SEDAR

Southeast Data, Assessment, and Review

SEDAR 26

Stock Assessment Report

U.S. Caribbean Redtail Parrotfish

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*

Red tail parrotfish (*Sparisoma chrysopterum*) is one of several species of parrotfish within the parrotfish fishery management unit (CFMC 2005). The regulatory overview describes the management measures that directly or indirectly impact red tail parrotfish. There are no regulations specific to any of the species of parrotfish in the US Caribbean.

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 parrotfish 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) included 9 species of parrotfish in the FMU, it did not include redfin parrotfish (*Sparisoma rubripinne*) and did not include size limits, seasonal closures or other management measures directed at the parrotfish fishery in the EEZ. However, regulations on the mesh size of traps that were implemented at the time had a direct impact on the parrotfish fishery. The redfin parrotfish was incorporated into 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). .

Measures in the original FMP, and in the follow-on amendments, that affect parrotfish 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 snappers and groupers	SFA	2005

In 2005, the Council ratified the Sustainable Fisheries Act (SFA) Amendment, which categorized parrotfish (along with groupers and other species) into fishery management units (FMUs). Parrotfish were all included in the Parrotfishes FMU (species included are: redtail parrotfish (*Sparisoma chrysopterum*), redfin (*S. rubripinne*), redband (*S. aurofrenatum*), stoplight (*S. viride*), blue (*Scarus coeruleus*), midnight *(S. coelestinus*), rainbow (*S. guacamaia*), queen (*S. vetula*), princess (*S. taeniopterus*), and striped parrotfish (*S. iseri*). 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 the parrotfish were undergoing overfishing. To respond to this determination, measures were included in the SFA Amendment to institute a total ban on the use of nets, a major gear used in the parrotfish fishery, in the EEZ and a prohibition on the bottom tending gear in all seasonally closed areas (HAPCs). A number of closed seasons for various FMUs during the peak spawning months of each species were also implemented and indirectly impact parrotfish. The implementation took place on November 28, 2005, and continues to the present. At the time of implementation these measures applied only to U.S. Caribbean EEZ waters.

Compatible regulations on the ban of nets were implemented by the Government of the Territory of the USVI for their local water on July 5, 2006. Also, the prohibition on the use of bottom tending gear (including traps) from the HAPCs was implemented by the USVI Government at the time.

Puerto Rico followed a slightly different strategy by implementing a ban on the use of SCUBA and nets fished together in 2004 (Regulation 6768 with an implementation date of March 12, 2004), establishing a mesh size for gillnets of more than 2 inches (51 mm) (as it was since 1936) and various restrictions on the construction of beach seines (beach seines were subsequently banned and re-established since 2004 to present). Although, as noted above, the implementation of Regulation 6768 was to begin in March 2004, a subsequent Administrative Order (Number 2004-12) delayed enforcement until January 1, 2005, in an effort to provide adequate opportunity to educate fishers on the new regulations. The Administrative Order included a 2-year grace period for these restrictions to be implemented.

Note that the closed seasons in all three island groups, were designed to benefit other species but not parrotfish (i.e., SU1 including silk snapper (October – December), Grouper Unit 4 (February-April, SU3 (mutton and lane snapper April-June), GU3 (red hind, December-February) and might have limited impact on parrotfish. However, the seasonal area closures described in Tables 2.1.1, 2.1.2, and 2.1.3 although not designed specifically for the protection of parrotfish could indirectly benefit parrotfish because the closure areas encompass habitats occupied by parrotfish species including red tail. 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 Parrotfish 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[4]	Start date	End date
1993										Lang Bank[1]	11/15	12/31
1994										Lang Bank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28[2]; 12/31 6/30
1995										Lang Bank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
1996										Lang Bank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
1997										Lang Bank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
1998										Lang Bank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
1999										Lang Bank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
2000										Lang Bank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
2001										Lang Bank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
2002										Lang Bank[1] Mutton Snapper[3]	1/1; 12/1 3/1	2/28; 12/31 6/30
2003										Lang Bank[1]	1/1;	2/28;

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

[1]EEZ waters only; [2]2/29 during leap years;[3]1993 territorial area closure; 1994 EEZ and territorial area closure; 1996 boundary change to make EEZ compatible with state; [4]Bottom tending gear (e.g., traps, nets, bottom longlines) prohibited from seasonally closed areas (i.e., HAPCs); [5]Boundary change to Tourmaline Bank closed area; [6]Closure extended to six months (October 1 through March 31) beginning with 2011 calendar year.

Table 2.1.2. Annual Commercial/Recreational Parrotfish 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[4]	Start date	End date
1990										Hind Bank(MCD)	12/1	12/31
1991										Hind Bank(MCD)	1/1; 12/1	2/28; 12/31
1992										Hind Bank(MCD)	1/1; 12/1	2/28; 12/31
1993										Hind Bank(MCD)	1/1; 12/1	2/28; 12/31
1994										Hind Bank(MCD)	1/1; 12/1	2/28; 12/31
1995										Hind Bank(MCD)	1/1; 12/1	2/28; 12/31
1996										Hind Bank(MCD)	1/1; 12/1	2/28; 12/31
1997										Hind Bank(MCD)	1/1; 12/1	2/28; 12/31
1998										Hind Bank(MCD)	1/1; 12/1	2/28; 12/31
1999										Hind Bank(MCD)	1/1; 12/1	2/28; 12/31
2000										Hind Bank(MCD)	1/1	12/31
2001										Hind Bank(MCD)	1/1	12/31
2002										Hind Bank(MCD)	1/1	12/31
2003										Hind Bank(MCD)	1/1	12/31
2004										Hind Bank(MCD)	1/1	12/31
2005										Hind Bank(MCD) Grammanik Bank	1/1 2/1	12/31 4/30
2006										Hind Bank(MCD) Grammanik Bank	1/1 2/1	12/31 4/30

2007										Hind Bank(MCD) Grammanik Bank	1/1 2/1	12/31 4/30
2008										Hind Bank(MCD) Grammanik Bank	1/1 2/1	12/31 4/30
2009										Hind Bank(MCD) Grammanik Bank	1/1 2/1	12/31 4/30
2010										Hind Bank(MCD) Grammanik Bank	1/1 2/1	12/31 4/30

[1]EEZ waters only; [2]1993 territorial area closure; 1994 EEZ and territorial area closure; 1996 boundary change to make EEZ compatible with state; [3]2/29 during leap years; [4]Bottom tending gear (e.g., traps, nets, bottom longlines) prohibited from seasonally closed areas (i.e., HAPCs); [5]Boundary change to Tourmaline Bank closed area; [6]Closure extended to six months (October 1 through March 31) beginning with 2011 calendar year.

Table 2.1.3. Annual Commercial/Recreational Parrotfish 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[4]	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[5]	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										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										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										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										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										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										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										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										Tourmaline Bank Abrir La Sierra Bajo de Sico[6]	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]1993 territorial area closure; 1994 EEZ and territorial area closure; 1996 boundary change to make EEZ compatible with state; [3]2/29 during leap years; [4]Bottom tending gear (e.g., traps, nets, bottom longlines) prohibited from seasonally closed areas (i.e., HAPCs); [5]Boundary change to Tourmaline Bank closed area; [6]Closure extended to six months (October 1 through March 31) beginning with 2011 calendar year.

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 parrotfishes.

2.3. Management Program Specifications

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

Species	Redtail parrotfish
Management Unit	Parrotfishes
Management Unit Definition	Includes redtail parrotfish (*S. chrysopterum*), redfin (*S. rubripinne*), redband (*S. aurofrenatum*), stoplight (*S. viride*), blue (*Scarus coeruleus*), midnight *(S. coelestinus*), rainbow (*S. guacamaia*), queen (*S. vetula*), princess (*S. taeniopterus*), and striped parrotfish (*S. iseri*)
Management Entity	Caribbean Fishery Management Council
Management Contacts SERO / Council	William Arnold - SERO Graciela García-Moliner - CFMC
Current stock exploitation status	Undergoing overfishing
Current stock biomass status	Unknown

As described in the following table, the 2005 SFA Amendment established reference points for parrotfishes. This fishery unit includes 10 species of parrotfish. The 2010 ACL Amendment proposes to prohibit all take of 3 parrotfish (midnight, blue and rainbow) from the EEZ, establish bag limits for the recreational catch of parrotfish, 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}	600,000	MSST = [(1-M) or 0.5 whichever is greater]*B_{MSY}	SEDAR 26
MFMT	F_{MSY} Proxy	0.43	F_{MSY}	SEDAR 26
MSY	Yield at F_{MSY} Proxy	304,000	Yield at F_{MSY}	SEDAR 26
F_{MSY}	M	0.43	F_{MAX}	SEDAR 26
OY	Yield at F_{OY}	285,000	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		0.43		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), the parrotfish FMU is considered to be undergoing overfishing but not overfished. 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 parrotfishes:

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 Parrotfishes in Puerto Rico (commercial and recreational) and in the USVI:

Current Quota Value ACL (pounds)	165,022 (PR); 48,818 (STT/STJ) 293,219 (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

[1]6 years for PR recreational and STT commercial; 7 years for PR and STX commercial.

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

Tables 2.1.1, 2.1.2, and 2.1.3 provide event timelines of State and federal EEZ management actions by island group. Additional details regarding regulatory history for Puerto Rico, USVI, and EEZ waters follow.

The principal gears used in targeting parrotfish are traps and nets (including herding with SCIBA gear) and spear. Trap and pots configurations have been regulated since 1936 in Puerto Rico, since 1972 in the USVI, and since 1985 in the EEZ. Nets (beach seines) have been regulated in Puerto Rico since 1936 and not until 2005 in the EEZ and in 2006 in the USVI.

Trap Regulations

Puerto Rico's Fishing Law of 1936 required that all traps have a self-destruct panel but made no mention of mesh size. In 1972, Act 3330 of the USVI regulated the mesh size of traps, establishing a minimum size of 1.25" in the smallest dimension. By convention rather than regulation, trap construction was of wood and hexagonal (i.e., chicken wire) wire mesh.

Starting in 1985 regulations associated with spiny lobster management established that, in all three jurisdictions, self-destruct panels must be configured into traps. Also in 1985, traps to be deployed in the EEZ had to have a minimum mesh size of 1.25" in the smallest dimension, resulting in compatible regulations between the USVI and the EEZ. However, the regulations were not implemented in federal waters until 1988. These regulations were established under the Fishery Management Plan for the Shallow-water Reef Fish Fishery of Puerto Rico and the USVI (i.e., Reef Fish FMP).

In the 1990's, amendments to the Reef Fish FMP (1990, 1991, 1993) increased the minimum mesh size for traps to 1.5" hexagonal or 1.5" square until September 13, 1993, and to 2" square thereafter. These regulations also required that the degradable panel be fastened with degradable material and established specifications for the composition of the degradable material. The intention of the CFMC was to have only one panel but as the regulations were written there was a requirement for two degradable panels plus a degradable door. This regulation was revised through a technical amendment, resulting in a requirement for only a single biodegradable panel.

In the EEZ by 1994, regulations for traps required that traps have a minimum mesh size of 1.5" hexagonal or 2" square mesh. The documentation for this requirement is available at the Council's office.

Act 3330 of the USVI regulates fishing and fishing gear. This 1972 regulation required that a minimum mesh size in traps be of 1.25" hexagonal in the smallest dimension and that an escape panel with degradable material also be incorporated into the traps.

In the USVI, each District imposes different requirements for trap construction but all traps have to be inspected and certified. In STT/STX beginning in 1996, all new traps must have a minimum mesh size identical to that required for the EEZ: 1.5" hexagonal or 2" square in the smallest dimension. The requirement for an escape panel with degradable fasteners is compatible in all jurisdictions.

However, in STX beginning in 1996, the minimum mesh size required for new traps was 1.5" hexagonal or 1.5" square in the smallest dimension.

Beginning in1998, the EEZ, STT/STJ, and STX required the same mesh size of 1.5” hexagonal (but not for the square mesh) for all new traps. Also beginning in 1998, all traps in the USVI had to comply with the 1.5” minimum hexagonal mesh size. The difference between the Districts remained with STT/STJ continuing to allow a square mesh of 2” whereas STX still required a 1.5” minimum mesh.

Beginning in 2000, STT/STJ required that all traps had a minimum mesh size of 2” hexagonal or 2” square. All traps had to be inspected and tagged. This is the most restrictive minimum mesh size requirement in the U.S. Caribbean.

Beginning in 2004, Puerto Rico regulated the construction of traps and required, but did not implement, a minimum mesh size of 1.5” hexagonal or 2” square. Implementation of these mesh size requirements did not occur until 2007.

In summary, the time periods during which mesh size regulations were stable are as follows:

1) For the EEZ, (a) 1.25” minimum mesh from 1988 to 1993 (total of 6 years), and (b) 1.5” hexagonal or 2” square from 1994 to present (total of 17 years through 2010).

2) For STT/STJ, (a) 1.25” minimum mesh from 1972 to 1996 (total of 25 years), (b) 1.5” hexagonal or 2” square from 1997 to 2000 (total of 4 years), and (c) 2” square or 2” hexagonal from 2001 to present (total of 10 years through 2010).

3) For STX, (a) 1.25” minimum mesh from 1972 to 1996 (total of 25 years), (b) 1.5” hexagonal or 1.5” square from 1996 (new traps) to 2009 (total of 14 years) or from 1998 (all traps) to 2009 (total of 12 years), (c) 1.5” hexagonal during 2009 (total of 1 year), and (d) 1.5” hexagonal or 2” square beginning in 2010 (total of 1 year to present).

Compatibility in the mesh size regulation was achieved as follows:

(a) 1.25” mesh in both USVI and EEZ waters between 1985 and 1988 (total of 4 years), (b) 1.5” hexagonal in both STT/STJ and EEZ waters between 1996 and 2000 (total of 5 years), and (c) 2” square from 1996 to present for both STT/STJ and EEZ waters (total of 16 years through 2010).

The missing years correspond to periods when the regulations included a mix of 1.25” minimum mesh, 1.5” hexagonal or square mesh, and 2” square mesh.

Compatibility of EEZ and STX regulations included (a) 1.25” between 1988 and 1994 (total of 7 years), (b) 1.5” hexagonal between 1996 and present (total of 16 years through 2010), and (c) for 2” square in 2010 (total of 1 year through 2010).

Tables 2.7.1, 2.7.2, and 2.7.3 summarize the number of years during which the mesh size was the same for the EEZ and each of the islands or island groups. Figure 2.7.1 provides a visual timeline for changes in regulations, clearly showing the predominance of regulations regarding mesh size.

Table 2.4.1. EEZ and STT/STJ years of compatible mesh size for traps.

			EEZ			
			1.25"	1.5"	2" square	2" hex
			1988	1994	1994	NO
	1.25"	1972	7 (1988-1996)			
STT	1.5"	1996		5 (1996-2000)		
	2" square	1996			5 (1996-2010)	
	2" hex	2000				

Table 2.4.2. EEZ and STX years of compatible mesh size in traps.

			EEZ			
			1.25"	1.5"	2" square	2" hex
			1988	1994	1994	NO
	1.25"	1972	7 (1988-1994)			
STX	1.5"	1996		5 (1996-2010)		
	2" square	2010			1 (2010)	
	2" hex					

Table 2.4.3. EEZ and Puerto Rico (this table needs to be reviewed).

			EEZ			
			1.25"	1.5"	2" square	2" hex
			1988	1994	1994	NO
	1.25"					
PR	1.5"	2007		4 (2007-2010)		
	2" square	2007		4 (2007-2010)		
	2" hex					

Table 2.4.4. Periods of time during which the same regulation of mesh size was maintained in each of the areas or jurisdictions.

Years during which the same mesh size was maintain in each jurisdiction				
Mesh/Area	EEZ	USVI	STT	STX
1.25"	1988-1993	1972-1996	1972-1998	1972-1998
1.5"hex/square	1993-1994			1996-1998
1.5" hex	1994-2010		1996-2000	1996-2010
2"square	1994-2010		1996-2010	2010
2" hex			2000-2010	

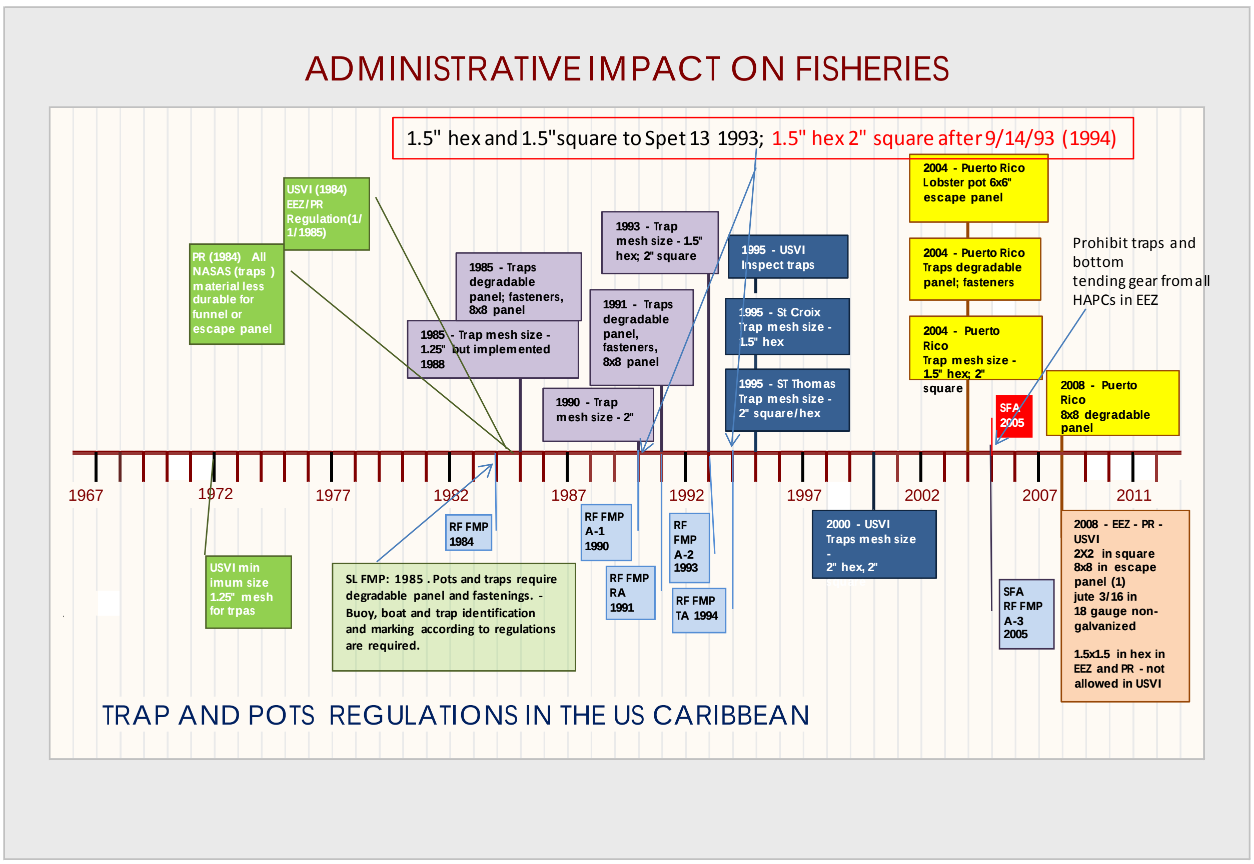

Figure 2.4.1. Schematic representation of the various FMPs and regulations that changed the way in which traps were constructed. The most significant changes are for mesh size.

References

Caribbean Fishery Management Council (CFMC). 1981. Fishery management plan, final environmental impact statement, and regulatory impact review for the spiny lobster fishery of Puerto Rico and the U.S. Virgin Islands. Caribbean Fishery Management Council, San Juan, Puerto Rico. 43 pp. + Appendices.

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Caribbean Fishery Management Council (CFMC). 1999. Amendment number 1 to the fishery management plan for corals and reef associated plants and invertebrates of Puerto Rico and the United States Virgin Islands for establishing a marine conservation district, including regulatory impact review and initial regulatory flexibility analysis and a final supplemental environmental impact statement. Caribbean Fishery Management Council, San Juan, Puerto Rico. 47 pp. + Appendices.

Caribbean Fishery Management Council (CFMC). 2004. Final environmental impact statement for the generic essential fish habitat amendment to: Spiny lobster fishery management plan

(FMP), queen conch FMP, reef fish FMP, and coral FMP for the U.S. Caribbean, Vol. I and II. Caribbean Fishery Management Council, San Juan, Puerto Rico.

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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

3. ASSESSMENT HISTORY AND REVIEW

U.S. Caribbean redtail parrotfish have not been formally assessed prior to SEDAR 26.

4. REGIONAL MAPS

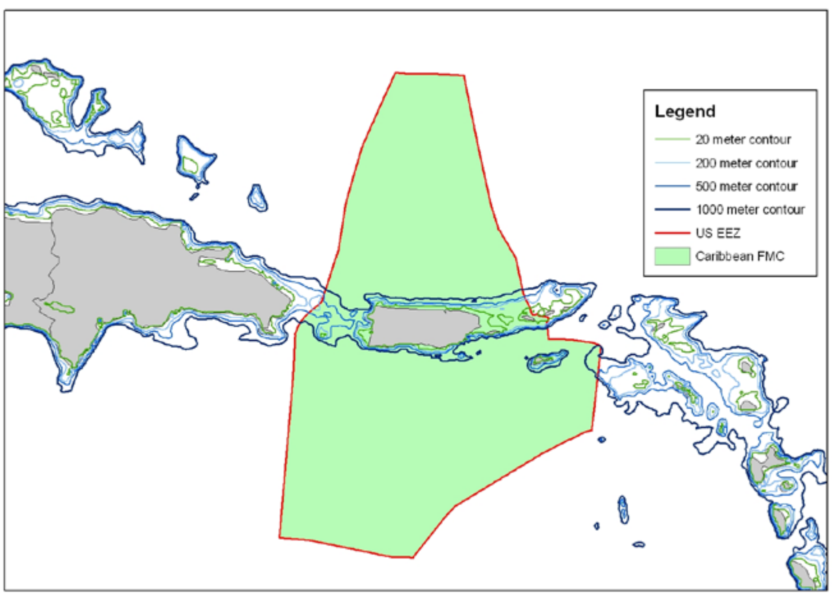

Figure 4.1 Caribbean management region including Council and EEZ Boundaries.

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 redtail parrotfish 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 of redtail parrotfish is occurring in the US Caribbean. The overfished status is unknown.

Stock Identification and Management Unit

- Redtail parrotfish are found 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
- The redtail parrotfish 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.

- No species-specific commercial landings for parrotfish are available from any of the islands; however the aggregate data was used for qualitative interpretation of the overfishing status.
- 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.
- No species-specific standardized abundance indices were produced, and aggregate indices were considered inappropriate for interpreting overfishing status.
- Commercial length data were available from the Trip Interview Program:

  St. Croix
  - Redtail parrotfish pots/traps data available years 1984-2002, 2005, 2007, 2010
  - Redtail parrotfish nets data available years 1993-1998, 2000-2005, 2007, 2010
  - Redtail parrotfish diver data available years 1996, 2002-2005, 2007-2010

  St. Thomas/St. John
  - Redtail parrotfish pots/traps data available years 1984-1988, 1991-1996, 2002-2006, 2008-2011

  Puerto Rico
  - Redtail parrotfish pots/traps data available years 1986-2007
  - Redtail parrotfish nets data available years 1986-2008
- 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:
  - The assessment report central (base) case values for K and L_{inf} were 0.78 per year and 300 mm respectively.
  - Lower and upper bounds were K=0.312 and 1.212 per year
  - L_{inf}=270 and 450 mm for all combinations of gear/island except PR pots and traps upper bound was 390 mm

Release Mortality

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

Assessment Methods

- The primary source of data for redtail parrotfish is length data from the NMFS TIP database. A review of the length frequency data available from the NMFS Trip Interview Program (TIP) database showed that sample sizes were sufficient to conduct a comprehensive time-series analysis for a limited number of species, island, and gear combinations (see SEDAR-DW-04 paper).

- The 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.
  - For Puerto Rico, both the pot/trap and net fishery were examined.
  - In St. Thomas/St. John, only the trap.pot fishery had sufficient sample sizes for analyses.
  - In St. Croix, the pot/trap fishery, the net fishery, and the diver-based fishery were examined for changes in mortality over the time series.

Catch Trends

- Commercial landings for the parrotfish family in Puerto Rico display a peak during the first few years of the time series (1983-1985), and have remained fairly constant since 2005.
- The bulk of the commercial landing come from St. Croix, where a slight increasing trend in reported landings can be observed for the parrotfish family over the time series.

Fishing Mortality Trends

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 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. The Review Panel agreed that without additional information it is not possible to provide estimates of stock size or change in stock size.

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

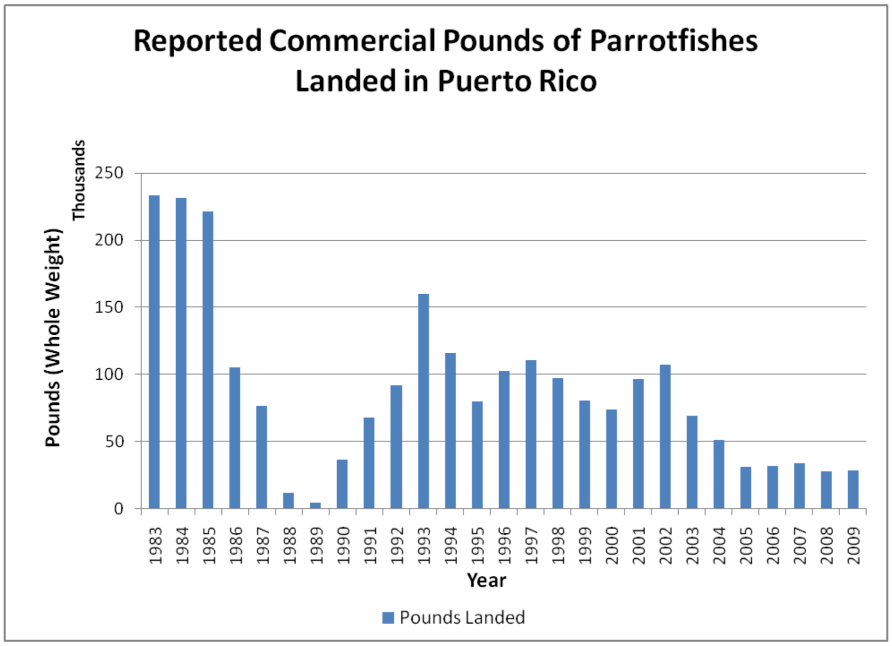

Figure 1. Reported commercial landings of parrotfish family in Puerto Rico, 1983-2009. 2009 data are preliminary. (*Figure 2.6.2 in the Assessment Workshop Report*)

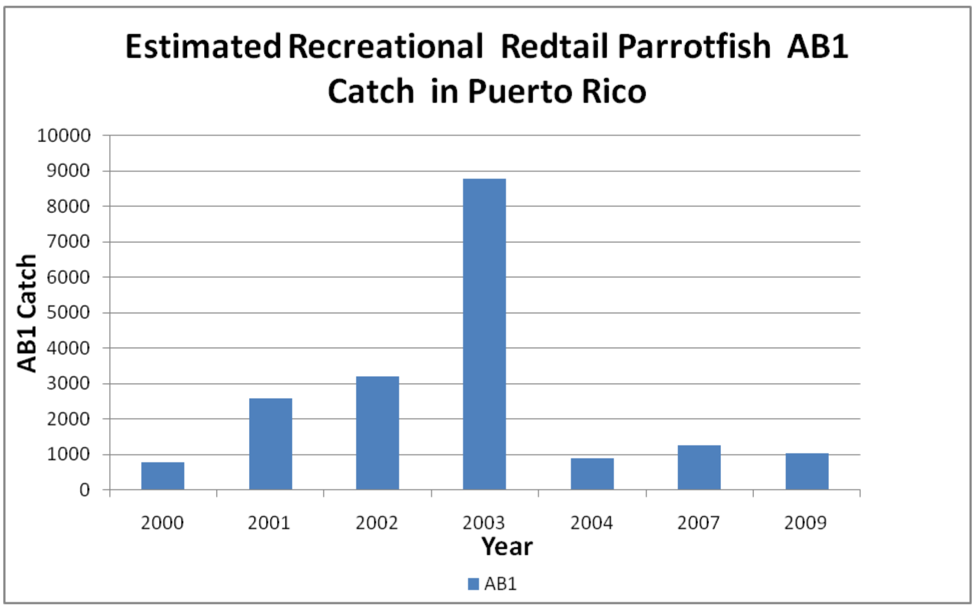

Figure 2. Estimated recreational catch of redtail parrotfish in Puerto Rico 2000-2010. Source = MRIP. Data are AB1 catch (numbers of fish). (*Figure 2.6.3 in the Assessment Workshop Report*)

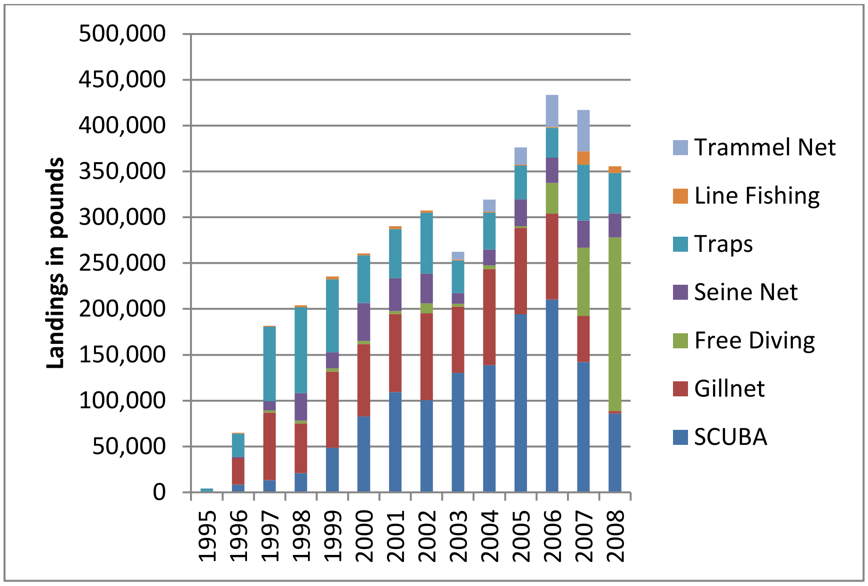

Figure 3. Yearly commercial landings of parrotfish by gear fished as reported (no expansion factors applied) on fisher logbooks from St. Croix. (*Figure 4.8.9 from the Data Workshop Report*)

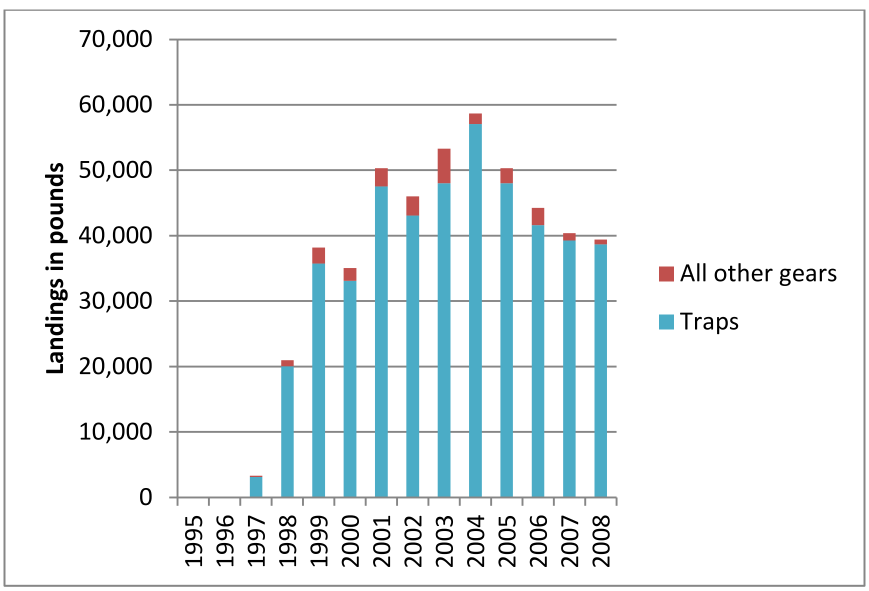

Figure 4. Yearly commercial landings of parrotfish by gear fished as reported (no expansion factors applied) on fisher logbooks from St. Thomas and St. John. (*Figure 4.8.10 from the Data Workshop Report*)

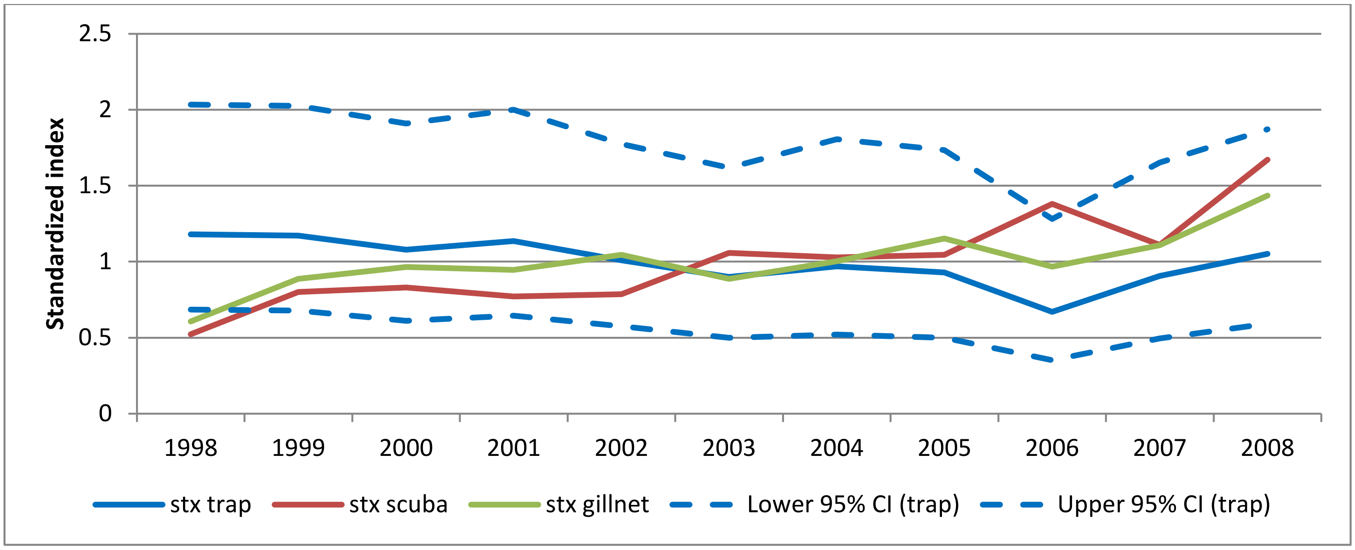

Figure 5. Parrotfish nominal standardized CPUE of commercial fishing vessels in St. Croix. Fish traps/pots CPUE = pounds parrotfish/trap haul/trip; SCUBA CPUE = pounds parrotfish/(amount of gear*trip duration); Gillnet CPUE = pounds parrotfish/(number of nets*trip duration). (*Figure 6.8.16 from the Data 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

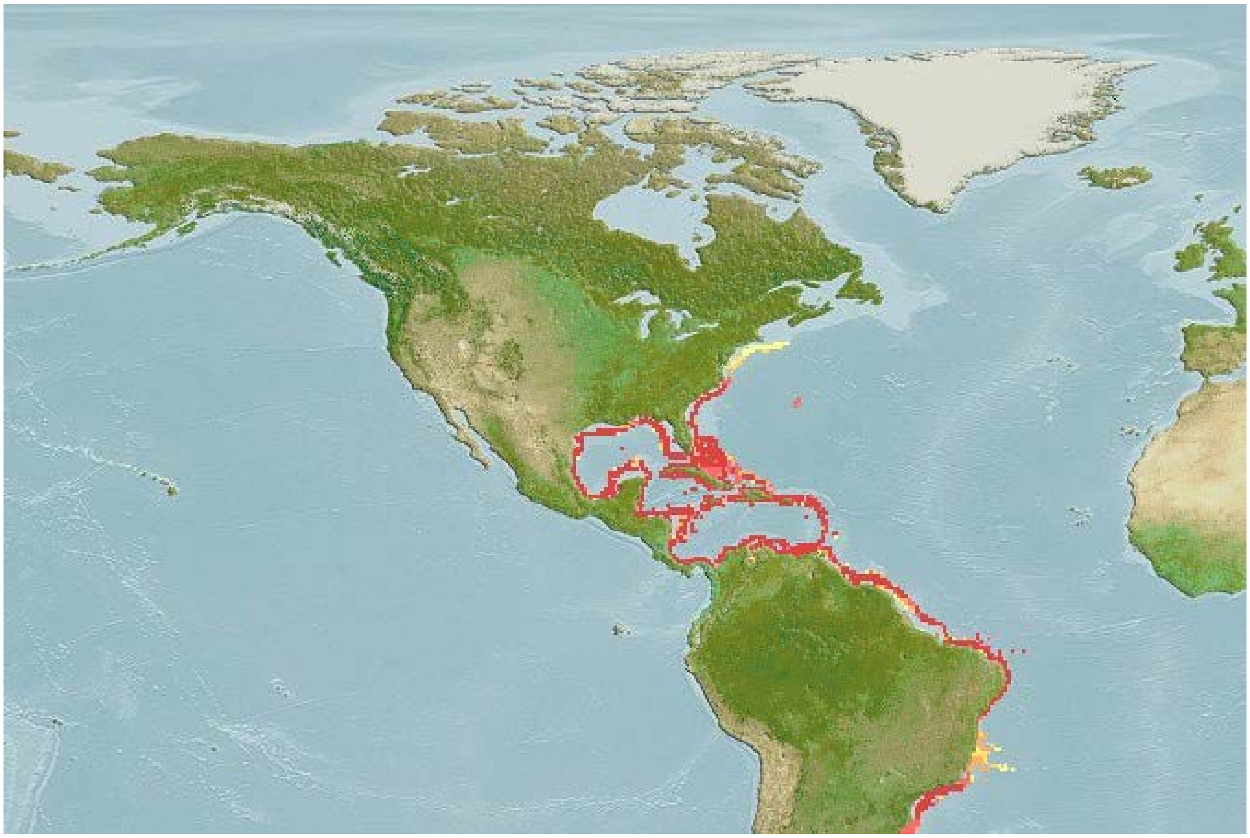

Figure 2.8.1. Geographical distribution of silk snapper, *Lutjanus vivanus* (Froese and Pauly 2011). The relative probability of occurrence in red and pink areas is greater than 60 percent. The relative probability of occurrence in orange areas is between 40 and 59 percent and in yellow areas the relative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

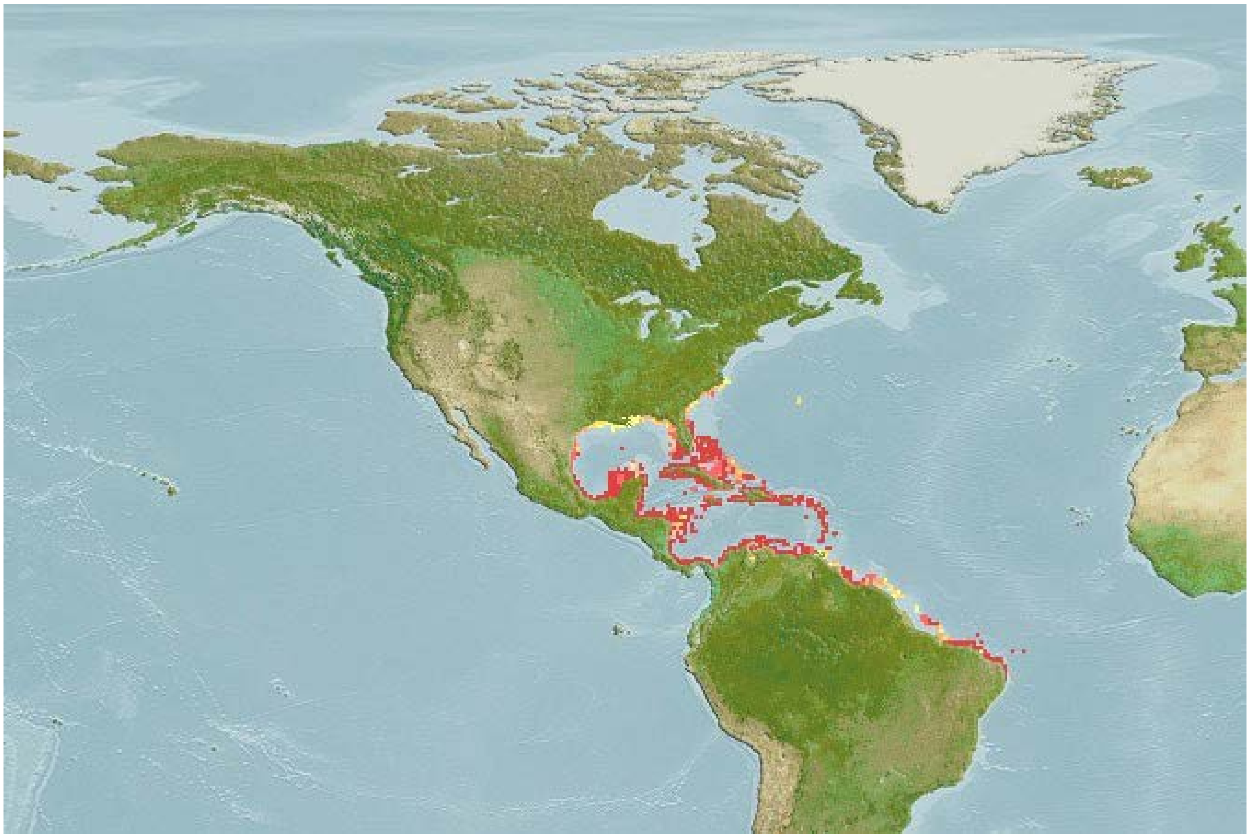

Figure 2.8.3. Geographical distribution of redtail parrotfish, *Sparisoma chrysopterum* (Froese and Pauly 2011). The relative probability of occurrence in red and pink areas is greater than 60 percent. The relative probability of occurrence in orange areas is between 40 and 59 percent and in yellow areas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

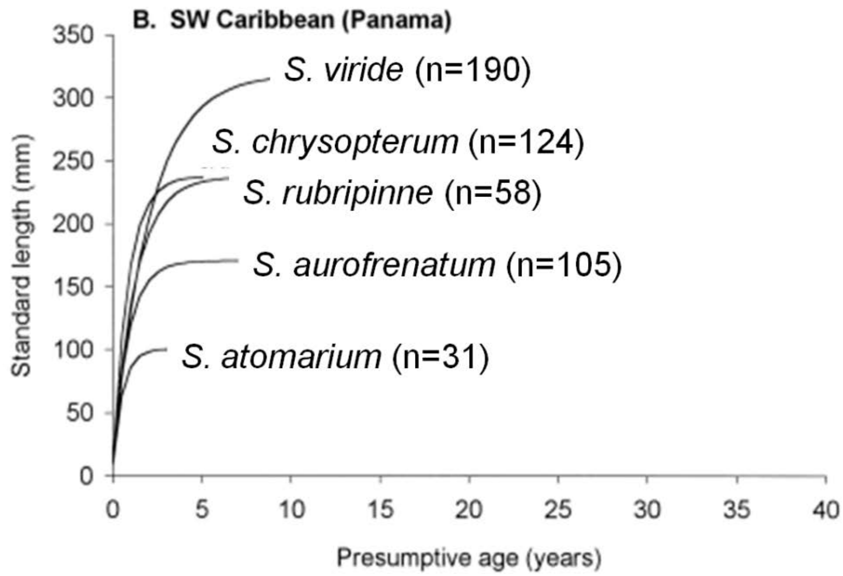

FIGURE 5 von Bertalanffy growth curves fitted to size-at-age data for 15 scarid taxa (von Bertalanffy parameters in Table 1; size-at-age data available from J. H. Choat). (A) West Pacific (northern GBR) taxa of *Bolbometopon, Chlorurus, Hipposcarus,* and *Scarus*. (B) Caribbean taxa of *Sparisoma* from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

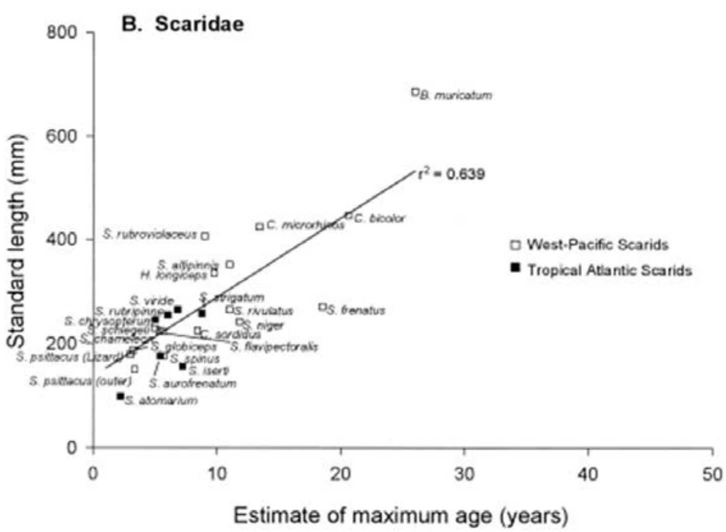

FIGURE 3 The relationship between maximum length and maximum age in 50 taxa of acanthurid and scarid fishes. Lines are least-squares regressions. (A) West Pacific and tropical Atlantic Acanthuridae. (B) West Pacific and tropical Atlantic Scaridae.

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.

3.8 LITERATURE CITED

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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.

	Inland Waters		State Waters		Federal Waters		Average Domestic 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

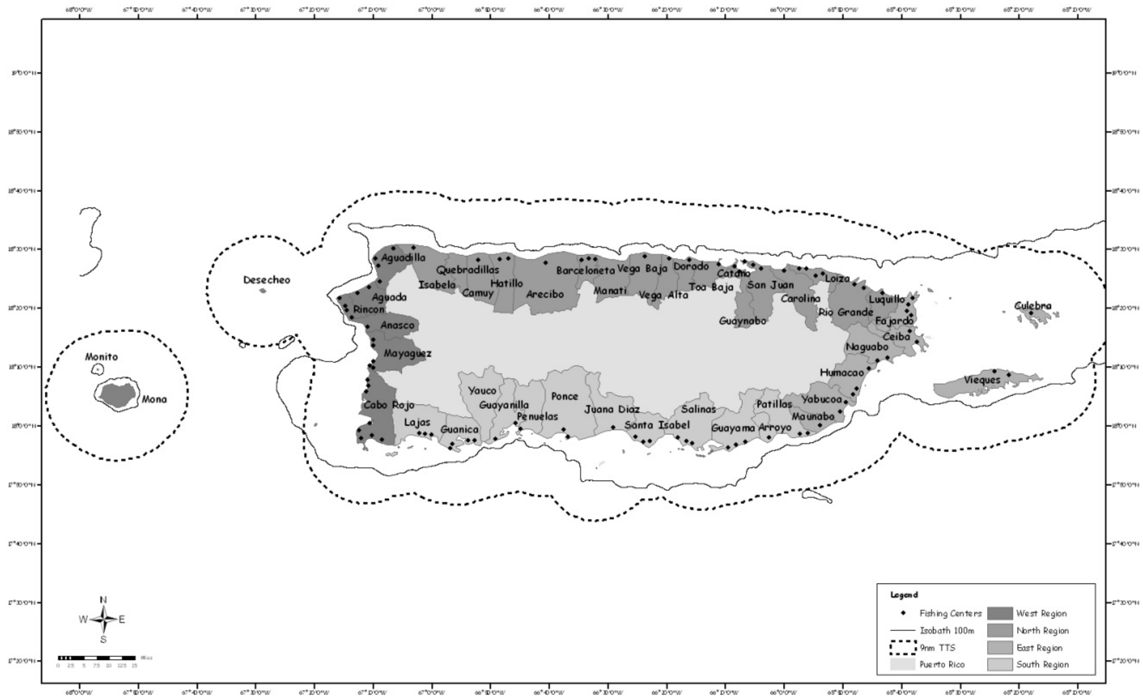

Figure 3.10.1. Map of general fishing zones around Puerto Rico and depiction of fishing centers.

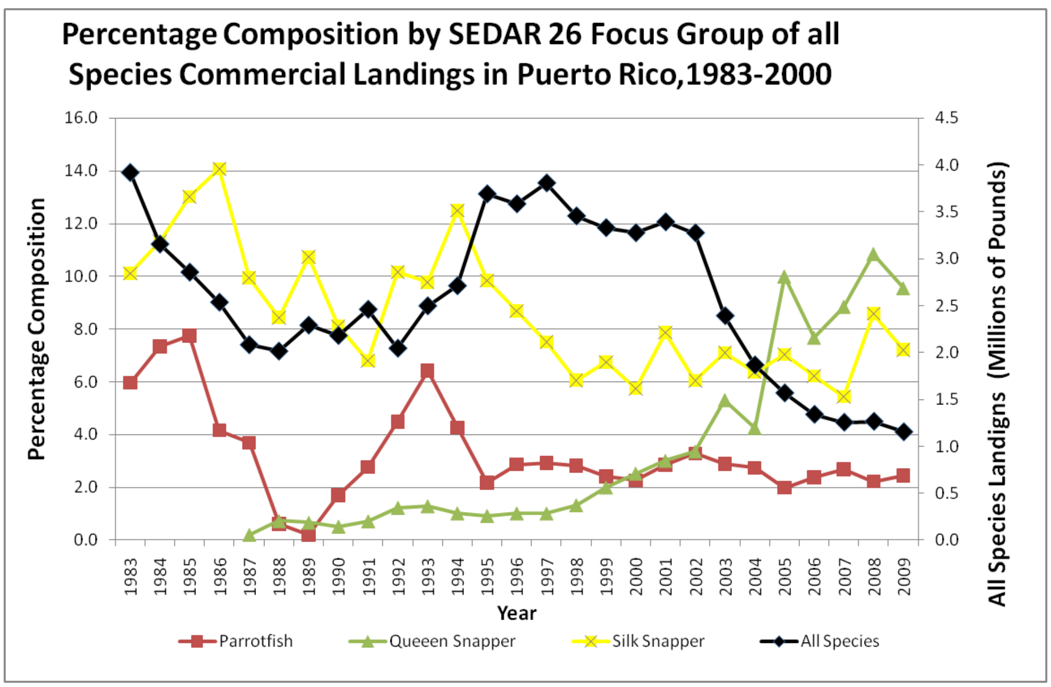

Figure 3.10.2. Percentage Composition of SEDAR 26 Focus Species (Silk and Queen Snapper and Parrotfish Family) of all Species commercial landings in Puerto Rico from 1983-2009.

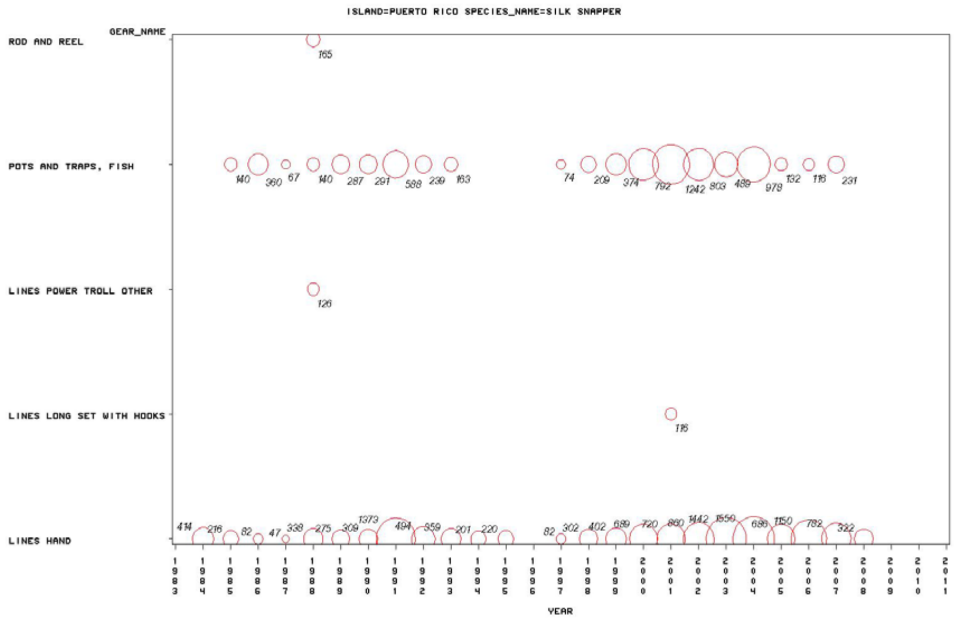

Figure 3.10.3. Number of silk snapper sampled fish by specific gear type from Puerto Rico, 1983-2011. The y-axis is average size (mm) and the x-axis is year.

