommended using landings as	• Commercial Catch Records (CCR) self reported commercial data • no species-specific data, species groups reported • 1998 first year of landings by species group and effort data reported • 2008 last year of data available for this assessment • Assessment workshop panel recommended using landings as reported from the years 1998-2008	• Commercial sales receipt data • silk and queen snapper species-specific data available (1983-2009) • parrotfish data not species-specific (reported as parrotfish) • Assessment workshop panel recommended using expanded landings in any analyses • Expansion factors to be used were those developed for SEDAR 14

	reported from the years 1998-2008 only • used for qualitative interpretation of parrotfish overfishing status; not useful for queen and silk snapper interpretation because no species-specific landings	only • used for qualitative interpretation of parrotfish overfishing status; not useful for queen and silk snapper interpretation because no species-specific landings	• Expansion factors based on active fishers:licensed fishers (1971-2002); since 2002 expansion factors based on landed pounds observed:landed pounds reported • used for qualitative interpretation of the overfishing status of all species

Indices	St. Croix	St. Thomas/ St. John	Puerto Rico
Fisheries Independent			
Queen Snapper	• Multiple short-term, spatially limited data sets • majority unavailable to assessment workshop • most were shallow water studies/surveys • NOAA SEFSC survey data used to produce nominal cpue series using handline, trap, and bottom longline (1979-1985, 2009) • not recommend for index construction due to short time series and low number of queen snapper observations • data workshop panel recommends that further exploration of these data be conducted to determined utility in future assessments • none used in this assessment due to insufficient spatial and/or temporal coverage (Data Workshop recommendation) • these data were not used for interpretation of overfishing status	• Multiple short-term, spatially limited data sets • majority unavailable to assessment workshop • most were shallow water studies/surveys • NOAA SEFSC survey data used to produce nominal cpue series using handline, trap, and bottom longline (1979-1985, 2009) • not recommend for index construction due to short time series and low number of queen snapper observations • data workshop panel recommends that further exploration of these data be conducted to determined utility in future assessments • none used in this assessment due to insufficient spatial and/or temporal coverage (Data Workshop recommendation) • these data were not used for interpretation of overfishing status	• Multiple short-term, spatially limited data sets • majority unavailable to assessment workshop • few deep water studies/surveys • NOAA SEFSC survey data used to produce nominal cpue series using handline, trap, and bottom longline (1979-1985, 2009) • not recommend for index construction due to short time series and low number of queen snapper observations • data workshop panel recommends that further exploration of these data be conducted to determined utility in future assessments • these data were not used for interpretation of overfishing status
Silk Snapper	• Multiple short-term, spatially limited data sets	• Multiple short-term, spatially limited data sets	• Multiple short-term, spatially limited data sets

	• majority unavailable to assessment workshop • NOAA SEFSC survey data used to produce nominal cpue series using handline, trap, and bottom longline (1979-1985, 2009) • not recommend for index construction due to short time series and low number of queen snapper observations • data workshop panel recommends that further exploration of these data be conducted to determined utility in future assessments • these data were not used for interpretation of overfishing status	• majority unavailable to assessment workshop • NOAA SEFSC survey data used to produce nominal cpue series using handline, trap, and bottom longline (1979-1985, 2009) • not recommend for index construction due to short time series and low number of queen snapper observations • data workshop panel recommends that further exploration of these data be conducted to determined utility in future assessments • these data were not used for interpretation of overfishing status	• majority unavailable to assessment workshop • few deep water studies/surveys • NOAA SEFSC survey data used to produce nominal cpue series using handline, trap, and bottom longline (1979-1985, 2009) • not recommend for index construction due to short time series and low number of silk snapper observations • data workshop panel recommends that further exploration of these data be conducted to determined utility in future assessments
Redtail Parrotfish	• Multiple short-term, spatially limited data sets • majority unavailable to assessment workshop • none constructed for this assessment due to insufficient spatial and/or temporal coverage or low sample size (Data Workshop recommendation)	• Multiple short-term, spatially limited data sets • majority unavailable to assessment workshop • none constructed for this assessment due to insufficient spatial and/or temporal coverage or low sample size (Data Workshop recommendation)	• Multiple short-term, spatially limited data sets • majority unavailable to assessment workshop • none constructed for this assessment due to insufficient spatial and/or temporal coverage or low sample size (Data Workshop recommendation)