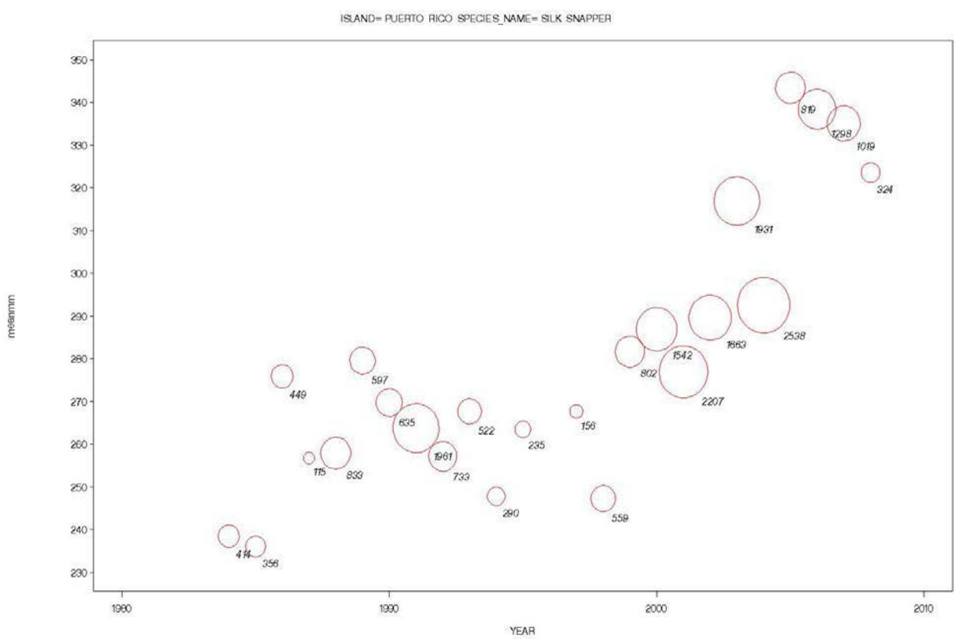

Figure 3.10.4. Silk snapper mean lengths and sample sizes from Puerto Rico, 1983-2011.

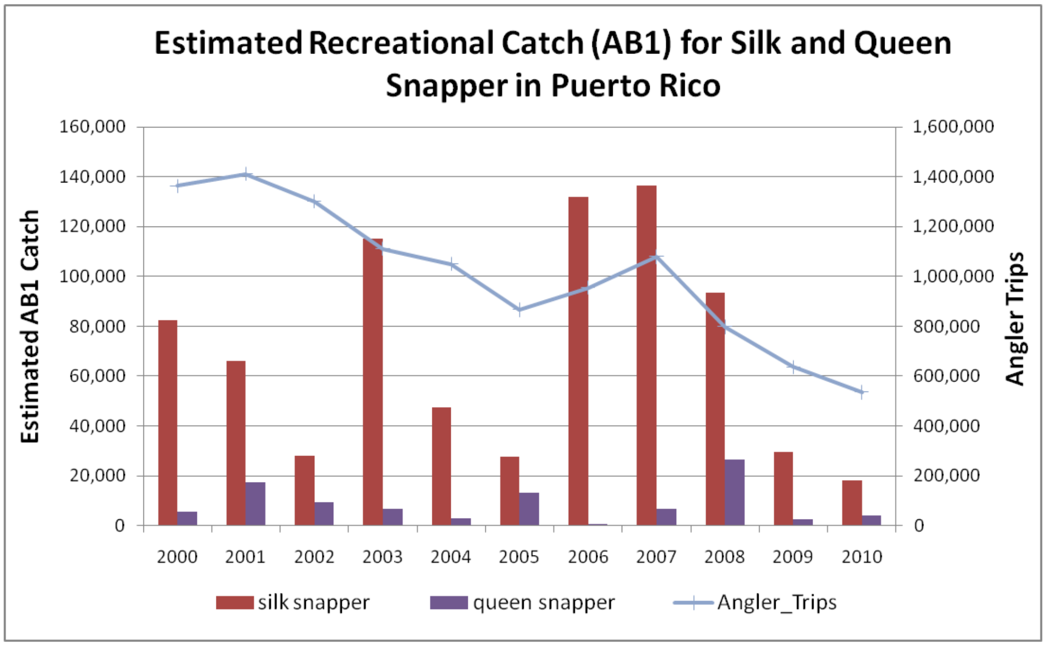

Figure 3.10.5. Estimated AB1 catch for silk and queen snapper and estimated number of recreational angler trips in Puerto Rico, 2000-2010. Units are numbers of fish. Source =MRIP survey.

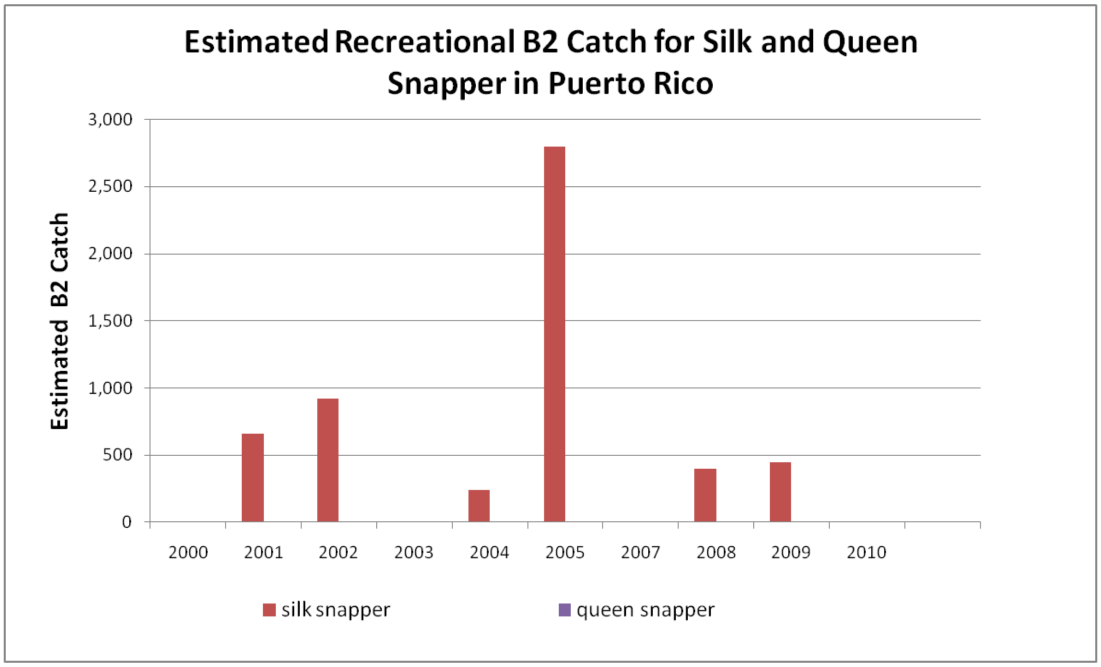

Figure 3.10.6. Estimated B2 catch by year for silk and queen snapper in Puerto Rico from 2000-2010 from the MRFSS survey. Units are numbers of fish. Source =MRIP survey. Queen snapper B2 catch was zero.

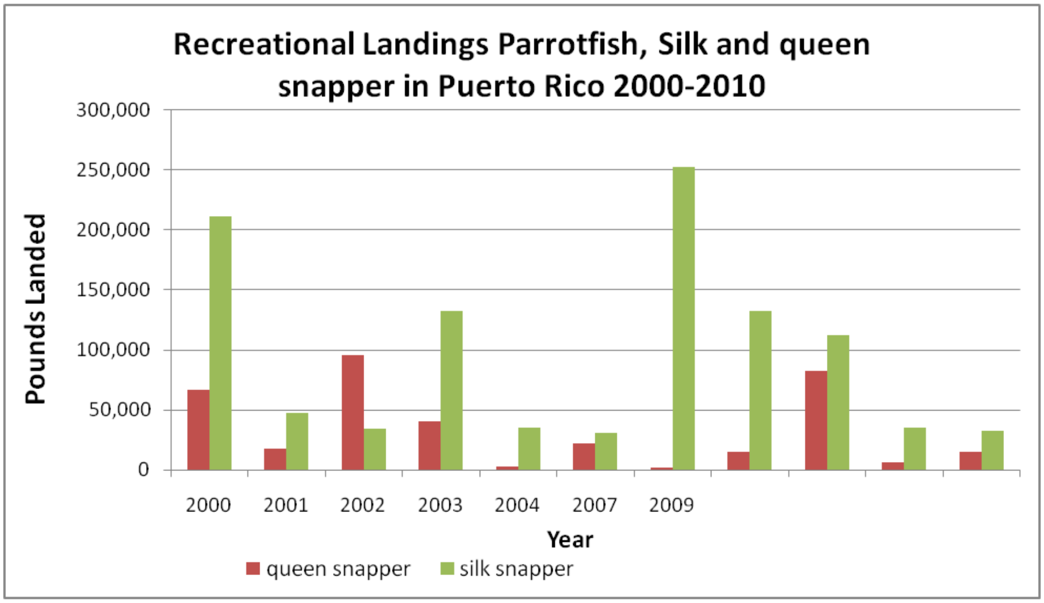

Figure 3.10.7. Estimated landings (AB1 catch in weight) silk and queen snapper in Puerto Rico from 2000-2010 from the MRFSS survey. Units are pounds whole weight. Source =MRIP survey

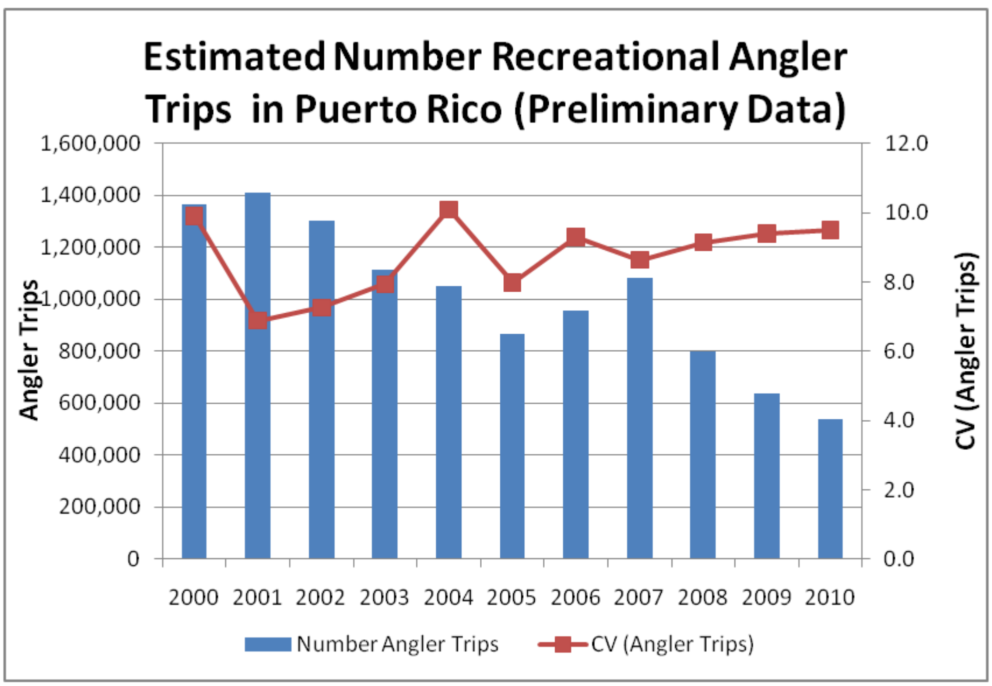

Figure 3.10.8. Profile of estimated number recreational angler trips in Puerto Rico 2000-2010. Source =MRIP survey

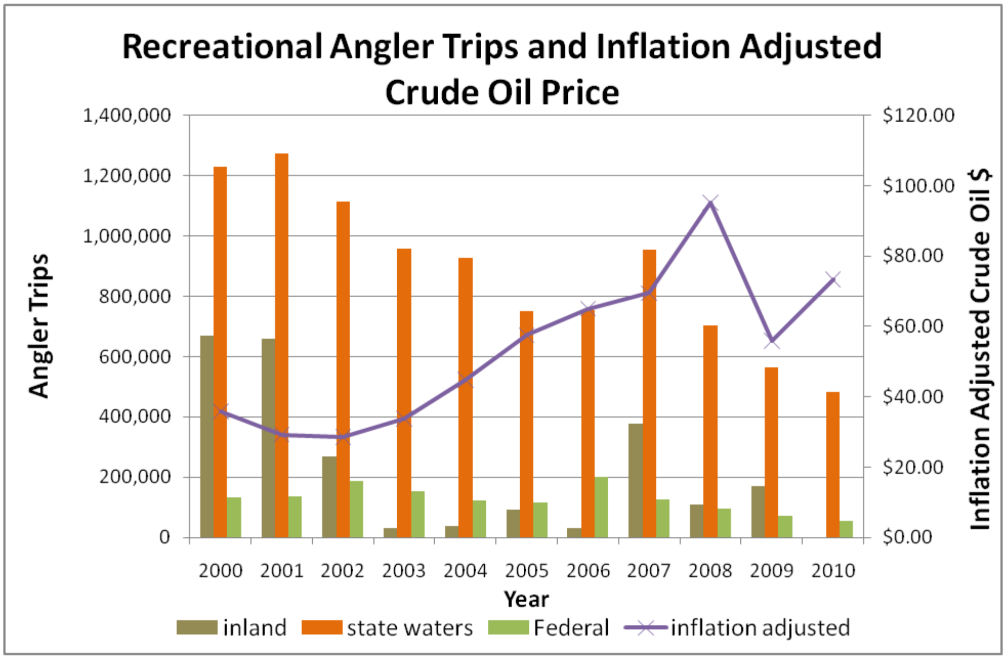

Figure 3.10.9. Estimated angler trips by area and adjusted crude oil price in U.S. Dollars.

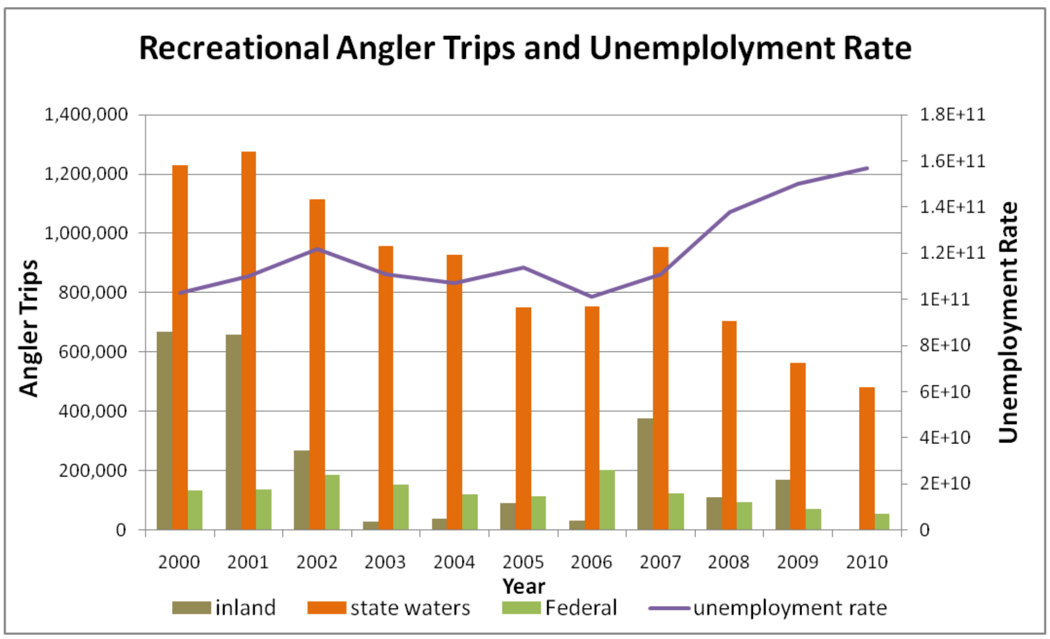

Figure 3.10.10. Estimated angler trips by area and unemployment .

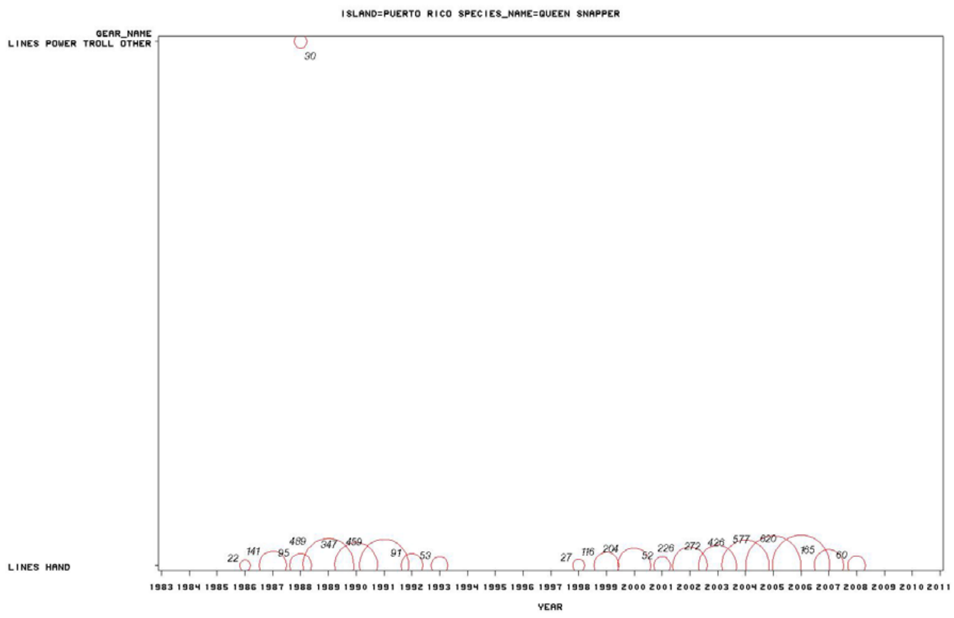

Figure 3.10.11. Queen snapper number of sampled fish by specific gear type from Puerto Rico, 1983-2011.

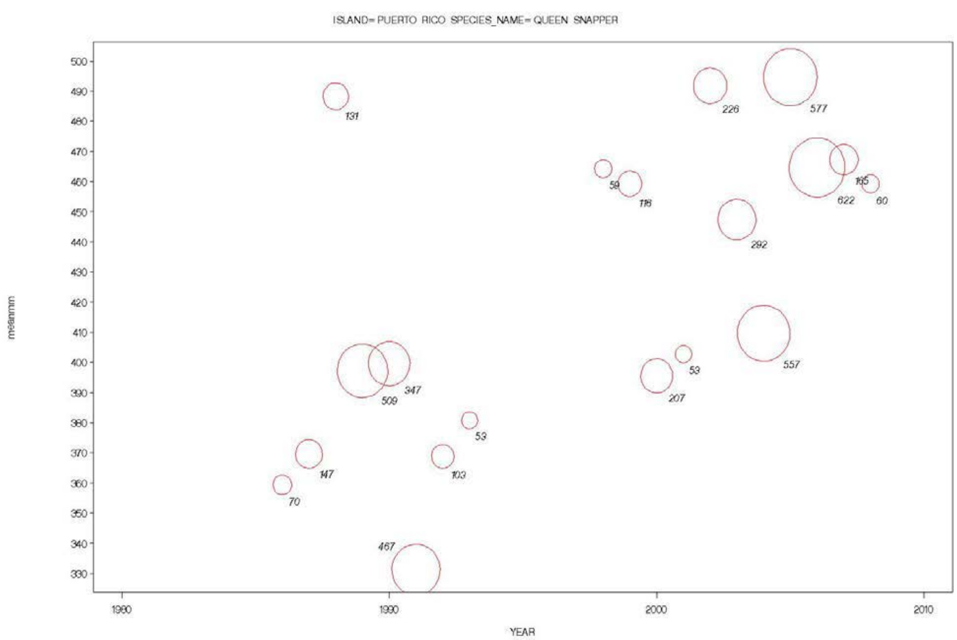

Figure 3.10.12. Queen snapper mean lengths and sample sizes from Puerto Rico, 1983-2011.

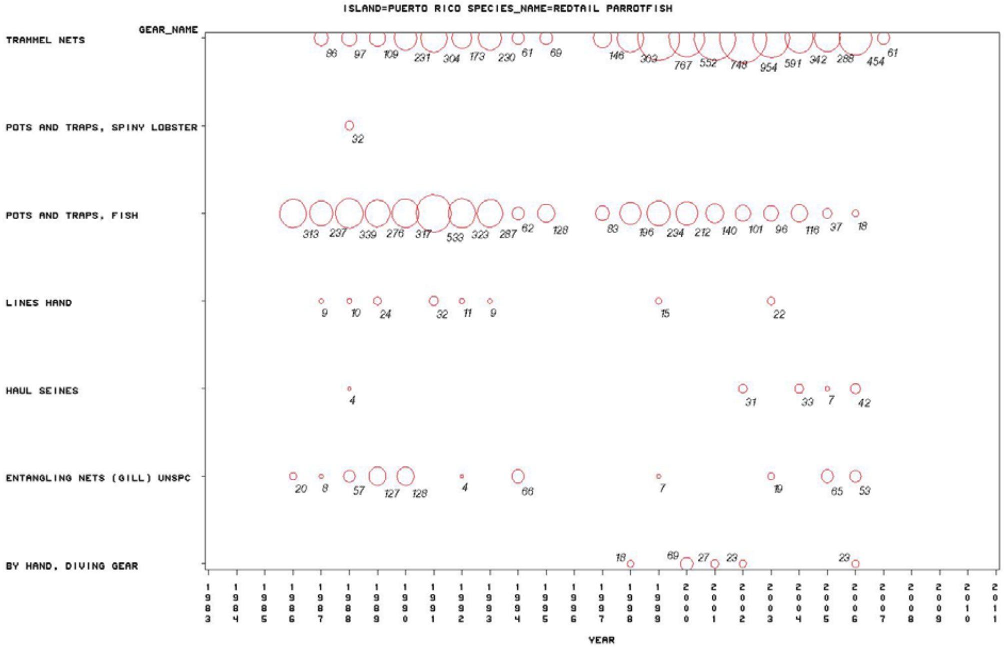

Figure 3.10.13. Redtail Parrotfish number of sampled fish by specific gear type from Puerto Rico, 1983-2011.

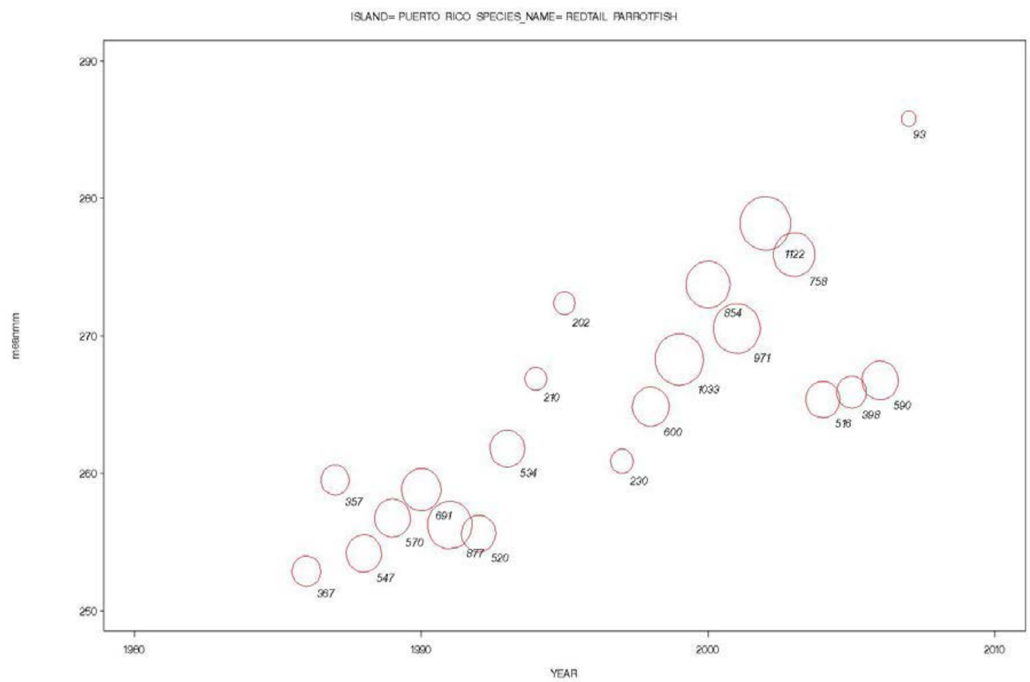

Figure 3.10.14. Redtail parrotfish mean lengths and sample sizes from Puerto Rico, 1983-2011.

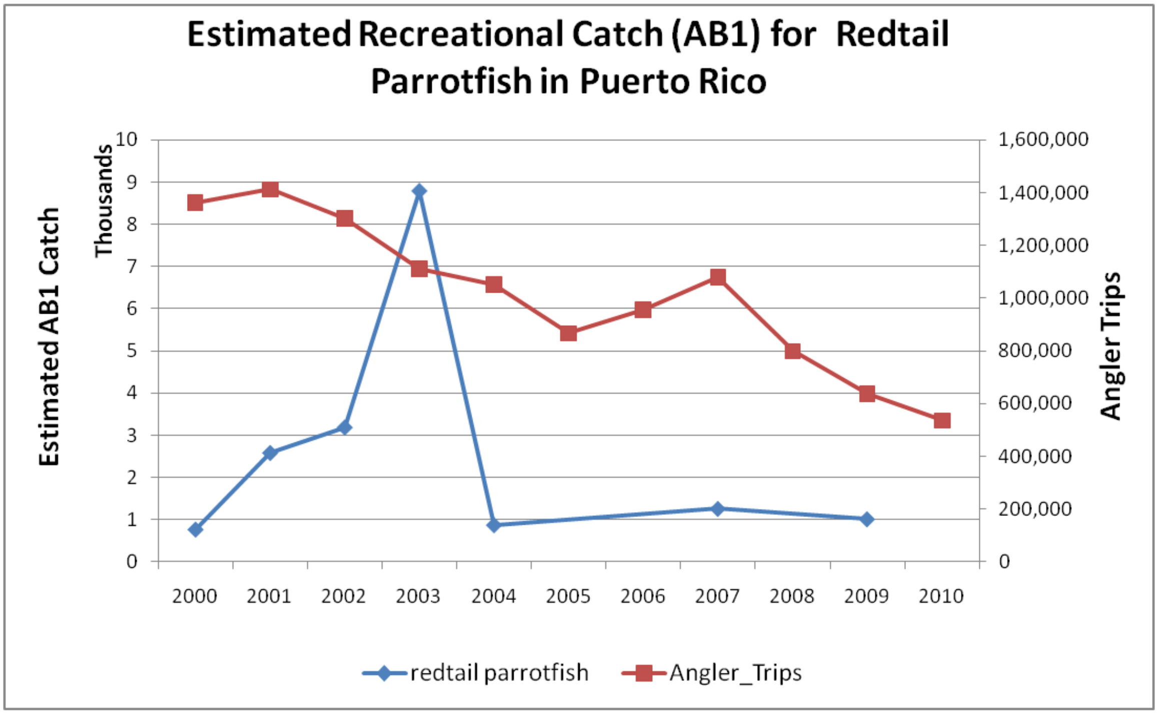

Figure 3.10.15. Estimated B2 catch by year for redtail parrotfish in Puerto Rico from 2000-2010 from the MRFSS survey. Units are numbers of fish. Source =MRIP survey

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

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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.

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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%)

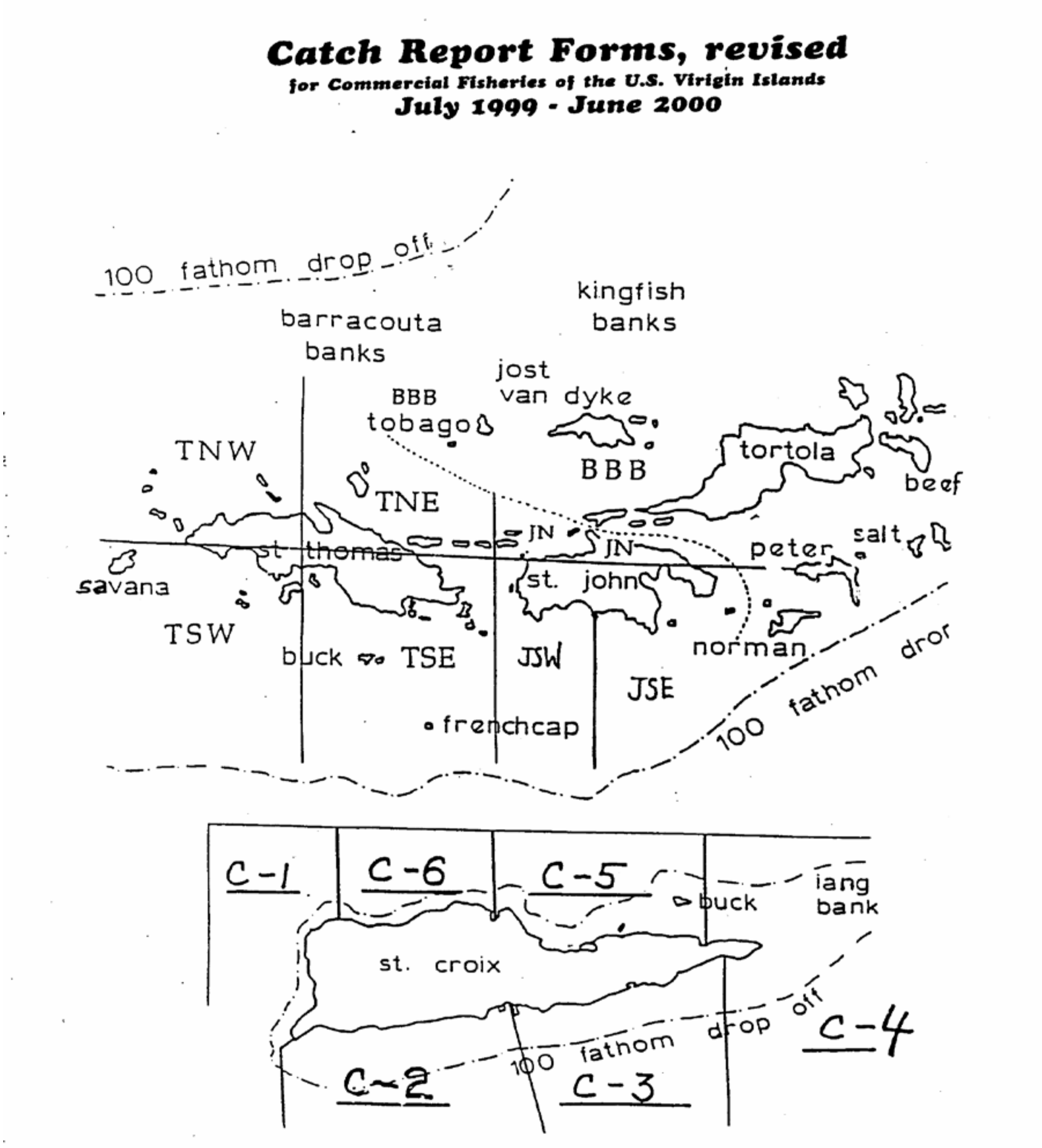
*** percent of column total shown in parentheses**

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).



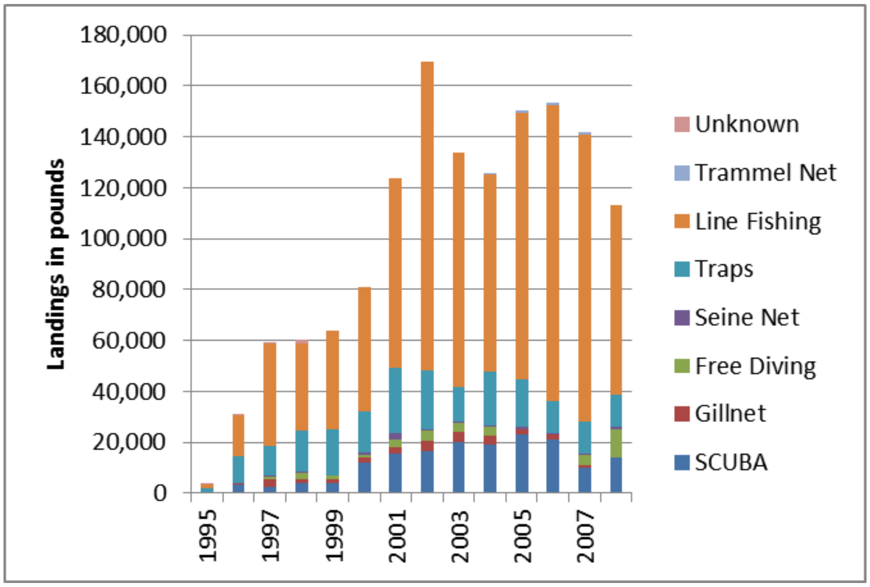


Figure 4.8.1. Yearly commercial landings of snappers by gear fished as reported (no expansion factors applied) on fisher logbooks from St. Croix.

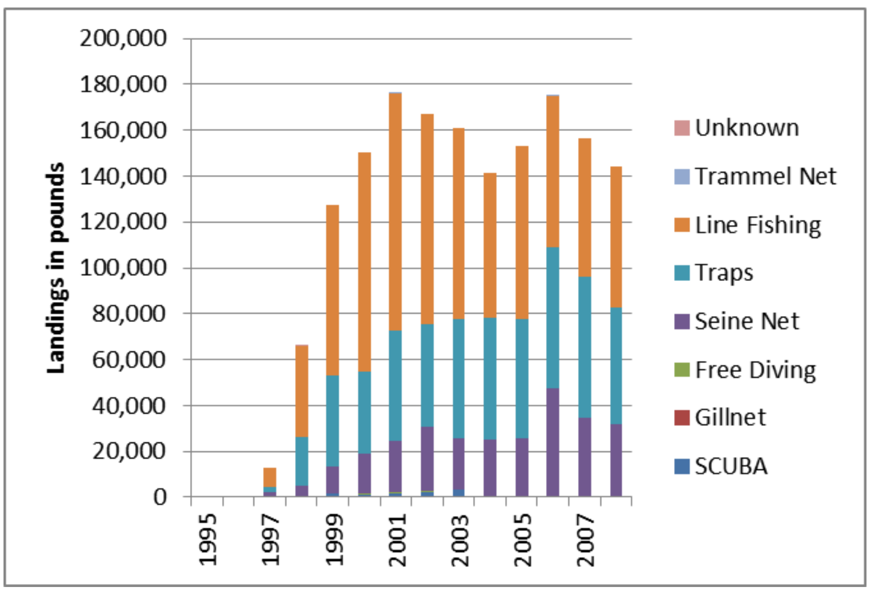


Figure 4.8.2. Yearly commercial landings of snappers by gear fished as reported (no expansion factors applied) on fisher logbooks from St. Thomas and St. John.

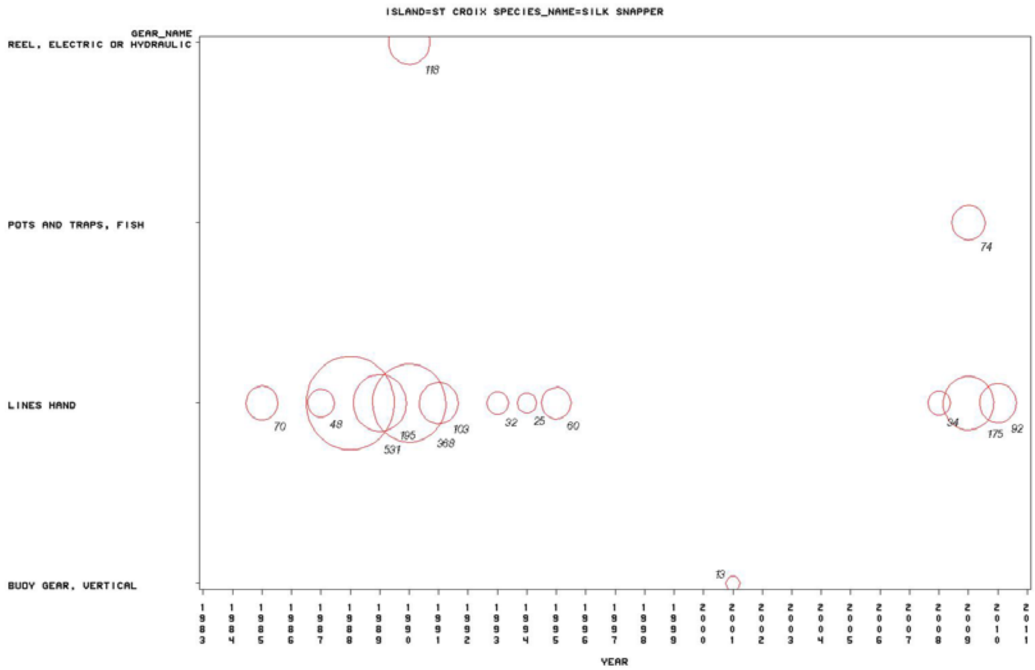


Figure 4.8.3. Silk snapper number of sampled fish by specific gear type from St. Croix, 1983-2011.

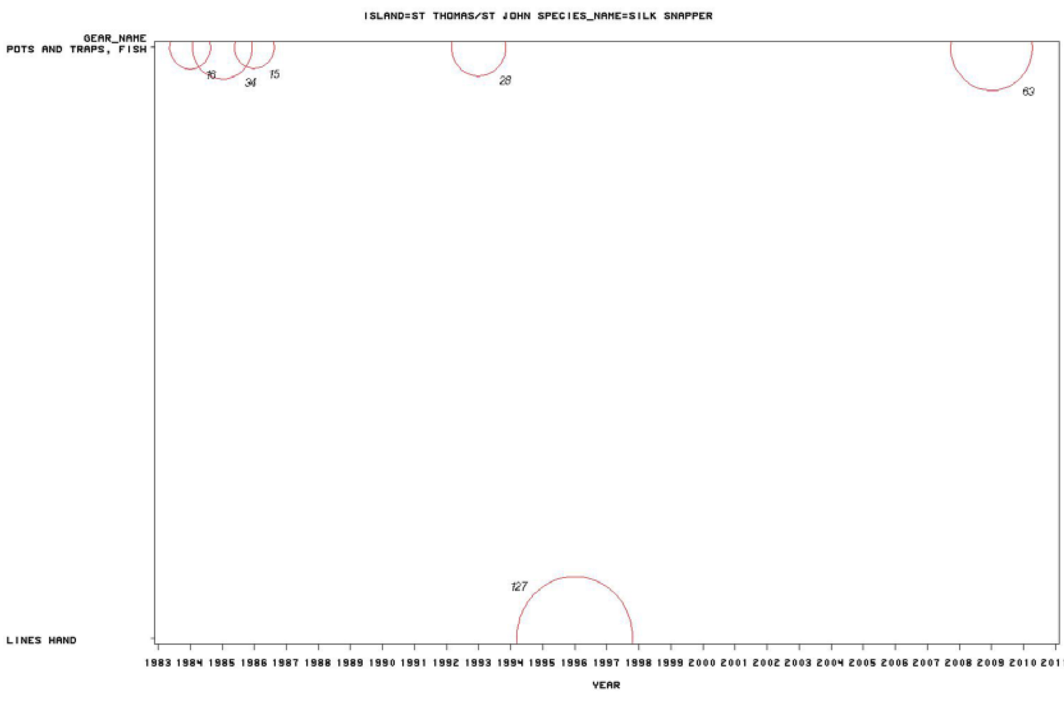


Figure 4.8.4. Silk snapper number of sampled fish by specific gear type from St. Thomas – St. John, 1983-2011.

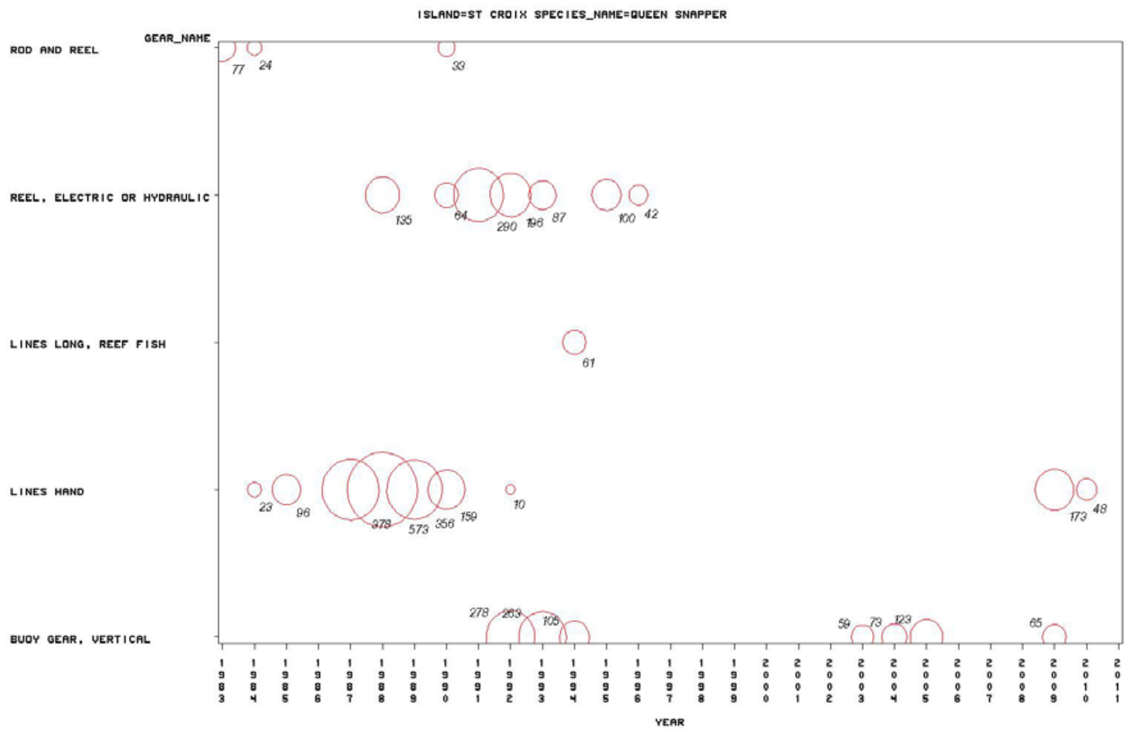


Figure 4.8.5. Queen snapper number of sampled fish by specific gear type from St. Croix, 1983-2011.

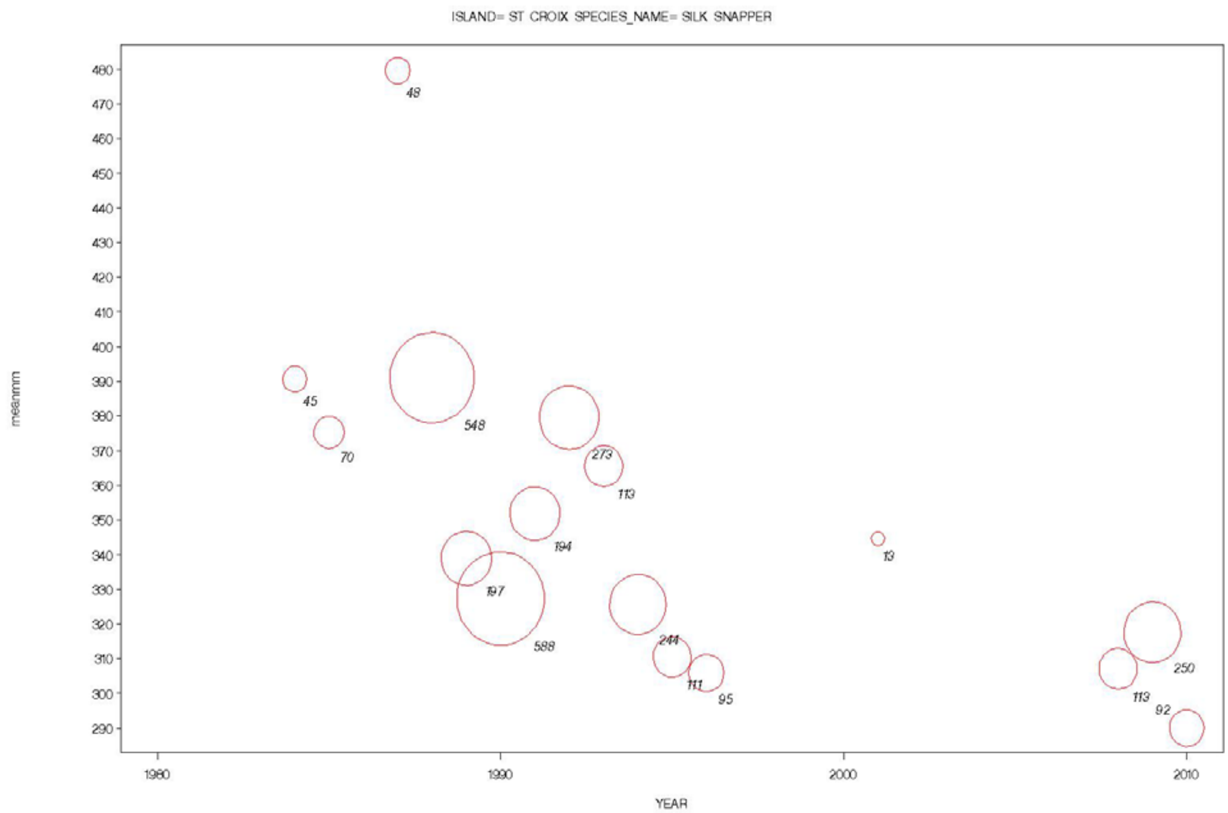


Figure 4.8.6. Silk snapper mean lengths and sample sizes from St. Croix, 1983-2011.

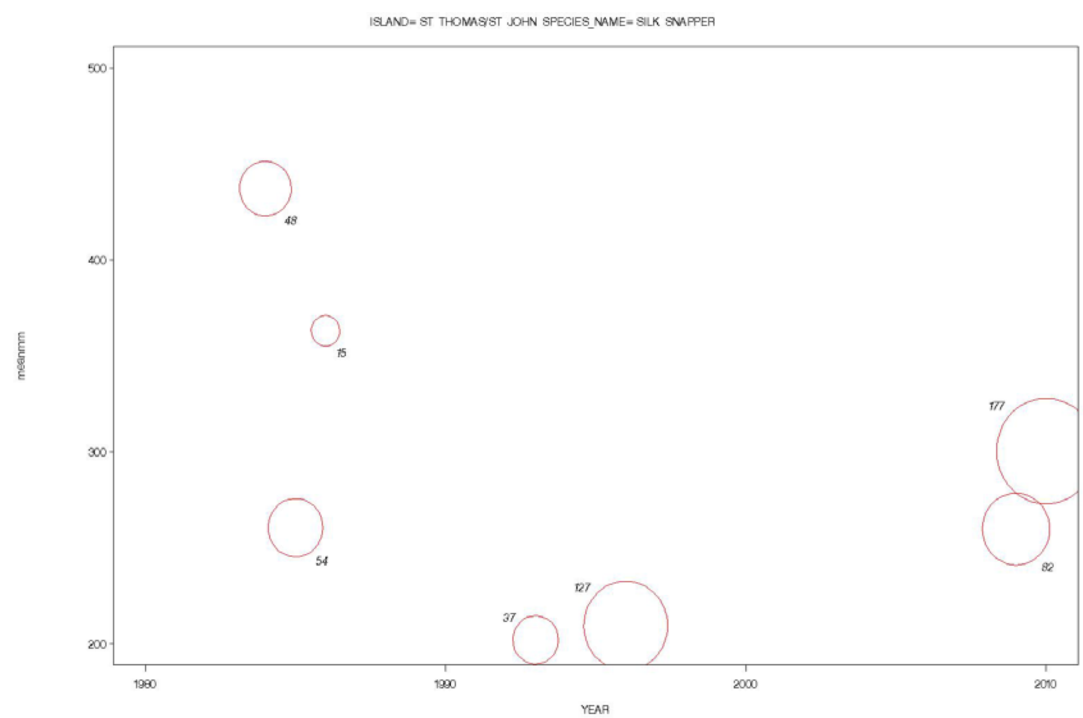


Figure 4.8.7. Silk snapper mean lengths and sample sizes from St. Thomas – St. John, 1983-2011.

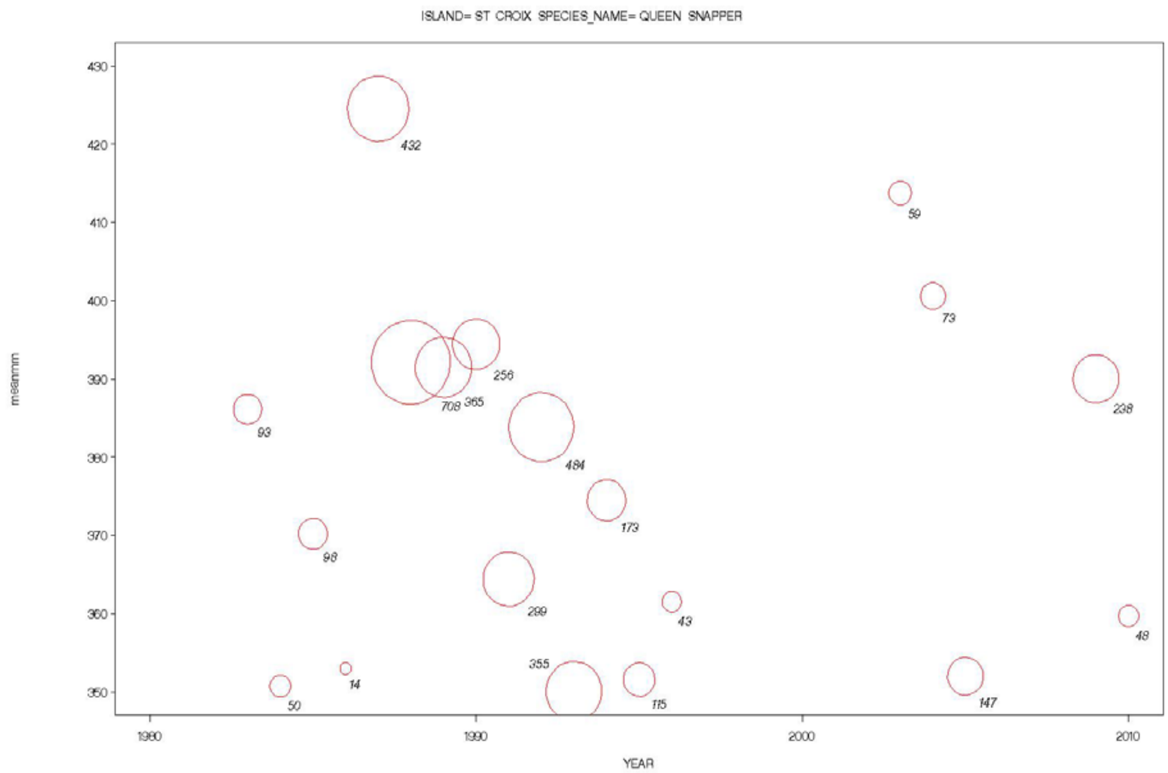


Figure 4.8.8. Queen snapper mean lengths and sample sizes from St. Croix, 1983-2011.

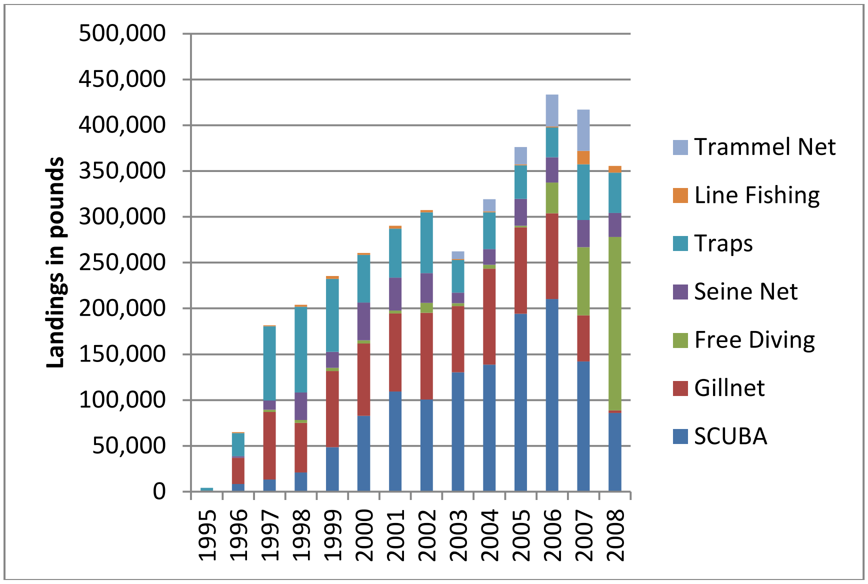


Figure 4.8.9. Yearly commercial landings of parrotfish by gear fished as reported (no expansion factors applied) on fisher logbooks from St. Croix.

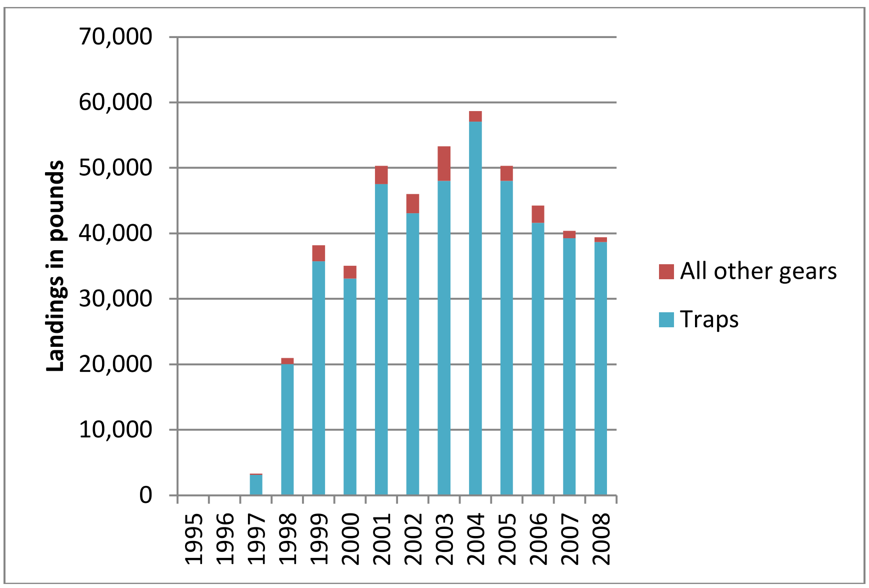


Figure 4.8.10. Yearly commercial landings of parrotfish by gear fished as reported (no expansion factors applied) on fisher logbooks from St. Thomas and St. John.

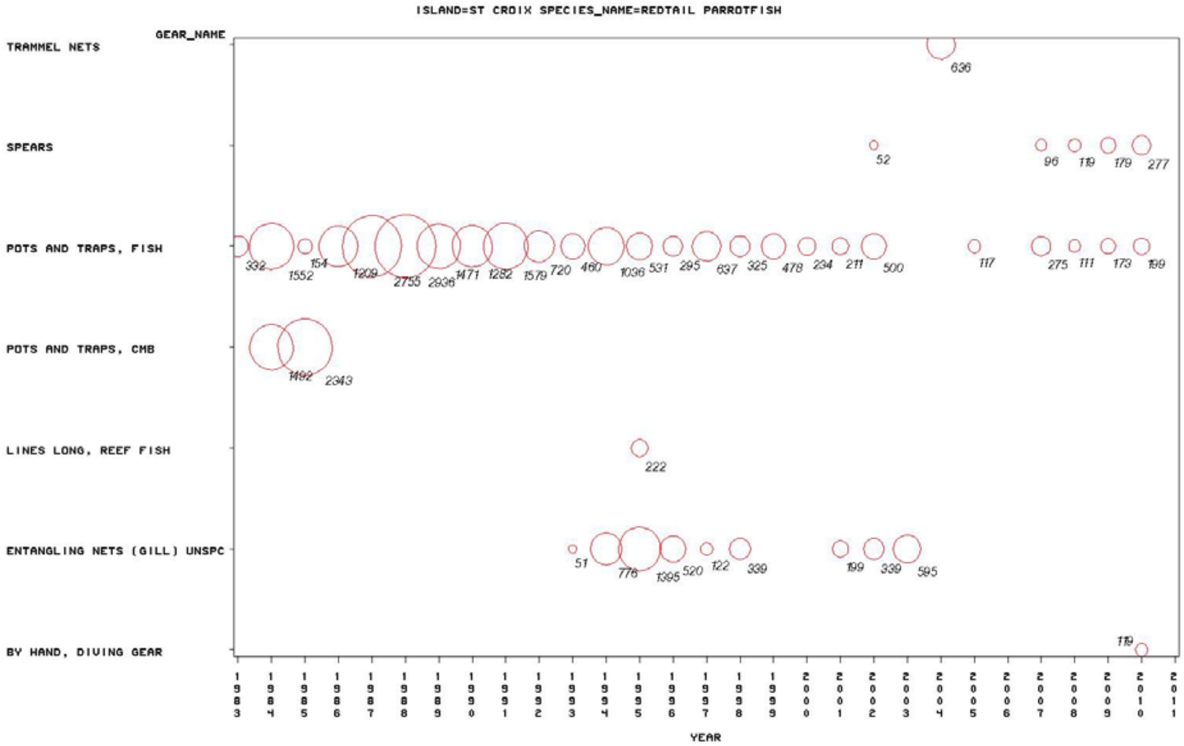


Figure 4.8.11. Redtail parrotfish number of sampled fish by specific gear type from St. Croix, 1983-2011.

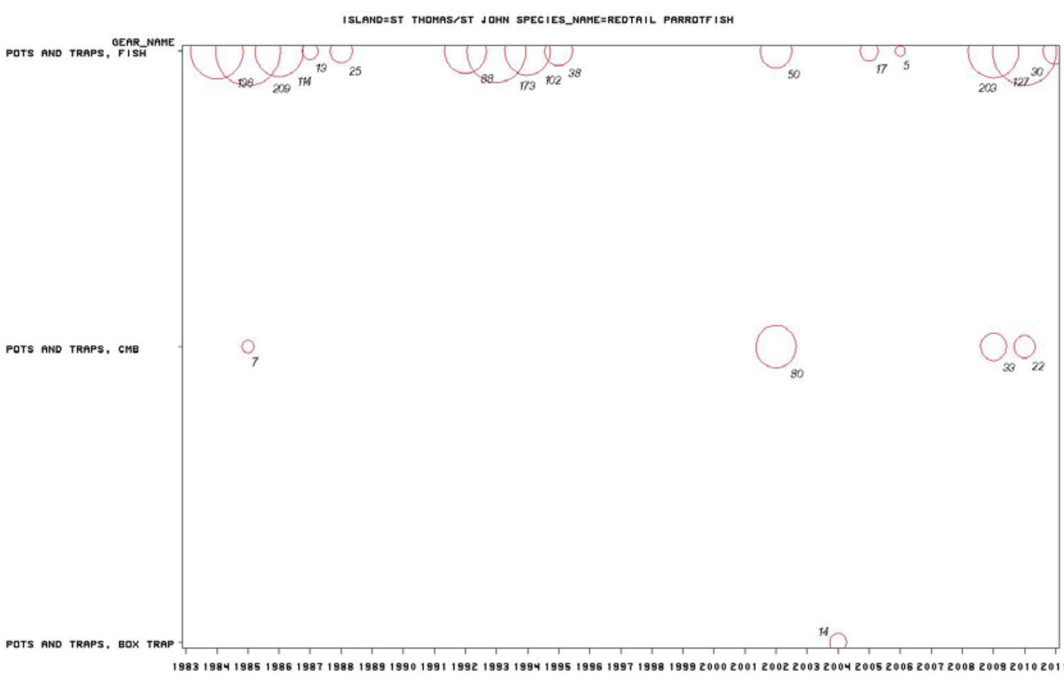


Figure 4.8.12. Redtail parrotfish number of sampled fish by specific gear type from St. Thomas/St. John, 1983-2011.

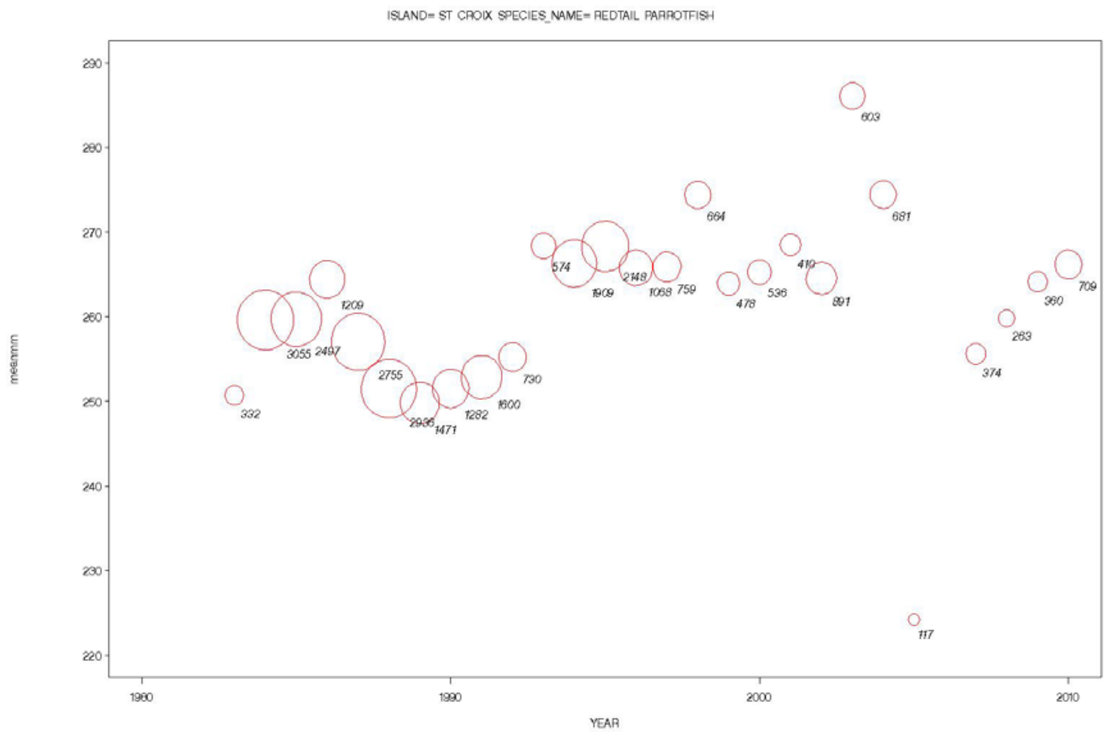


Figure 4.8.13. Redtail parrotfish mean lengths and sample sizes from St. Croix, 1983-2011.

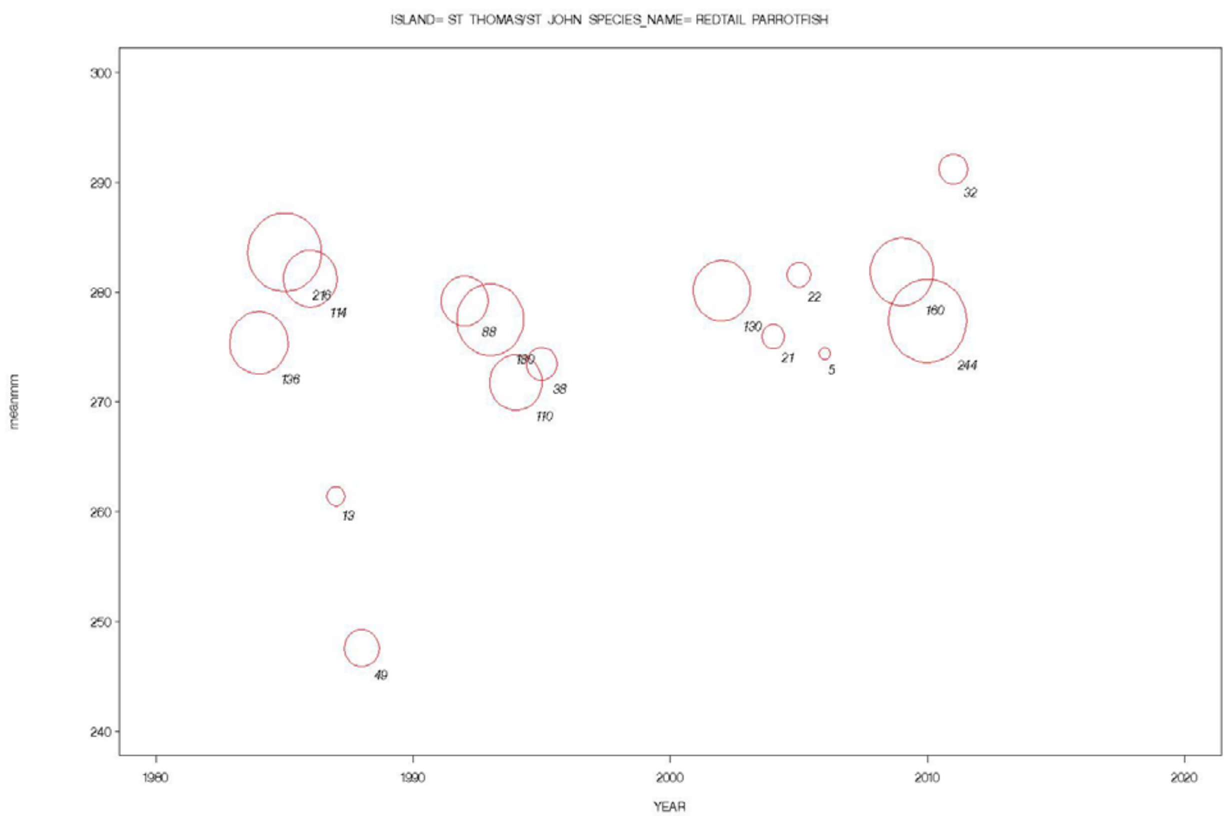


Figure 4.8.14. Redtail parrotfish mean lengths and sample sizes from St. Thomas – St. John, 1983-2011.

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:

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

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:

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

where

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

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 $\geq$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.

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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

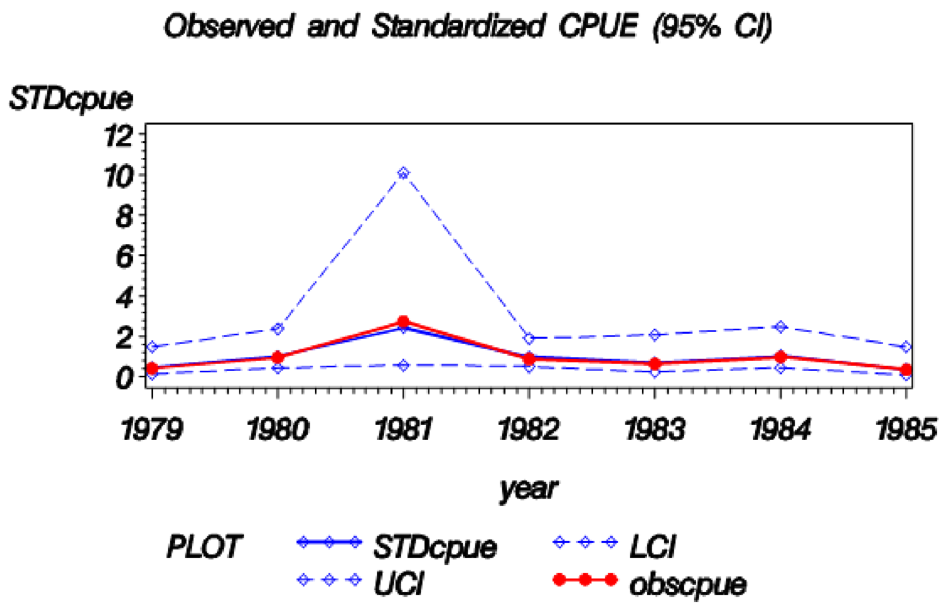

Figure 6.8.1. Queen snapper nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for fishery independent bottom longline data from Puerto Rico. CPUE = number of fish per 100 hook hour

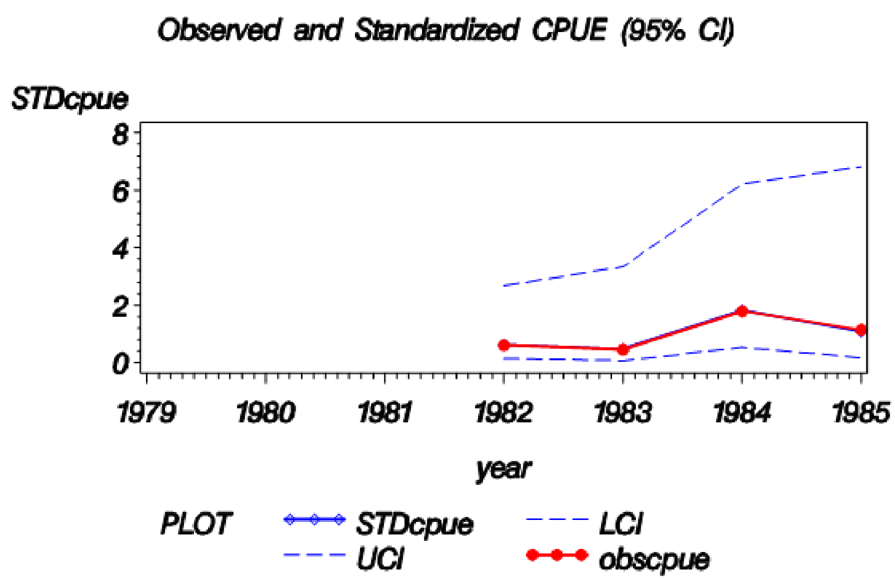

Figure 6.8.2. Queen snapper nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for fishery independent off bottom longline data from Puerto Rico. CPUE = number of fish per 100 hook hour

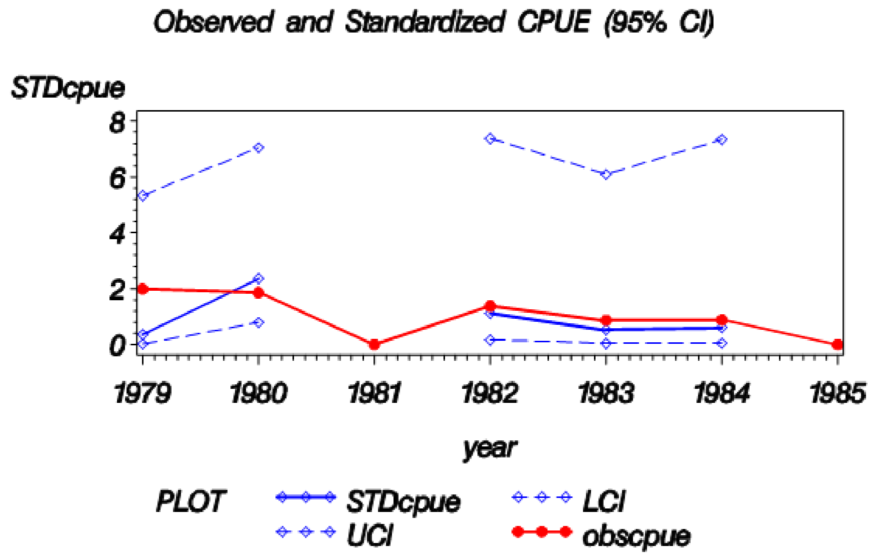

Figure 6.8.3. Silk snapper nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for fishery independent bottom longline data from Puerto Rico. CPUE = number of fish per 100 hook hour

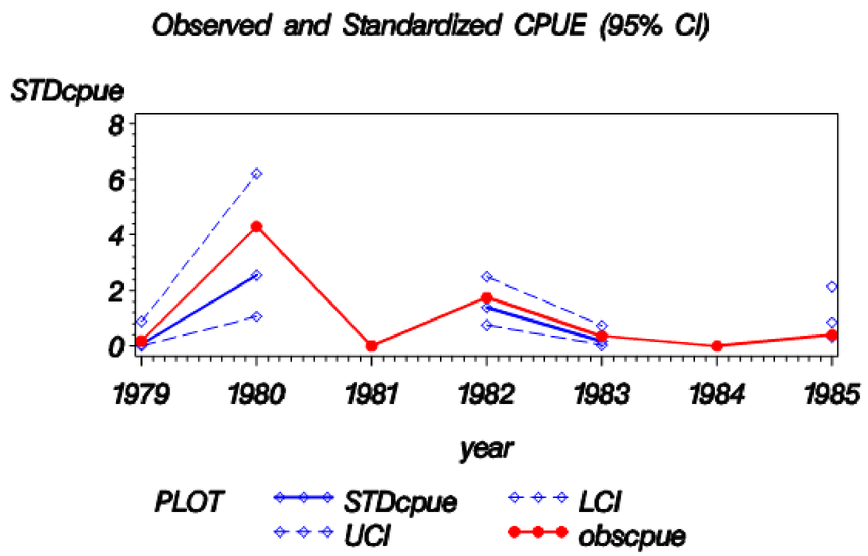

Figure 6.8.4. Silk snapper nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for fishery independent fish trap data from Puerto Rico. CPUE = number of fish per trap

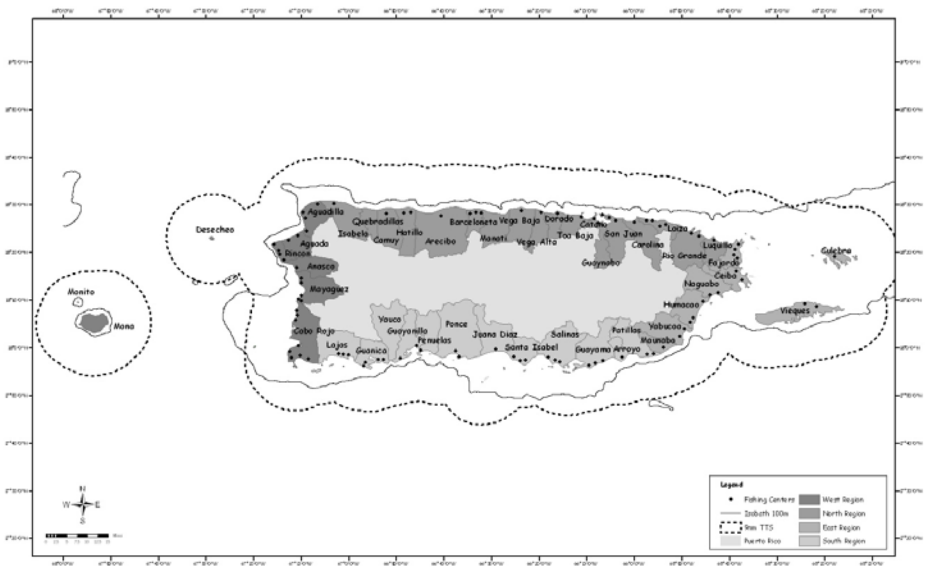

Figure 6.8.5. Map depicting fishing center (municipality) locations for the commercial fisheries in Puerto Rico.

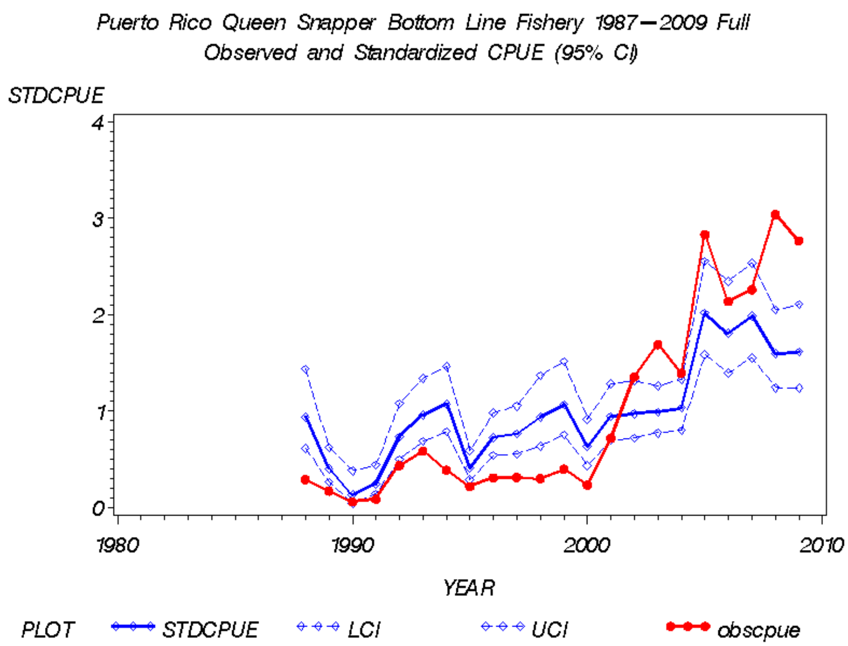

Figure 6.8.6. Queen snapper nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels fishing bottom lines in Puerto Rico. CPUE = pounds per trip

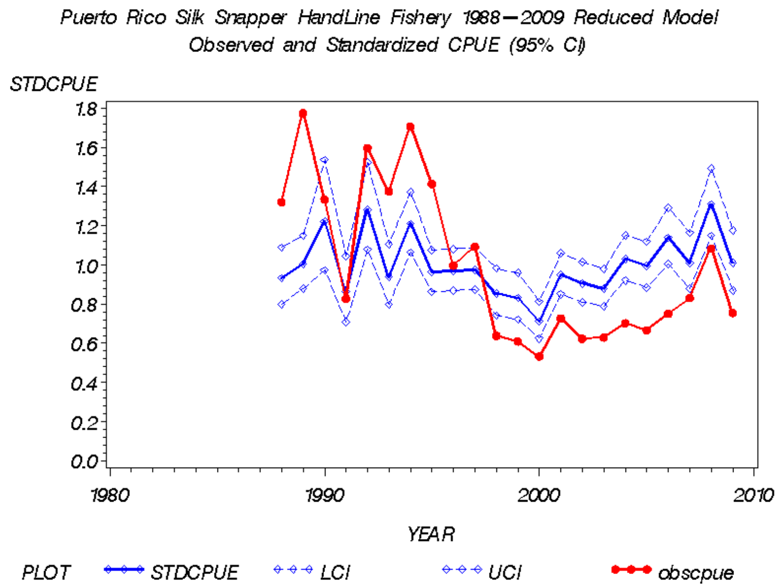

Figure 6.8.7. Silk snapper nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels fishing handlines in Puerto Rico. CPUE = pounds per trip

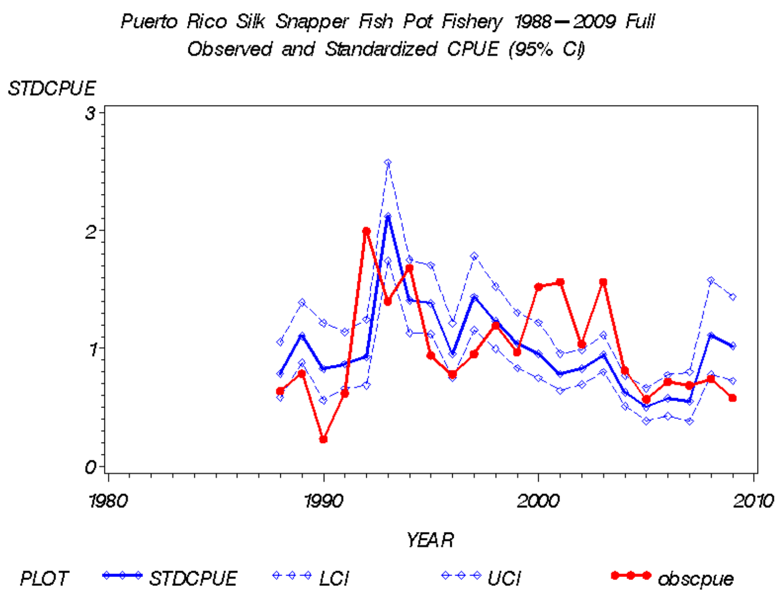

Figure 6.8.8. Silk snapper nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels fishing fish pots in Puerto Rico. CPUE = pounds per trip

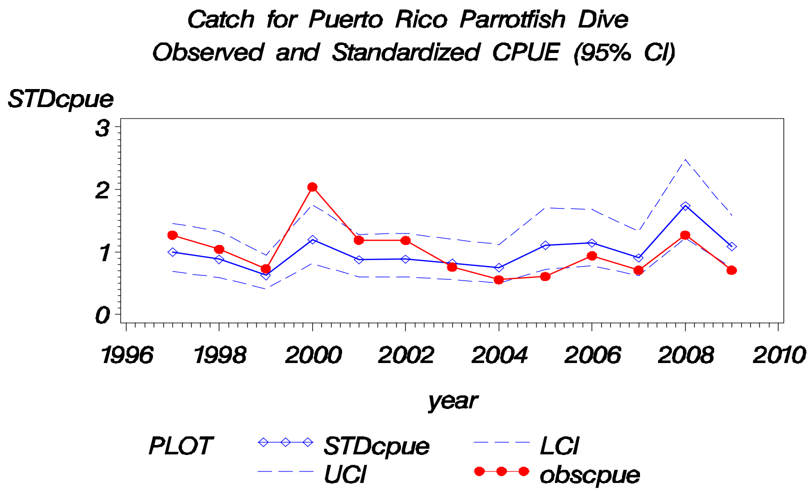

Figure 6.8.9. Parrotfish nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels diving for fish in Puerto Rico. CPUE = number of fish per trip

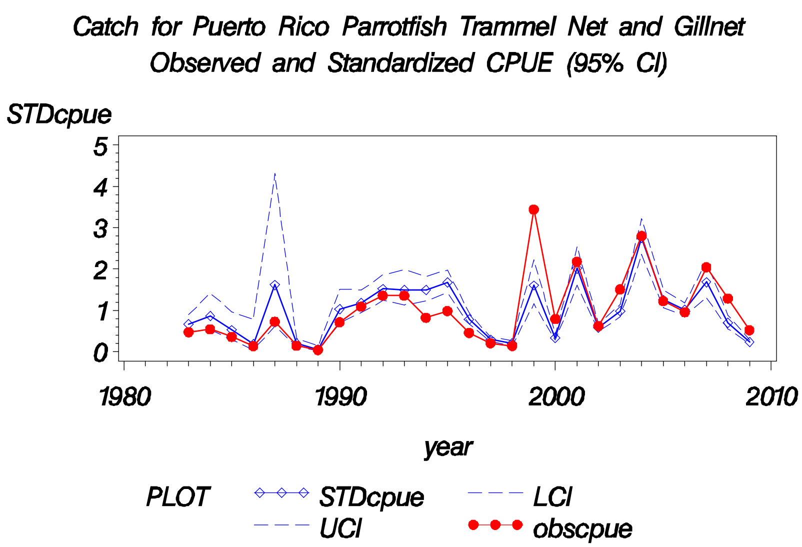

Figure 6.8.10. Parrotfish nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels using trammel and gillnets in Puerto Rico. CPUE = length (fathoms) by hours soaked

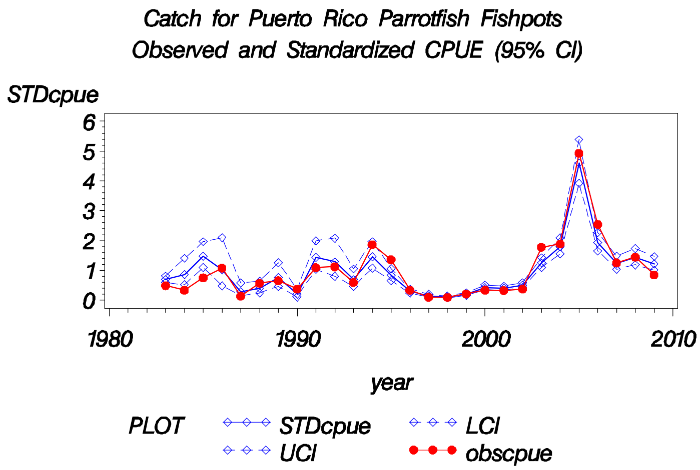

Figure 6.8.11. Parrotfish nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels using fish pots in Puerto Rico. CPUE = number of fish per fish pot

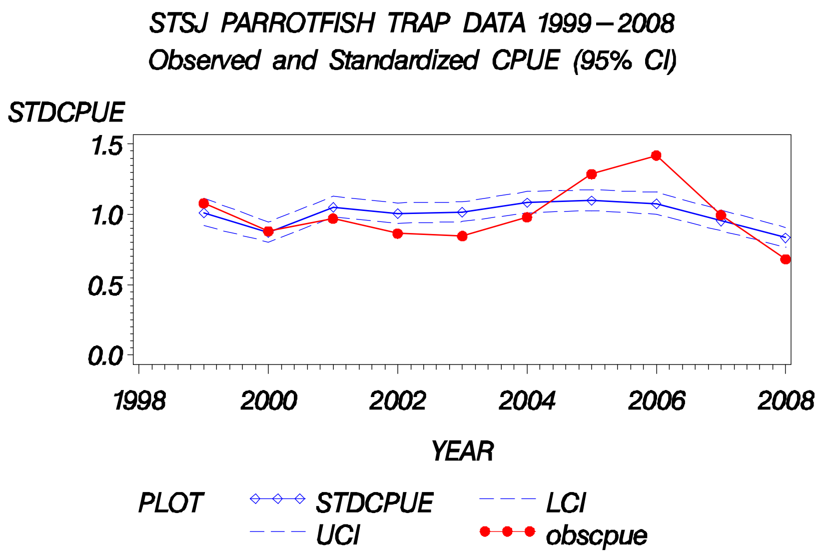

Figure 6.8.12. Parrotfish nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels fishing fish traps/pots in St. Thomas/St. John. CPUE = pounds parrotfish/trap haul/trip

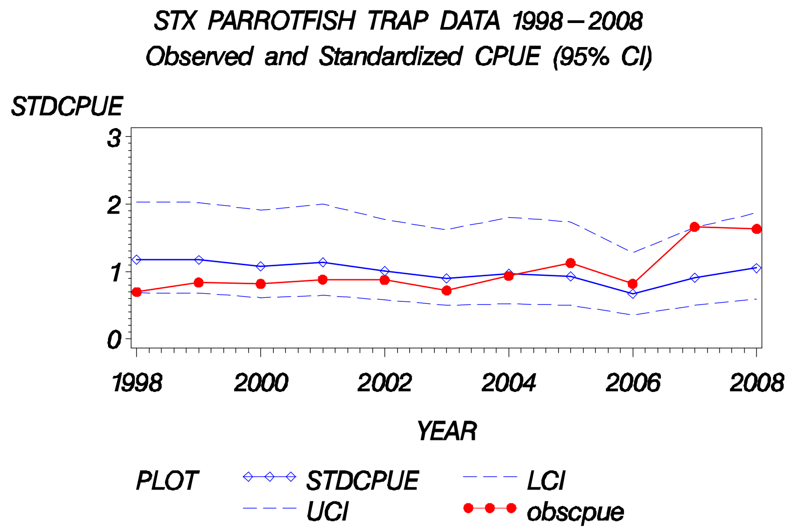

Figure 6.8.13. Parrotfish nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial vessels fishing fish traps/pots in St. Croix. CPUE = pounds parrotfish/trap haul/trip

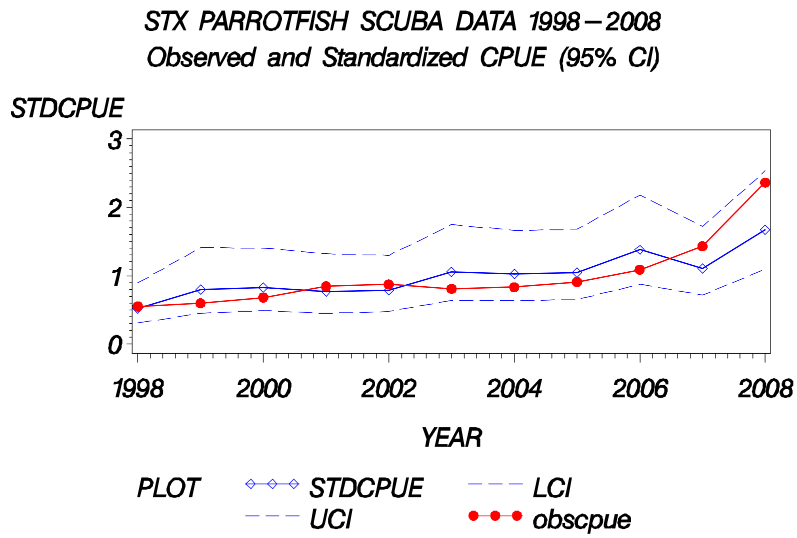

Figure 6.8.14. Parrotfish nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial fishers using SCUBA in St. Croix. CPUE = pounds parrotfish/(amount of gear*trip duration).

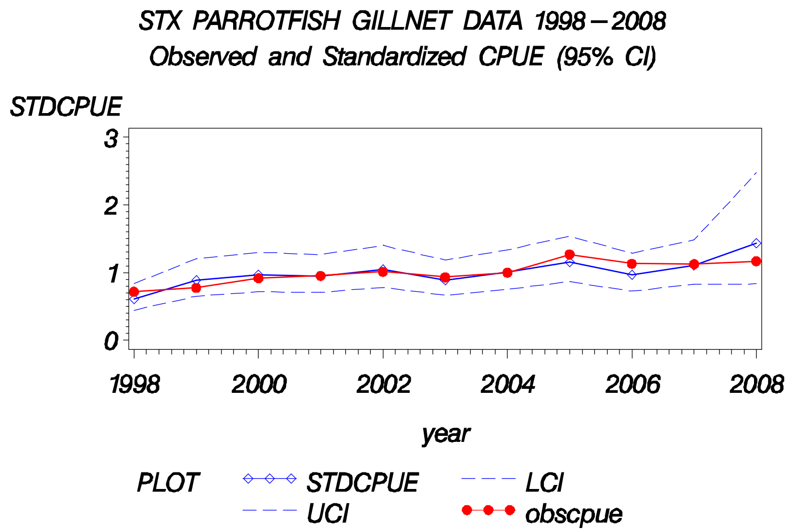

Figure 6.8.15. Parrotfish nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for commercial gillnet vessels in St. Croix. CPUE = pounds parrotfish/(number of nets*trip duration).

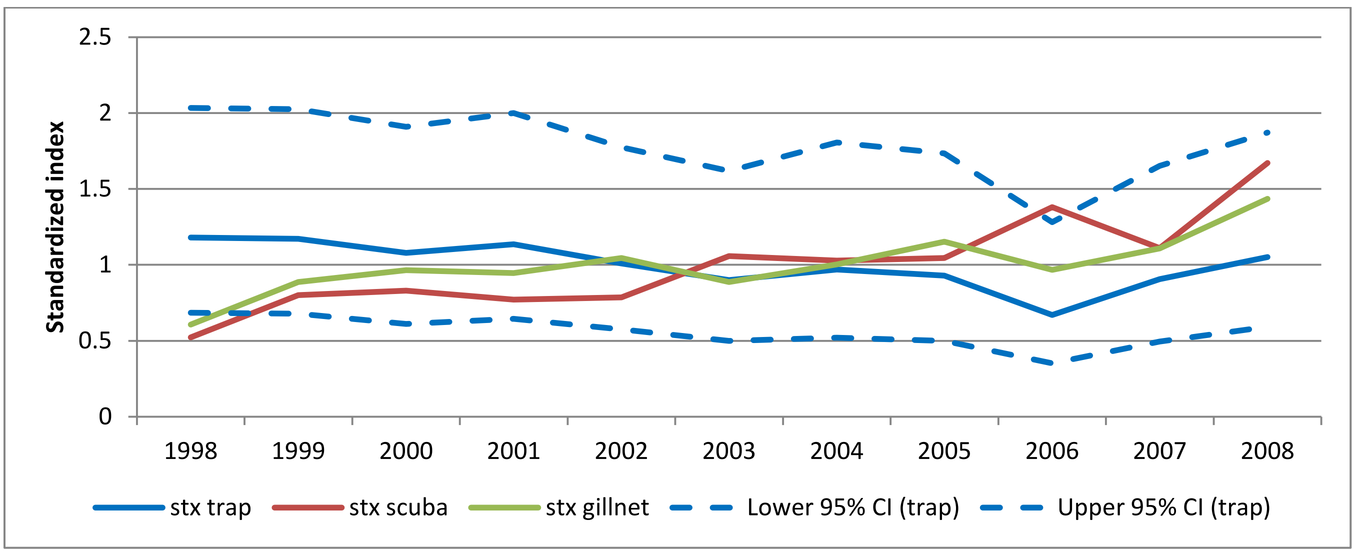

Figure 6.8.16. Parrotfish nominal standardized CPUE of commercial fishing vessels in St. Croix. Fish traps/pots CPUE = pounds parrotfish/trap haul/trip; SCUBA CPUE = pounds parrotfish/(amount of gear*trip duration); Gillnet

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 500l 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

	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?	✓			

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.

	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	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.

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:

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)

	Not Applicable	Absent	Incomplete	Complete
DESCRIPTION OF THE DATA SOURCE				
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				
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

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

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.	✓			

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.	✓			

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 Redtail Parrotfish: St. Croix Commercial Gillnet (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.

	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:

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

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.

	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)

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.

	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 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.

	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:

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	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				
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 Redtail Parrotfish

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. 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. 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. 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. 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) for redtail parrotfish were length frequency observations from the National Marine Fisheries Service (NMFS) Trip Interview Program (TIP). The data as presented at the DW were used for analysis

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 application of a length based total mortality estimator (Gedamke and Hoenig, 2006) to the available length frequency observations. Section 3.1.3 describes the model configuration and assumptions in detail.

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.*

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 3.3, 4.3, and 5.3.

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'*

Considerable uncertainty exists in the absolute estimates of total mortality from the mean length analysis. A comprehensive sensitivity analysis was conducted to evaluate this uncertainty. This is discussed in Section 3.3, 4.3, and 5.3.

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 significant uncertainty in available life history parameters.

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*

Estimates of population benchmarks were not possible due to data limitations but discussion of results in the context of management is presented in Sections 3.3, 4.3, and 5.3.

1.2.7. Term of Reference 7

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

A discussion of results in the context of management is presented in Sections 3.3, 4.3, 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 was not completed due to 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.

Projections were not considered for this evaluation due to data limitations but discussion of results in the context of management is presented in Sections 3.3, 4.3, 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 should 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.

Length-frequency data and the corresponding age-growth relationships will likely serve as the primary source of information for assessments in the US Caribbean in the near future. A direct focus on increasing sampling intensity with a well-designed program (as being developed in the current Caribbean Data Improvement Plan) should be placed as a top priority.

Reliable estimates of the von Bertalanffy growth parameters, required inputs for length-based mortality estimators, should be another research priority. Deriving age-growth relationships from data collected from the region would also allow stronger conclusions to be drawn from the TIP data. Well-designed age and growth studies in Puerto Rico and the USVI should be instated to meet this research objective.

2. DATA REVIEW AND UPDATE

Length data from the NMFS Trip Interview Program (TIP) was the main source of data for this analysis. The length data were initially evaluated to determine island and gear combinations with sufficient data to conduct analyses (SEDAR26-DW-04). The length-frequency histograms for each combination were evaluated over five year time periods to determine changes in selectivity and length at full vulnerability, L_c, an important input parameter for the length-based mortality estimator that will be explained in Section 3.1.3.

2.1. Puerto Rico

2.1.1. Commercial Landings Data

Updated information on commercial landings of parrotfishes in Puerto Rico was presented in SEDAR 26-DW-03. The reported commercial landings were summarized for the complete time series, 1983-2009. Sales records documenting landed weight by fishing center (Figure 2.6.1) 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. Table 2.5.1 and Figure 2.6.2 presents the reported landings from 1983-2009 for parrotfishes in Puerto Rico. Landings estimated using expansion factors to account for under reporting are also provided in Table 2.5.1.

2.1.2. Recreational Landings Data

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). SEDAR26 DW-02 presented information on recreational catches of redtail parrotfish from 2000-2010 and provided estimates of total angler effort and associated coefficients of variation. Information on directed effort for redtail parrotfish is not available. Table 2.5.2 and Figure 2.6.3 present estimated redtail parrotfish recreational catch since 2000 and Table 2.5.3 and Figure 2.6.4 presents total estimated angler effort.

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

Single species CPUE analyses were not carried out for Puerto Rico fisheries since parrotfish are not identified to species level in the reported landings.

2.1.4. 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.

2.1.5. Length-frequency Analysis

Table 3.5.1 summarizes the sample size and analysis type for each gear type recorded as landing redtail parrotfish in the TIP database. Figures 3.6.1 and 3.6.2 show the length-frequency histograms for the pot and trap fishery and the net fishery. These figures suggest that the length distribution for redtail parrotfish in Puerto Rico has been stable over time. The stability of the length distribution of redtail parrotfish landings reported in the TIP database is also shown in Figures 3.5.3 and 3.5.

The SEDAR 26 assessment workshop (AW) panel expressed an interest in evaluating the length-frequency data to identify targeting of spawning aggregations and to determine temporal changes in recruitment. Redtail parrotfish are thought to spawn year-round in groups or in pairs (Figuerola et al. 1998). Monthly length-frequency plots are shown in Figures 3.6.5 and 3.6.6 for the pot and trap fishery and the net fishery, respectively. The length-frequency histograms are similar among months and well developed for all calendar months. Figures 2.6.5 and 2.6.6 do not suggest fishers are targeting spawning aggregations. Annual length-frequency plots suggest the length-distribution of the catch has remained stable over time (Figures 3.6.7 and 3.6.8).

2.1.6. Auxiliary information from the TIP database

The AW panel also expressed a concern about spatio-temporal patterns in fishing. The TIP database contains some information about fishing region and depth. Figures 3.6.9 and 3.6.10 show the number of interviews reporting redtail parrotfish landings by fishing region. The number of interviews reporting redtail parrotfish landings caught by the pot and trap fishery have been mainly in the west, southwest and southeast regions of Puerto Rico (Figure 3.6.9). A greater number of interviews reported landings in the west, southwest region earlier in the time series than the southeast region, indicating a potential shift is the regional distribution of effort. The net fishery, as depicted in the TIP database, has mainly occurred in the west, southwest region (Figure 3.6.10). The depth distribution of fishing has been seemingly stable over time for the pot and trap fishery and the net fishery (Figures 3.6.11 and 3.6.12). The mean depth of fishing for both fisheries lies between 10 and 25 fathoms.

2.2. St. Thomas/St. John

2.2.1. St. Thomas/St. John Commercial Landings

The Data Workshop Panel recommended that the time series for commercial landings of redtail parrotfish include the years 1998-2008. That period included the first complete year during which species were reported by species group rather than as “snapper-grouper” and “not snapper-grouper” or by gear fished (e.g., “pot fish”) and also included the final complete year of data available for this assessment. In addition, the assumption was also made, and supported by the DW Panel, that the majority of landings reported as “parrotfish” in St. Thomas/St. John were redtail parrotfish.

Following much discussion and review of the SEDAR14 Data Workshop Report and the SEDAR Caribbean Data Evaluation Report, the Assessment Workshop Panel recommendation was to use St. Thomas/St. John landings as reported. The Panel found that percentage of fishers reporting landings was sufficiently high that expansion factors were not necessary. The percentage of Virgin Islands commercial license holders who submitted either landings reports or no fishing reports are provided in Figure 2.6.5. For the most recent years in the time series (i.e., the years during which landings of “parrotfish” had been reported; highlighted in the box, Figure 2.6.5), the reporting percentage often approached 100 percent and was below 80 percent only during one year in St. Thomas/St. John. An example of monthly reporting frequency within a fishing year is shown in Figure 2.6.6, where reporting percentage was above 90 percent for most months. Parrotfish landings by year and gear, as reported, are provided in Table 2.5.4a. The total number of commercial fishing trips reporting landings (of any species) by gear is provided in Table 2.5.4b.

2.2.2. Recreational Landings

Recreational landings and effort data were not available for St. Thomas/St. John.

2.2.3. St. Thomas/St. John Indices of Abundance

A description of the methods used to construct US Virgin Islands fishery dependent indices of abundance are provide in document SEDAR26-DW09. The methods used to construct the indices were approved either in plenary session at the data workshop or in a post-workshop webinar.

2.2.4. Length-frequency Analysis

Table 3.5.1 summarizes the sample size and analysis type for each gear type recorded as landing redtail parrotfish in the TIP database. The only gear type with sufficient sample size for analysis is pots and traps. Figure 4.6.1 shows the length-frequency histogram for the pot and trap fishery. The length-frequency histograms and the density curves presented in Figures 4.6.1 and 4.6.2 suggest the length-distribution of the fish landed by the pot and trap fishery in St. Thomas/St. John has been stable over time.

Monthly length-frequency histograms suggest that the length distribution of landed redtail parrotfish is similar among months (Figure 3.6.3). It is not evident that fishers target spawning aggregations. Given the variability in annual sample size it is not possible to use the TIP database to identify recruitment patterns for redtail parrotfish in St. Thomas/St. John (Figure 3.6.4).

2.2.5. Auxiliary information from the TIP database

There are no obvious spatio-temporal trends in fishing in St. Thomas/St. John given insufficient sample size. Figure 2.6.5 shows the number of recorded interviews by fishing region. The majority of interviews indicated fishing in the southwest region of St. Thomas/St. John, however, the sample size is quite small (N=49). The number of interviews reported fishing depth was also variable among years. Figure 4.6.6 suggests that mean depth of fishing has been relatively constant over time and has been between 10 and 25 fathoms.

2.3. St. Croix

2.3.1. St. Croix Commercial Landings

As discussed in Section 2.2.1, the Assessment Workshop panel recommended using St. Croix parrotfish landings as reported for the years 1998-2008. Parrotfish landings by year and gear for

St. Croix are provided in Table 2.5.5a. The total number of commercial fishing trips reporting landings (of any species) by gear is provided in Table 2.5.5b.

2.3.2. Recreational Landings

Recreational landings and effort data were not available for St. Croix.

2.3.3. St. Croix Indices of Abundance

A description of the methods used to construct US Virgin Islands fishery dependent indices of abundance are provide in document SEDAR26-DW09. The methods used to construct the indices were approved either in plenary session at the data workshop or in a post-workshop webinar.

2.3.4. Length-frequency analysis

Table 3.5.1 summarizes the sample size and analysis type for each gear type recorded as landing redtail parrotfish in the TIP database. The majority of TIP records for redtail parrotfish in St. Croix indicate they are mainly caught by pots and traps followed by nets and divers. Figures 5.6.1-5.6.3 show the length-frequency histograms and Figures 4-6 show the corresponding density curves for the pot and trap fishery and the net fishery. The ascending limb of the length-distribution of fish landed by the pot and trap fishery has shifted towards smaller sized fish over time (Figures 5.6.1 and 5.6.4). The length distribution between time periods for the net fishery and the diver-based fishery are more variable between time periods than the pot and trap fishery. After 1997 the length distribution of redtail parrotfish increased for the time period 1998-02, shifts towards smaller redtail parrotfish in 2003-2007 and finally shifts towards larger redtail parrotfish between 2008-2011 (Figures 5.6.2 and 5.6.5). Ignoring the time period 1998-2002 due to small sample size, the length-distribution of redtail parrotfish for the diver-based fishery has shifted towards landing larger individuals over time (Figures 5.6.3 and 5.6.6).