Indices	**St. Croix**	**St. Thomas/ St. John**	**Puerto Rico**
Fisheries dependent			
Queen Snapper	• only CCR data available • not species-specific • no accepted method for partitioning snapper species group to individual species • no index constructed	• only CCR data available • not species-specific • no accepted method for partitioning snapper species group to individual species • no index constructed	• commercial sales receipt data set • bottom line/longline catch/effort data used to construct index of abundance • queen snapper reported 1987-2009 • time series believed to reflect catchability changes, not abundance trends

			• Assessment workshop panel did not recommend use of this index • these data were not used for interpretation of overfishing status
Queen Snapper Multispecies Analysis	• N/A	• N/A	• commercial sales receipt data available • multispecies index produced for queen snapper and wenchman bottom line/longline (1987-2009) • data workshop did not recommend for use (method needs further peer review) • these data were not used for interpretation of overfishing status
Silk Snapper	• only CCR data available • not species-specific • no accepted method for partitioning snapper species group to individual species • no index constructed	• only CCR data available • not species-specific • no accepted method for partitioning snapper species group to individual species • no index constructed	• commercial sales receipt data available • possible species misreporting prior to 1988 • handline catch/effort data used to construct index of abundance (1988-2009); Assessment workshop panel did not recommend for use due to change in targeting • fish pots catch/effort data used to construct index of abundance (1988-2009); Assessment workshop panel did not recommend for use due to change in targeting and small proportion of landings by this gear • these data were not used for interpretation of overfishing status
Silk Snapper Multispecies analysis	• N/A	• N/A	• commercial sales receipt data available • multispecies fish pots index produced for snapper unit 1 (silk, vermilion, blackfin, black snapper); index includes years

			1988-2009; data workshop did not recommend for use (method needs further peer review) • multispecies handline index produced for snapper unit 1 (silk, vermilion, blackfin, black snapper); index includes years 1988-2009; data workshop did not recommend for use (method needs further peer review) • these data were not used for interpretation of overfishing status
Redtail Parrotfish	• only CCR data available • not species-specific; all parrotfish species reported in the species group "parrotfish" • no accepted method for partitioning species group to individual species • redtail parrotfish believed to make up the majority of reported parrotfish • separate trap, dive, and gillnet indices constructed for the period 1998-2008; insufficient parrotfish landings and effort reported for other gears • data workshop recommended all indices for use as required in additional analyses • the use of aggregate indices was considered inappropriate for determining overfishing status	• only CCR data available • not species-specific; all parrotfish species reported in the species group "parrotfish" • no accepted method for partitioning species group to individual species • redtail parrotfish believed to make up the majority of reported parrotfish • trap index constructed for the period 1998-2008; insufficient parrotfish landings and effort reported for other gears • data workshop recommended all indices for use as required in additional analyses • the use of aggregate indices was considered inappropriate for determining overfishing status	• commercial sales receipt data available • no species-specific parrotfish data available • parrotfish family dive gear delta-lognormal index constructed (1997-2009); assessment workshop did not recommend for use due to concerns regarding possible changes in catchability among parrotfish species • parrotfish family trammel net and gillnet delta-lognormal index constructed (1983-2009); assessment workshop did not recommend for use due to concerns regarding possible changes in catchability among parrotfish species • parrotfish family fish pot delta-lognormal index (1983-2009); assessment workshop did not recommend for use due to concerns regarding possible changes in catchability among parrotfish species • these data were not used for interpretation of overfishing status

Redtail Parrotfish Multispecies analysis	• N/A	• N/A	• commercial sales receipt data available • multispecies method - parrotfish modeled with all other species • applied to dive data (1997-2009); data workshop did not recommend for use (method needs further peer review) • applied to trammel net and gillnet data (1983-2009); data workshop did not recommend for use (method needs further peer review) • applied to fish pot data (1983-2009); data workshop did not recommend for use (method needs further peer review) • these data were not used for interpretation of overfishing status
Length-frequency Data	**St. Croix**	**St. Thomas/ St. John**	**Puerto Rico**
Recreational	• no data available	• no data available	• length frequency data from MRFSS/MRIP were insufficient for length frequency analysis
Commercial	• Trip Interview Program (TIP) - trained port samplers measure sampled fish from commercial landings • Queen snapper hook and line data available years 1984-1997, 2002-2006, 2008-2010 • Silk snapper hook and line data available years 1984-1997, 2001-2010 • Redtail parrotfish pots/traps data available years 1984-2002, 2005, 2007, 2010 • Redtail parrotfish nets data available	• Trip Interview Program (TIP) - trained port samplers measure sampled fish from commercial landings • Redtail parrotfish pots/traps data available years 1984-1988, 1991-1996, 2002-2006, 2008-2011 • Often sampling of vessels was not random • Sampling of catch may not be random in all cases • All above time series used in length-frequency analyses	• Trip Interview Program (TIP) - trained port samplers measure sampled fish from commercial landings • Queen snapper hook and line data available years 1983, 1986-1993, 1995-2008 • Silk snapper hook and line data available years 1983-2008 • Silk snapper pots/traps data available years 1983, 1985-2007 • Redtail parrotfish pots/traps data