As indicated in Section 2.1.1 the length-frequency data were evaluated to identify whether fishers target spawning aggregations. The majority of fish measured and recorded in the TIP database fall at or above the reported mean length of maturity, ~235mmin Puerto Rico (Figuerola and Torres, 1997; Figuerola et al. 1998; Figures 5.6.7-5.6.9). It is not evident that fishers target spawning aggregations from the length-frequency histograms for the pot and trap fishery, the net fishery, and the diver-based fishery (Figures 2.6.7-2.6.9). The length data were also plotted to examine annual length frequency plots to identify recruitment patterns, no obvious patterns emerged (Figures 5.6.10-5.6.12).

2.3.5. Auxiliary information from the TIP database

Spatio-temporal patterns were evaluated using the TIP database. Figures 5.6.13-5.6.15 show the number of interviews with respect to regional fishing distribution. The majority of interviews reported fishing in the east region of St. Croix in the late 1980s and early 1990s (Figure 5.6.13). The data indicate a shift of fishing towards the northeast region of St. Croix in the early 1990s to the early 2000s. There has also been some fishing in the southeast and southwest of St. Croix (Figure 5.6.13). The number of interviews from the net fishery reporting regional fishing is minimal and any patterns shown in Figure 5.6.14 may not genuinely reflect the effort distribution of the net fishery. The same holds true for the diver fishery as well (Figure 5.6.15).

The mean depth of fishing for redtail parrotfish by the pot and trap fishery remained very stable over most of the time series (1983-2002; Figure 5.6.16). More recently, 2005-2008, the mean depth has been more variable and the sample size is much lower than previous years. The mean depth of fishery for the net fishery has been more variable than the pot and trap fishery (Figure 5.6.17). Mean depth of fishing was between 11 and 12 fathoms (similar to the pot and trap fishery) during the late 1980s until the early 2000s and declined over the remaining years. Figure 5.6.18 shows the mean depth of fishing for the diver-based fishery; samples were not consistent over time and a pattern is discernible.

2.4. References

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.

Cummings, N.J. and V. Matter. 2011. Summarized information on recreational catches of silk and queen snapper and parrotfish in Puerto Rico since 2000. SEDAR 26–DW-02.

Ingram, 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.

McCarthy, K.J. 2011. Standardized catch rates of parrotfish from commercial fish traps, SCUBA, and gillnets in the US Virgin Islands, 1998-2008. SEDAR 26–DW–09.

2.5. Tables

Table 2.5.1. Reported commercial landings of parrotfish family in Puerto Rico, 1983-2009. 2009 data are preliminary. Data presented = number reported landings observations (N) and reported pounds (whole weight). Landings as estimated using expansion factors to account for under reporting are also presented.

Year	Number of Reports	Parrotfish Pounds Landed (reported)	Parrotfish Pounds Landed (expanded)
1983	2,677	233,579	382,954
1984	1,698	231,387	392,189
1985	2,105	221,378	395,416
1986	1,763	105,546	140,724
1987	1,370	76,854	102,478
1988	265	12,208	21,822
1989	71	4,279	8,393
1990	470	36,849	72,269
1991	914	68,059	133,489
1992	1,134	91,932	153,229
1993	1,171	160,187	266,961
1994	1,549	115,750	180,931
1995	2,017	79,881	112,449
1996	2,547	102,799	144,705
1997	2,713	110,944	142,271
1998	2,433	97,503	125,025
1999	2,403	80,547	103,272
2000	3,054	74,041	130,092
2001	3,665	96,762	142,285
2002	3,172	107,485	124,912
2003	3,277	69,229	115,470
2004	2,488	51,152	145,568
2005	1,644	31,157	141,577
2006	1,792	31,922	51,015
2007	1,858	33,742	58,056
2008	1,740	28,134	88,708
2009	1,969	28,353	60,560

Table 2.5.2. Estimated recreational AB1 (landings) and B2 (discards) catch for redtail parrotfish in Puerto Rico from the MRIP survey. AB1 and B2 units are numbers of fish.

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
redtail parrotfish Total		18,479	22,221

Table 2.5.3. Estimated number recreational angler trips in Puerto Rico, 2000-2010. Source = MRIP survey.

YEAR	Estimated Number of Trips	Coefficient of Variation (Estimated 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

Table 2.5.4a. St. Thomas/St. John parrotfish commercial fishing vessel landings in pounds (as reported).

Year	Line Fishing	Multiple Gears	Nets	SCUBA	Traps	Unknown
1998	154	confidential	confidential	585	20,058	
1999	315	106	confidential	1,953	35,674	
2000	460	confidential	101	1,382	33,129	confidential
2001	997	confidential		1,751	47,377	
2002	566	confidential		2,367	42,851	
2003	1,484	100	confidential	3,650	47,949	
2004	879	confidential	confidential	714	57,038	
2005	374	78	106	confidential	47,958	
2006	495	1,735	456	1,457	40,095	
2007	227	1,282	103	451	38,314	confidential*
2008	270		confidential	376	38,655	

*landings from trips with unknown gears combined with landings from multiple gear trips

Table 2.5.4b. St. Thomas/St. John total effort (number of commercial fishing trips).

Year	Line Fishing	Longline	Multiple Gears	Nets	SCUBA	Traps	Unknown
1998	762		29	213	90	1,305	7
1999	1,434		27	451	186	2,474	confidential*
2000	1,978		5	587	271	2,548	confidential*
2001	2,499		41	530	408	2,714	confidential*
2002	2,338		35	531	438	2,697	confidential*
2003	1,955		30	517	365	2,789	
2004	1,716		13	540	155	2,789	
2005	1,529	confidential*	138	490	141	2,628	
2006	1,756		166	624	197	2,487	confidential*
2007	1,458	confidential*	165	548	189	2,427	confidential*
2008	1,265	confidential*	20	543	160	2,498	confidential*

*effort (number of trips) with longline and unknown gears combined with multiple gear effort

Table 2.5.5a. St. Croix parrotfish commercial fishing vessel landings in pounds (as reported).

Year	Line Fishing	Multiple Gears	Nets	SCUBA	Traps	Unknown
1998	2,073	40,706	72,569	20,734	68,039	9,338
1999	3,020	14,600	121,421	29,520	67,301	confidential*
2000	2,002	1,667	152,825	51,991	51,990	
2001	3,242	386	170,508	62,977	53,386	confidential*
2002	2,528	544	148,738	89,414	66,367	confidential*
2003	905	confidential	144,186	81,602	35,656	
2004	1,247	8,032	178,789	91,658	39,470	54
2005	1,320	5,831	222,981	109,692	36,565	confidential*
2006	1,144	4,717	256,575	143,301	27,608	
2007	3,353	35,636	201,998	140,722	36,389	228
2008	7,413	11,984	128,681	175,773	32,712	

*landings from trips with unknown gears combined with landings from multiple gear trips

Table 2.5.5b. St. Croix total effort (number of commercial fishing trips).

Year	Line Fishing	Longline	Multiple Gears	Nets	SCUBA	Traps	Unknown
1998	2,897		312	898	2,182	2,349	247
1999	3,321		135	947	2,361	2,045	9
2000	3,568		92	876	3,431	2,154	
2001	4,594		137	1,129	4,474	2,247	15
2002	5,654		147	1,007	4,703	2,451	13
2003	4,641		12	962	4,566	1,854	21
2004	4,193		59	978	4,840	1,898	30
2005	4,035		123	1,116	5,036	1,891	3
2006	4,343		96	1,158	5,969	1,670	
2007	4,020	confidential*	478	871	5,290	1,425	3
2008	2,857	confidential*	417	687	4,688	1,156	

*effort (number of trips) with longline gear combined with multiple gear effort

2.6. Figures

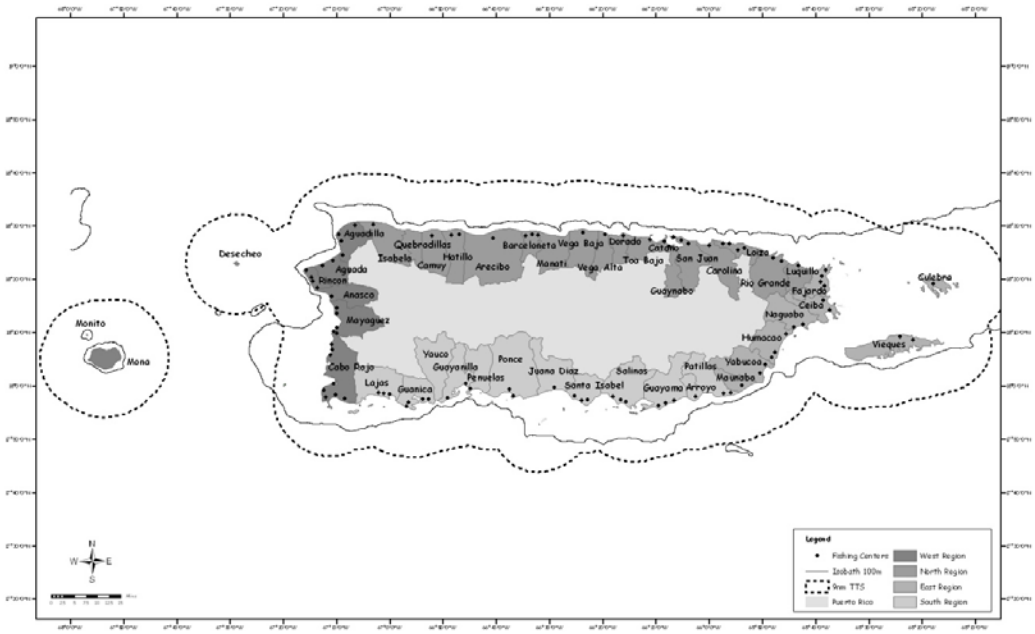

Figure 2.6.1. Map depicting fishing center (municipality) locations for the commercial fisheries in Puerto Rico.

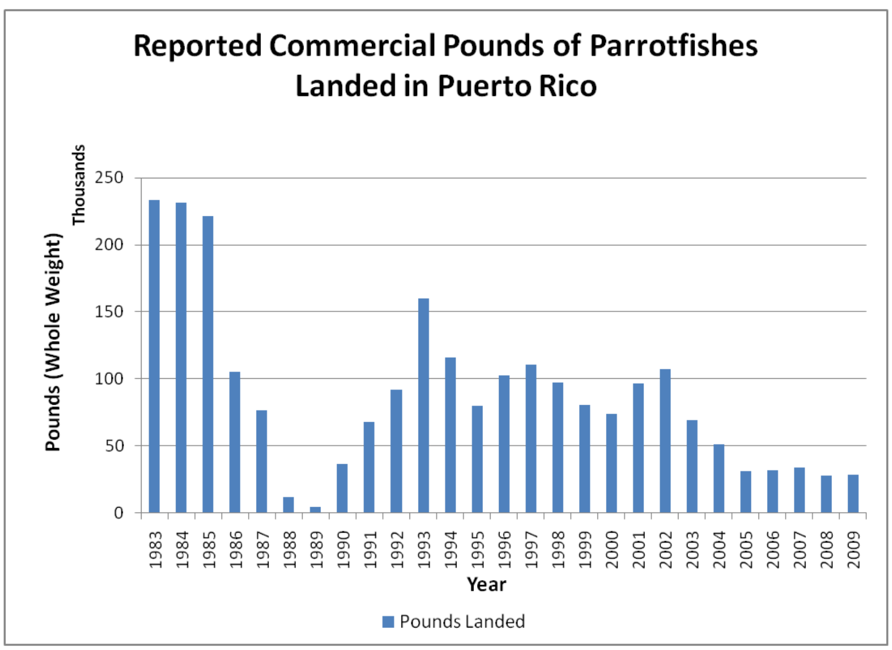

Figure 2.6.2. Reported commercial landings of parrotfish family in Puerto Rico, 1983-2009. 2009 data are preliminary.

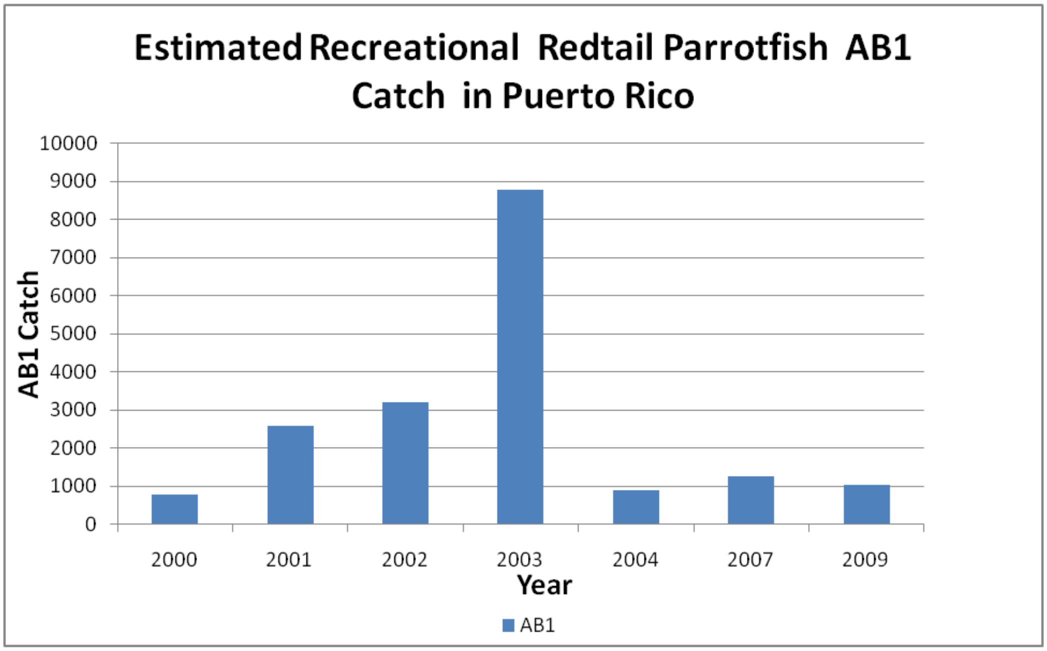

Figure 2.6.3. Estimated recreational catch of redtail parrotfish in Puerto Rico 2000-2010. Source = MRIP. Data are AB1 catch (numbers of fish).

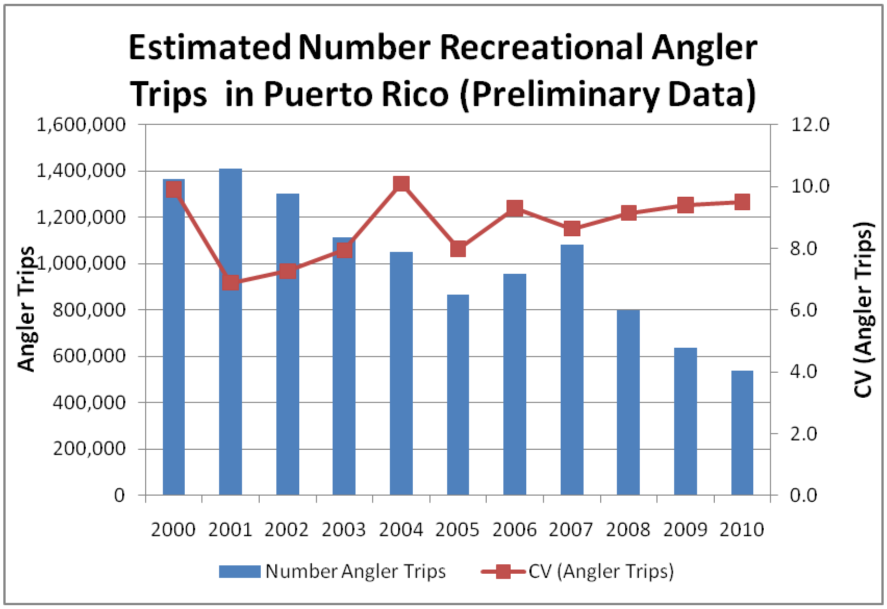

Figure 2.6.4. Profile of estimated number recreational angler trips in Puerto Rico 2000-2010. Source =MRIP survey.

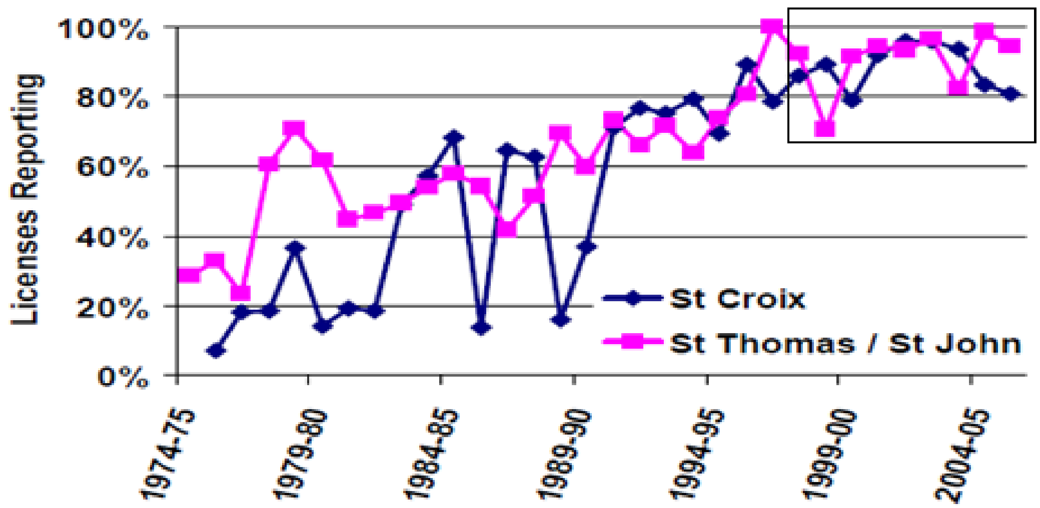

Figure 2.6.5. Percentage of Virgin Islands commercial license holders reporting either landings or no fishing by year. Most recent years (highlighted in the box) include the years during which landings of "parrotfish" had been reported. This figure was taken from the SEDAR 14 Data Workshop Report (DW Figure 2) where data for the fishing year 2005-06 were the most recent data available.

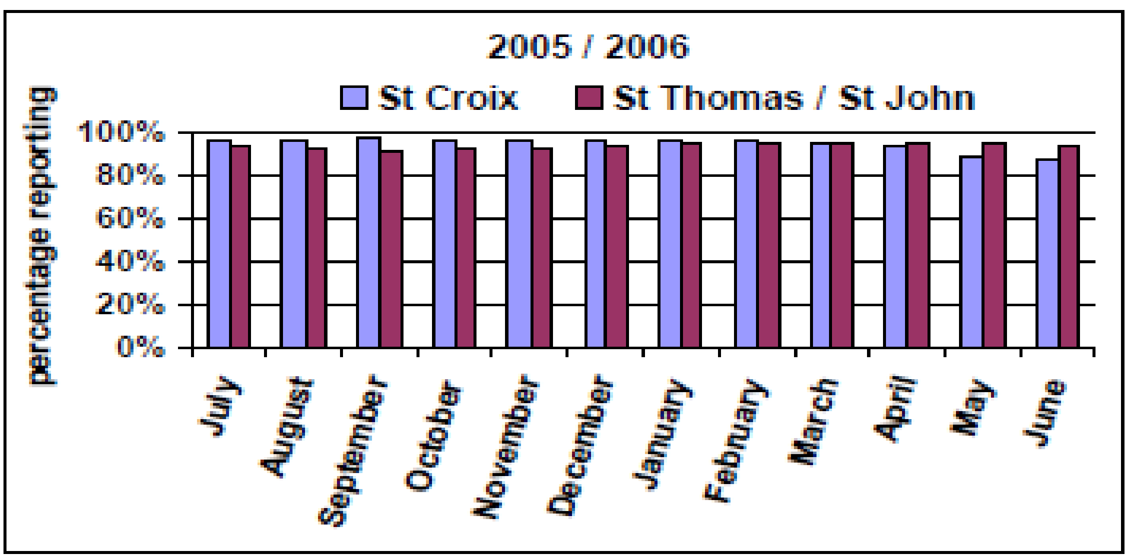

Figure 2.6.6. Percentage of Virgin Islands commercial license holders who reported landings or no fishing by moth during the 2005-06 fishing year. This figure was taken from the SEDAR 14 Data Workshop Report (DW Figure 3).

3. Puerto Rico Parrotfish Stock Assessment Models and Results

3.1. Model 1 – Length frequency analysis of TIP data Methods

3.1.1. Overview

The main source of data for redtail parrotfish is length data from the NMFS TIP database. A review of the length frequency data available from the NMFS Trip Interview Program (TIP) database showed that sample sizes were sufficient to conduct a comprehensive time-series analysis for a limited number of species, island, and gear combinations (see SEDAR-DW-04 paper). 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).

3.1.2. Data Sources

The only source of data for this analysis was from the TIP database (detailed evaluation is presented in SEDAR-DW-04 paper). Input values for other necessary values were gathered from available literature (Table 3.5.2). At the data workshop (DW) and the assessment workshop (AW) considerable uncertainty about existing von Bertalanffy growth parameters was expressed. Information from comparable species and expert opinion were used to develop the sensitivity range for the input parameters, which will be explained later.

3.1.3. Model Configuration and Equations

The Beverton-Holt mortality estimator has received widespread use, especially in data-limited situations, because the only required information is 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:

$$Z = \frac{K(L_\infty - \bar{L})}{\bar{L} - L_c} \quad .$$

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 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 3.6.1 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.

3.1.4. Parameters Estimated

The parameters estimated by the non-equilibrium length method as described in Section 3.1.3 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.

3.1.5. Uncertainty and Measures of Precision

The panel at the SEDAR 26 data workshop (DW) and assessment workshop (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 value of the von Bertalanffy growth parameter (K) used for base case model runs was 0.78 (Molina-Urena 2009). For all sensitivity analyses the range of K inputs were set to a value 60% above and below the base value; the range of the K explored was 0.312 – 1.212. The range of the asymptotic growth parameter (L_∞) explored varied according the relationship between the base case value and the maximum observed length. The value used for base case model runs was 300mm, which represents the mean of the two estimates obtained from Molina-Urena (2009). The upper bound was either 1) the maximum observed length, which was gear-dependent, 2) 10% above the base value when the maximum observed was less than the base case 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 length frequency histograms (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 Lc values used in the sensitivity analysis were clearly below the actual length at full vulnerability and included only to demonstrate model behavior.

3.1.6. 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.

3.1.7. Projection methods

NA

3.2. Model 1 Results – Length frequency analysis of TIP data

3.2.1. Measures of Overall Model Fit

The AIC results did not provide strong support (ΔAIC <5) for a model indicating a change in the estimate of total mortality (Z) for neither the pot and trap fishery or the net fishery (Tables 3.5.3 and 3.5.4). Figures 3.6.13 and 3.6.14 show the model fit to the data for the pot and trap fishery and the net fishery, respectively.

3.2.2. Parameter estimates & associated measures of uncertainty

Section 3.2.8 provides further explanation of the results from the sensitivity analysis.

3.2.3. Stock Abundance and Recruitment

NA

3.2.4. Stock Biomass

NA

3.2.5. Fishery Selectivity

NA

3.2.6. 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.

3.2.7. Stock-Recruitment Parameters

NA

3.2.8. Evaluation of Uncertainty

Tables 3.5.5 and 3.5.6 summarize the input parameter range explored in the sensitivity analysis when using data from the pot and trap fishery and the net fishery, respectively. Model convergence problems were encountered (i.e., mortality estimates hit lower bound of 0.001 or upper bound of 5) when using unrealistic input parameter combinations. Figures 3.6.15 and 3.6.16 summarize the number of times the model failed to converge with respect to the input parameter values. In general, the number of convergence failures increased with an increasing L_c input value. The increased frequency of convergence failures corresponds to L_c values paired with L_∞ values that are less than or close to the L_c value. The size distribution for redtail parrotfish has remained relatively stable over time, lending confidence in the chosen value of L_c from visual inspection. Given this confidence, rather than present sensitivity results from unrealistic parameter combinations the presentation of the results will focus on the base case value of Lc, the full range of the K values and a subset of the L_∞ values. The results from the comprehensive sensitivity analysis are presented in the Appendix.

Figures 3.6.17 and 3.6.18 show the range of current total mortality estimates resulting from the time-series analysis. For sensitivity runs done with the data from the pot and trap fishery and the net fishery, current total mortality represents a single estimate for the entire time period. AIC results did not provide strong support for the model predicting a change in total mortality for the combinations of the von Bertalanffy growth parameters with the base case value of L_c. The range of the absolute total mortality estimates was between 0.01(near lower bound) and 4.5; the entire range was estimated for the base case value of L_c. The range of the total mortality estimate is due to increasing values of the von Bertalanffy growth parameters. Total mortality increased with increasing values of K and L_∞ (Figures 3.6.17 and 3.6.18).

3.2.9. Benchmarks / Reference Points / ABC values

NA

3.2.10. Projections

NA

3.3. Discussion

The length frequency analysis was unable to detect a change in total mortality in Puerto Rico and therefore a proportional change in mortality could not be calculated and directional trend was not evident. Without accessory information, and given the extreme variability in von Bertalanffy growth parameter inputs, the resulting absolute estimates of total mortality are unreliable and not useful for management purposes alone. The fact that our analysis was unable to detect a change in mortality and that the size structure of sampled fish has remained relatively stable since 1983 suggests that the population has not undergone significant changes in size during the time period.

Although definitive quantitative metrics are not available from this assessment to define stock status in terms of MSY, there are some qualitative aspects which suggest that the current and proposed management plan is risk averse. First, the stability of the size structure suggests that exploitation levels have been sustainable. Secondly, the majority of measured fish are above the reported size at maturity for the species. Lastly, the proposed ACL (68,000 lbs.) in the 2010 amendment are intended to reduce parrotfish average landings by at least 15 percent and are below the SSC recommendation of 80,000 lbs.

3.4. References

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3.5. Tables

Table 3.5.1. 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 TIP database.

SPECIES NAME	ISLAND	GEAR NAME	SAMPLES	ANALYSIS
REDTAIL PARROTFISH	PUERTO RICO	DIVERS	199	ID
REDTAIL PARROTFISH	PUERTO RICO	HOOK AND LINE	183	ID
REDTAIL PARROTFISH	PUERTO RICO	NETS	6853	TS
REDTAIL PARROTFISH	PUERTO RICO	POTS AND TRAPS	3693	TS
REDTAIL PARROTFISH	ST CROIX	DIVERS	3111	TS
REDTAIL PARROTFISH	ST CROIX	HOOK AND LINE	239	ID
REDTAIL PARROTFISH	ST CROIX	NETS	6761	TS
REDTAIL PARROTFISH	ST CROIX	POTS AND TRAPS	25393	TS
REDTAIL PARROTFISH	ST THOMAS	HOOK AND LINE	1	ID
REDTAIL PARROTFISH	ST THOMAS	NETS	42	ID
REDTAIL PARROTFISH	ST THOMAS	POTS AND TRAPS	1481	TS

Table 3.5.2. Input parameter values for base case scenario. L_C: length at full vulnerability, K: von Bertalanffy growth parameter, and L_∞: the asymptotic length.

SPECIES NAME	ISLAND	GEAR NAME	Lc	VBK	$L\infty$
REDTAIL PARROTFISH	PUERTO RICO	NETS	266	0.78	300
REDTAIL PARROTFISH	PUERTO RICO	POTS AND TRAPS	256	0.78	300
REDTAIL PARROTFISH	ST CROIX	DIVERS	272	0.78	300
REDTAIL PARROTFISH	ST CROIX	NETS	272	0.78	300
REDTAIL PARROTFISH	ST CROIX	POTS AND TRAPS	262	0.78	300
REDTAIL PARROTFISH	ST THOMAS	POTS AND TRAPS	280	0.78	300

Table 3.5.3. Summary of time-series analysis results for the base case for redtail parrotfish caught by pots and traps in Puerto Rico. Npar is the number of parameters, LLIKE is the negative log-likelihood, Z is total mortality, and ΔYear is the estimated year of change.

Npar	Nobs	AIC	LLIKE	Z	Sigma	Lc	VBK	L_Inf	Z1	ΔYear1	Z2	ΔYear2	Z3	ΔYear3	Z4
2	22	139.081	67.22	0.640	40.31	256	0.78	300	-	-	-	-	-	-	-
4	22	139.879	64.76	-	36.04	256	0.78	300	0.676	2002	0.001	-	-	-	-
6	22	143.125	62.76	-	32.91	256	0.78	300	0.454	1986	0.760	2001	0.139	-	-
8	22	150.144	61.53	-	31.12	256	0.78	300	0.416	1986	0.882	1992	0.645	2002	0.007

Table 3.5.4. Summary of time-series analysis results for the base case for redtail parrotfish caught by nets in Puerto Rico. Npar is the number of parameters, LLIKE is the negative log-likelihood, Z is total mortality, and ΔYear is the estimated year of change.

Npar	Nobs	AIC	LLIKE	Z	Lc	VBK	L_Inf	Z1	ΔYear1	Z2	ΔYear2	Z3	ΔYear3	Z4
2	23	152.511	73.9557	0.324	266	0.78	300	-	-	-	-	-	-	-
4	23	152.425	71.1013	-	266	0.78	300	0.623	1991	0.261	-	-	-	-
6	23	156.334	69.5419	-	266	0.78	300	0.191	1988	1.578	1990	0.258	-	-
8	23	164.493	69.1036	-	266	0.78	300	0.192	1988	1.569	1990	0.266	2005	0.001

Table 3.5.5. The lower bound, the base case, and the upper bound values used for the input parameters for the pot and trap fishery in Puerto Rico.

Parameter	Lower bound	Base	Upper bound
L_c	246mm	256mm	286mm
VBK	0.32	0.78	1.212
L_∞	270mm	300mm	390mm

Table 3.5.6. The lower bound, the base case, and the upper bound values used for the input parameters for the net fishery in Puerto Rico.

Parameter	Lower bound	Base	Upper bound
L_c	256mm	266mm	276mm
VBK	0.32	0.78	1.212
L_∞	270mm	300mm	450mm

3.6. Figures

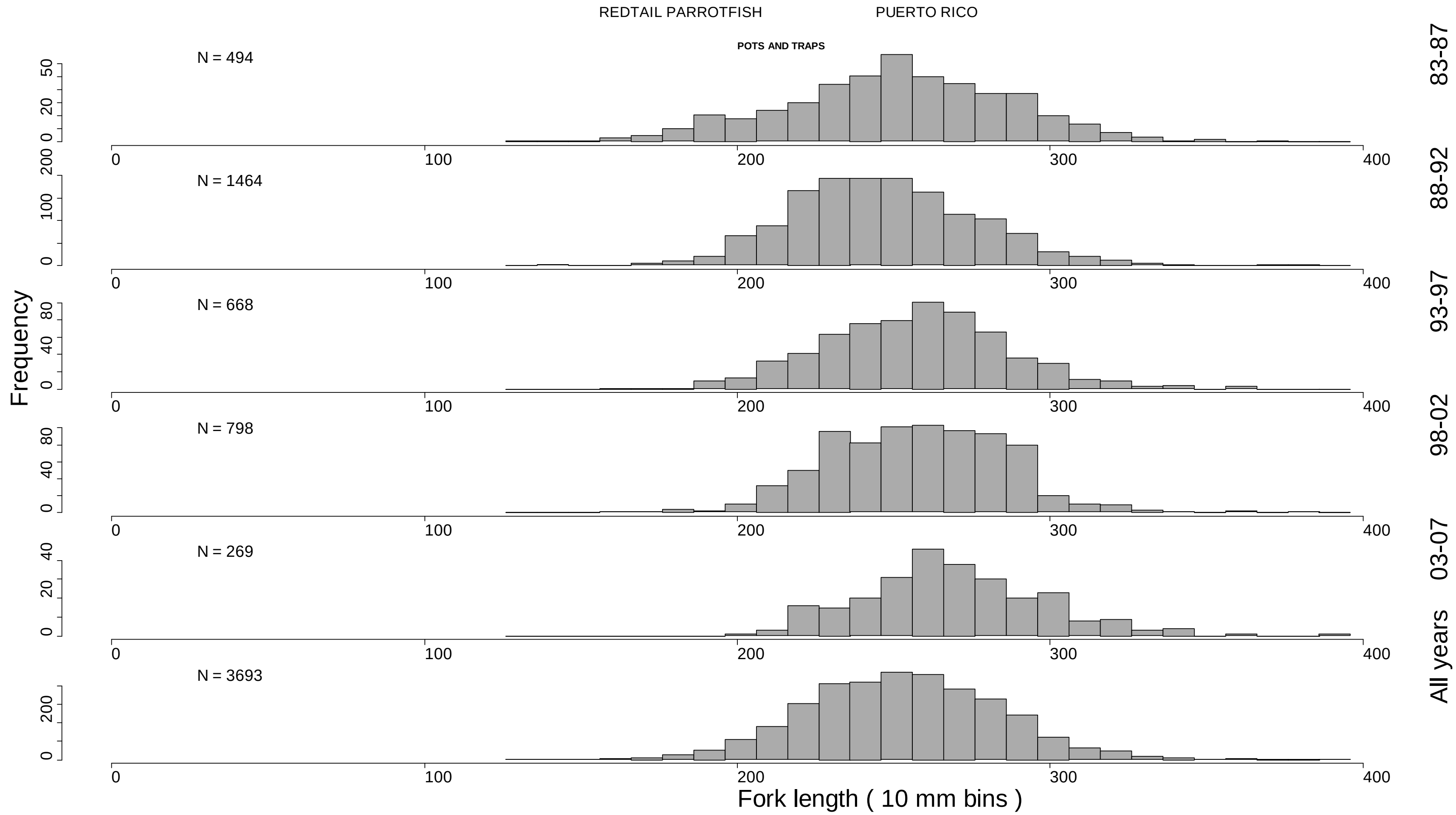

Figure 3.6.1. Length frequency distribution for redtail parrotfish caught by pots and traps in Puerto Rico. Each panel includes data from a five-year time period, which is indicated at the right side of each panel. The bottom panel includes data from all years. Sample numbers (N) are indicated in each panel.

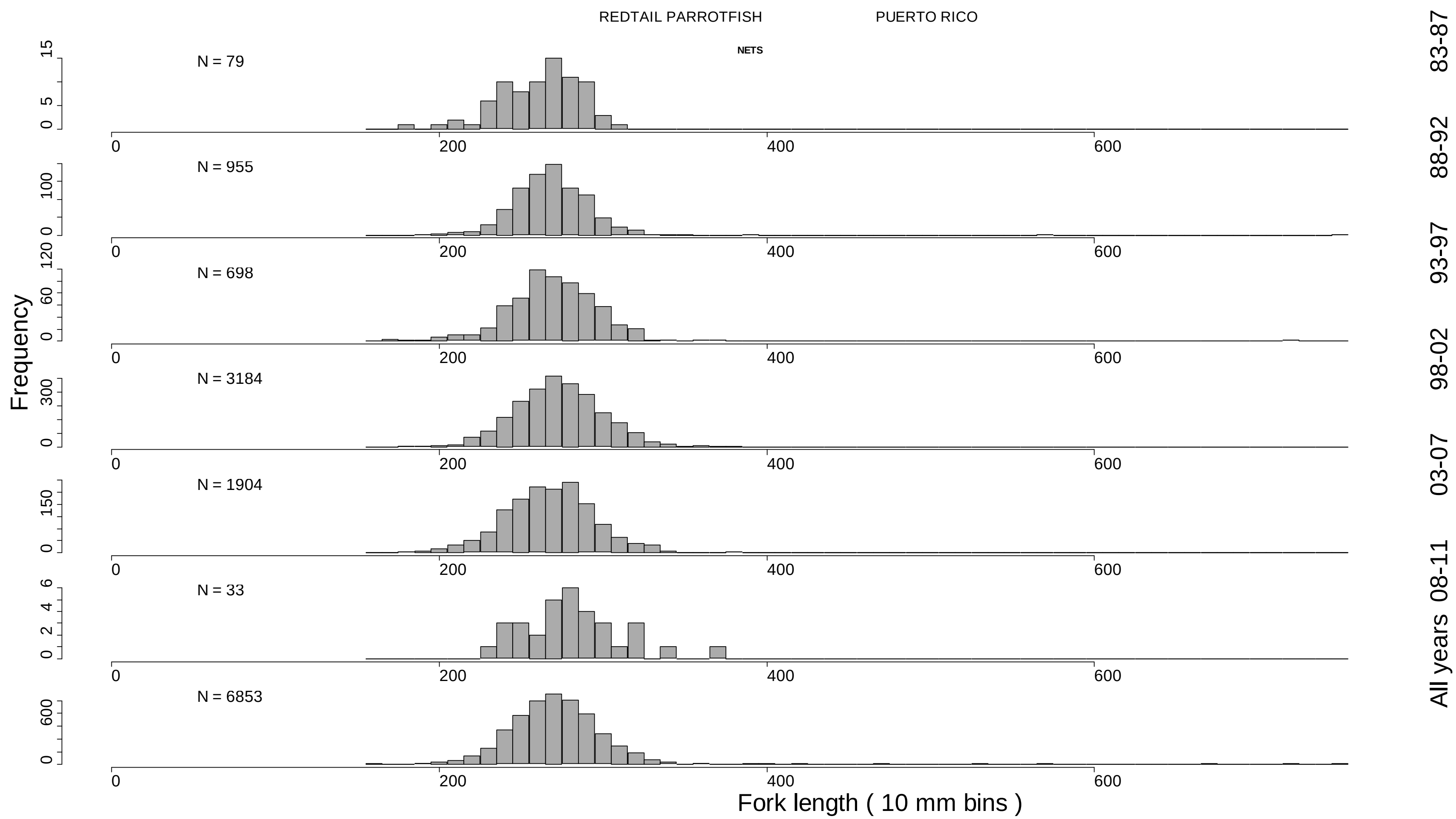

Figure 3.6.2. Length frequency distribution for redtail parrotfish caught by nets in Puerto Rico. Each panel includes data from a five-year time period, which is indicated at the right side of each panel. The bottom panel includes data from all years. Sample numbers (N) are indicated in each panel.

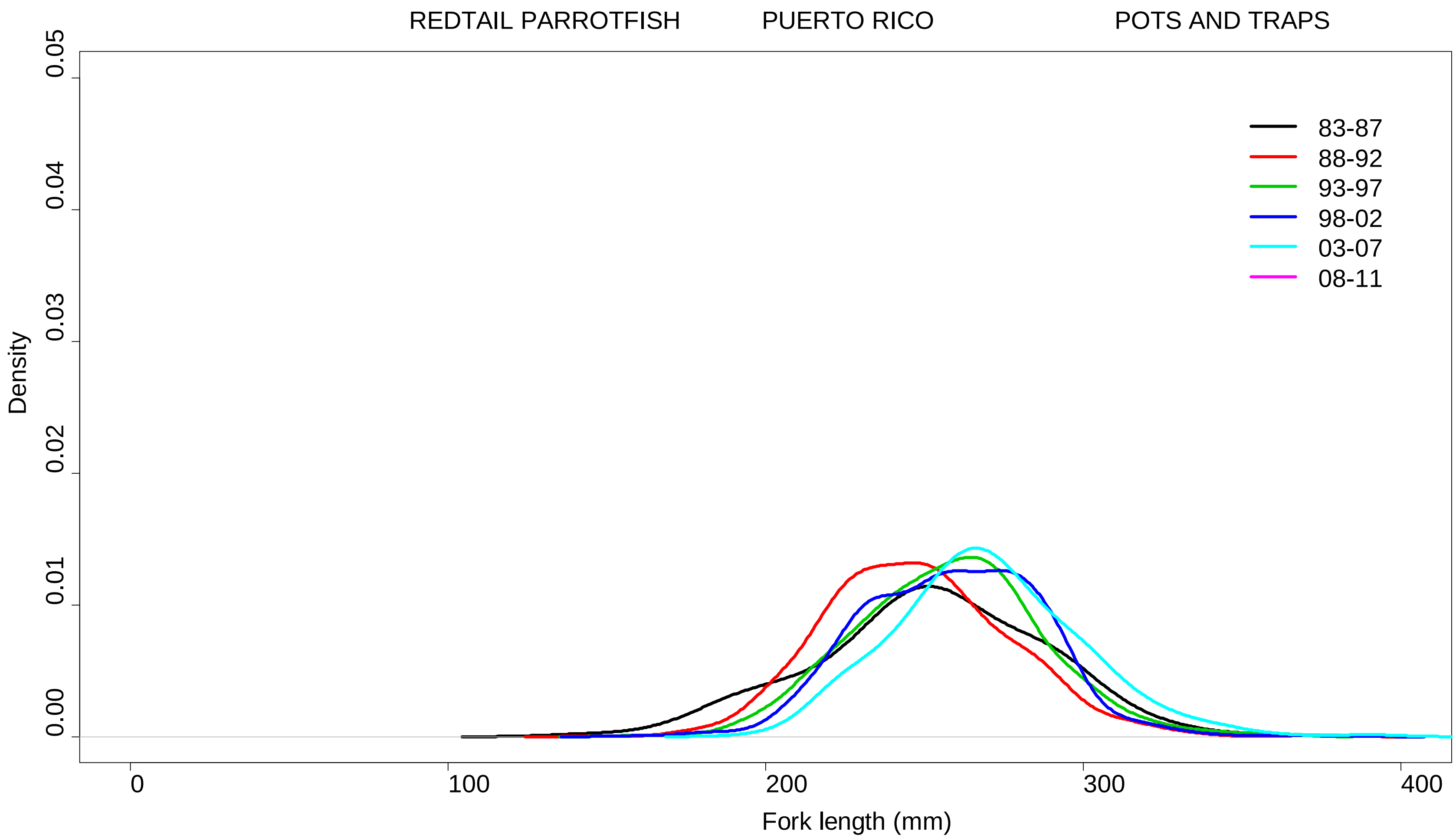

Figure 3.6.3. Density plot of observed lengths from the TIP database for redtail parrotfish caught by pots and traps in Puerto Rico. Each curve represents a five-year time-period.

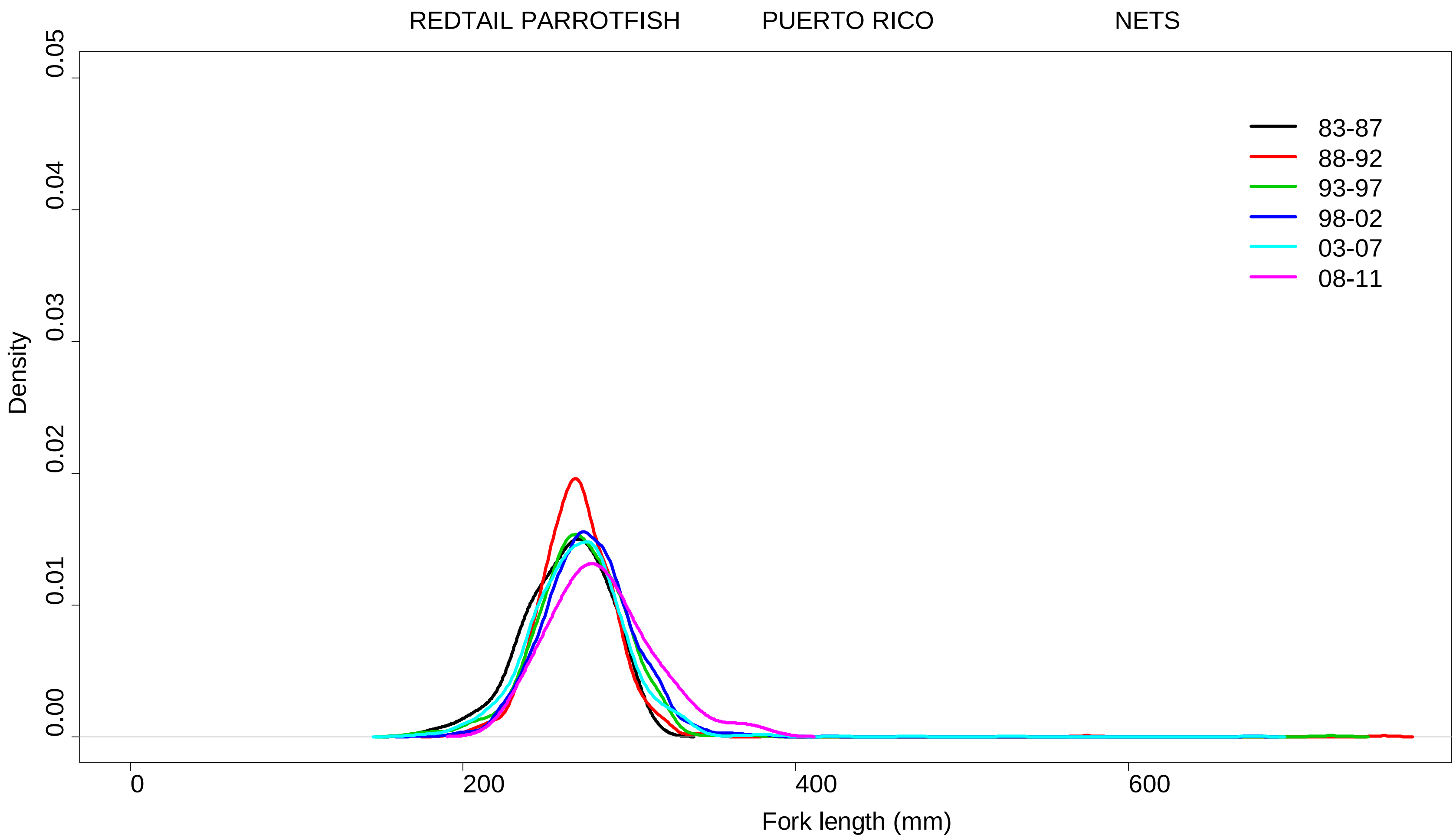

Figure 3.6.4. Density plot of observed lengths from the TIP database for redtail parrotfish caught by nets in Puerto Rico. Each curve represents a five-year time-period.

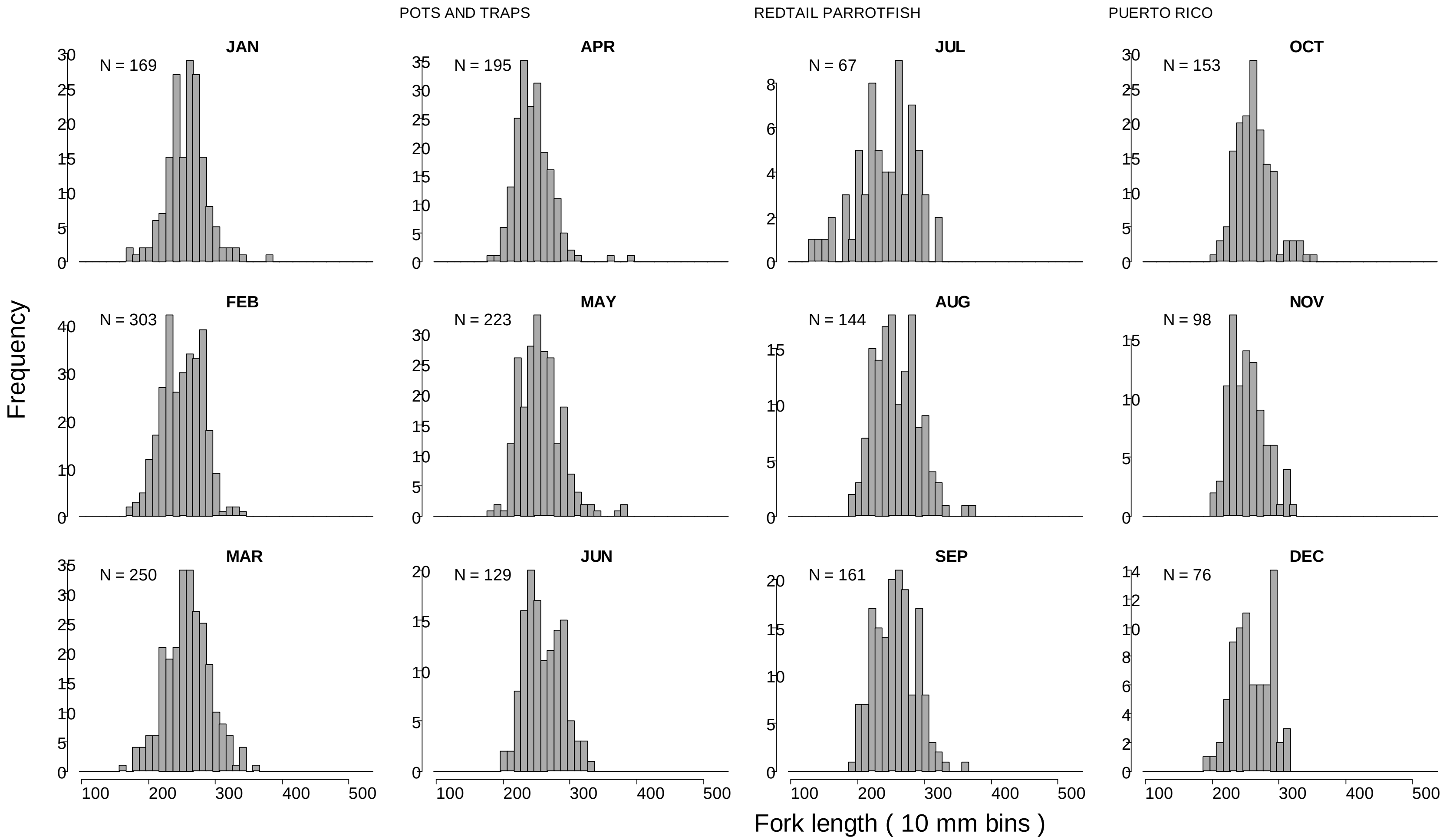

Figure 3.6.5. Monthly length-frequency histograms, where the length data was aggregated over years, for redtail parrotfish caught the pot and trap fishery in Puerto Rico. N represents the sample size.

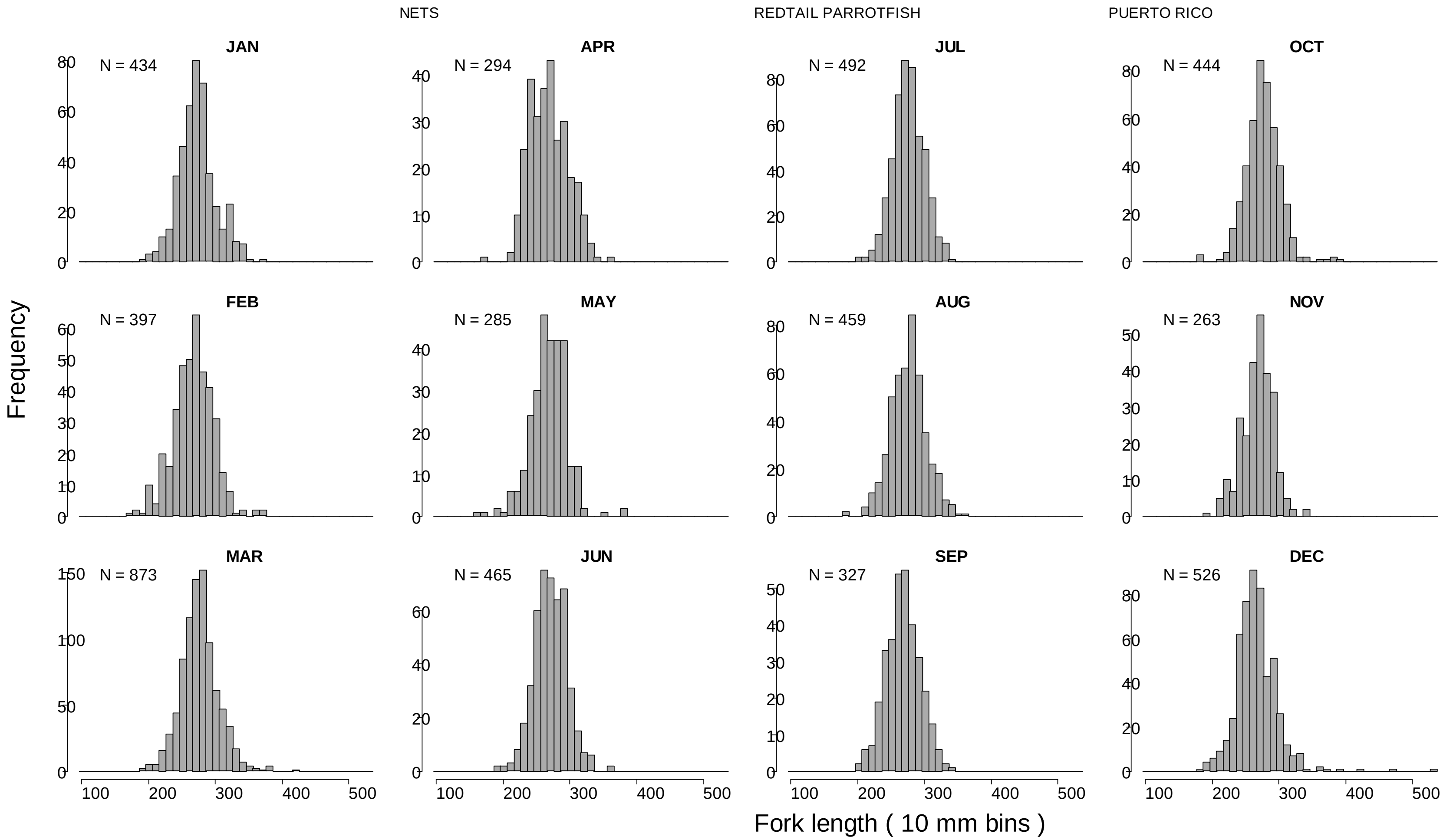

Figure 3.6.6. Monthly length-frequency histograms, where the length data was aggregated over years, for redtail parrotfish caught the net fishery in Puerto Rico. N represents the sample size.

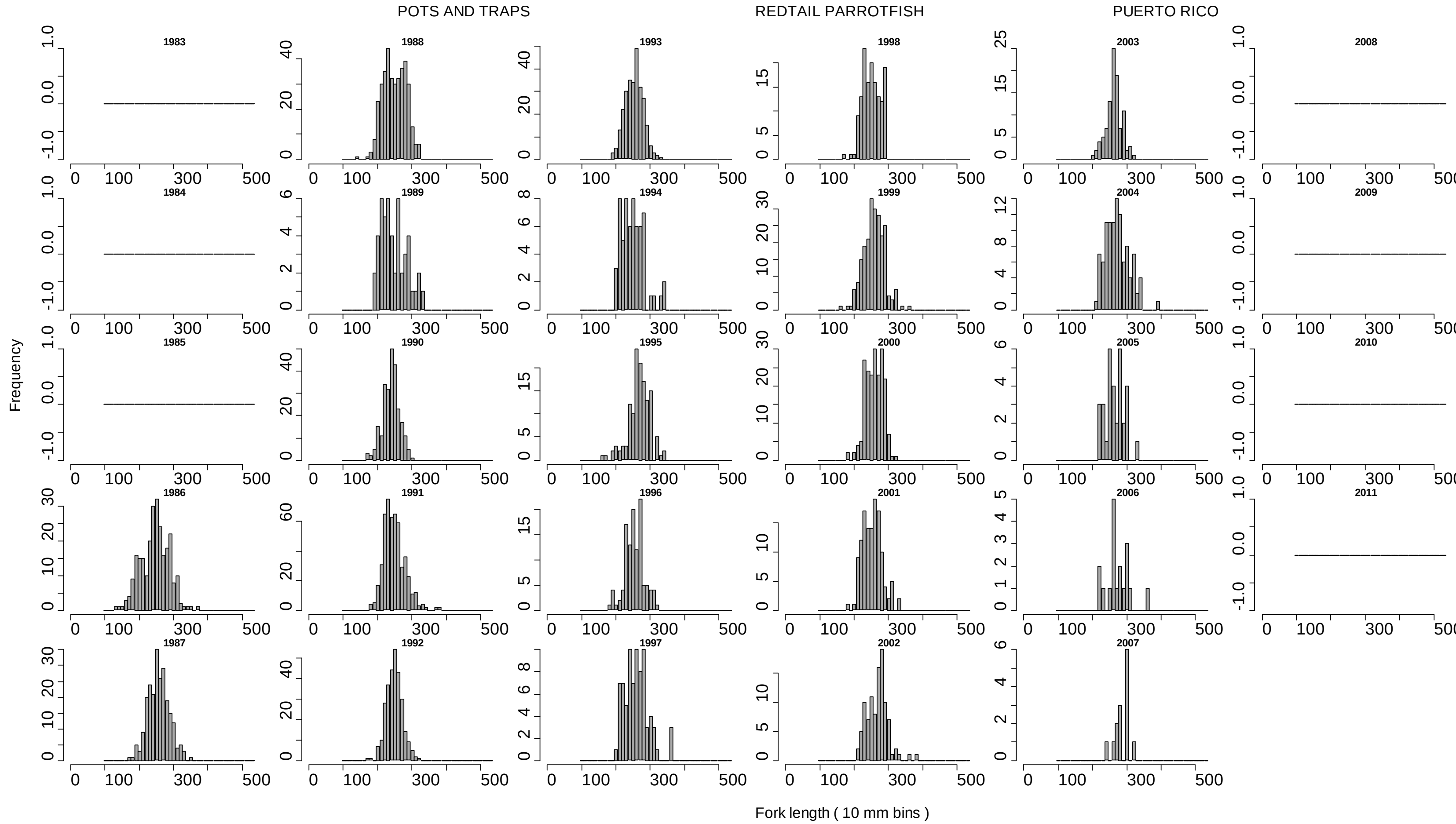

Figure 3.6.7. Annual length-frequency histograms for redtail parrotfish caught by the pot and trap fishery in Puerto Rico. Flat lines at zero indicate length-data was not collected in those years. Please note that the scale of the y-axis differs for each panel.

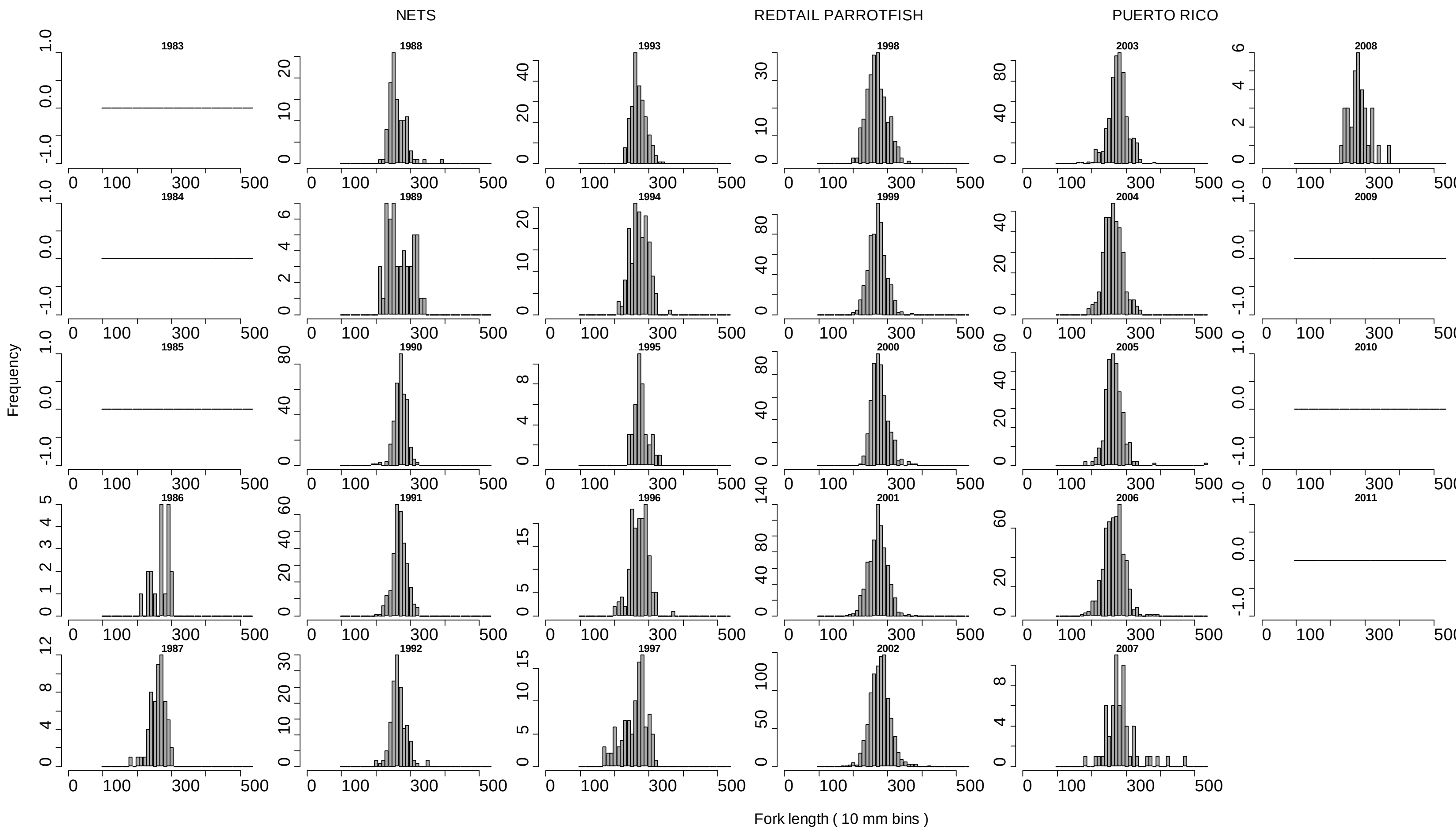

Figure 3.6.8. Annual length-frequency histograms for redtail parrotfish caught by the net fishery in Puerto Rico. Flat lines at zero indicate length-data was not collected in those years. Please note that the scale of the y-axis differs for each panel.

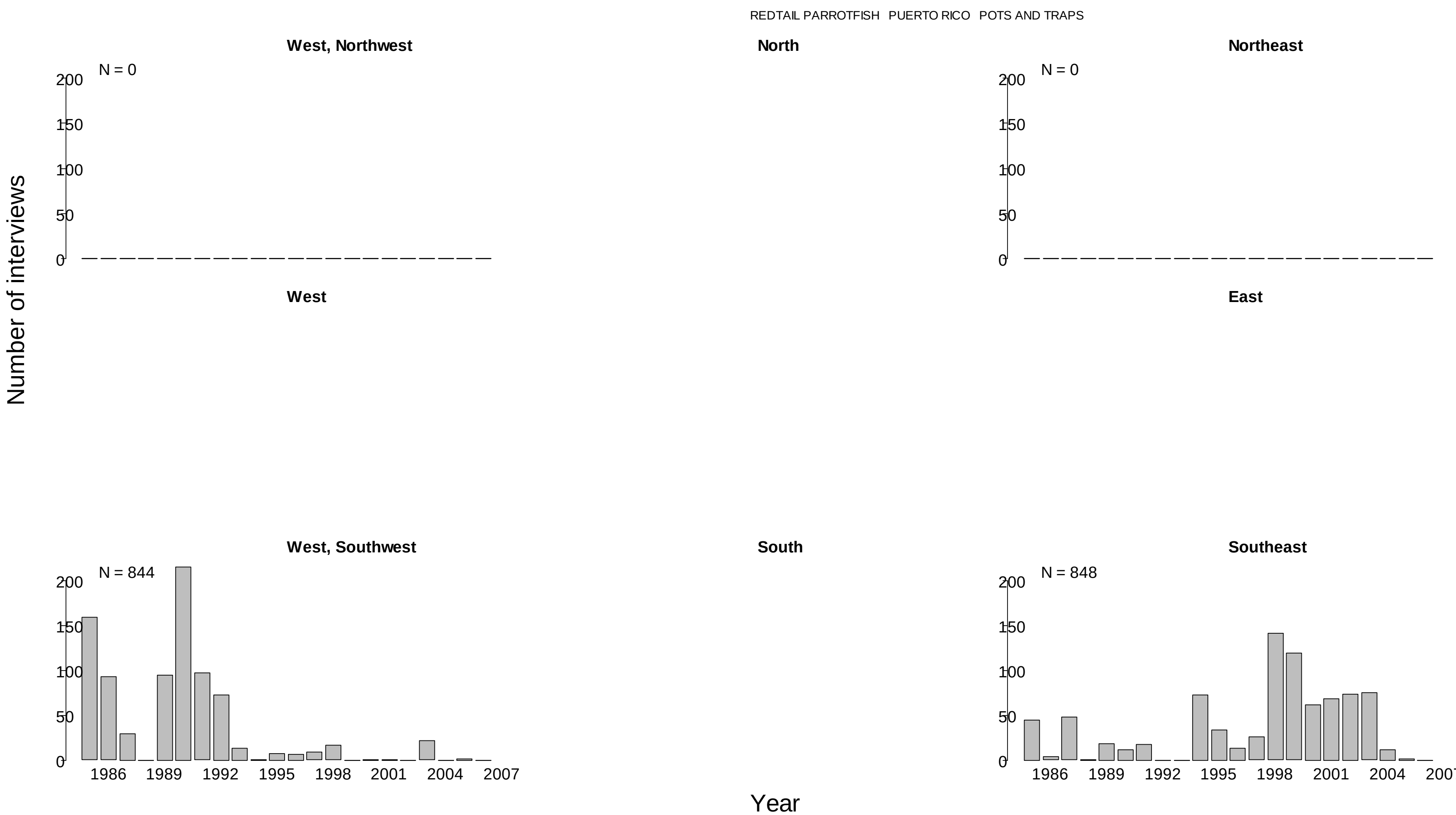

Figure 3.6.9. Number of interviews indicating fishing in a particular region around Puerto Rico where redtail parrotfish was caught by the pot and trap fishery. N is the total number of interviews indicating fishing within a given region.

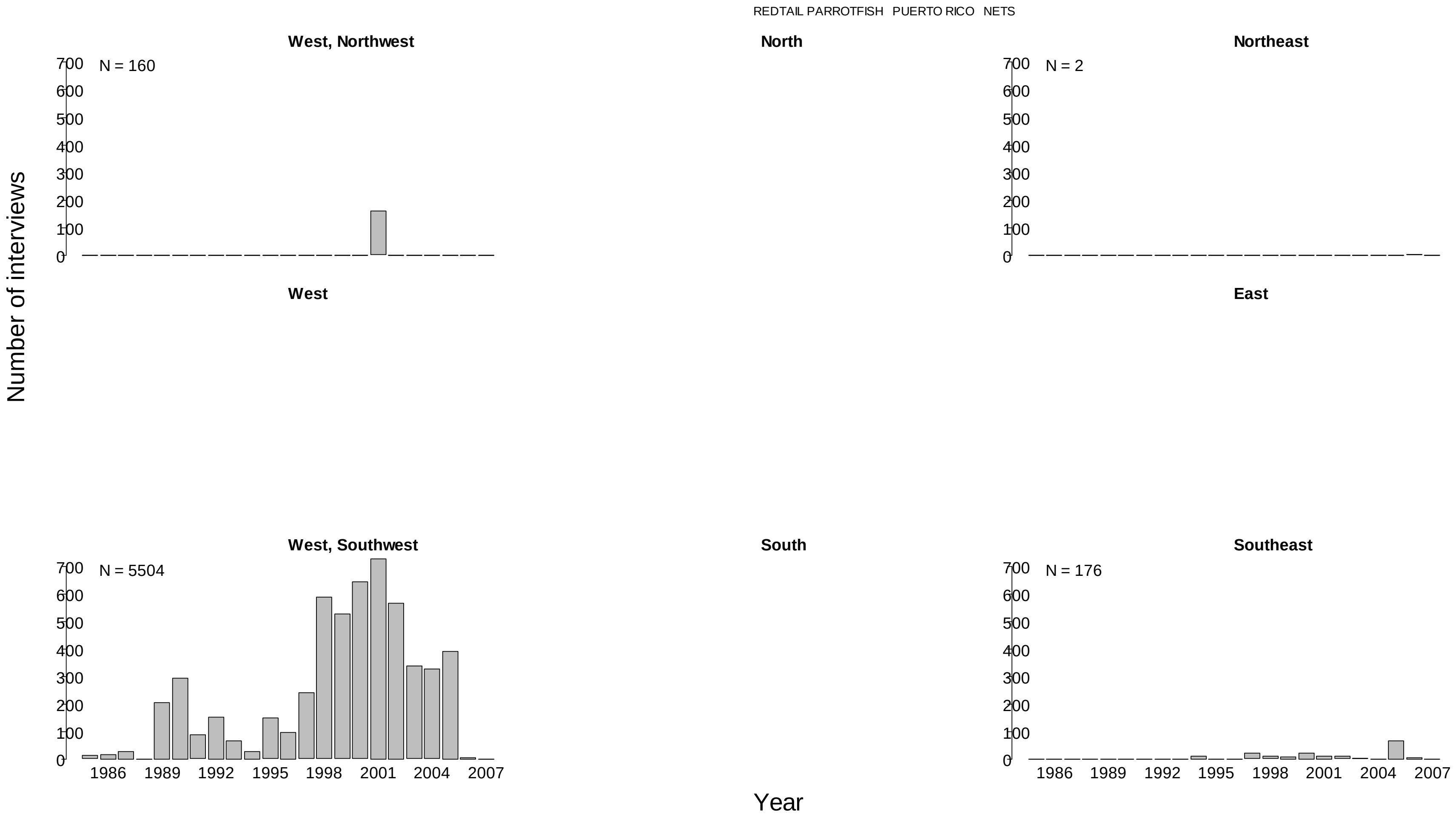

Figure 3.6.10. Number of interviews indicating fishing in a particular region around Puerto Rico where redtail parrotfish was caught by the net fishery. N is the total number of interviews indicating fishing within a given region.

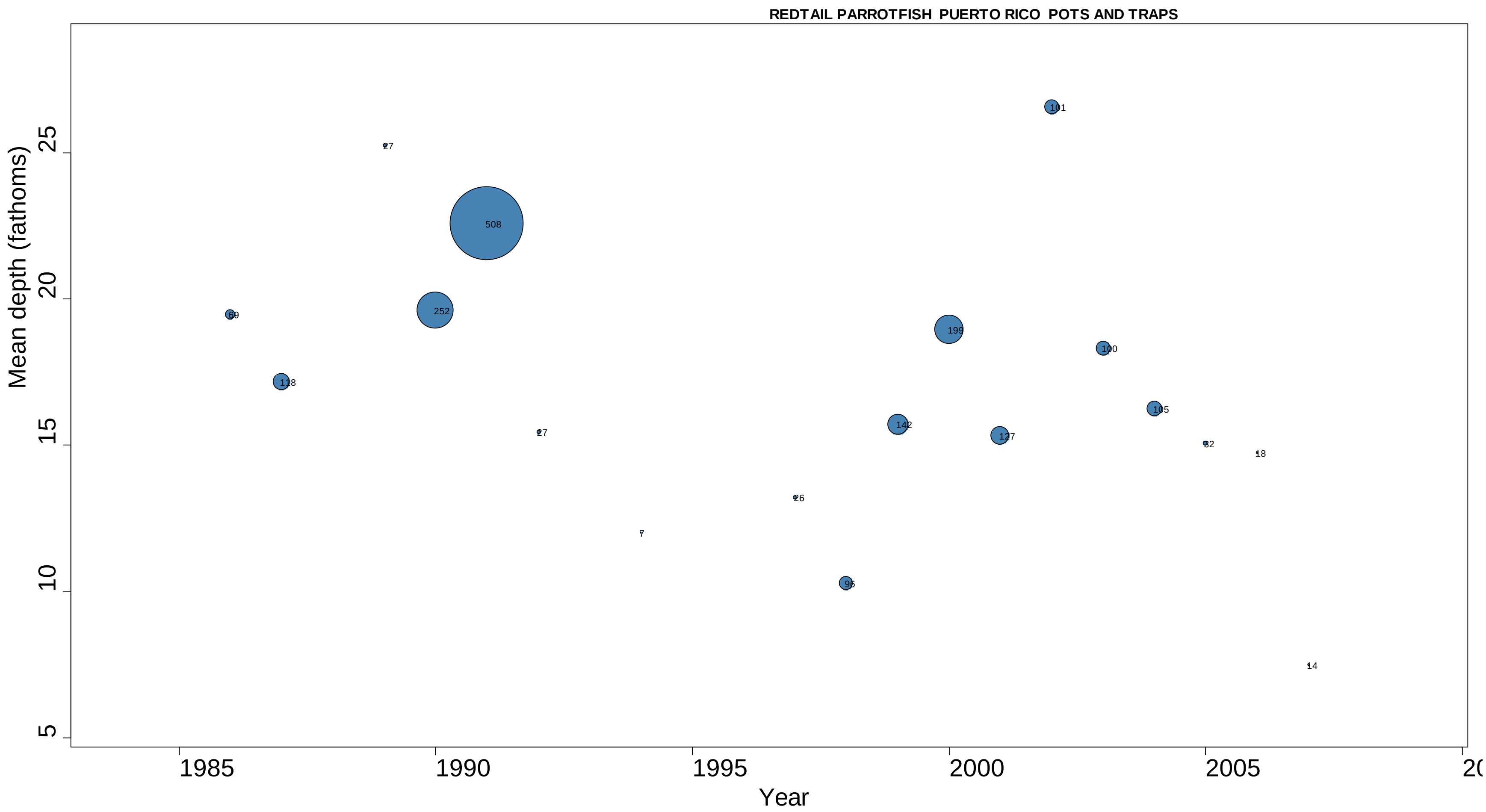

Figure 3.6.11. Mean depth (measured in fathoms) of fishing and capture of redtail parrotfish by the pot and trap fishery in Puerto Rico. Bubble size indicates the number of interviews from the TIP database for a given year that were used to calculate the mean and is scaled with respect to other years. The numbers plotted within the figure represent the number of interviews per bubble.

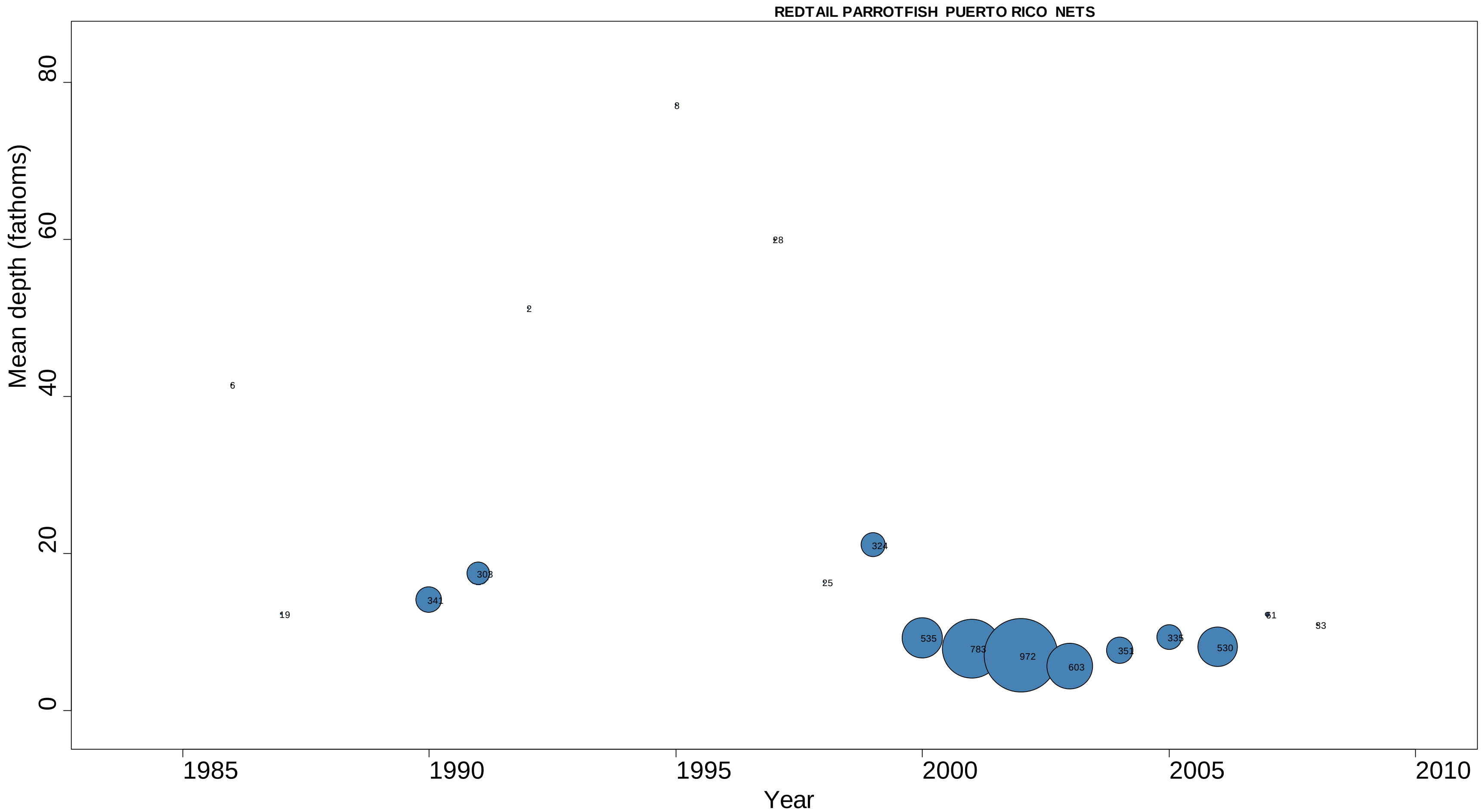

Figure 3.6.12. Mean depth (measured in fathoms) of fishing and capture of redtail parrotfish by the net fishery in Puerto Rico. Bubble size indicates the number of interviews from the TIP database for a given year that were used to calculate the mean and is scaled with respect to other years. The numbers plotted within the figure represent the number of interviews per bubble.

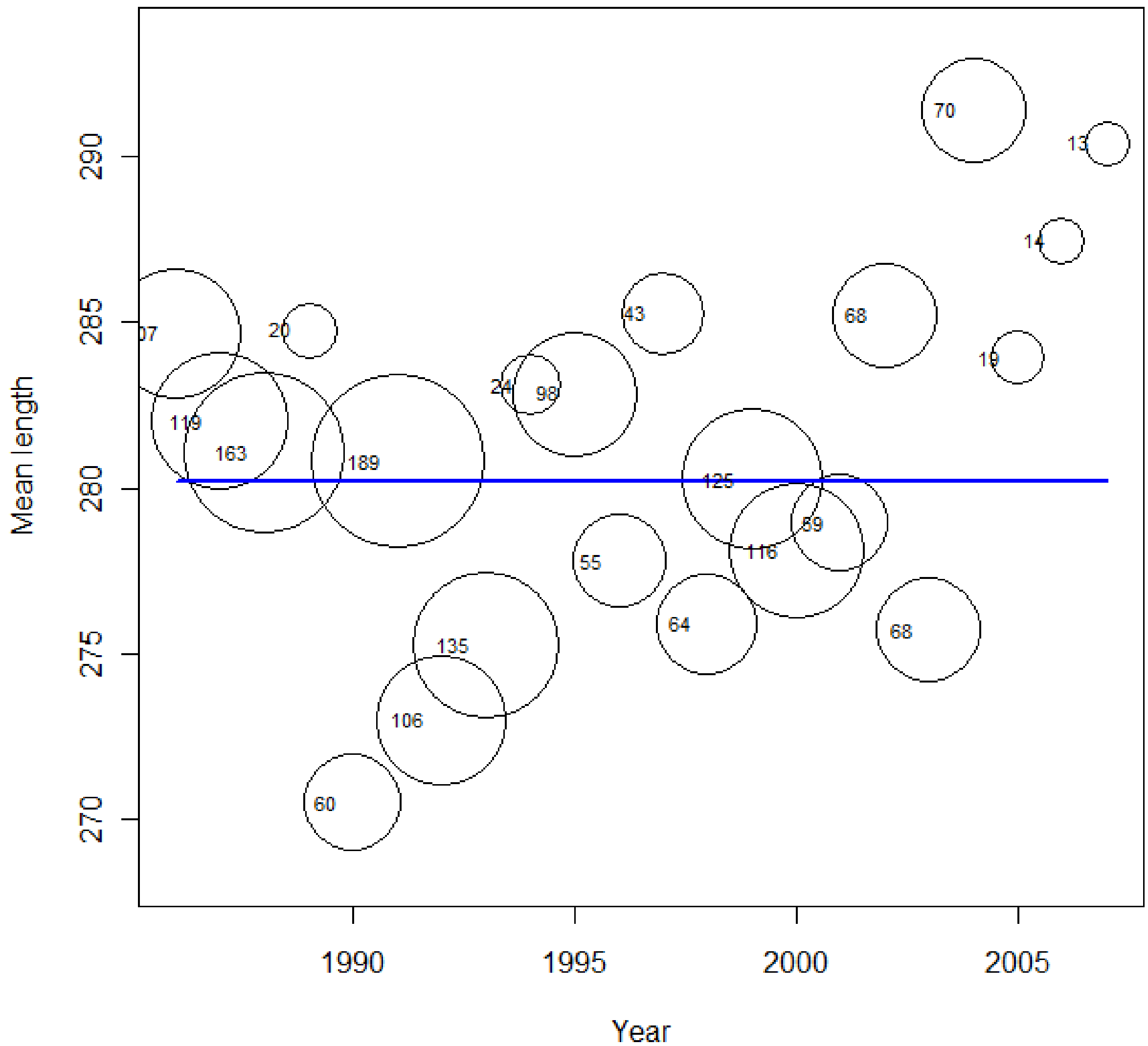

Figure 3.6.13. Annual mean length of fully-vulnerable individuals for the base-case scenario for redtail parrotfish caught by pots and traps in Puerto Rico. Bubble size indicates annual sample size relative to other years; the solid blue line represents the line of best fit.

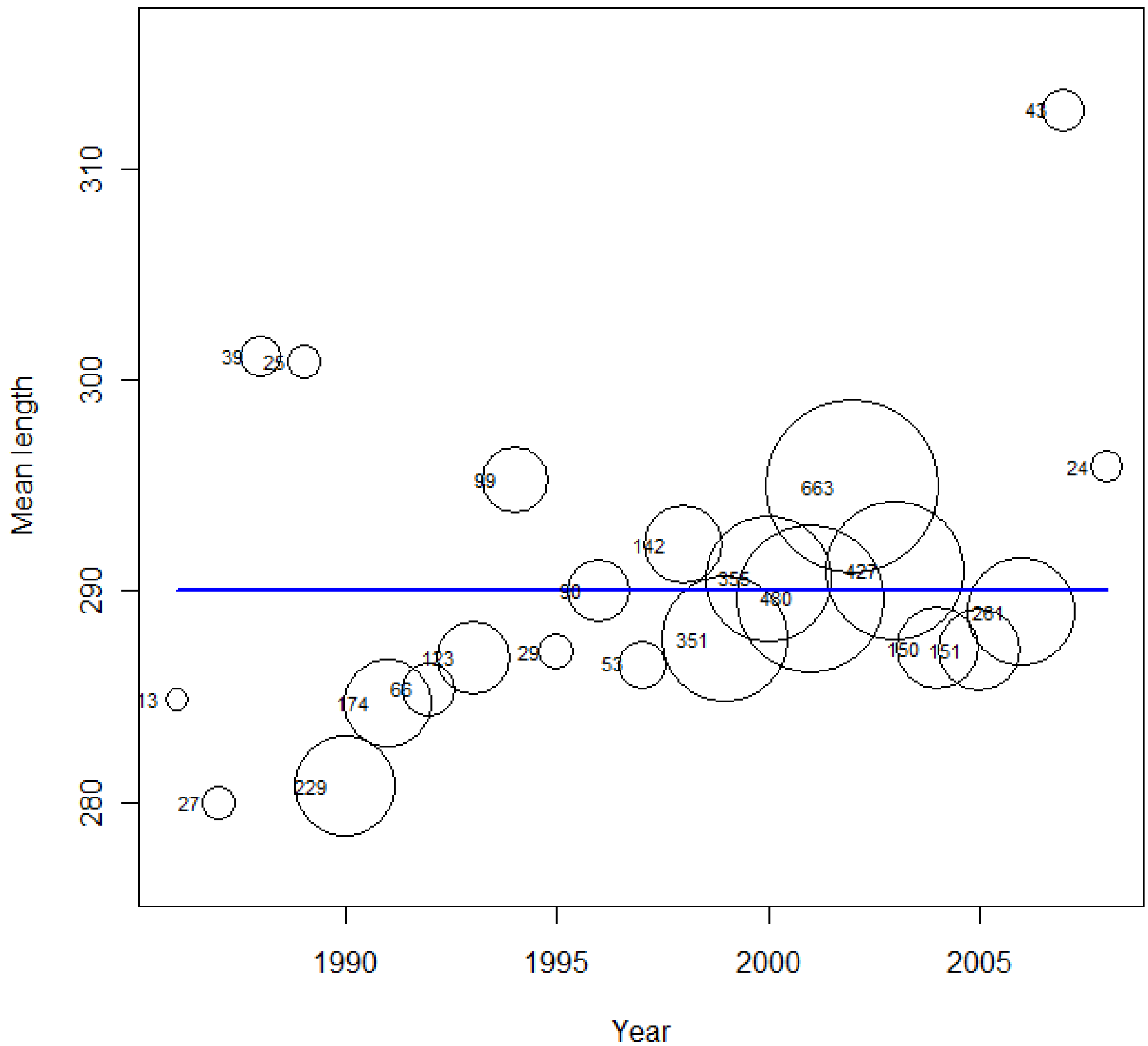

Figure 3.6.14. Annual mean length of fully-vulnerable individuals for the base-case scenario for redtail parrotfish caught by nets in Puerto Rico. Bubble size indicates annual sample size relative to other years; the solid blue line represents the line of best fit.

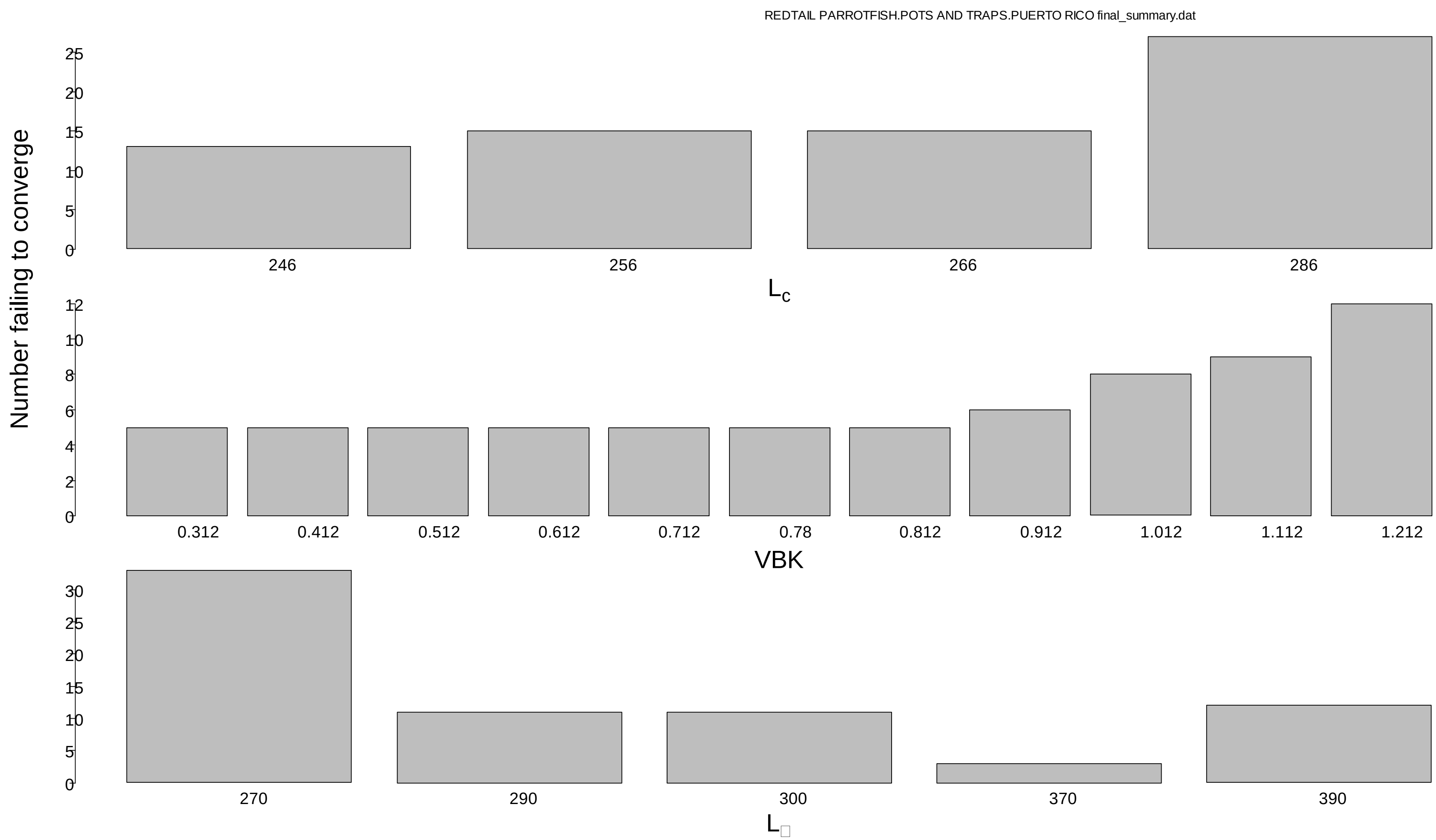

Figure 3.6.15. The number of sensitivity runs that failed to converge with respect to the input parameter values for the pot and trap fishery in Puerto Rico.

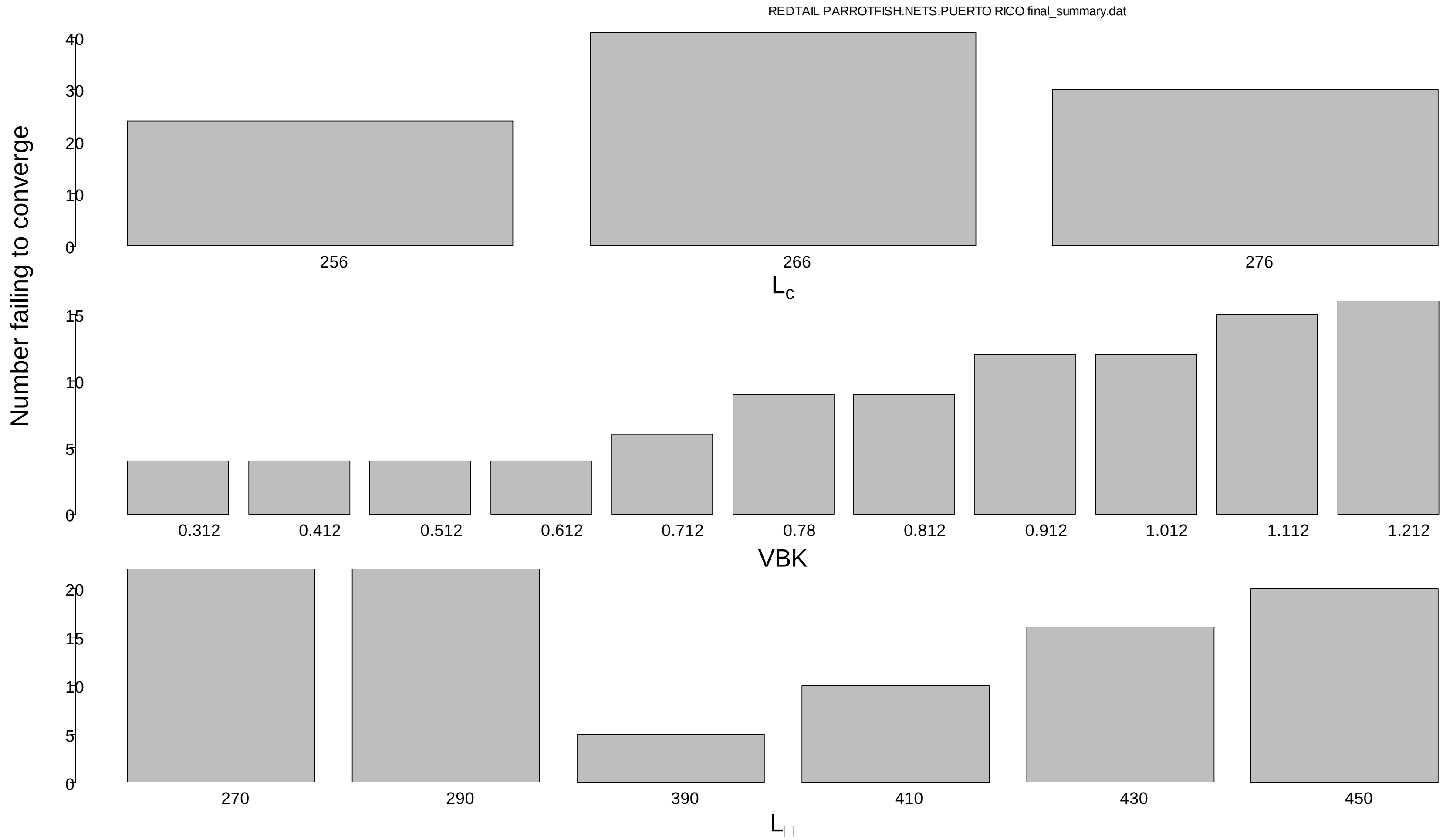

Figure 3.6.16. The number of sensitivity runs that failed to converge with respect to the input parameter values for the net fishery in Puerto Rico.

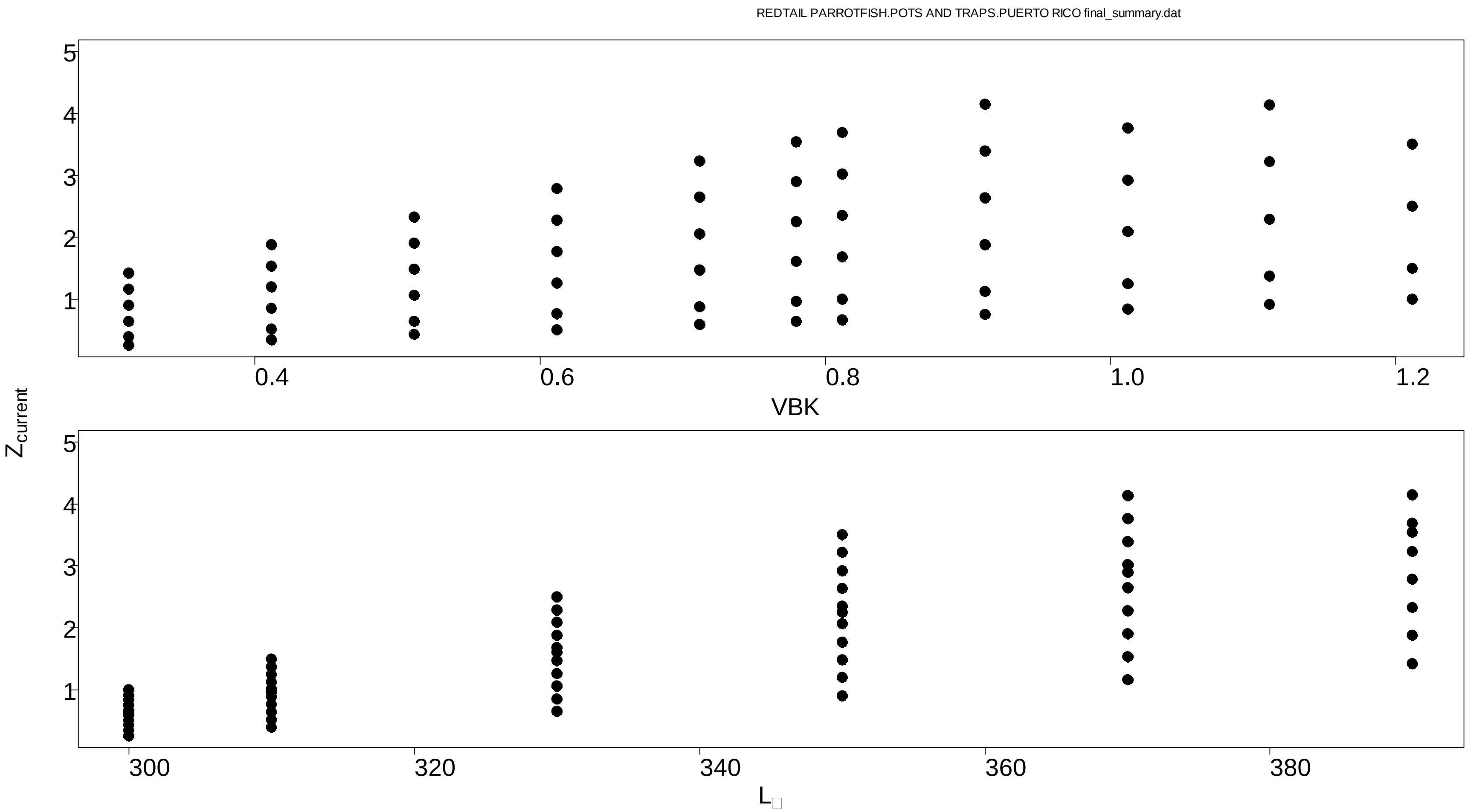

Figure 3.6.17. Current estimates of total mortality ($Z_{current}$) as a function of base case value for length at full vulnerability (L_c = 256mm), the full sensitivity range of the von Bertalanffy growth coefficient (K, top panel), and a reduced range of the asymptotic length parameter (L_∞, bottom panel) from the time-series analysis for redtail parrotfish caught by pots and traps in Puerto Rico. The total mortality estimates are the result of a model that does not predict a change in total mortality, which was strongly supported by AIC (ΔAIC>5).

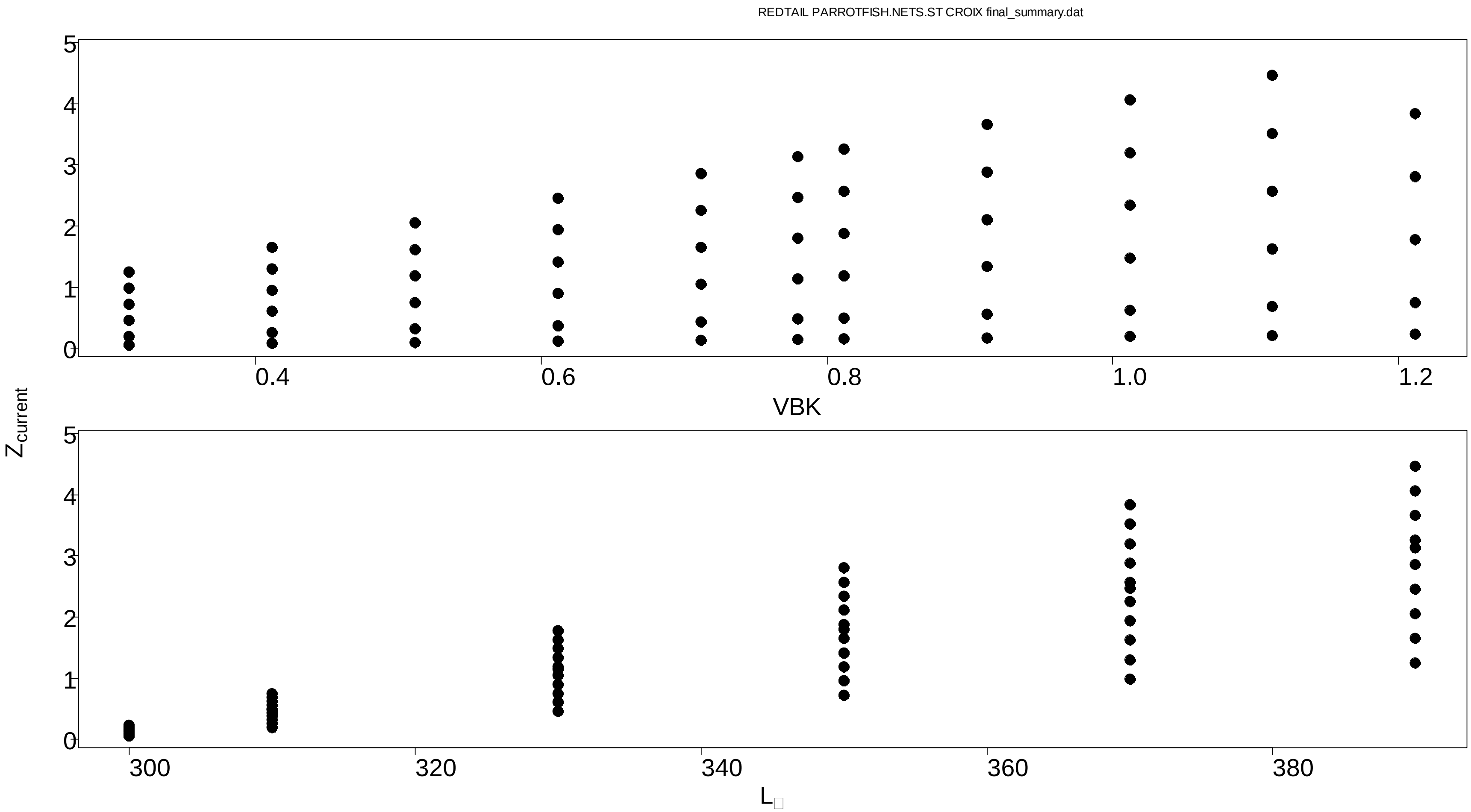

Figure 3.6.18. Current estimates of total mortality ($Z_{current}$) as a function of base case value for length at full vulnerability (L_c = 266mm), the full sensitivity range of the von Bertalanffy growth coefficient (K, top panel), and a reduced range of the asymptotic length parameter (L_∞, bottom panel) from the time-series analysis for redtail parrotfish caught by nets in Puerto Rico. The total mortality estimates are the result of a model that does not predict a change in total mortality, which was strongly supported by AIC (ΔAIC>5).

4. St. Thomas/St. John Parrotfish Stock Assessment Models and Results

4.1. Model 1 - Length frequency analysis of TIP data Methods

4.1.1. Overview

See Section 3.1.1 for the overview

4.1.2. Data Sources

See Section 3.1.2 for information about the data source.

4.1.3. Model Configuration and Equations

See Section 3.1.3 for model configuration and equations

4.1.4. Parameters Estimated

The parameters estimated by the non-equilibrium length method as described in Section 3.1.3 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.

4.1.5. Uncertainty and Measures of Precision

The panel at the SEDAR 26 data workshop (DW) and assessment workshop (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 value of the von Bertalanffy growth parameter (K) used for base case model runs was 0.78 (Molina-Urena 2009). For all sensitivity analyses the range of K inputs were set to a value 60% above and below the base value; the range of the K explored was 0.312 – 1.212. The range of the asymptotic growth parameter (L_∞) explored varied according the relationship between the base case value and the maximum observed length. The value used for base case model runs was 300mm, which is the mean of the two estimates found in Molina-Urena (2009). 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 L_c value was chosen by visual inspection of length-frequency histograms (Thorson and Prager 2011). To satisfy the concerns of the AW panel a wide range of L_c values were explored. 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. Table 4.5.1 summarizes the values used for the input parameters for the pot and trap fishery in St. Thomas.

4.1.6. 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.

4.1.7. Projection methods

NA

4.2. Model 1 Results - Length frequency analysis of TIP data

4.2.1. Measures of Overall Model Fit

The AIC results did not provide strong support (ΔAIC <5) for the model indicating a change in the estimate of total mortality (Z) for the pot and trap fishery in St. Thomas/St. John (Table 4.5.2). Figure 4.6.5 shows the model fit to the data for the pot and trap fishery.