	years 1993-1998, 2000-2005, 2007, 2010 • Redtail parrotfish diver data available years 1996, 2002-2005, 2007-2010 • Often sampling of vessels was not random • Sampling of catch may not be random in all cases • All above time series used in length-frequency analyses • Queen snapper nets, (n=3) and pots and traps (n=24) length-frequency data not sufficient for analysis • Silk snapper dive gear (n=1) and pots/traps (n=150) length-frequency data not sufficient for analysis • Redtail parrotfish hook and line (n=239) length-frequency data not sufficient for analysis	• Queen snapper dive gear (n=17), hook and line (n=176), and nets (n=8) length-frequency data not sufficient for analysis • Silk snapper dive gear (n=3), hook and line (n=392), nets (n=0), and pots and traps (n=246) length-frequency data not sufficient for analysis • Redtail parrotfish hook and line (n=1) and nets (n=42) length-frequency data not sufficient for analysis	available years 1986-2007 • Redtail parrotfish nets data available years 1986-2008 • Often sampling of vessels was not random • Sampling of catch may not be random in all cases • All above time series used in length-frequency analyses • Queen snapper nets (n=61) and pots and traps (n=9) length-frequency data not sufficient for analysis • Silk snapper dive gear (n=3) and nets (n=98) length-frequency data not sufficient for analysis • Redtail parrotfish dive gear (n=199) and hook and line (n=183) length-frequency data not sufficient for analysis

SEDAR 26 Available Life-history Data

Characteristic	Silk Snapper	Queen Snapper	Redtail Parrotfish
Stock distribution	• Silk snapper are found in western Atlantic waters, as far north as Cape Hatteras, North Carolina and Bermuda and as far south as Brazil, including the Gulf of Mexico along the continental shelf	• Similar to silk snapper	• North as far as south Florida, throughout Caribbean, and as far south as Brazil. • Juveniles are associated with seagrass meadows and adults are associated with coral reefs, seagrass, sand and mud flat, and mangroves.
Reported Depth	• 64m – 300m, with younger, smaller fish are generally found in shallower depths than older and larger individuals	• Literature reports depths of 100 to 500m, but suggestions during the SEDAR 26 Data Workshop were that they can be found depth deeper than 500m.	• not included in DW report
Natural Mortality	• Large range published from 0.19 to 0.86 per year, although upper range likely to be unfeasible. These data were not used in this assessment.	• Two published papers only one value reported: 0.33. This datum was not used in the assessment.	• Lack of published literature, nor related species – therefore none available.
Age and Growth	• The reported ranges for: • L_{inf} : 600mm-1170mm length type often not reported • K: 0.051-0.32 per year • t_0 : -2.309 - -0.04 years • The following were used in the length-frequency analysis: o For assessment central (base) case VBG values of K=0.1 per year, L_inf=794 mm o Lower and upper K 0.04 and 0.14 per year used in sensitivity analyses o Lower and upper L_inf 714 and 824 mm used in sensitivity analyses[1]	• Very limited information available. Reported estimates for L_inf and K were 1020 mm TL and 1030 mm TL, and 0.29-0.61 per year, respectively. • The following were used in the length-frequency analysis: o For assessment central (base) case values for PR and STX used K=0.45 per year and L_inf =888 mm. o Lower and upper values for K, 0.25 and 0.65 (PR) and 0.18-0.68 (STX) o Lower and upper values for L_Inf are 846 mm and 906 mm (PR) and 799-899 (STX)	• A range of different parrotfish growth rates were compared and found to be very similar to each other in term of growth rates, but differ in terms of asymptotic length. • The following were used in the length-frequency analysis: o The assessment report central (base) case values for K and L_inf were 0.78 per year and 300 mm respectively. o Lower and upper bounds were K=0.312 and 1.212 per year o L_inf=270 and 450 mm for all combinations of