4.2.2. Parameter estimates & associated measures of uncertainty

Please refer to section 4.2.8

4.2.3. Stock Abundance and Recruitment

NA

4.2.4. Stock Biomass

NA

4.2.5. Fishery Selectivity

NA

4.2.6. 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.

4.2.7. Stock-Recruitment Parameters

NA

4.2.8. Evaluation of Uncertainty

Table 4.5.1 summarizes the input value range for the parameters explored in the sensitivity analysis for the St. Thomas pot and trap fishery. The results from the base-model run indicate that a detectable change in total mortality was not strongly supported (ΔAIC <5) and more importantly given the combination of base case values the model did not converge and estimated total mortality to be the same as the lower bound of the uniform prior on the total mortality parameter in the estimation model (Table 4.5.2). This estimate does not reflect an estimate of total mortality, but rather an unrealistic combination of input parameters.

Model convergence was a problem when using unrealistic input parameter combinations. Figure 4.6.8 summarizes the number of times the model failed to converge with respect to the input parameter values. In general, the number of convergence failures increased with an increasing L_c input value. The increased frequency of convergence failures corresponds to L_c values paired with L_∞ values that are less than or close to the L_c value or L_c's which reduced sample size. The size distribution for redtail has remained relatively stable over time, lending confidence in the chosen value of L_c from visual inspection. Given this confidence, rather than present sensitivity results from unrealistic parameter combinations the presentation of the results will focus on the base case value of L_c, the full range of the K values and a subset of the L_∞ values. The results from the comprehensive sensitivity analysis are presented in the Appendix.

Figure 4.6.9 shows the total mortality estimates that resulted from the narrowed range of the sensitivity analysis. The total mortality estimates ranged between 0.01 and 4.5, where the estimates from the model that did not predict a change in total mortality (Figure 4.6.9, left panel) covered this range whereas the estimates from the model predicting a change (ΔAIC >5) in total mortality were concentrated around higher values (Figure 4.6.9, right panel). An increase in the total mortality estimates corresponded to an increase in the von Bertalanffy growth parameters (Figure 4.6.9, middle and bottom panels).

Figure 4.6.10 shows the direction of proportional change in total mortality. Total mortality was predicted to increase for all sensitivity runs predicting a change in total mortality. The range of proportional change was between 60% and 130% (Figure 4.6.10). The influence of the von Bertalanffy parameters on the total mortality estimates is not seen in the estimates of proportional change (Figure 4.6.10). Figure 4.6.11 shows the proportional change in total mortality with respect to the predicted year of change for the base case value of L_c. The predicted year of change for the base case value of Lc across the narrowed range of L and the full range of K was either 1992 or 1993 (Figure 4.6.11).

4.2.9. Benchmarks / Reference Points / ABC

See Section 4.3 for discussion

4.2.10. Projections

NA

4.3. Discussion

The length frequency analysis was able to detect a change in redtail parrotfish total mortality in St. Thomas/St. John in a limited number of the sensitivity runs for the pot and trap fishery, however, no consistent and clear pattern was evident. Sample sizes are very low and a slightly greater proportion of larger fish were measured between 1983-1985 resulted in some cases indicating an increase in mortality in the early 1990s (see Figures 4.6.1, 4.6.2, 4.6.4, and 4.6.11). Without accessory information, and given the extreme variability in von Bertalanffy parameter inputs, the resulting absolute estimates of total mortality are unreliable and not useful for management purposes alone.

Although quantitative metrics are not available from this assessment to define stock status in terms of MSY, there are some qualitative aspects which suggest that the current management plan is risk adverse. First, and even with the noise inherent in low sample sizes, the length-frequency composition of the sampled fish appears to have remained relatively stable suggesting that the population has not undergone significant changes in size during the time period (see Figure 4.6.1 and 4.6.2) and that exploitation levels have been sustainable. Secondly, the majority of measured fish are above the reported size at maturity for the species. In recent years, virtually all of the fish sampled were above the reported size at maturity. Finally, the proposed ACL (42,500 lbs.) in the 2010 amendment are intended to reduce parrotfish average landings by at least 15 percent and below the SSC recommendation of 50,000 lbs.

4.4. References

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4.5. Tables

Table 4.5.1. The lower bound, base case, and upper bound values for the time-series analysis input parameters for the pot and trap fishery in St. Thomas/St. John.

Parameter	Lower bound	Base	Upper bound
L_c	260mm	280mm	300mm
VBK	0.312	0.78	1.212
L_∞	270mm	300mm	450mm

Table 4.5.2. Summary of time-series analysis results for the base case for redtail parrotfish caught by pots and traps in St. Thomas. Npar is the number of parameters, LLIKE is the negative log-likelihood, Z is total mortality, and ΔYear is the estimated year of change.

Npar	Nobs	AIC	LLIKE	Z	Lc	VBK	L_Inf	Z1	ΔYear1	Z2	ΔYear2	Z3	ΔYear3	Z4
2	20	150.894	73.094	0.001	280	0.78	300	-	-	-	-	-	-	-
4	20	155.563	72.448	-	280	0.78	300	0.001	1999	0.533	-	-	-	-
6	20	162.839	72.189	-	280	0.78	300	0.001	2005	2.812	2007	0.001	-	-
8	20	173.469	72.189	-	280	0.78	300	0.001	1984	0.001	2005	2.812	2007	0.001

4.6. Figures

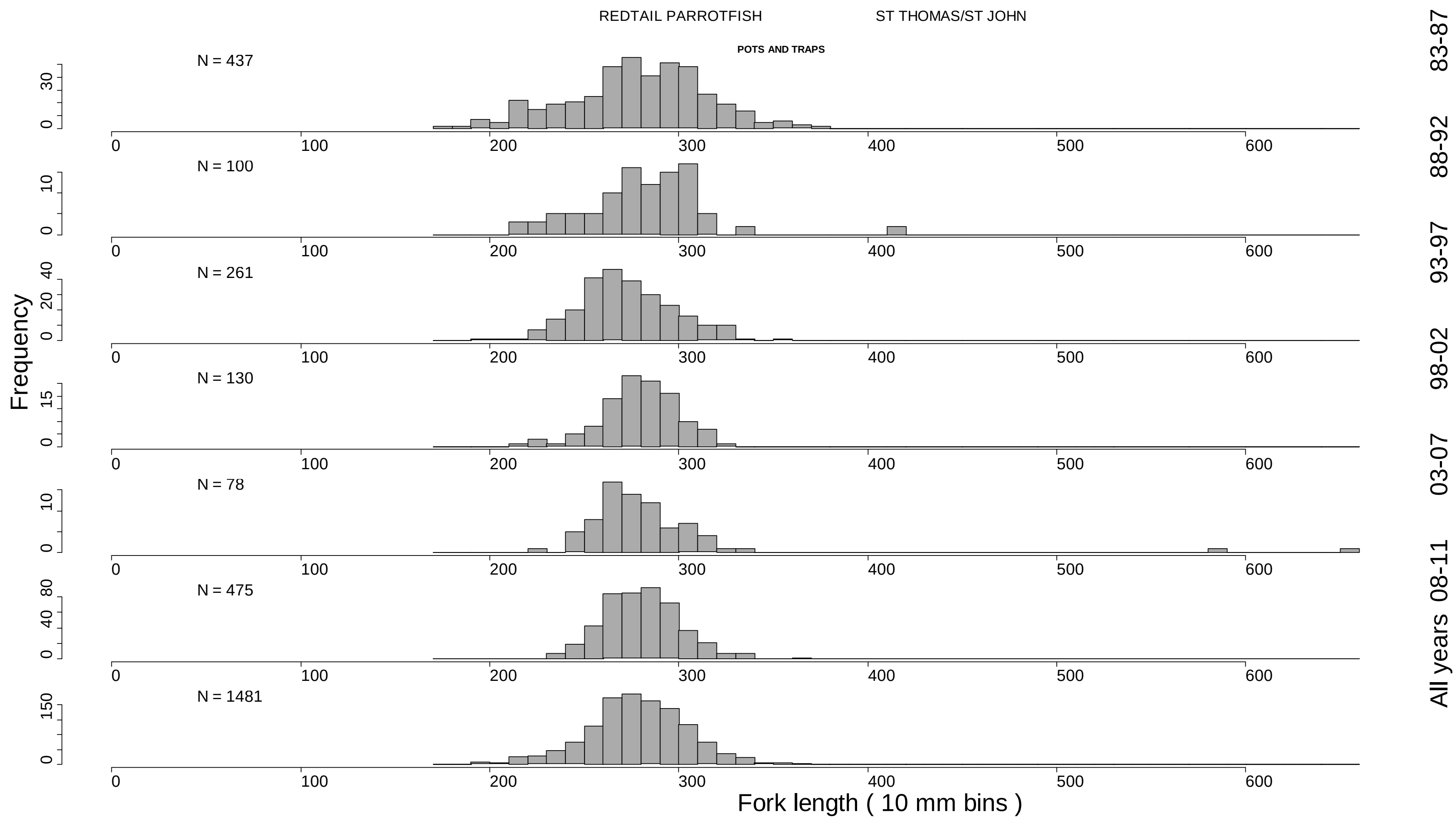

Figure 4.6.1. Length frequency distribution for redtail parrotfish caught by pots and traps in St. Thomas. Each panel includes data from a five-year time period, which is indicated at the right side of each panel. The bottom panel includes data from all years. Sample numbers (N) are indicated in each panel.

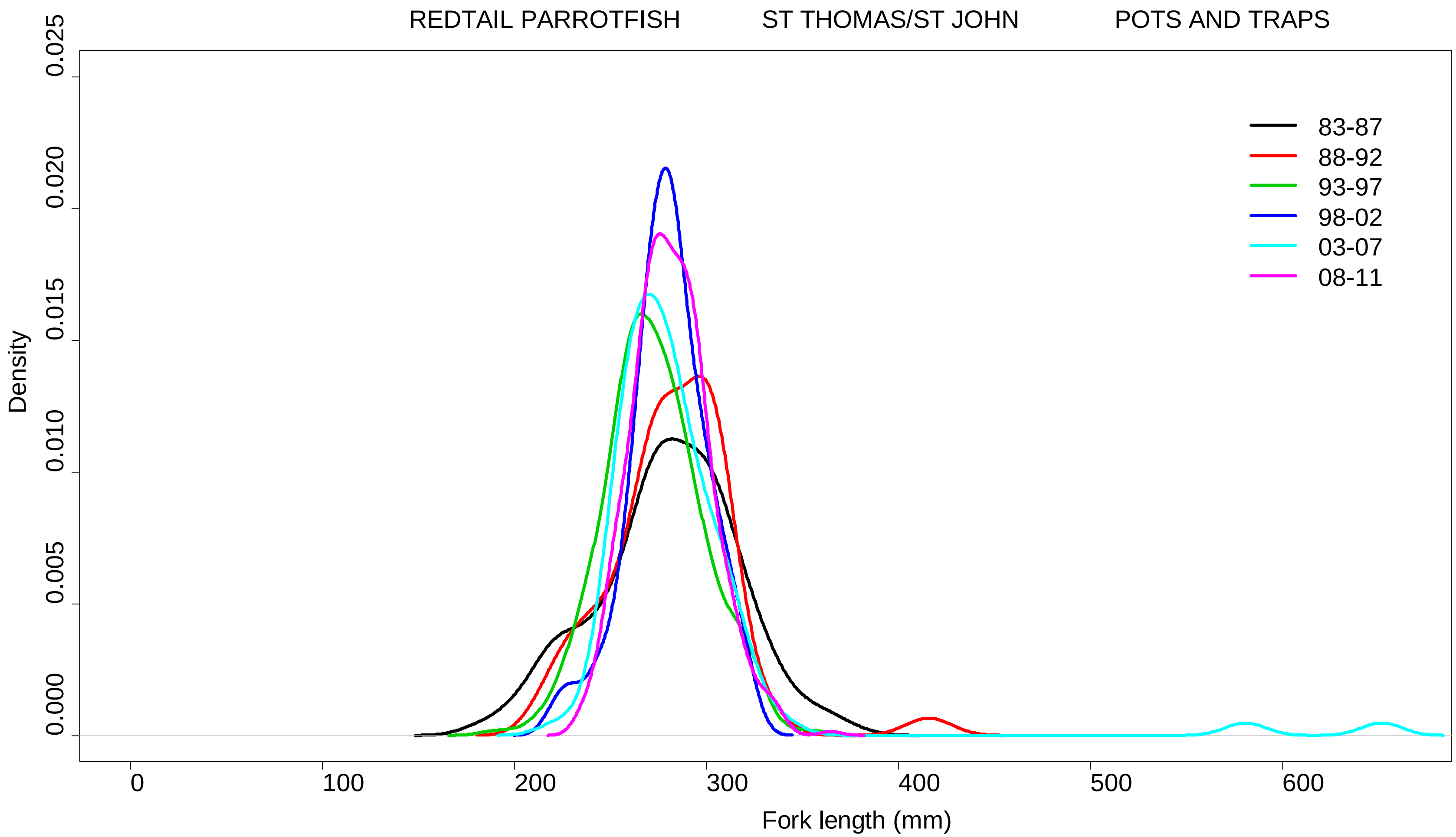

Figure 4.6.2. Density plot of the observed lengths from the TIP database for redtail parrotfish caught by pots and traps in St. Thomas. Each curve represents a five-year time period.

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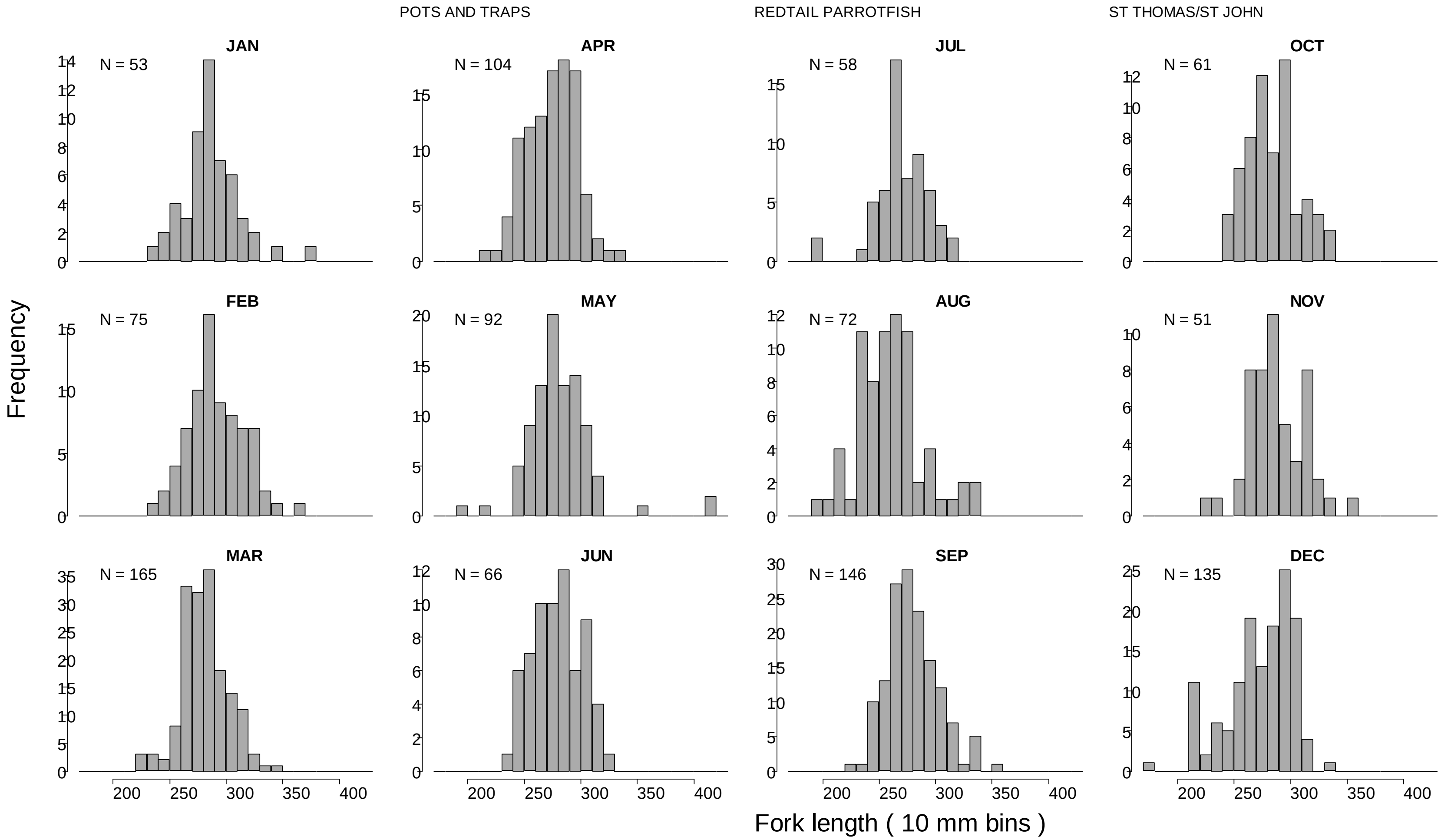

Figure 4.6.3. Monthly length-frequency histograms, where the length data were aggregated over years, for redtail parrotfish caught by the pot and trap fishery in St. Thomas/St. John. N represents sample size.

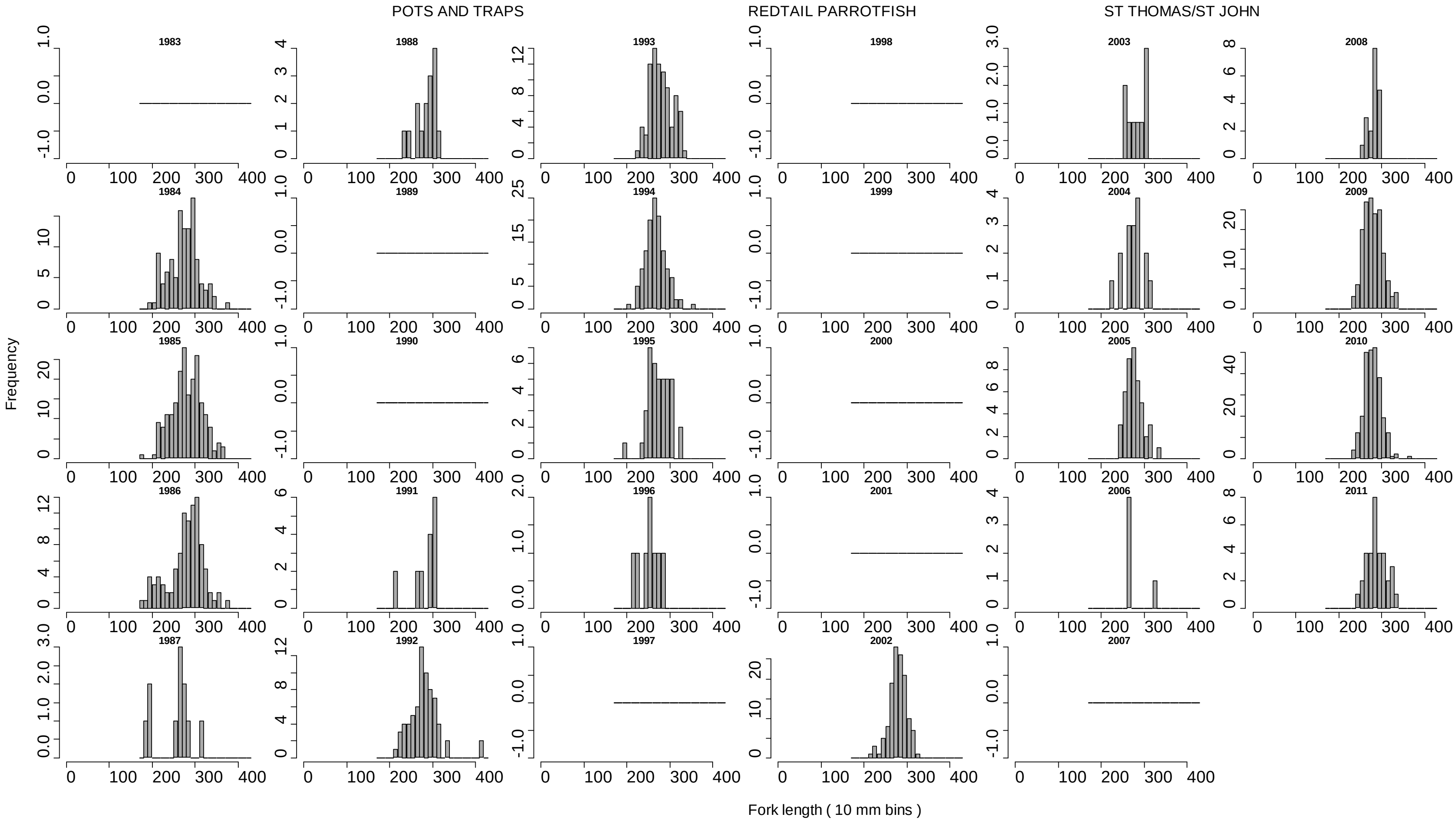

Figure 4.6.4. Annual length-frequency histograms for redtail parrotfish caught by the pot and trap fishery in St. Thomas/St. John. Flat lines at zero indicate length-data were not collected in those years. Please note that the scale of the y-axis differs for each panel.

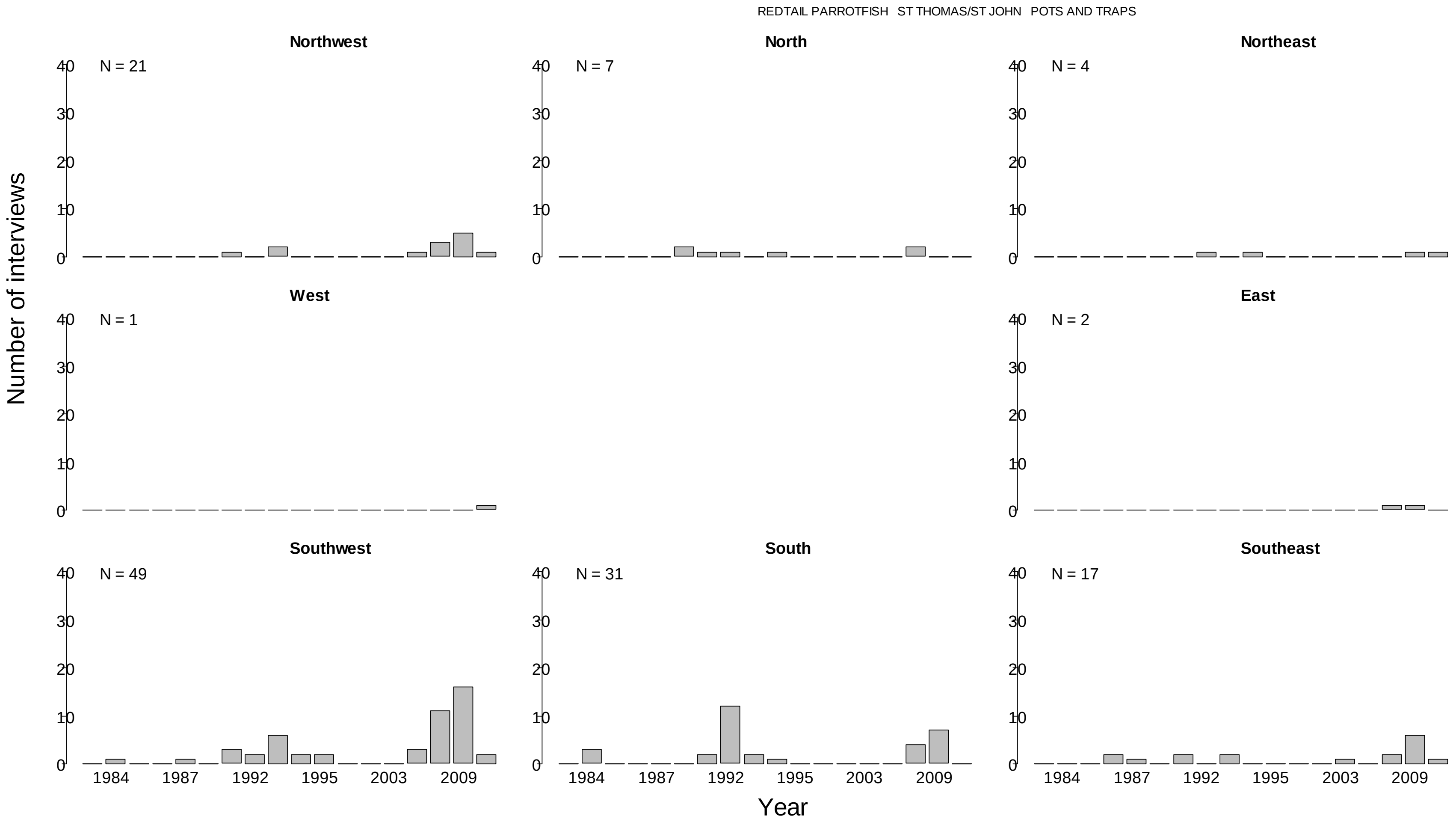

Figure 4.6.5. Regional fishing distribution for redtail parrotfish as indicated by the TIP database for pots and traps in St. Thomas/St. John. N is the total number of interviews within a region.

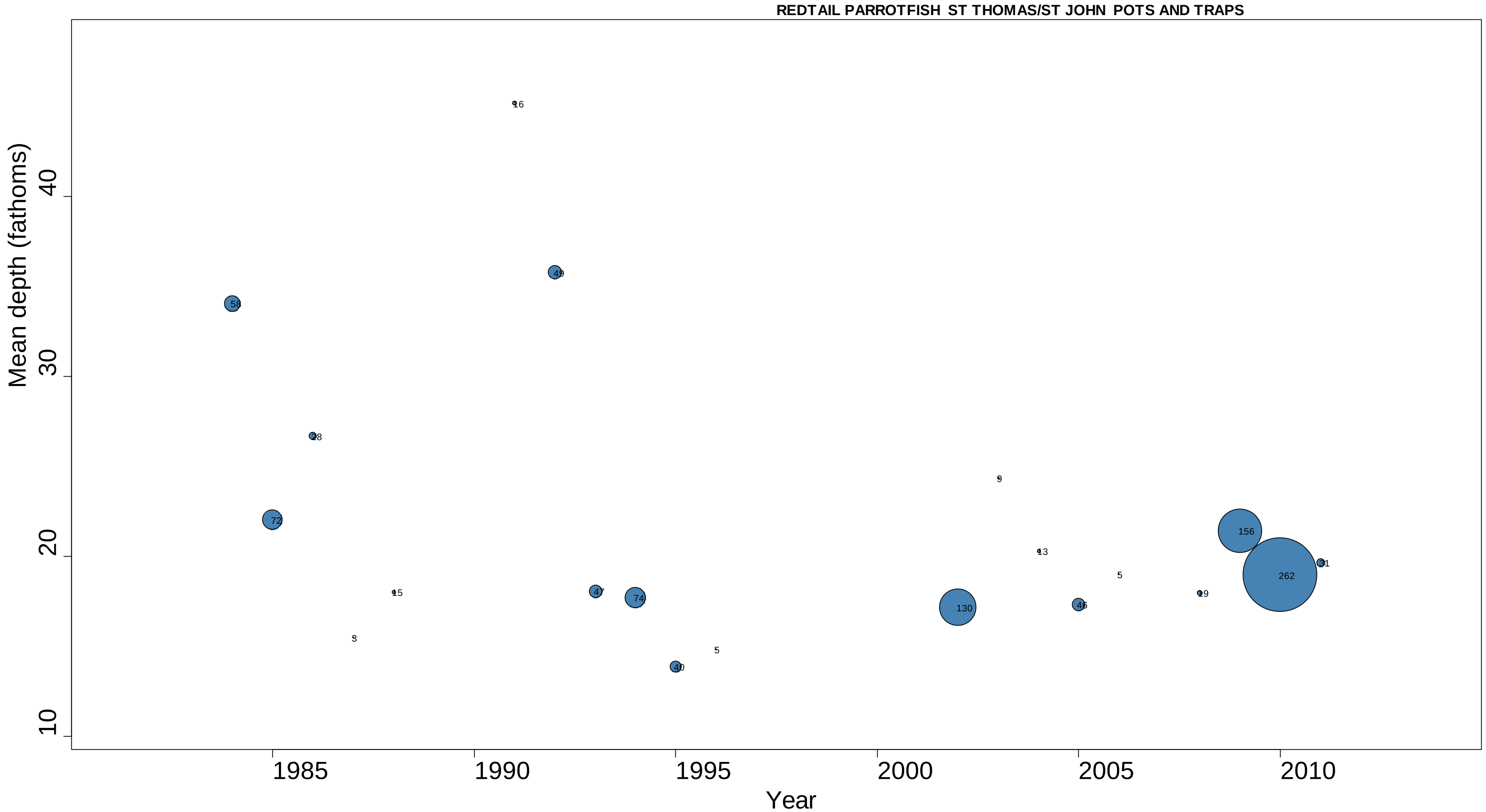

Figure 4.6.6. Mean depth (measured in fathoms) of fishing and capture of redtail parrotfish by the pot and trap fishery in St. Thomas/St. John. Bubble size indicates the number of interviews from the TIP database for given years that were used to calculate the mean and is scaled with respect to other years. The numbers plotted within the figure represent the number of interviews per bubble.

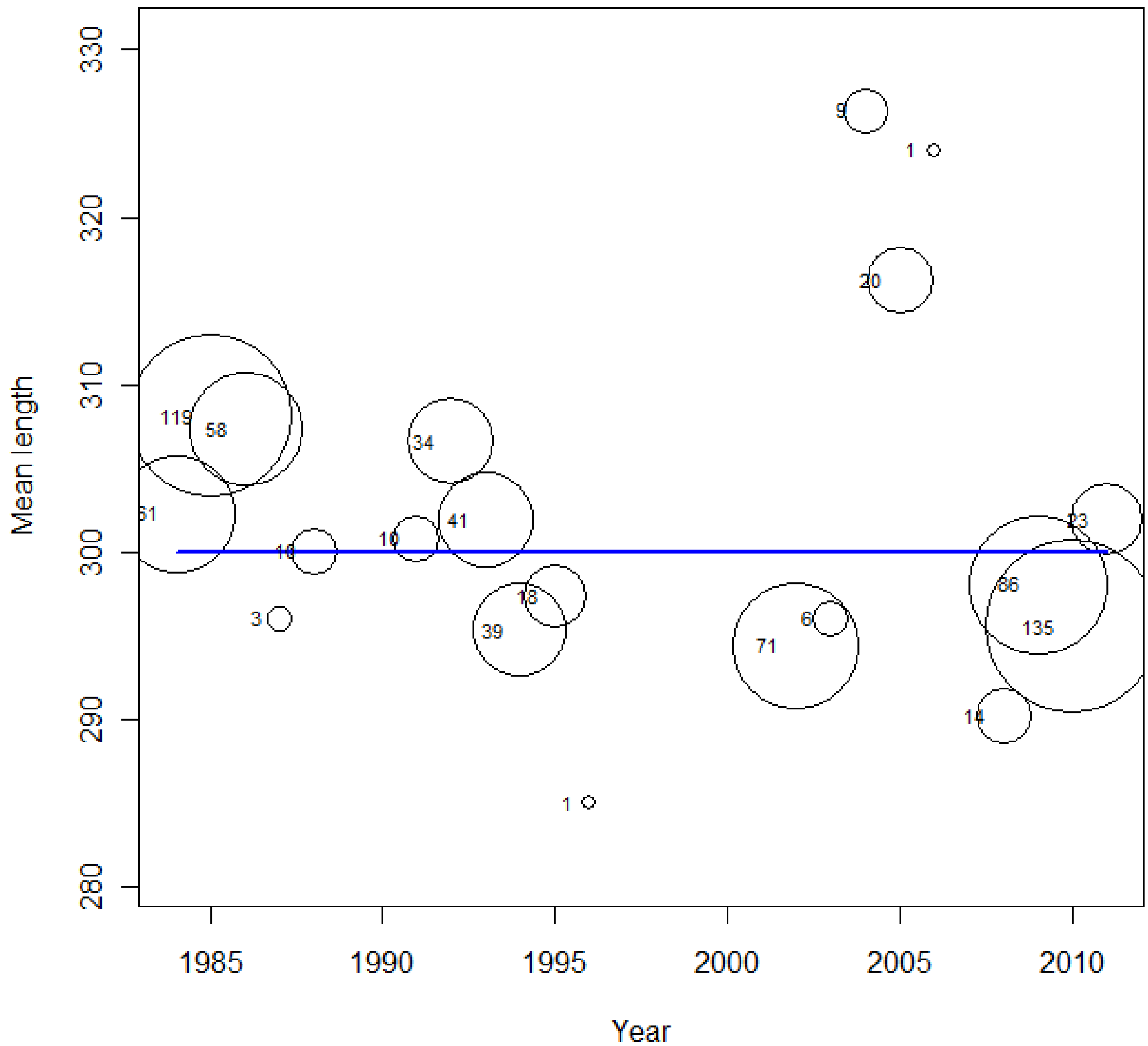

Figure 4.6.7. Annual mean length of fully-vulnerable individuals for the base-case scenario for redtail parrotfish caught by nets in St. Thomas/St. John. Bubble size indicates annual sample size relative to other years; the solid blue line represents the line of best fit.

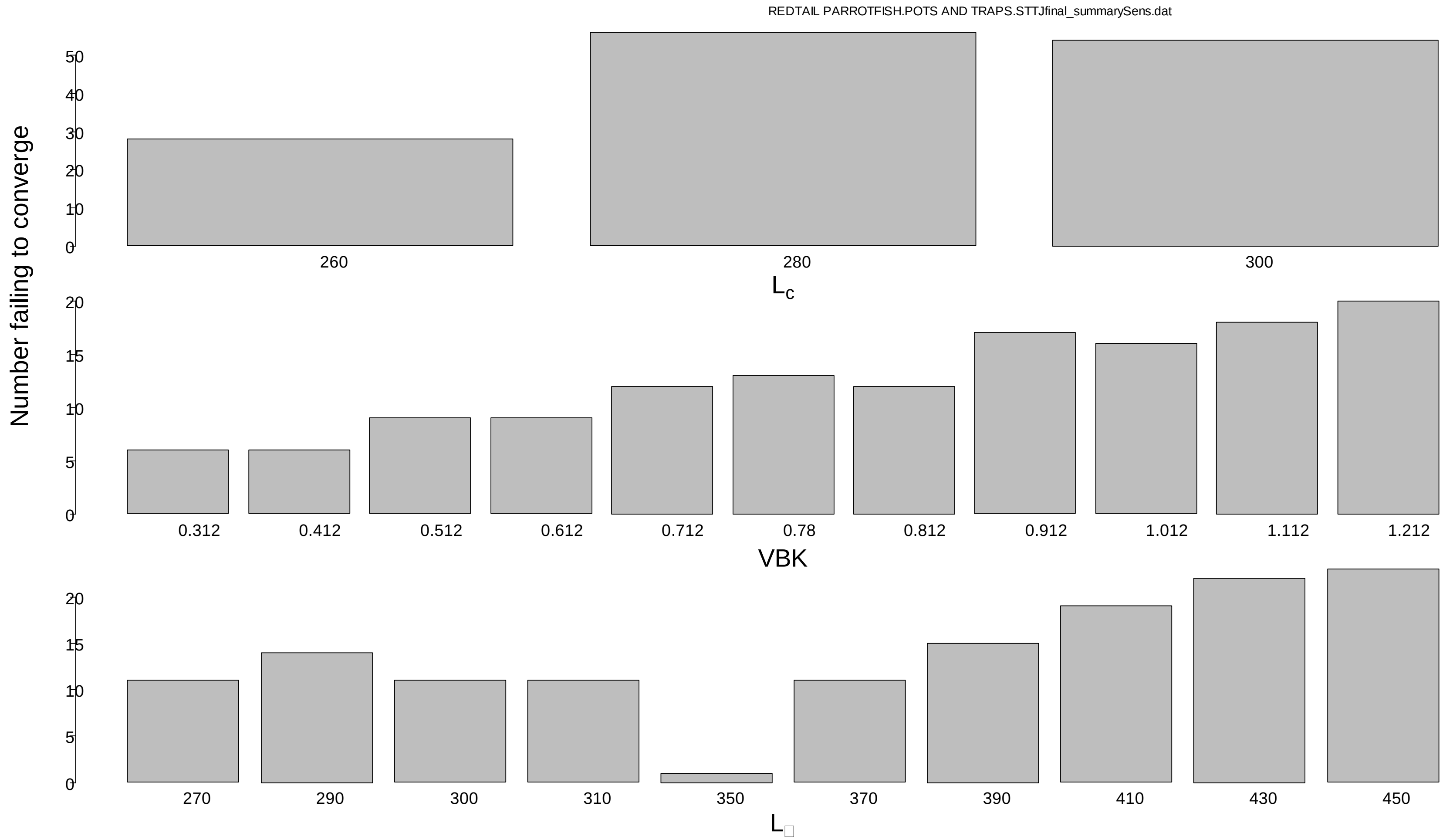

Figure 4.6.8. The number of sensitivity runs that failed to converge with respect to the input parameter values when data from the pot and trap fishery in St. Thomas/St. John were applied to the total mortality estimator.

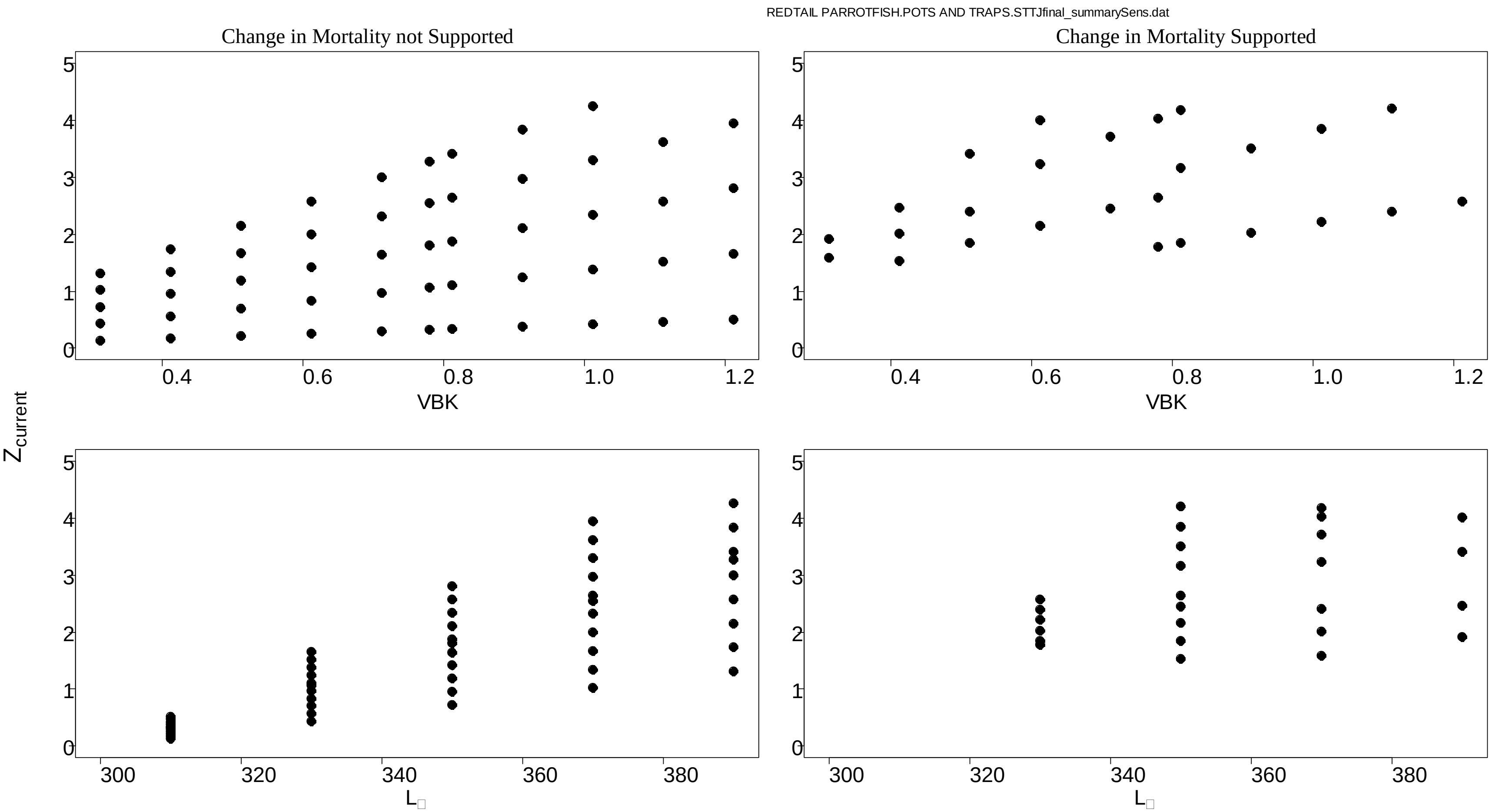

Figure 4.6.9. Current estimates of total mortality ($Z_{current}$) as a function of base case value for length at full vulnerability (L_c= 280mm), the full sensitivity range of the von Bertalanffy growth coefficient (K, top panel), and a reduced range of the asymptotic length parameter (L_∞, bottom panel) from the time-series analysis for redtail parrotfish caught by pots and traps in St. Thomas/St. John. The total mortality estimates presented in the left panels are the estimated mortality rates for the entire time series when a change in total mortality was not strongly supported by AIC (ΔAIC>5). The total mortality estimates presented in the right panels are the most recent estimated mortality rate when a change in total mortality was strongly supported by AIC (ΔAIC>5).

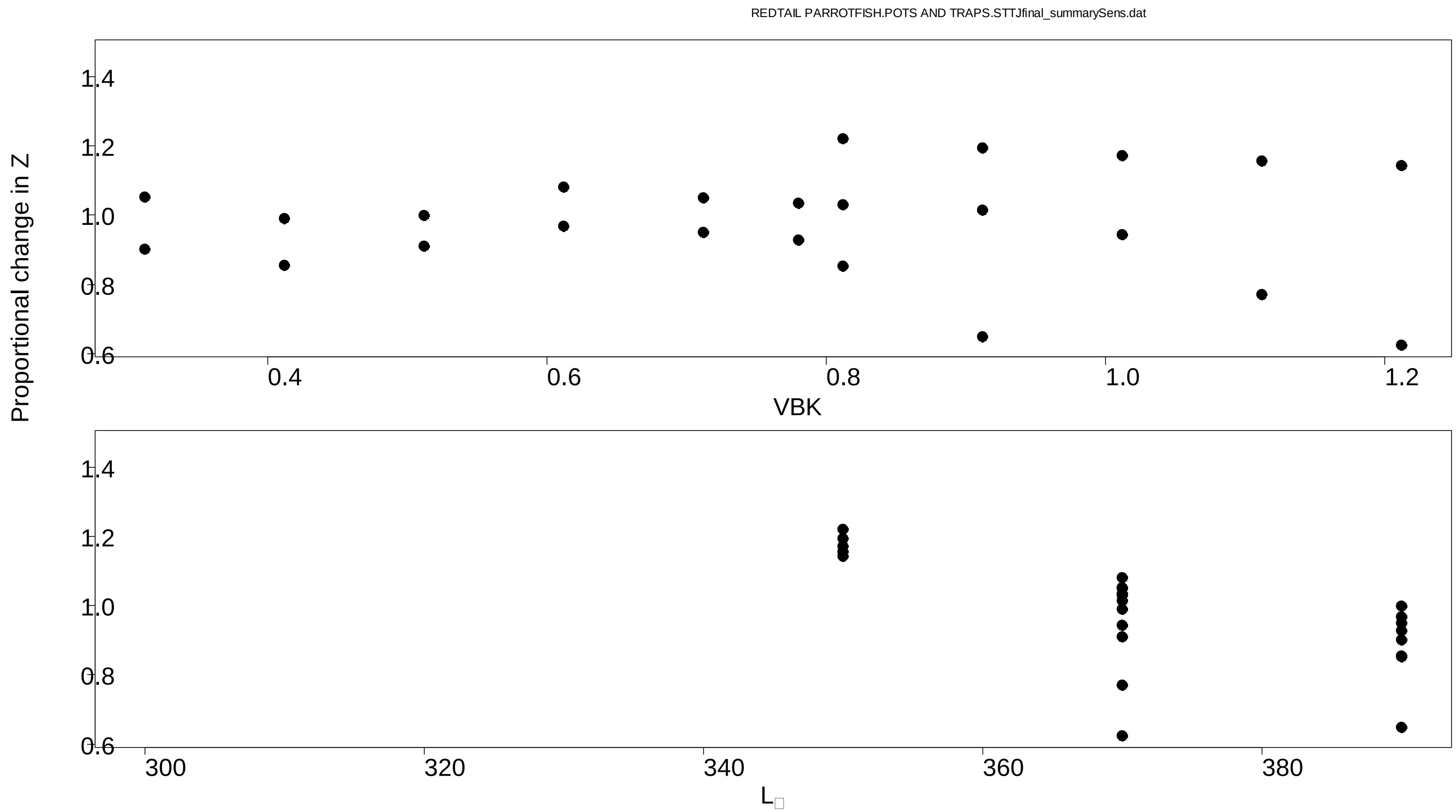

Figure 4.6.10. Proportional change in total mortality (when a change in mortality was supported by an improvement in AIC (ΔAIC>5) as a function of base case value for length at full vulnerability (L_c = 280mm), the full sensitivity range of the von Bertalanffy growth coefficient (K, top panel), and a reduced range of the asymptotic length parameter (L_∞, bottom panel) from the time-series analysis for redtail parrotfish caught by pots and traps in St. Thomas/St. John.

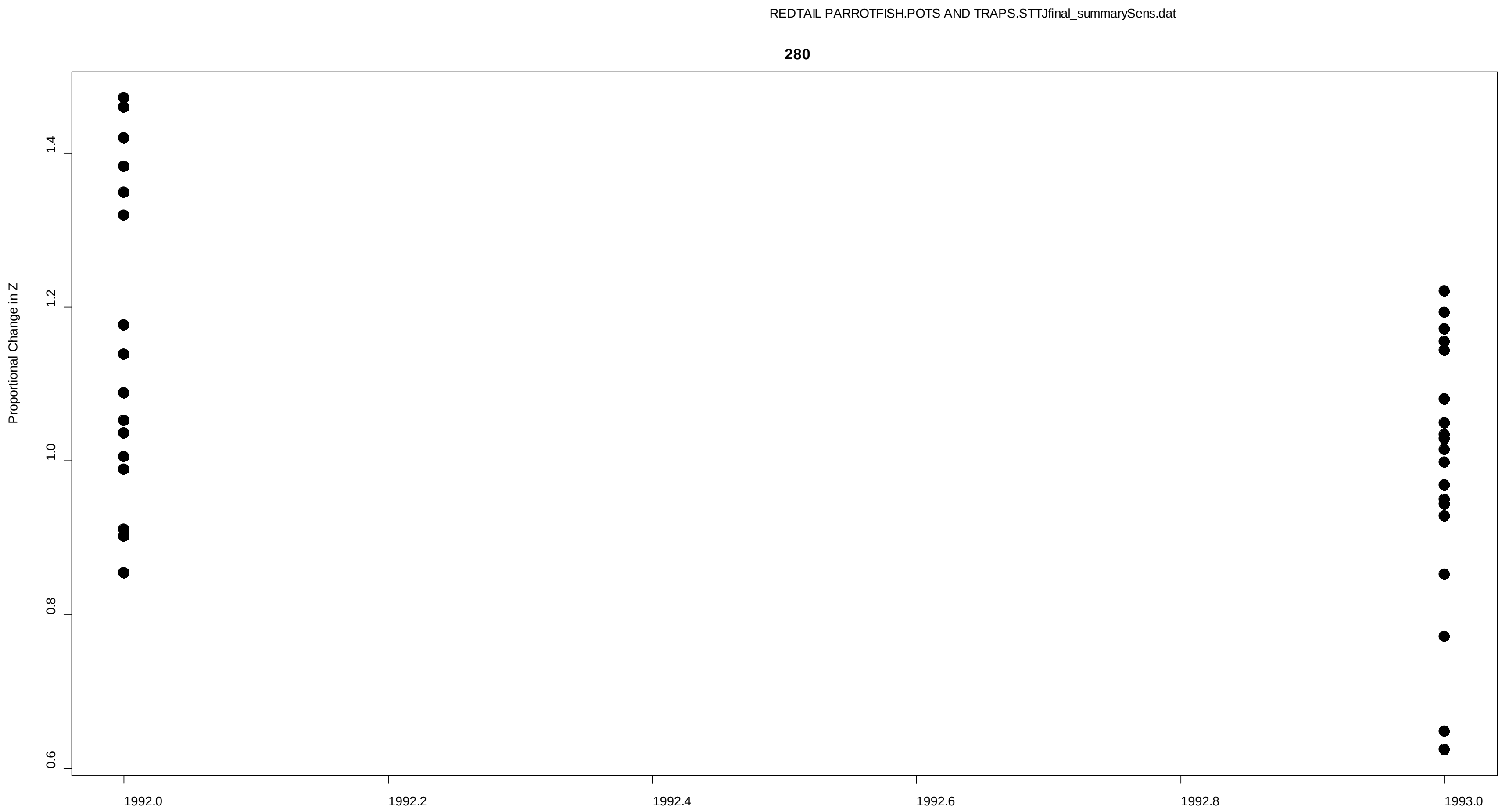

Figure 4.6.11. Proportional change in total mortality with respect to the predicted year of change for the base case L_c, 280mm, for the pot and trap fishery in St. Thomas/St. John.

5. St. Croix Parrotfish Stock Assessment Models and Results

5.1. Model 1 - Length frequency analysis of TIP data Methods

5.1.1. Overview

Please refer to section 3.1.1.1 for the overview.

5.1.2. Data Sources

Please refer to section 3.1.1.2 for information about the data sources.

5.1.3. Model Configuration and Equations

Please refer to section 3.1.3 for information about the model, its configuration, and the equations.

5.1.4. Parameters Estimated

The parameters estimated by the non-equilibrium length method as described in section 3.1.3 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.

5.1.5. Uncertainty and Measures of Precision

The panel at the SEDAR 26 data workshop (DW) and assessment workshop (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 value of the von Bertalanffy growth parameter (K) used for base case model runs was 0.78 (Molina-Urena 2009). For all sensitivity analyses the range of K inputs were set to a value 60% above and below the base value; the range of the K explored was 0.312 – 1.212. The range of the asymptotic growth parameter (L_∞) explored varied according the relationship between the base case value and the maximum observed length. The value used for base case model runs was 300mm, which was the mean of the two estimates found in Molina-Urena (2009). 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).

L_c was chosen by visual inspection of length-frequency histograms (Thorson and Prager 2011). To satisfy the concerns of the AW panel a wide range of L_c values were explored. 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. Tables 5.5.1-5.5.3 summarize the values used for the input parameters for the pot and trap fishery in St. Croix.

5.1.6. 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.

5.1.7. Projection methods

NA

5.2. Model 1 Results

5.2.1. Measures of Overall Model Fit

The AIC results provided strong support (ΔAIC >5) for a detectable change in the estimate of total mortality for the pot and trap fishery, however, support was not provided (ΔAIC <5) for a detectable change for the net fishery or the diver-based fishery (Tables 5.5.4-5.5.6).

5.2.2. Parameter estimates & associated measures of uncertainty

Please refer to section 5.2.8

5.2.3. Stock Abundance and Recruitment

NA

5.2.4. Stock Biomass

NA

5.2.5. Fishery Selectivity

NA

5.2.6. 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.

5.2.7. Stock-Recruitment Parameters

NA

5.2.8. Evaluation of Uncertainty

Tables 5.5.1-5.5.3 summarize the input value range for the input parameters explored in the sensitivity analysis for the St. Croix fisheries. The results from the base-model run indicate that a detectable reduction in mortality was strongly supported (ΔAIC >5) for the pot and trap fishery (Table 5.5.4, Figure 5.6.19). Total mortality was estimated to have changed in 1996, from 1.23 to 0.55, corresponding to the observed increasing mean length (Table 5.5.4, Figure 5.6.19). A detectable change in total mortality was not strongly supported (ΔAIC <5) for the net or diver fisheries (Tables 5.5.5 and 5.5.6, Figure 5.6.20 and 5.6.21).

Model convergence was a problem when using unrealistic input parameter combinations. Figures 5.6.22-5.6.24 summarize the number of times the model failed to converge with respect to the input parameter values for the St. Croix fisheries. In general, the number of convergence failures increased with an increasing L_c and K input values. The relationship between the number of convergence failures and the input value of L_∞, however, is concave (Figures 5.6.22-5.6.24, bottom panel). The increased frequency of convergence failures corresponds to L_c values paired with L_∞ values that are less than or close to the L_c value or when L_c was high enough to result in low sample sizes. The size distribution for redtail has remained relatively stable over time, lending confidence in the base value of L_c from visual inspection. Given this confidence, rather than present sensitivity results from unrealistic parameter combinations the presentation of the results will focus on the base case value of L_c, the full range of the K values and a subset of the L_∞ values, which includes the base case value. The results from the comprehensive sensitivity analysis are presented in the Appendix.

Figure 5.6.25-5.6.27 show the total mortality estimates that resulted from the narrowed range of the sensitivity analysis. The total mortality estimates ranged between 0.01 and 4.5 for all fisheries. The higher values of total mortality estimates corresponded to higher values the von Bertalanffy growth parameter (Figure 5.6.25-5.6.27). A stronger signal of change in mean length was present in the pot and trap fishery where 100% of the sensitivity runs for the pot and trap fishery resulted in strong support for the model predicting a change in total mortality (Figure 5.6.25). On the other hand, in both the net and diver fishery 100% of the sensitivity runs did not support the more complex change in total mortality model (Figure 5.6.26 and 27).

Figure 5.6.28 shows the direction of proportional change in total mortality for the sensitivity results for the pot and trap fishery. Total mortality was estimated to have declined in 100% of the sensitivity runs for the pot and trap fishery (Figure 5.6.28). Total mortality was estimated to decline between 35% and 60% between time periods. The influence of the von Bertalanffy growth coefficient seen in the total mortality estimates is not seen in the estimates of proportional change; however, the influence of the L_∞ value is still prevalent (Figure 5.6.28). The predicted year of change in total mortality is estimated to be between 1993 and 1996 (Figure 5.6.29).

5.2.9. Benchmarks / Reference Points / ABC values

See Section 5.3 for discussion.

5.2.10. Projections

NA

5.3. Discussion

Parrotfish are a preferred species in St. Croix and landings are greater on this platform as compared to Puerto Rico and St. Thomas/St. John. As a result, sample sizes for redtail parrotfish were sufficient to conduct a time series analysis of length frequency data collected from three different gear types: nets, divers, and pots and traps. Given our best estimate of L_c for each gear type, none of the runs conducted in our sensitivity analyses supported an increase in redtail total mortality rates during the time period where data were available (i.e. 1983 – 2011). A detectable change in mortality was only present in the samples collected in the pot and trap fishery where all the sensitivity runs supporting the more complex model indicated a decrease in mortality of between 35% and 60% occurring between 1993 and 1996. As discussed for the other two platforms, the uncertainty surrounding the von Bertalanffy parameter inputs required a comprehensive sensitivity analysis and without additional information the absolute estimates of total mortality when no change is detected are unreliable and not useful for management purposes alone.

The pattern of length frequency over time for redtail parrotfish in St. Croix requires some additional comments as compared to Puerto Rico and St. Thomas/St. John. Unlike the other two platforms, the ascending limb of the distribution, and in some cases the peak, appears to have changed over time. For example, the density plots contained in Figure 4 show that the distributions for 2003 to 2007 and for 2008 to 2011 are shifted to the left corresponding to a greater proportion of smaller animals. The most likely explanation is that the effective selectivity (either through gear or fisher behavior) is retaining smaller animals. By choosing the maximum length at full vulnerability (L_c) observed during the time series, the confounding effect of changing selectivity is taken into account and estimates are robust to this process. Alternatively, particularly good year classes or pulses of recruitment could result in a greater number of smaller animals. If recruitment were increasing in the most recent years (i.e. since 2003) the mean length of the population would be smaller than expected resulting in an overestimate of mortality and an underestimate of the proportional reductions in mortality. A close inspection of the descending limb (to the right of the Lc's; Figure 5.6.1) show that the size structure of fully selected animals has remained relatively constant over time and, as illustrated by our results, has slightly shifted toward larger older animals in the case of the pot and trap fishery.

Although definitive quantitative metrics are not available from this assessment to define stock status in terms of MSY, there are some qualitative aspects which suggest that the current management plan is risk adverse. First, the length-frequency composition of fully selected sampled fish appears to have remained relatively stable suggesting that the population has not undergone significant changes in size during the time period. Secondly, the majority of measured fish are above the reported size at maturity for the species. Finally, the proposed ACL (240,000 lbs.) in the 2010 amendment are intended to reduce parrotfish landings by at least 20 percent which is a slightly greater reduction from average landings than applied to the other two island groups and below the SSC recommendation of 300,000 lbs.

5.4. References

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5.5. Tables

Table 5.5.1. The lower bound, base case, and upper bound values for the time-series analysis input parameters for the pot and trap fishery in St. Croix.

Parameter	Lower bound	Base	Upper bound
L_c	242mm	262mm	302mm
VBK	0.312	0.78	1.212
L_∞	270mm	300mm	450mm

Table 5.5.2. The lower bound, base case, and upper bound values for the time-series analysis input parameters for the net fishery in St. Croix.

Parameter	Lower bound	Base	Upper bound
L_c	252mm	272mm	292mm
VBK	0.312	0.78	1.212
L_∞	270mm	300mm	450mm

Table 5.5.3. The lower bound, base case, and upper bound values for the time-series analysis input parameters for the diver-based fishery in St. Croix.

Parameter	Lower bound	Base	Upper bound
L_c	252mm	272mm	292mm
VBK	0.312	0.78	1.212
L_∞	270mm	300mm	450mm

Table 5.5.4. Summary of mean length time-series analysis results for the base case for redtail parrotfish caught by pots and traps in St. Croix. Npar is the number of parameters, LLIKE is the negative log-likelihood, Z is total mortality, and ΔYear is the estimated year of change.

Npar	Nobs	AIC	LLIKE	Z	Sigma	Lc	VBK	L_Inf	Z1	ΔYear1	Z2	ΔYear2	Z3	ΔYear3	Z4
2	23	128.979	62.190	1.138	54.170	262	0.78	300	-	-	-	-	-	-	-
4	23	118.145	53.961	-	37.878	262	0.78	300	1.228	1996	0.550	-	-	-	-
6	23	119.764	51.257	-	33.676	262	0.78	300	1.208	1989	2.590	1991	0.774	-	-
8	23	120.035	46.874	-	27.834	262	0.78	300	1.208	1989	2.505	1991	0.914	1998	0.504

Table 5.5.5. Summary of mean length time-series analysis results for the base case for redtail parrotfish caught by nets in St. Croix. Npar is the number of parameters, LLIKE is the negative log-likelihood, Z is total mortality, and ΔYear is the estimated year of change.

Npar	Nobs	AIC	LLIKE	Z	Sigma	Lc	VBK	L_Inf	Z1	ΔYear1	Z2	ΔYear2	Z3	ΔYear3	Z4
2	14	103.845	49.377	0.147	91.930	272	0.78	300	-	-	-	-	-	-	-
4	14	109.097	48.327	-	85.285	272	0.78	300	0.321	1993	0.001	-	-	-	-
6	14	120.184	48.092	-	83.869	272	0.78	300	0.318	1993	0.001	2002	0.386	-	-
8	14	137.768	46.484	-	74.767	272	0.78	300	0.305	1993	0.001	2003	4.529	2005	0.001

Table 5.5.6. Summary of mean length time-series analysis results for the base case for redtail parrotfish caught by divers in St. Croix. Npar is the number of parameters, LLIKE is the negative log-likelihood, Z is total mortality, and ΔYear is the estimated year of change.

Npar	Nobs	AIC	LLIKE	Z	Sigma	Lc	VBK	L_Inf	Z1	ΔYear1	Z2	ΔYear2	Z3	ΔYear3	Z4
2	9	48.378	21.189	0.238	22.956	272	0.78	300	-	-	-	-	-	-	-
4	9	58.027	20.014	-	20.146	272	0.78	300	0.142	2003	0.321	-	-	-	-
6	9	90.149	18.075	-	16.241	272	0.78	300	0.135	2006	0.760	2008	0.001	-	-
8	9	99999	19.910	-	19.915	272	0.78	300	0.169	1996	0.001	1998	0.001	2000	0.299

5.6. Figures

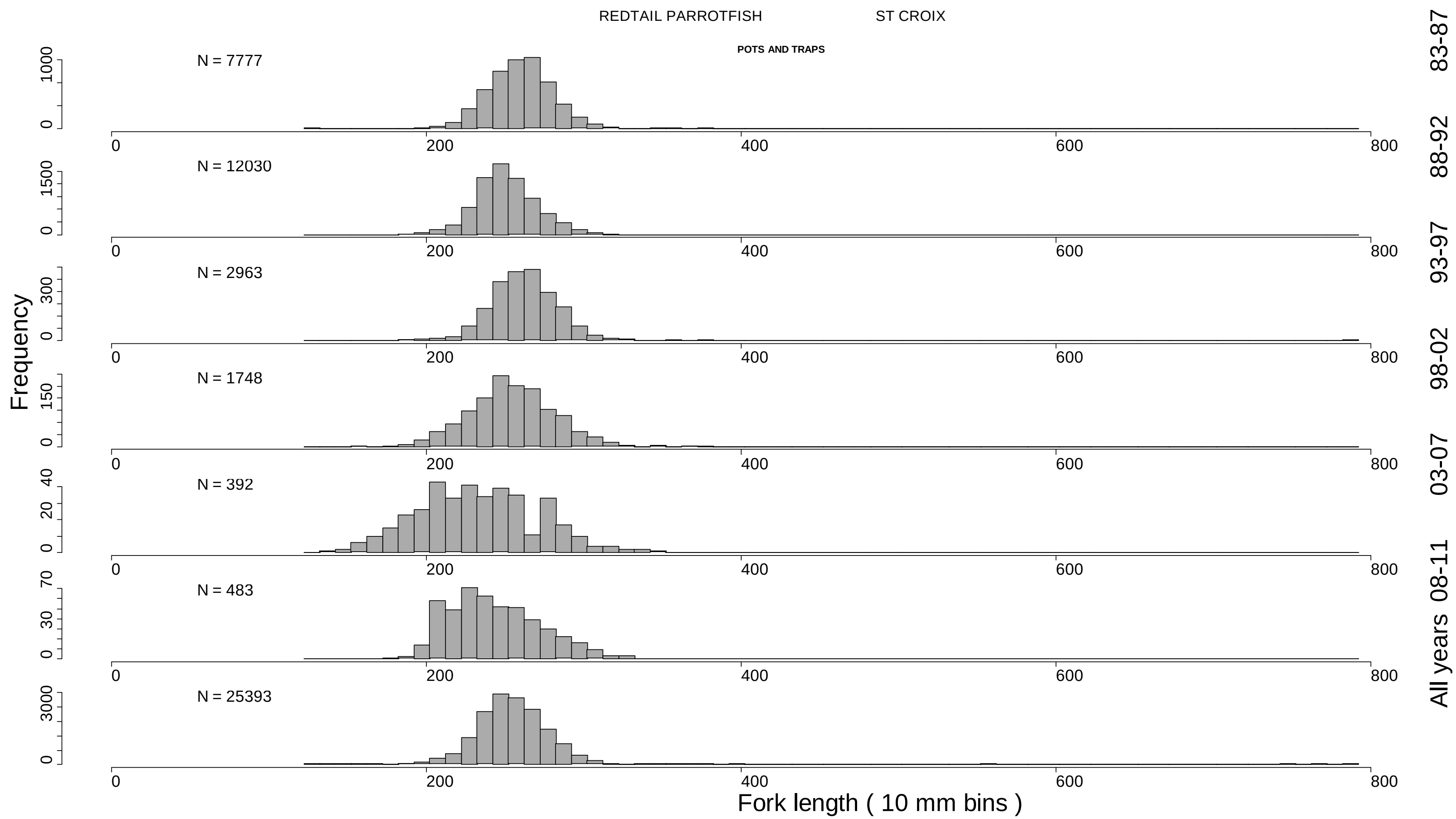

Figure 5.6.1. Length frequency distribution for redtail parrotfish caught by pots and traps in St. Croix. Each panel includes data from a five-year time period, which is indicated at the right side of each panel. The bottom panel includes data from all years. Sample numbers (N) are indicated in each panel.

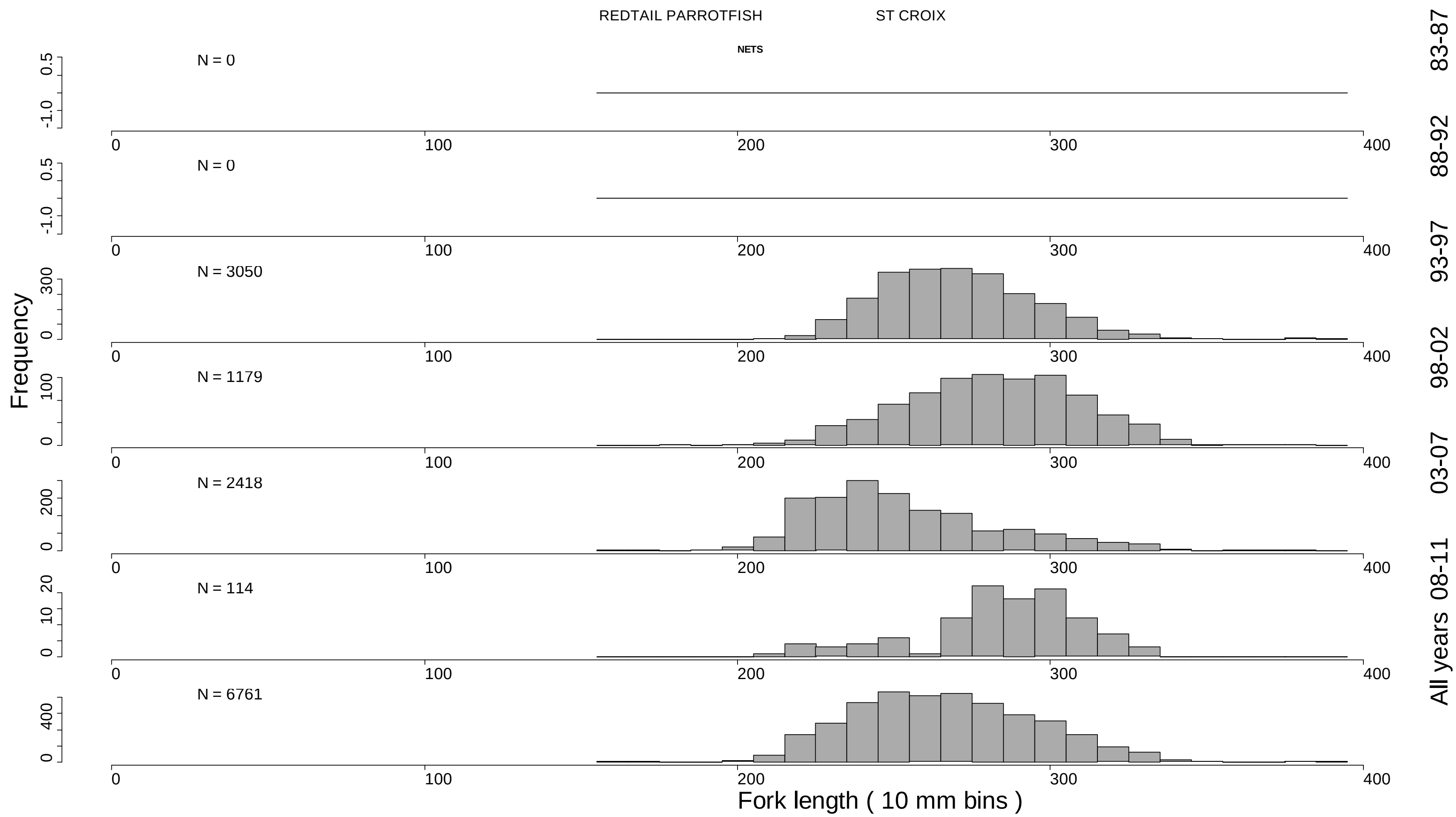

Figure 5.6.2. Length frequency distribution for redtail parrotfish caught by nets in St. Croix. Each panel includes data from a five-year time period, which is indicated at the right side of each panel. The bottom panel includes data from all years. Sample numbers (N) are indicated in each panel.

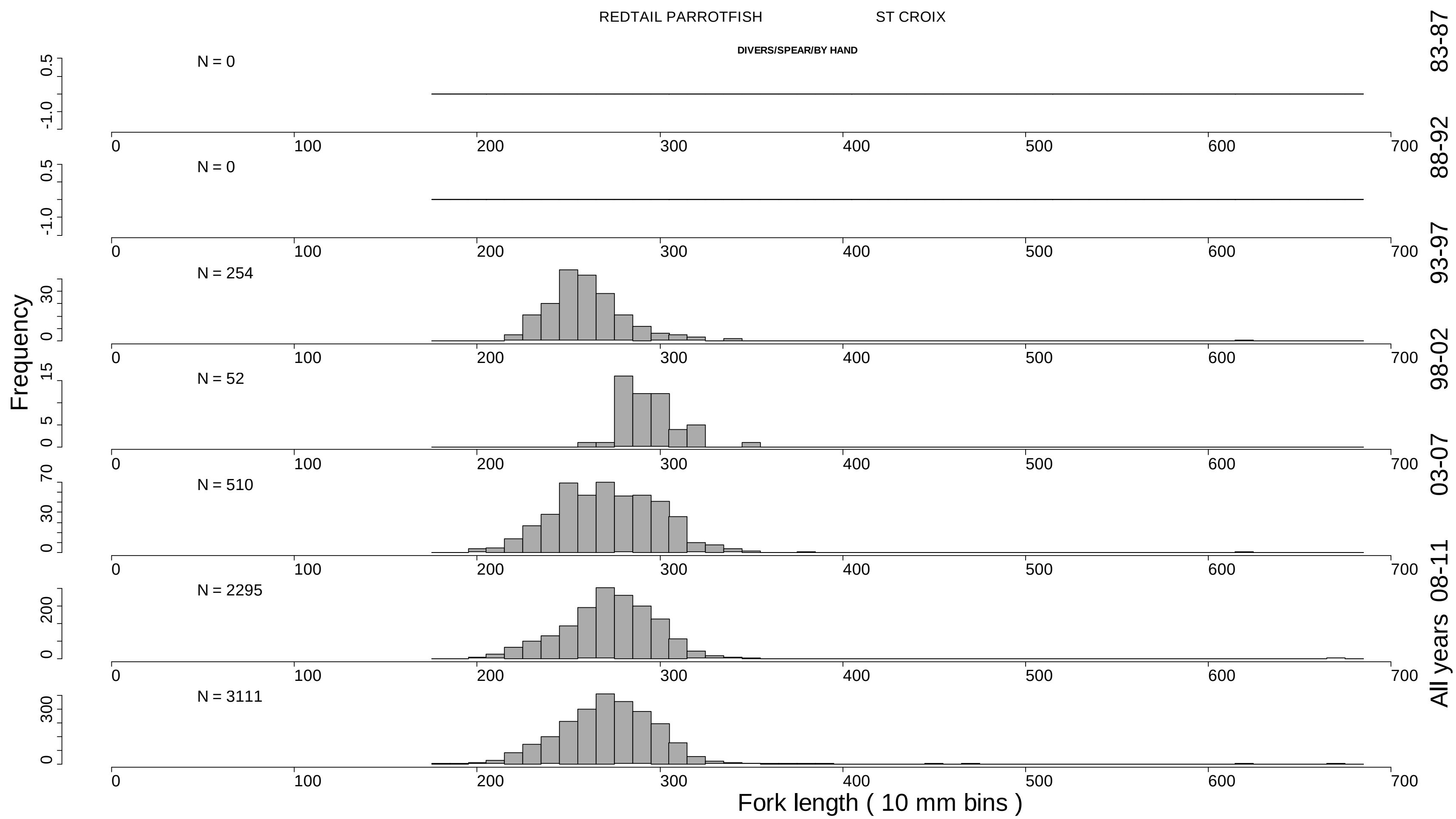

Figure 5.6.3. Length frequency distribution for redtail parrotfish caught by divers in St. Croix. Each panel includes data from a five-year time period, which is indicated at the right side of each panel. The bottom panel includes data from all years. Sample numbers (N) are indicated in each panel.

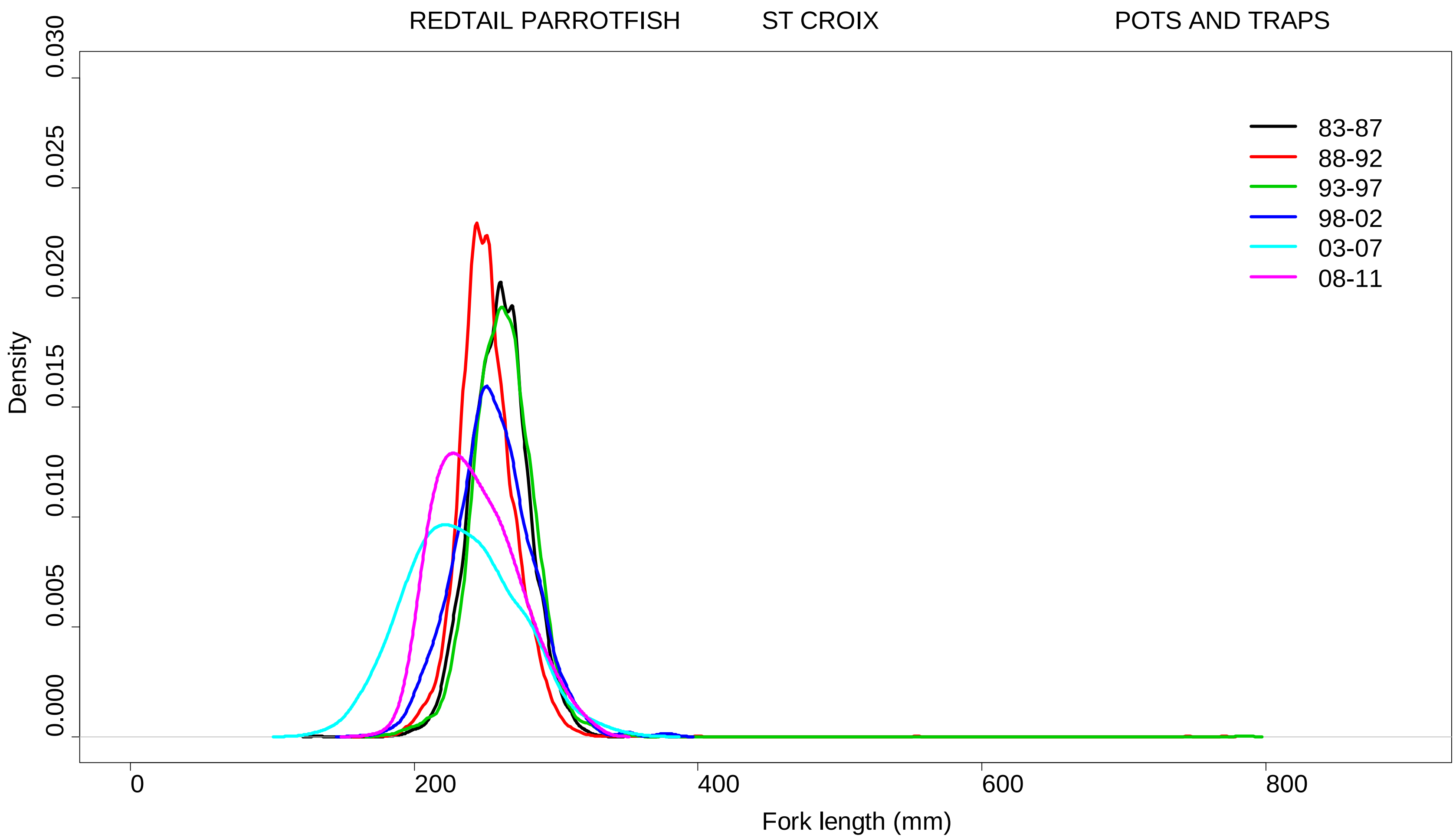

Figure 5.6.4. Density plot of observed lengths from the TIP database for redtail parrotfish caught by pots and traps in St. Croix. Each curve represents a five-year time-period.

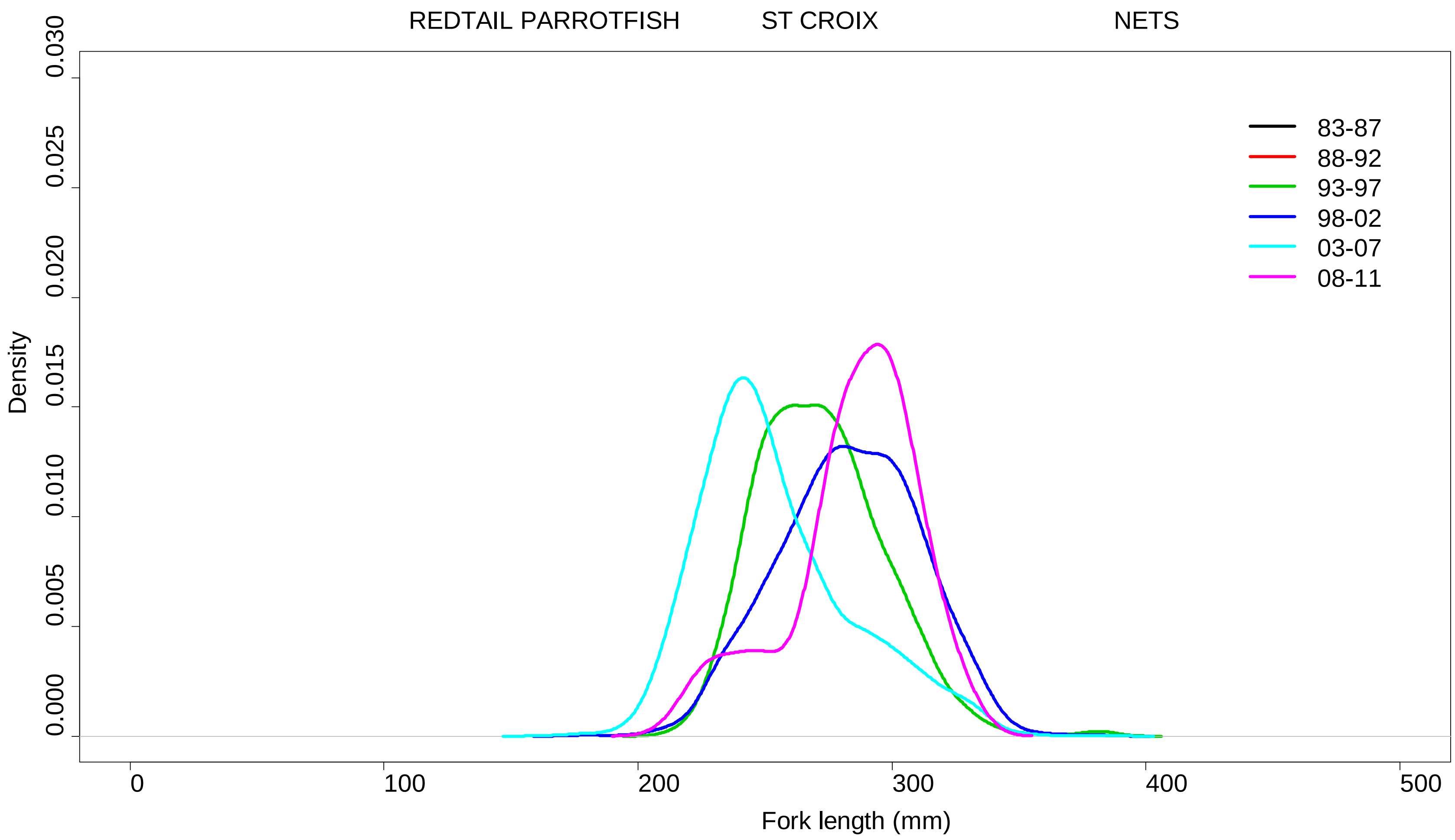

Figure 5.6.5. Density plot of observed lengths from the TIP database for redtail parrotfish caught by nets in St. Croix. Each curve represents a five-year time-period.

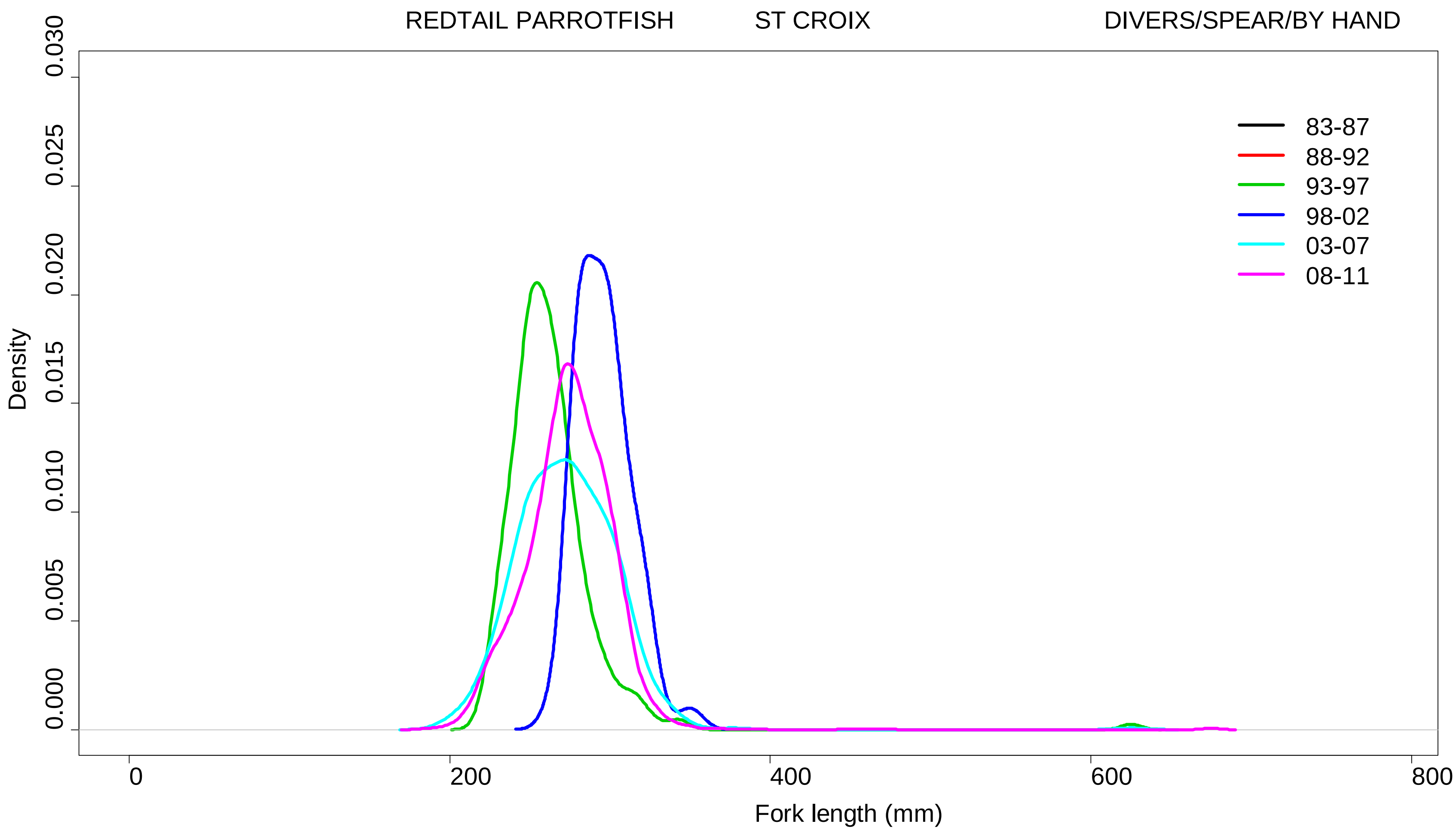

Figure 5.6.6. Density plot of observed lengths from the TIP database for redtail parrotfish caught by divers in St. Croix. Each curve represents a five-year time-period.

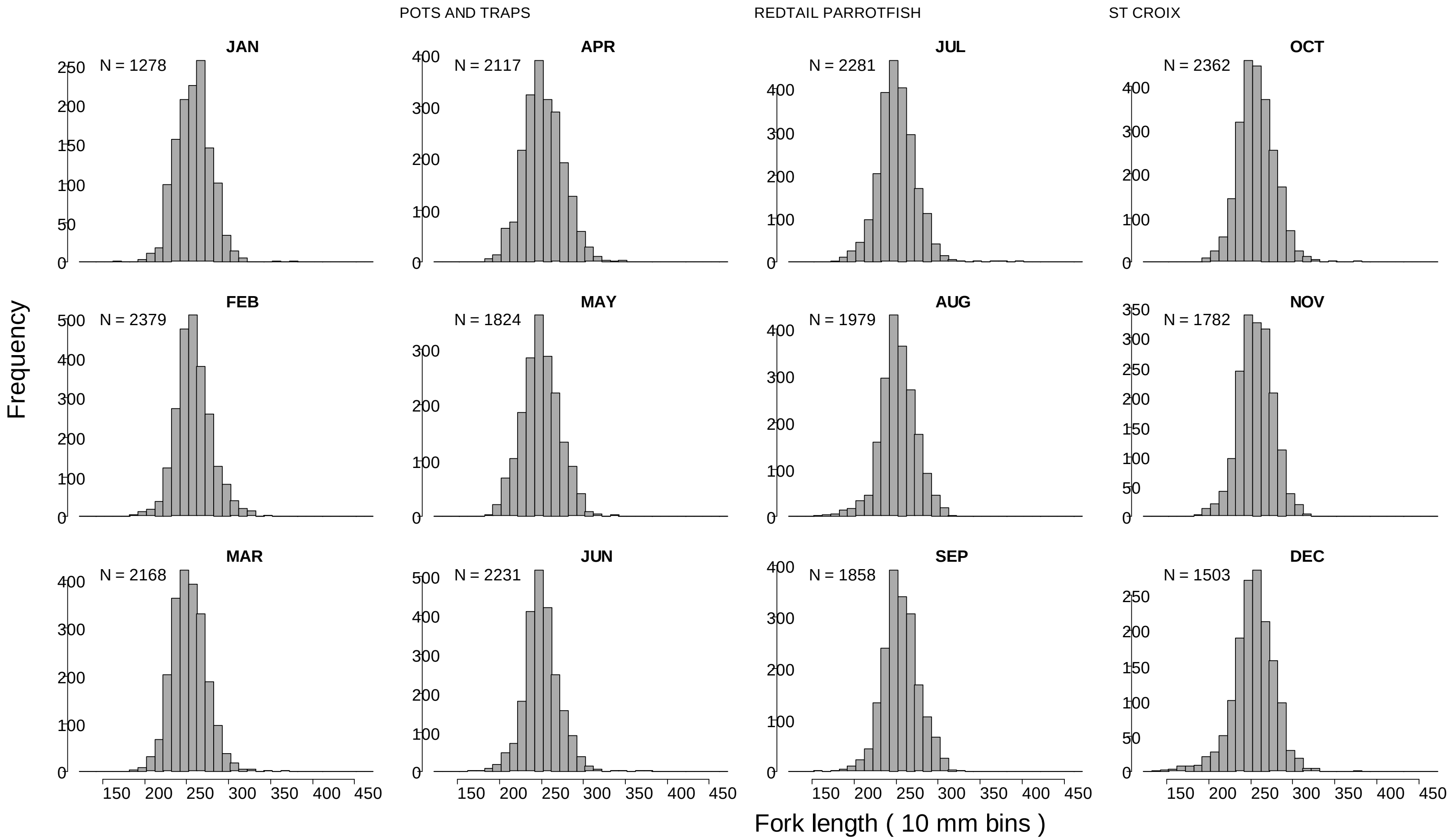

Figure 5.6.7. Monthly length-frequency histograms, where the length data were aggregated over years, for redtail parrotfish caught by the pot and trap fishery in St. Croix. N represents sample size.

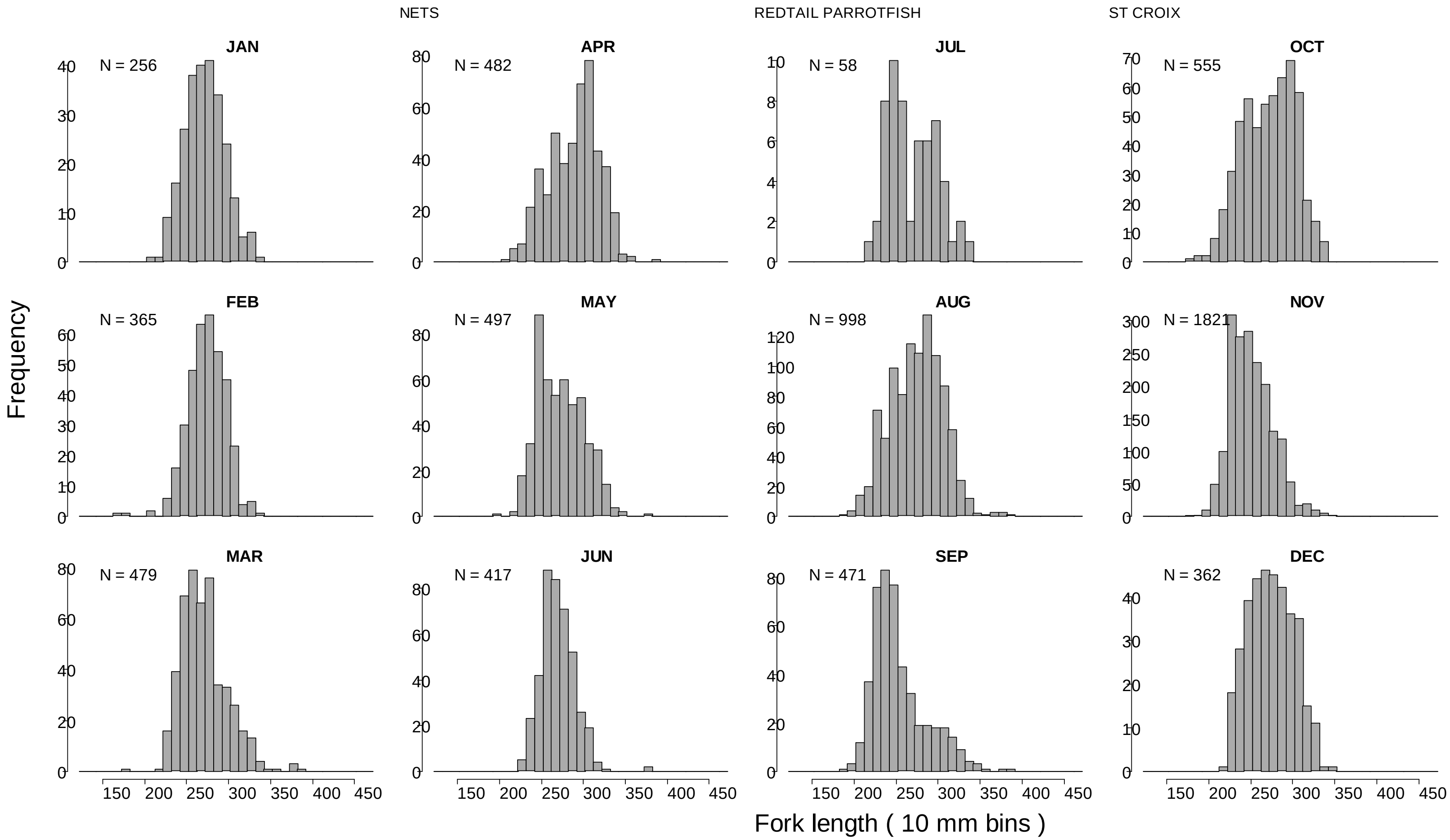

Figure 5.6.8. Monthly length-frequency histograms, where the length data were aggregated over years, for redtail parrotfish caught by the net fishery in St. Croix. N represents sample size.

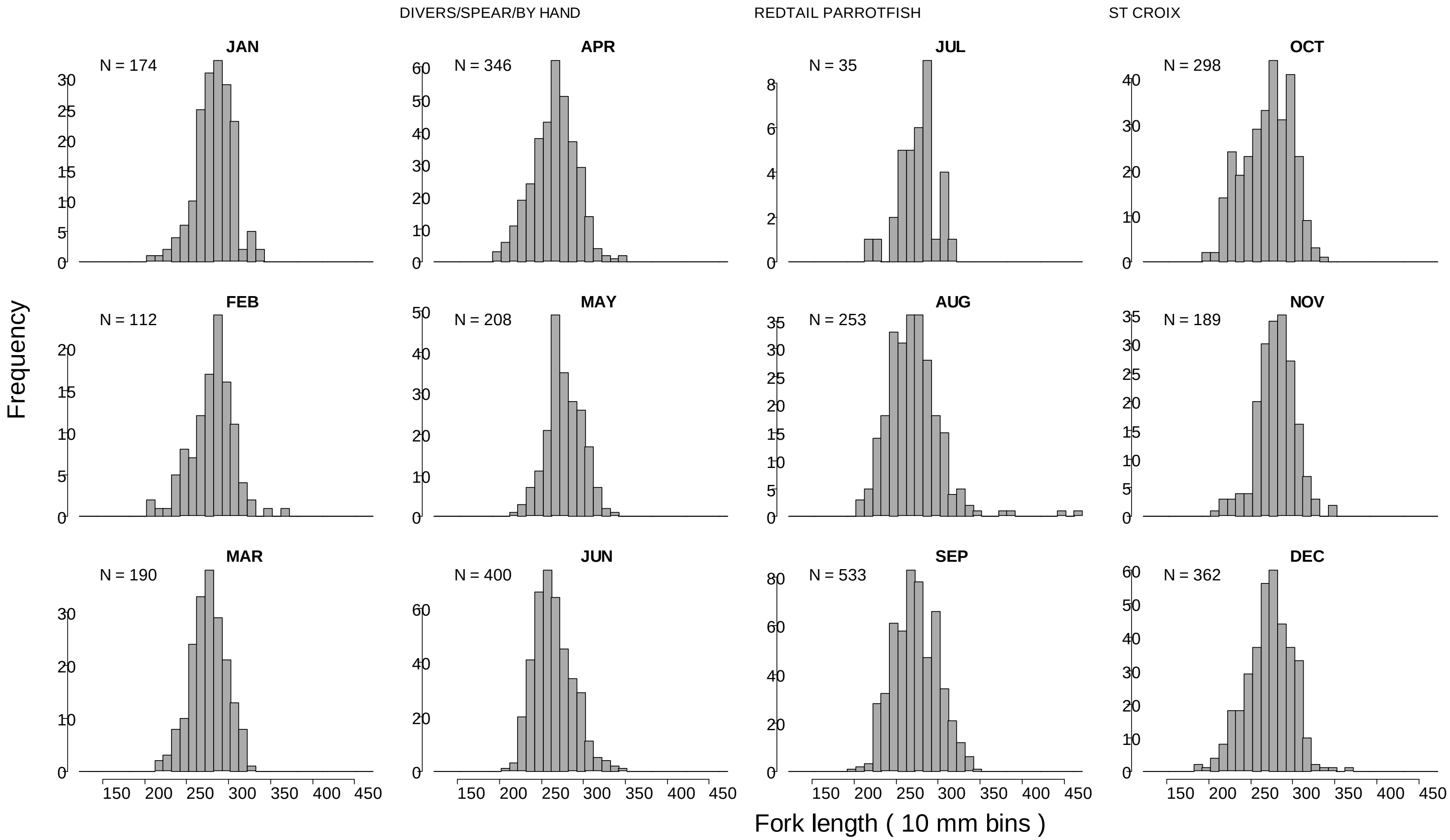

Figure 5.6.9. Monthly length-frequency histograms, where the length data were aggregated over years, for redtail parrotfish caught by divers in St. Croix. N represents sample size.

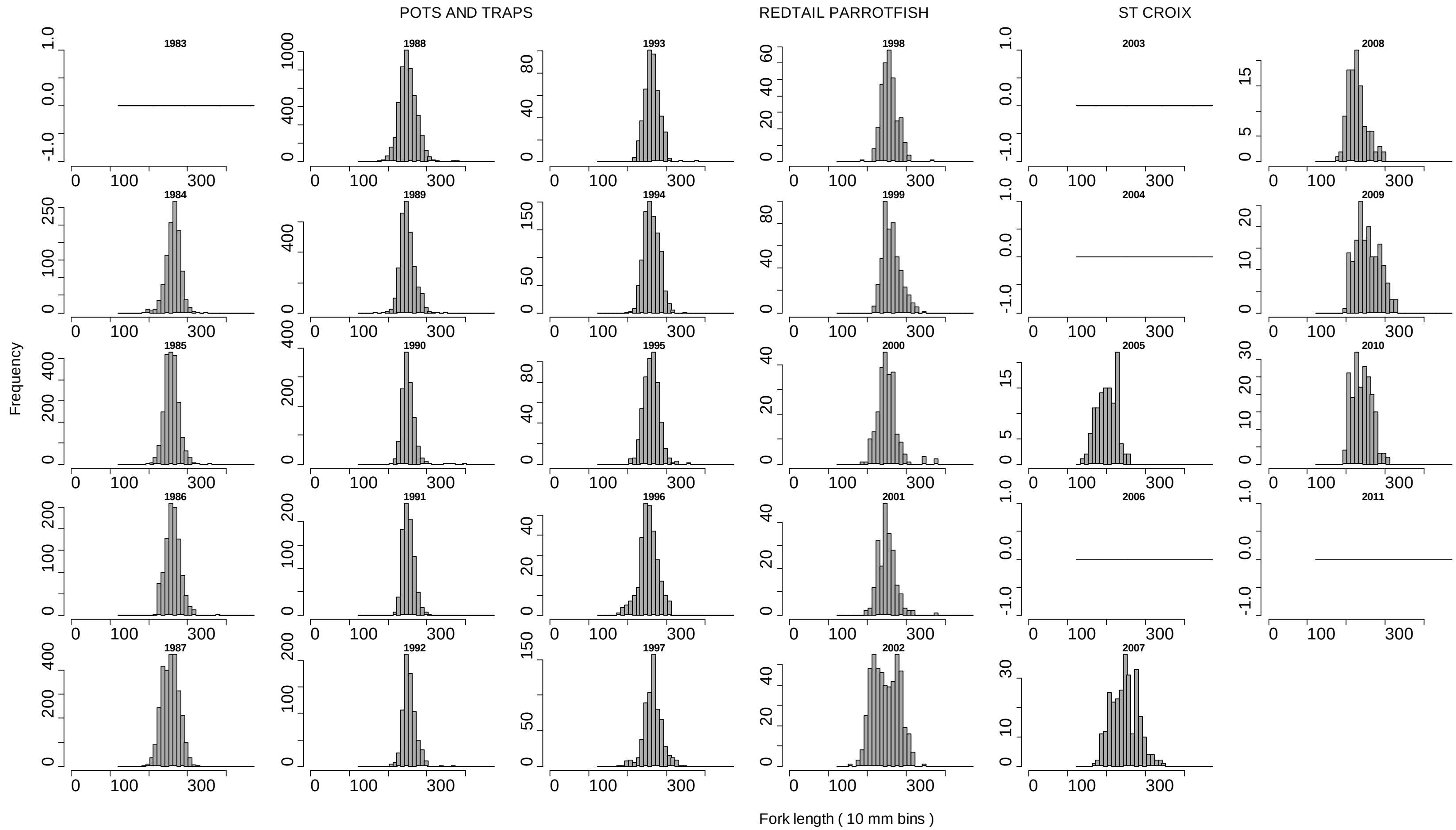

Figure 5.6.10. Annual length-frequency histograms for redtail parrotfish caught by the pot and trap fishery in St. Croix. Flat lines at zero indicate length-data were not collected in those years. Please note that the scale of the y-axis differs for each panel.

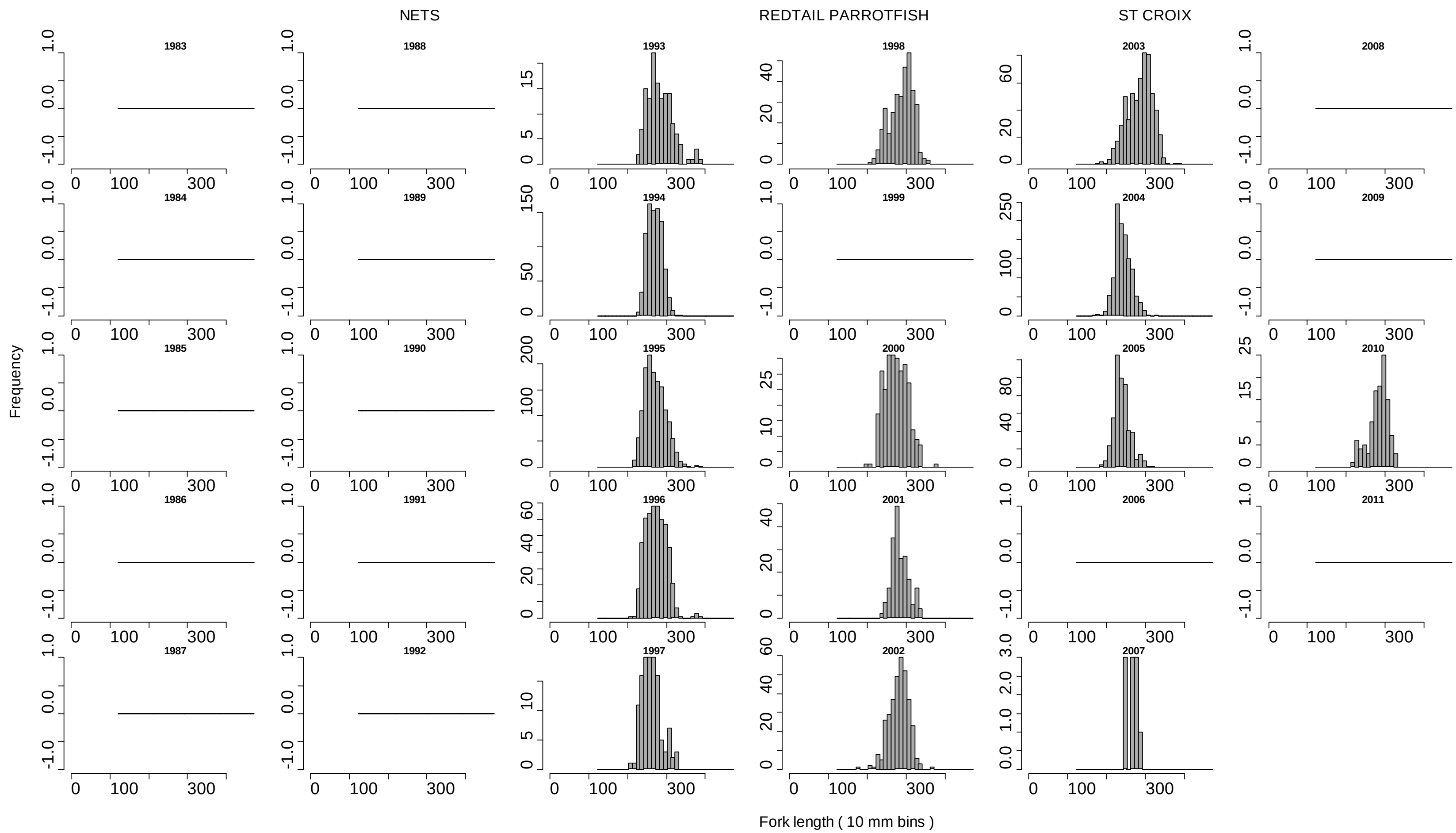

Figure 5.6.11. Annual length-frequency histograms for redtail parrotfish caught by the net fishery in St. Croix. Flat lines at zero indicate length-data were not collected in those years. Please note that the scale of the y-axis differs for each panel.