			gear/island except PR pots and traps upper bound was 390 mm
Reproduction	• Gonochronistic • Spawn all year round with peaks in USVI in April-June and October-December. • Length at maturity (L_mat) from the literature varied from the lowest of 296 and 267 mm fork length (FL) for males and females respectively. The remaining estimates ranged between 340 mm and 600 mm TL. Length type not reported in all cases. • Age at maturity was between 2 and 6 years.	• Gonochronistic • Spawn throughout year with peaks during October and November in PR. • Length at maturity (L_mat) reported from Puerto Rico was 233 mm (males) and 310 mm (females). A single report of 536 mm was reported from the "south Atlantic". • Age at maturity ranged from 1 to 2 years.	• Protogynous hermaphrodites • Reproduce throughout the year • Length at maturity values were 140 to 242 mm SL respectively • No age at maturity estimates are available.

[1] If parameters in assessment reports were different from the Data Review report, then those in the more recent assessment reports were used.

2) Summary Statement

Data limitations in the US Caribbean preclude the use of advanced quantitative analyses that provide measures of uncertainty. However, the following conclusions can be made based on the data-poor methodologies used in the assessment, the fundamental principles of population dynamics and an overall interpretation of the basic data.

Queen snapper - US Caribbean

Given the available information for all three island groups there is no evidence to suggest that overfishing is occurring on queen snapper in the US Caribbean. This conclusion is based on the following aspects of our evaluations:

Puerto Rico

- The total mortality estimates of queen snapper resulting from the sensitivity analysis were variable and alone are difficult to use for developing management advice. When looking at proportional change in mortality the effect of the von Bertalanffy growth coefficient inputs is reduced. Even with the comprehensive sensitivity analysis, all results fall within the range of a 55%-85% increase in total mortality. This may not be informative for many situations, however, given the fact that this fishery developed during the time range explored additional conclusions may be discerned.
    - There are no reported landings between 1983 and 1986 and since that time reported landings have increased to over 100 thousand pounds. If it is assumed from this information that the fishery was un- or lightly-exploited at the start of the time series, the estimates of initial total mortality should be close to the natural mortality (M). A general rule of thumb, given surplus production theory, is that F_{MSY} is twice the natural mortality rate (Gulland, 1971; Garcia et al. 1989). In this analysis and given the situation, a doubling of the initial mortality rate would be at or near F_{MSY}.
    - The results presented here suggest that regardless of the input parameters total mortality has increased by a maximum estimate of 85%. Therefore as long as the fishery was unexploited or very lightly exploited at the beginning part of the time series and the assumption that F_{MSY} = M, the current fishing mortality rate (F) should theoretically be below F_{MSY}.

These results suggest that the stock is not likely to be undergoing overfishing. Further support that the stock is currently not subject to overfishing:

- Presence of larger individuals in length-frequency samples throughout the time series
- Large proportion of the catch at size samples were above the 50% size at maturity
- Landings have been relatively stable, although noisy, over the last decade
- Recreational fishing pressure on queen snapper was believed to be relatively low due to the depth distribution and equipment necessary to harvest the species, however

discussions during the review meeting suggest additional work to quantify is necessary.

In addition, the scientific interpretation of these results should consider that the 2010 Annual Catch Limit (ACL) amendment, which proposes to reduce landings by 15% from recent average annual catch, would provide an additional buffer against overfishing.

St. Croix

Overall, the size structure of queen snapper in St. Croix has not exhibited dramatic changes over the time series investigated. Additionally, lack of change in size structure has led to an inability to detect a change in total mortality with the available data and strong AIC criteria. The results suggest that fishing has been occurring at rates that are sustainable; however, given data limitations (e.g., species-specific landings) we cannot interpret results in relation to stock status. A cautious interpretation of the absolute values of total mortality indicates that the exploitation rates appear to be higher than in Puerto Rico.

Although length-frequency results were inconclusive, the following observations suggest that the stock is not undergoing overfishing:

- Size structure of sampled individuals remained constant over the time series
- Presence of larger individuals in length-frequency samples throughout the time series
- Large proportion of the catch at size samples were above the 50% size at maturity
- It is believed that commercial fishing pressure is low in the deep-water snapper fishery (i.e., local experts report that only 3 fisherman are actively fishing deep water snappers)
- Recreational fishing pressure on queen snapper is believed to be relatively low due to the depth distribution and equipment necessary to harvest the species.

St. Thomas/St. John

The limited number of length samples in recent years and lack of species-specific landings data does not allow for conclusions to be made regarding changes in mortality, the current mortality rate, or stock status.