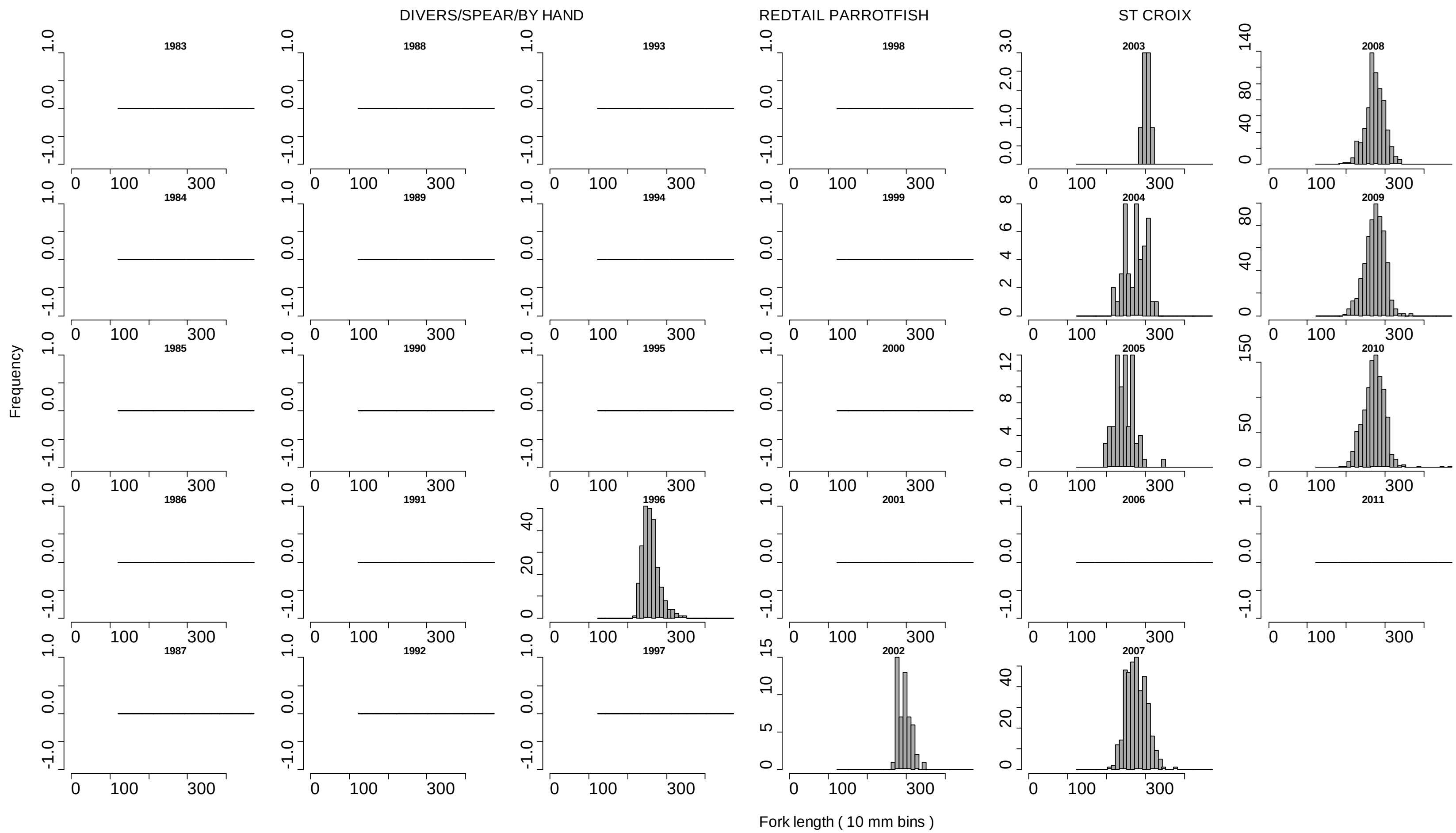

Figure 5.6.12. Annual length-frequency histograms for redtail parrotfish caught by divers in St. Croix. Flat lines at zero indicate length-data were not collected in those years. Please note that the scale of the y-axis differs for each panel.

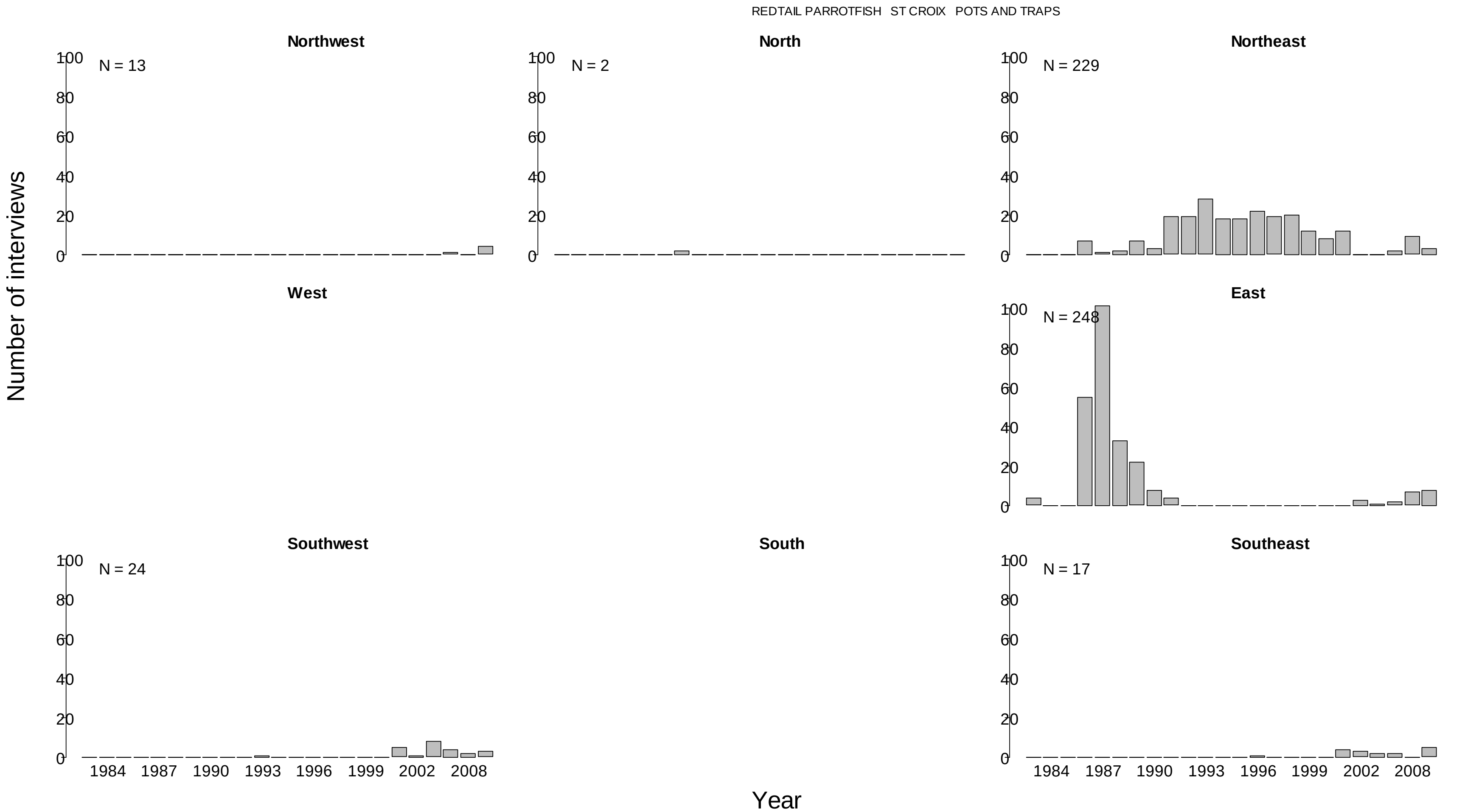

Figure 5.6.13. Regional fishing distribution as indicated by the TIP database for redtail parrotfish caught by the pot and trap fishery in St. Croix. N is the total number of interviews within a region.

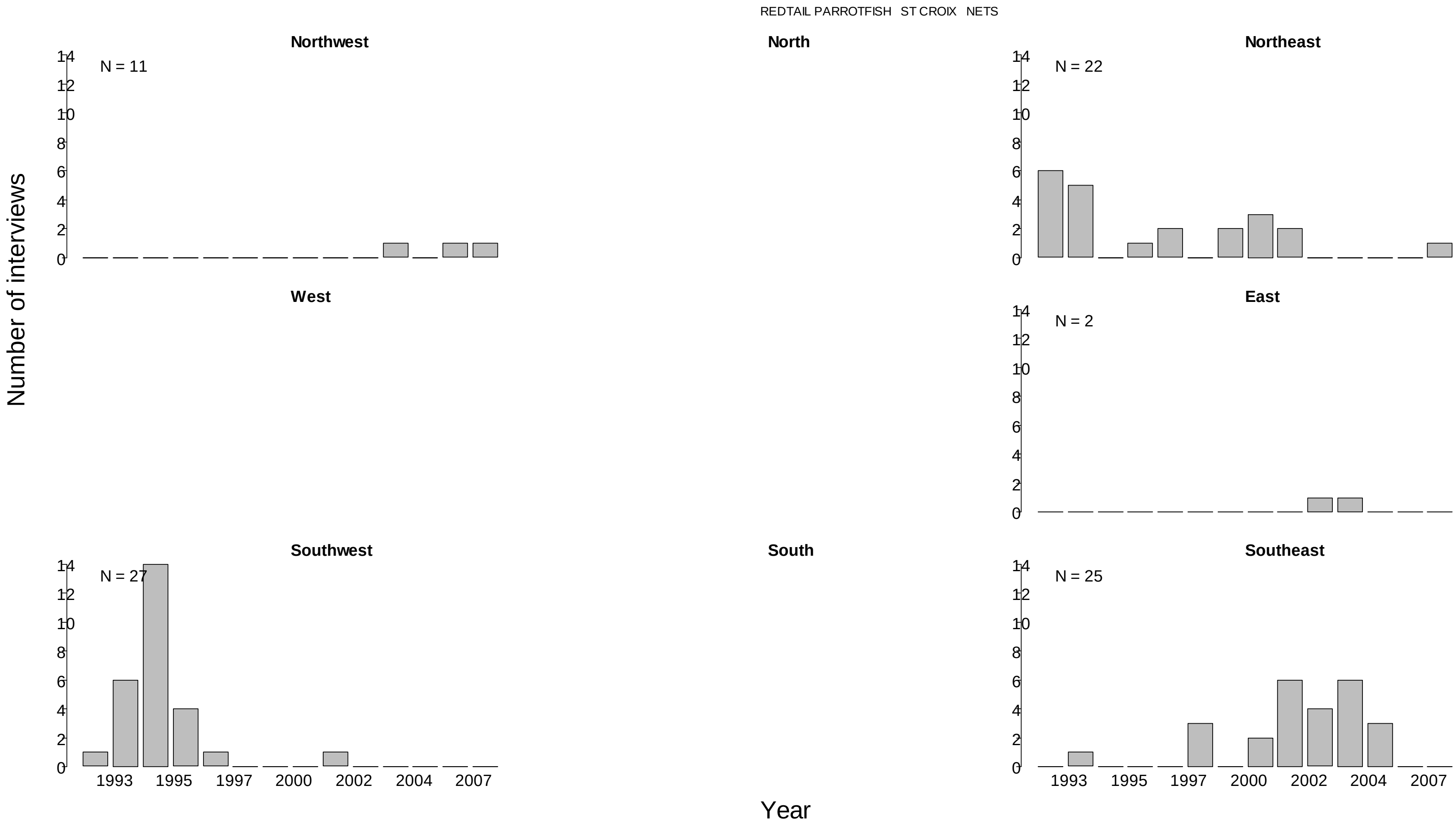

Figure 5.6.14. Regional fishing distribution as indicated by the TIP database for redtail parrotfish caught by the net fishery in St. Croix. N is the total number of interviews within a region.

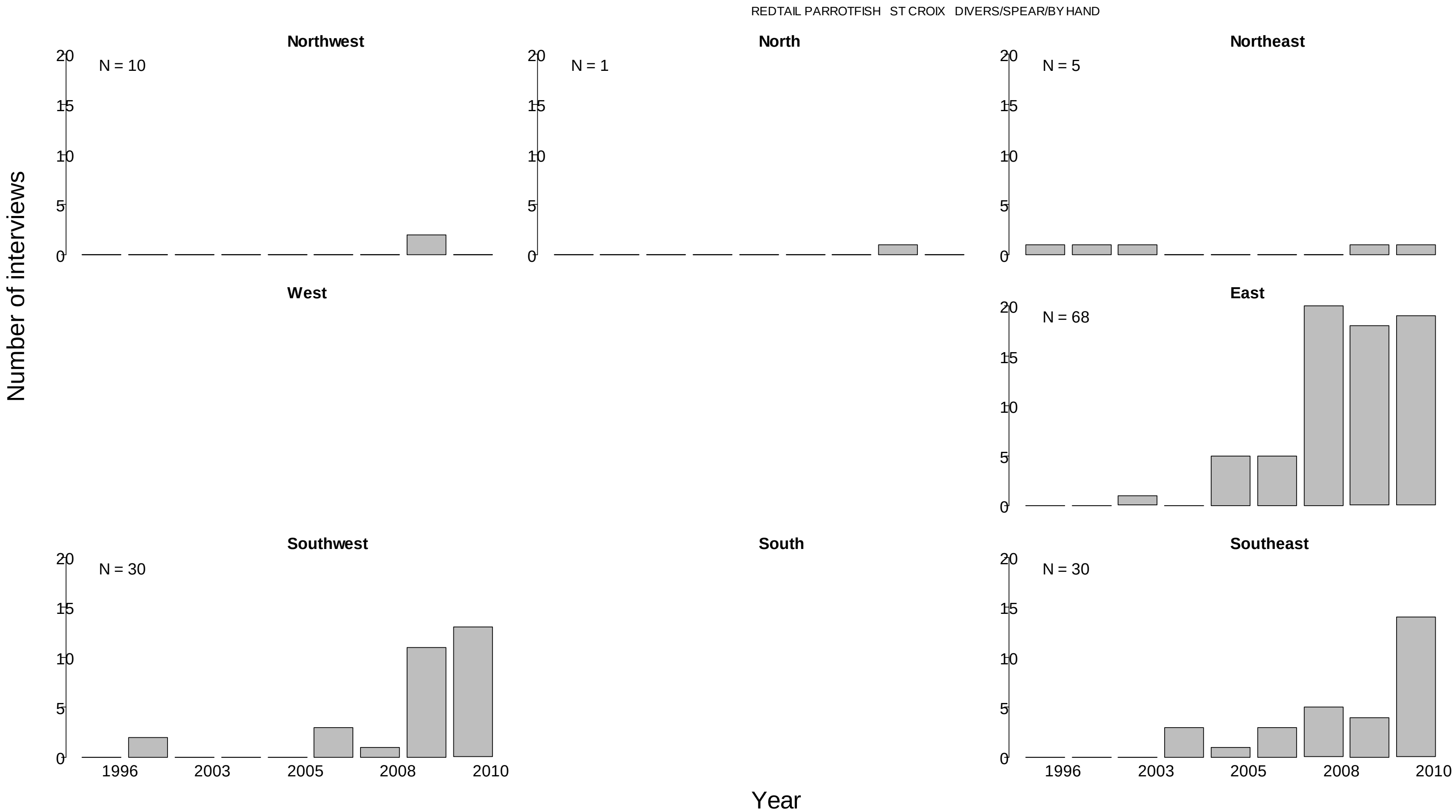

Figure 5.6.15. Regional fishing distribution as indicated by the TIP database for redtail parrotfish caught by the net fishery in St. Croix. N is the total number of interviews within a region.

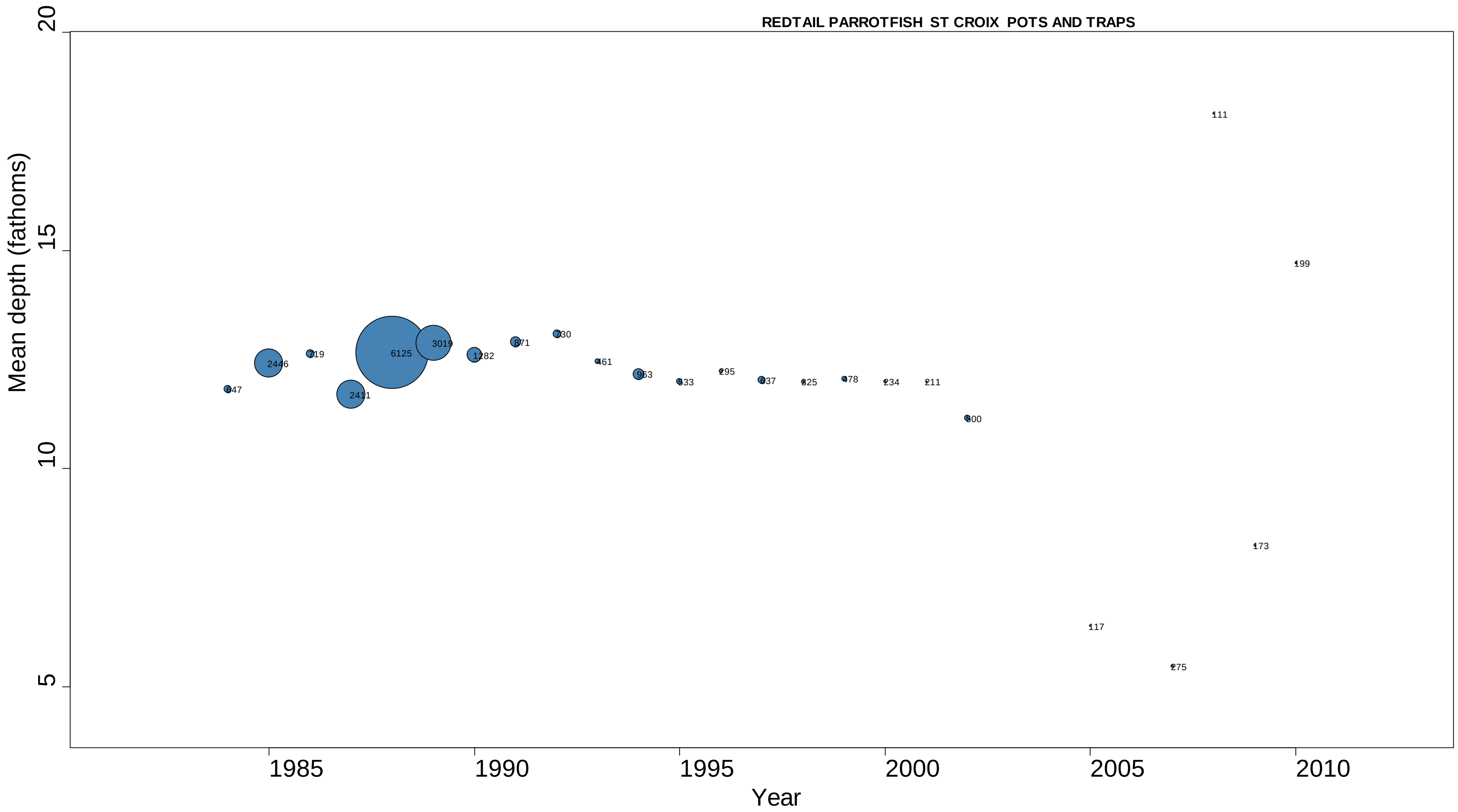

Figure 5.6.16. Mean depth (measured in fathoms) of fishing and capture of redtail parrotfish by the pot and trap fishery in St. Croix. Bubble size indicates the number of interviews from the TIP database for a given year that were used to calculate the mean and is scaled with respect to other years. The numbers plotted within the figure represent the number of interviews per bubble.

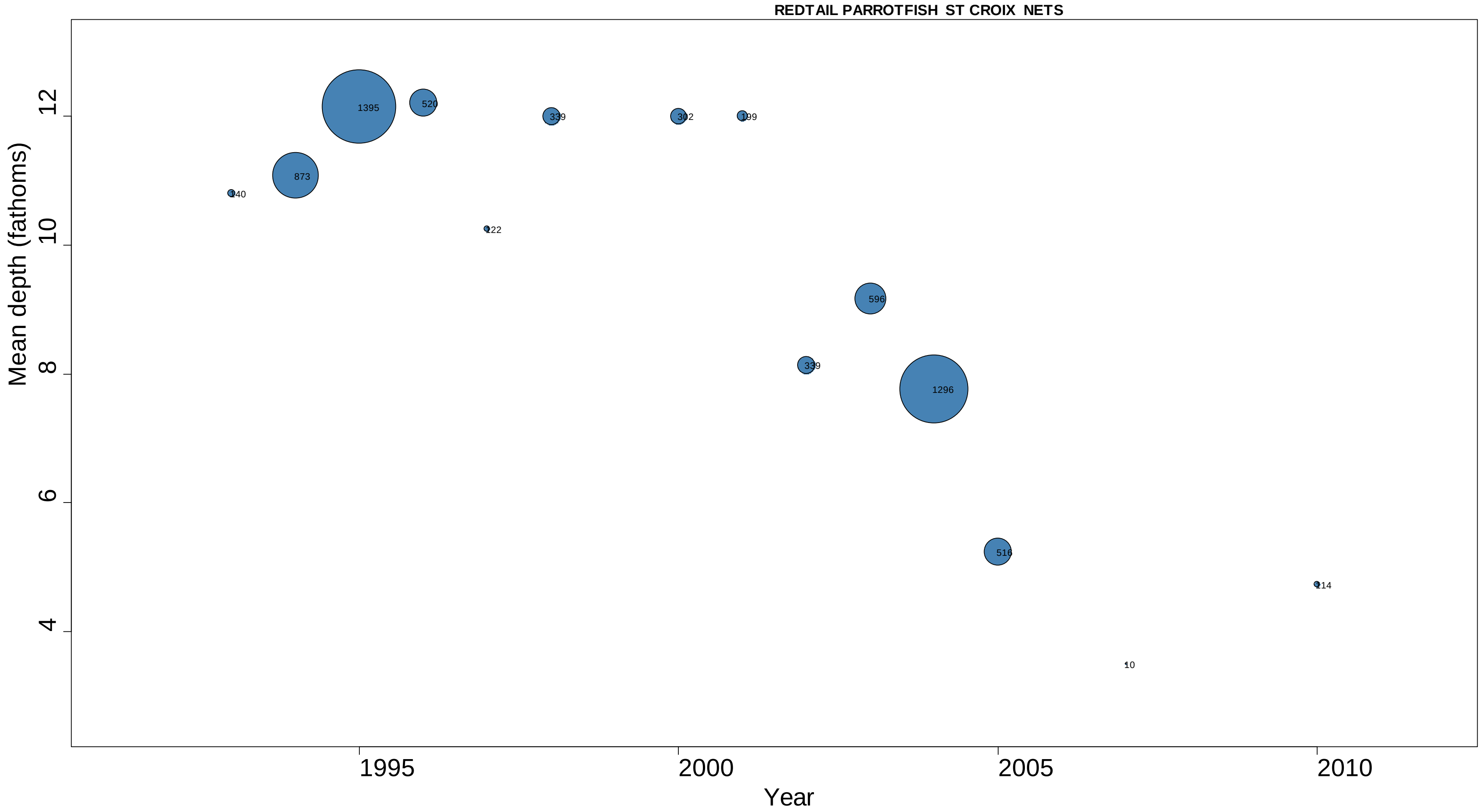

Figure 5.6.17. Mean depth (measured in fathoms) of fishing and capture of redtail parrotfish by the net fishery in St. Croix. Bubble size indicates the number of interviews from the TIP database for a given year that were used to calculate the mean and is scaled with respect to other years. The numbers plotted within the figure represent the number of interviews per bubble.

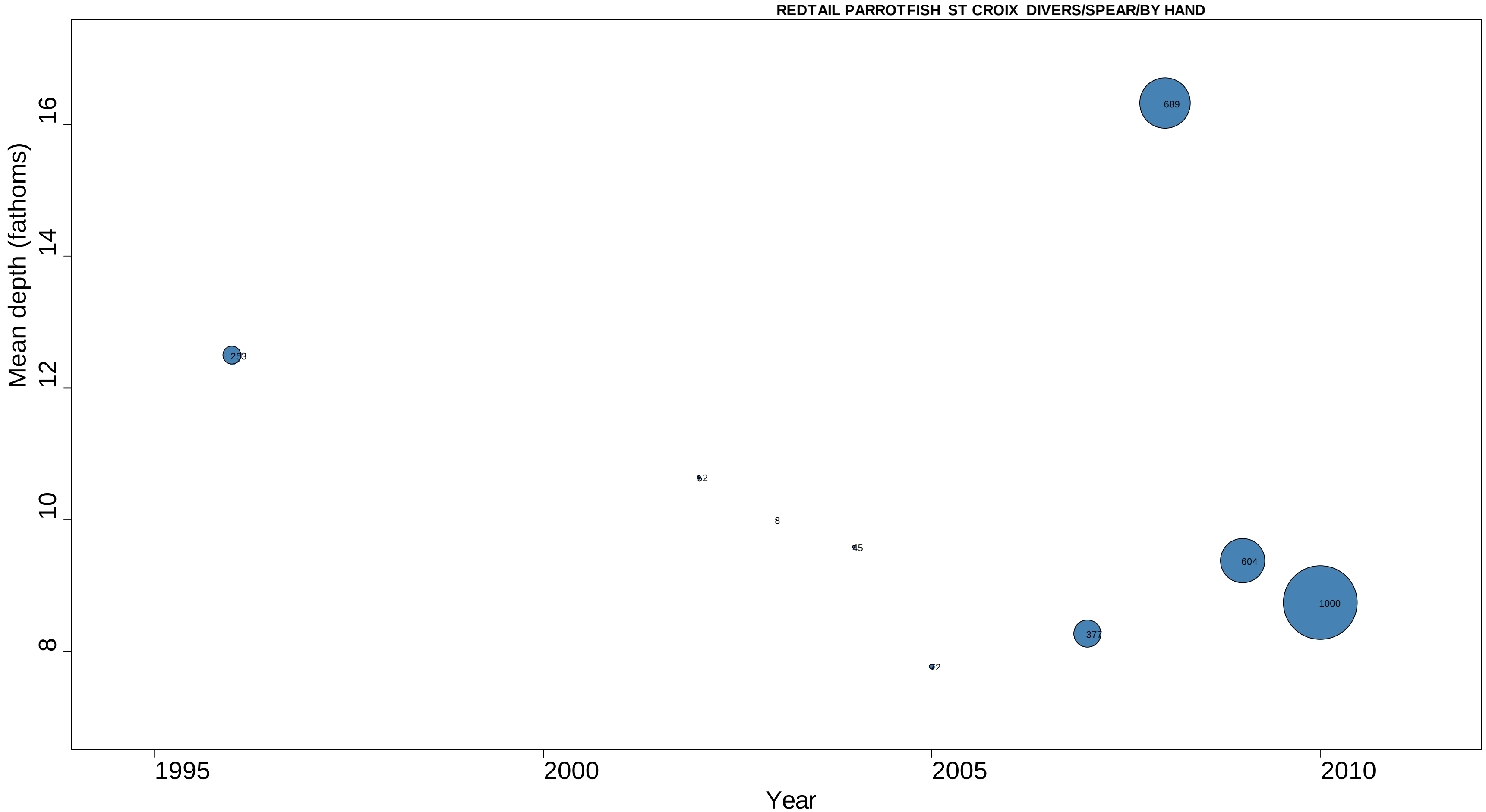

Figure 5.6.18. Mean depth (measured in fathoms) of fishing and capture of redtail parrotfish by diver fishery in St. Croix. Bubble size indicates the number of interviews from the TIP database for a given year that were used to calculate the mean and is scaled with respect to other years. The numbers plotted within the figure represent the number of interviews per bubble.

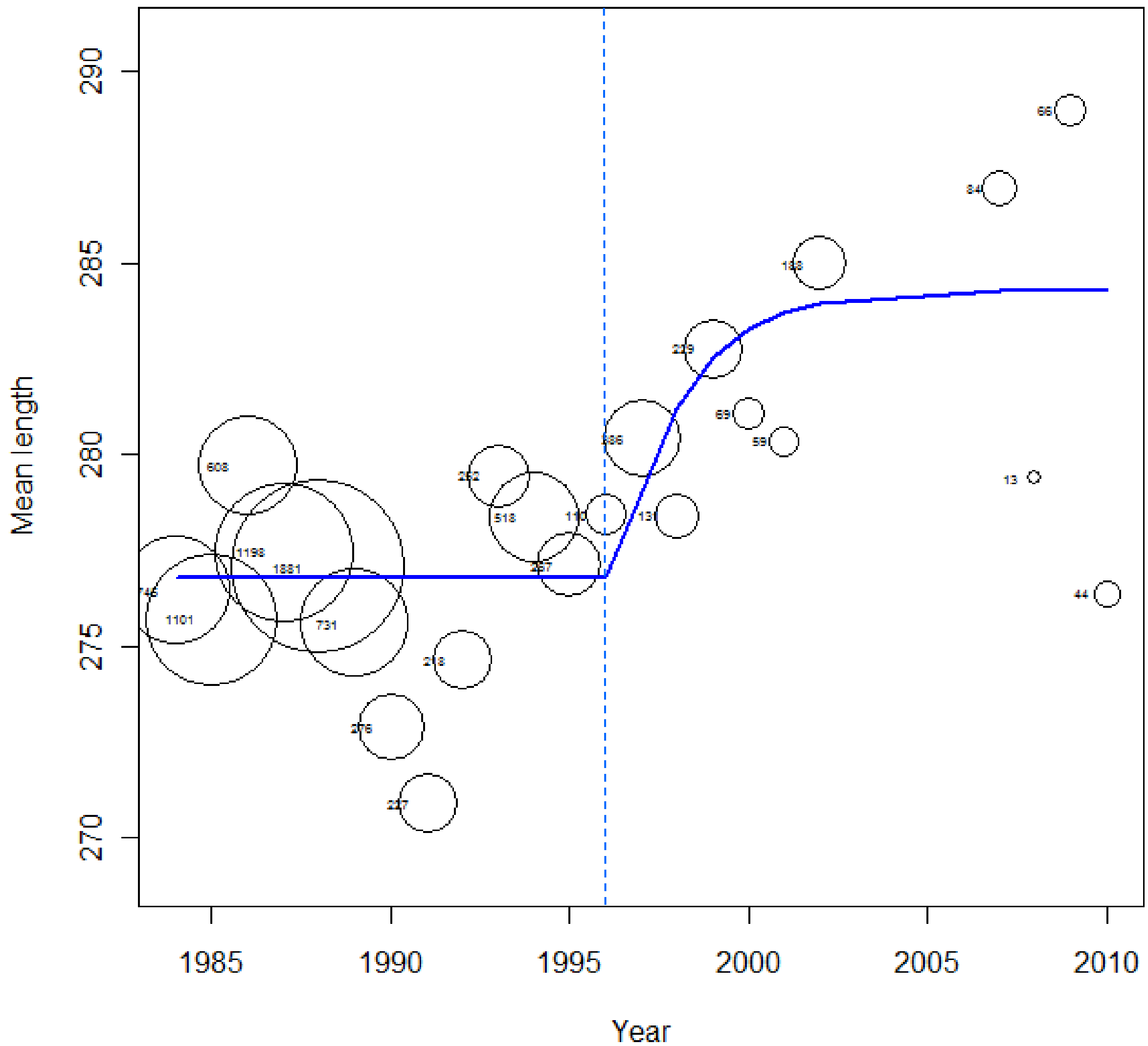

Figure 5.6.19. Annual mean length of fully-vulnerable individuals for the base-case scenario for redtail parrotfish caught by pots and traps in St. Croix. Bubble size indicates annual sample size relative to other years, the solid blue line represents the line of best fit, and the dashed blue line marks the year of change.

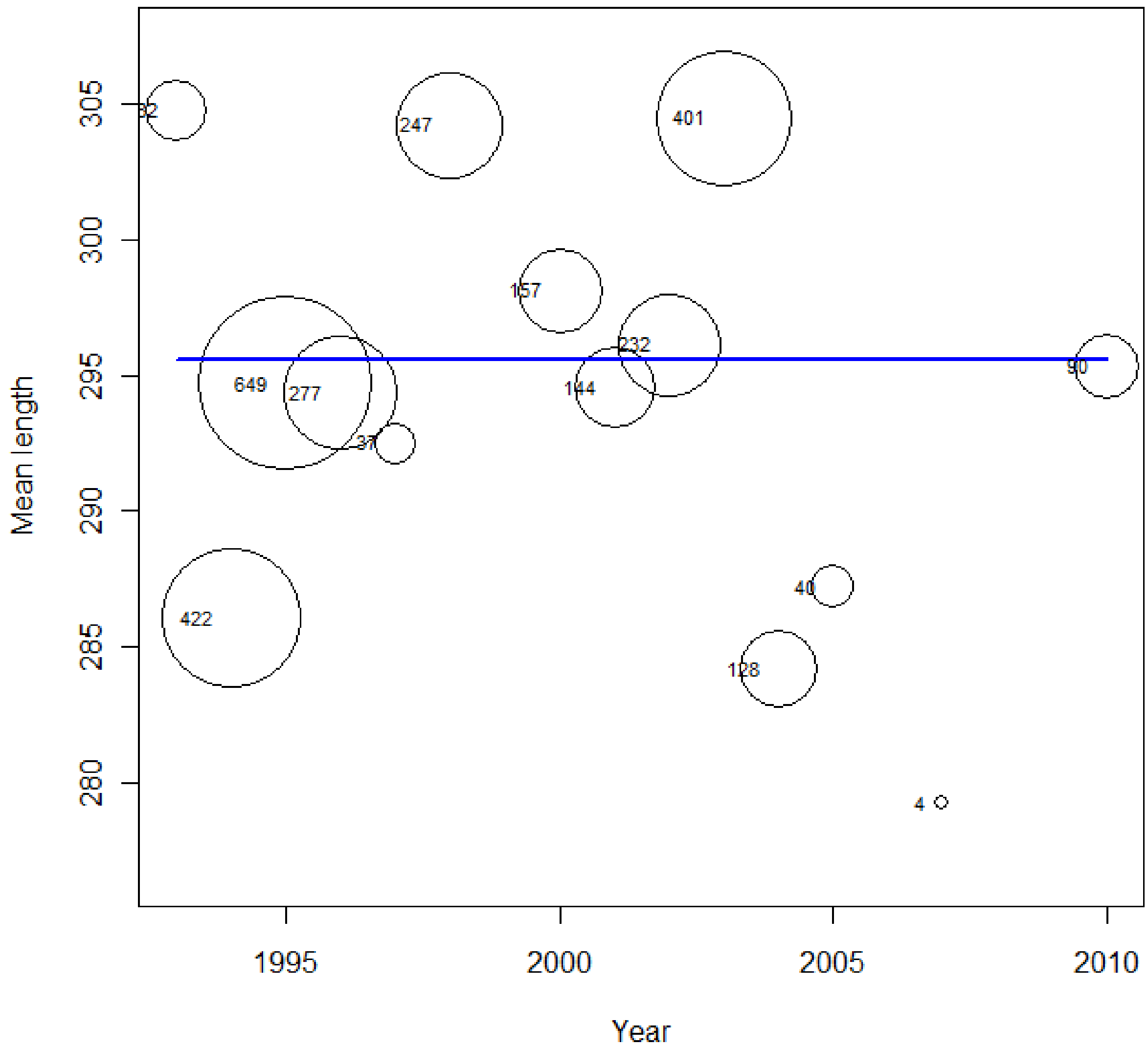

Figure 5.6.20. Annual mean length of fully-vulnerable individuals for the base-case scenario for redtail parrotfish caught by nets in St. Croix. Bubble size indicates annual sample size relative to other years and the solid blue line represents the line of best fit which corresponds to the no change in mortality model.

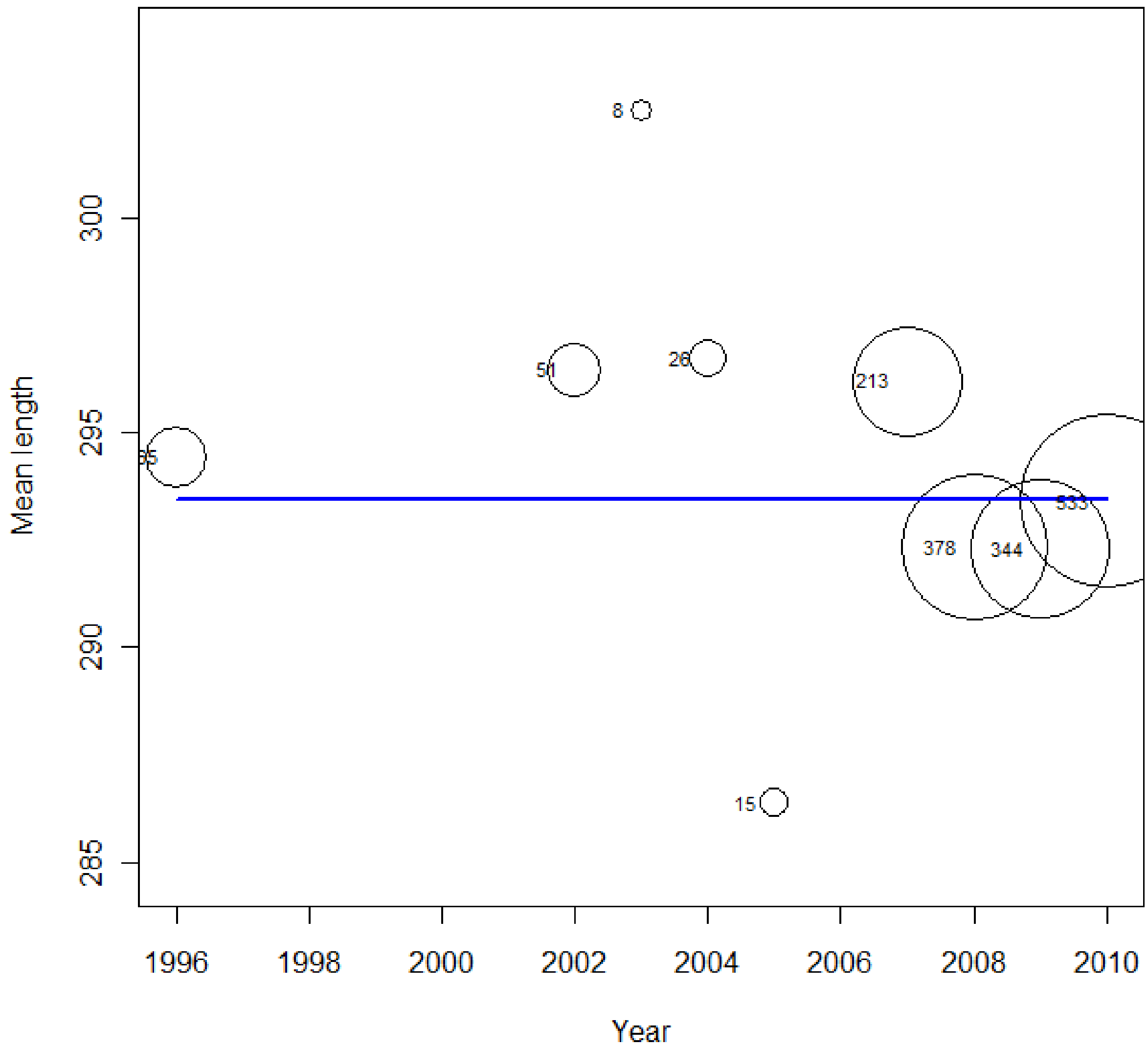

Figure 5.6.21. Annual mean length of fully-vulnerable individuals for the base-case scenario for redtail parrotfish caught by divers in St. Croix. Bubble size indicates annual sample size relative to other years and the solid blue line represents the line of best fit corresponding to the no change in mortality model.

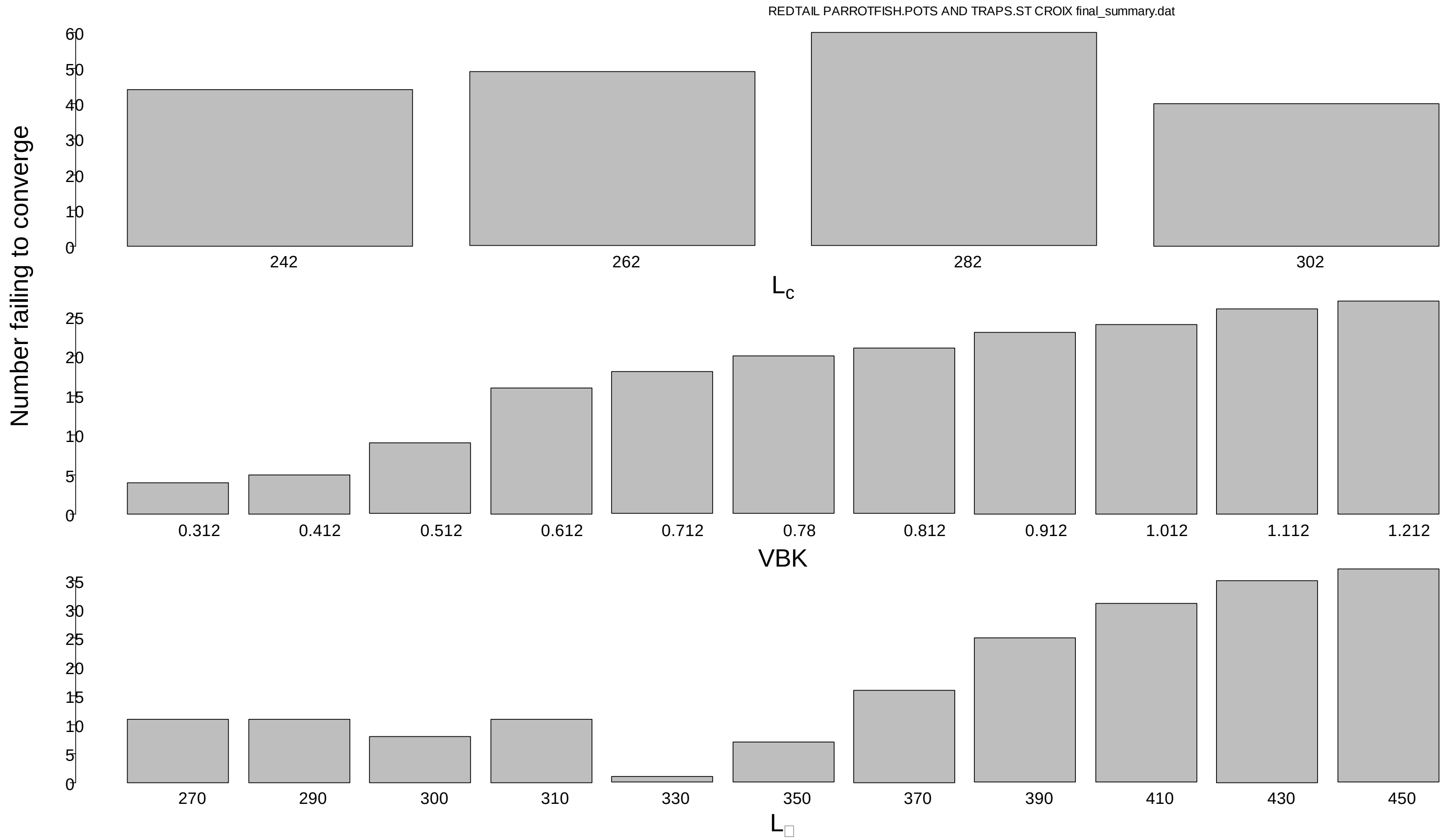

Figure 5.6.22. The number of sensitivity runs that failed to converge with respect to the input parameter values when data from the pot and trap fishery in St. Croix were applied to the total mortality estimator.

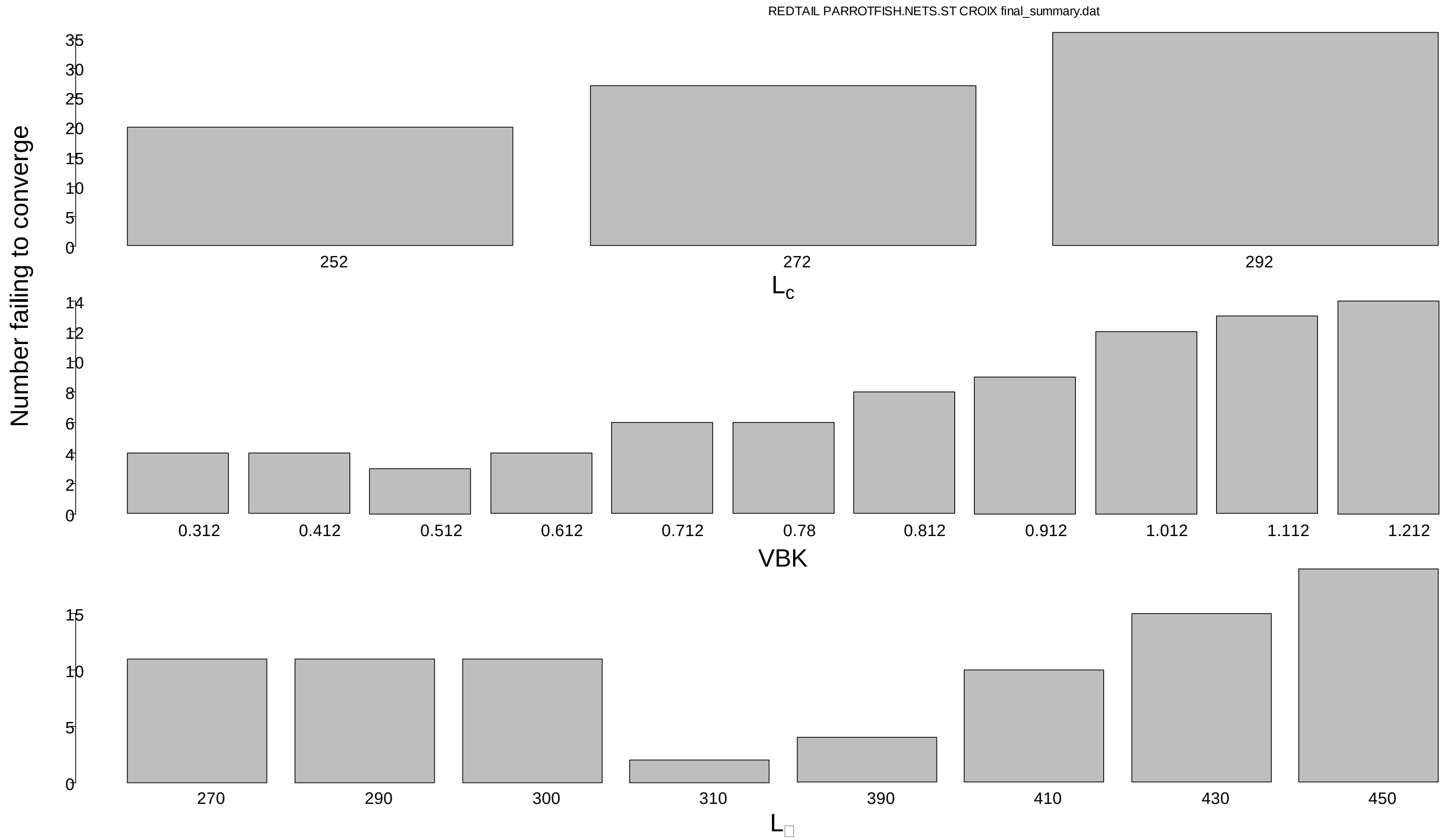

Figure 5.6.23. The number of sensitivity runs that failed to converge with respect to the input parameter values when data from the net fishery in St. Croix were applied to the total mortality estimator.

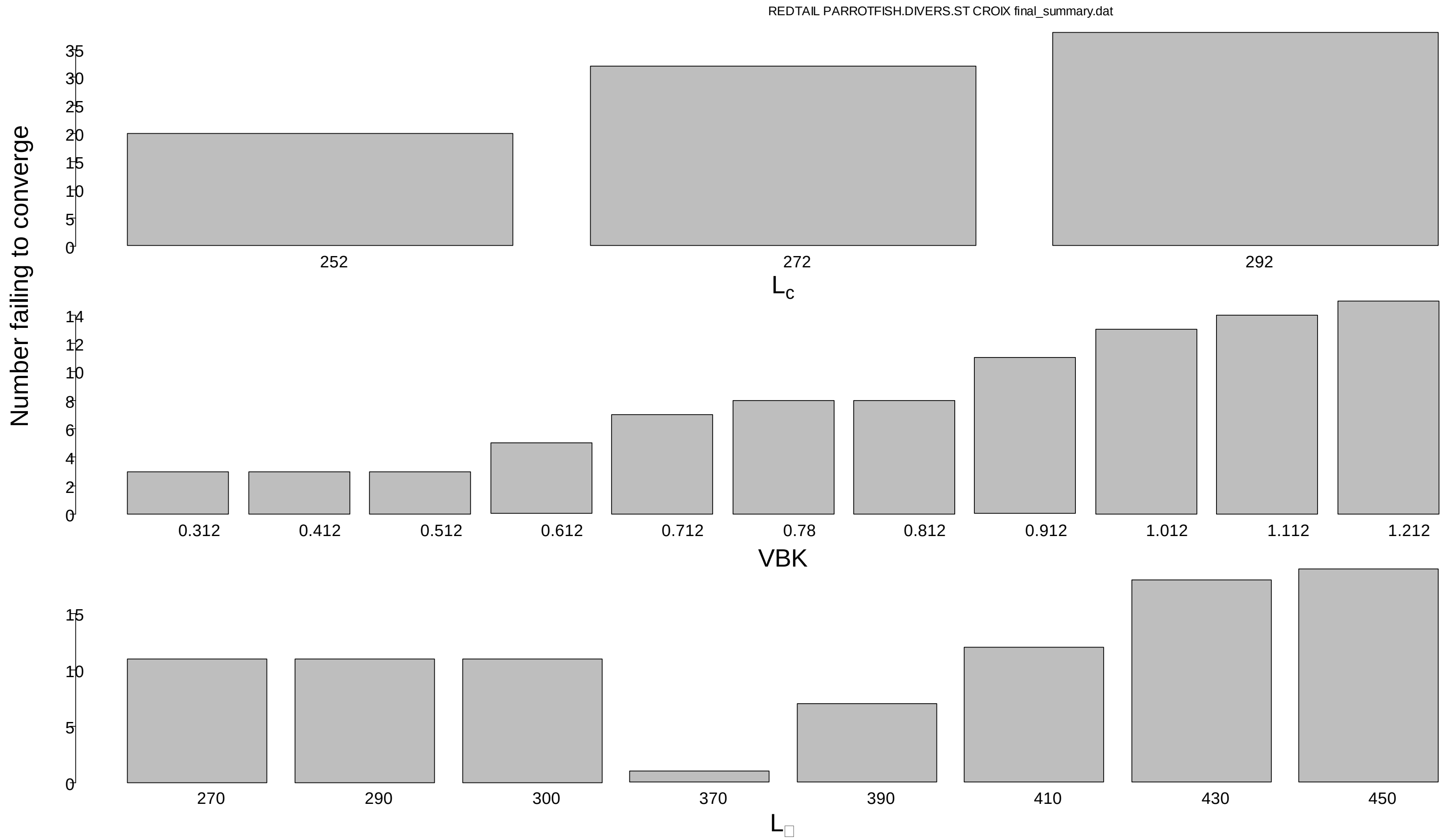

Figure 5.6.24. The number of sensitivity runs that failed to converge with respect to the input parameter values when data from the diver fishery in St. Croix were applied to the total mortality estimator.

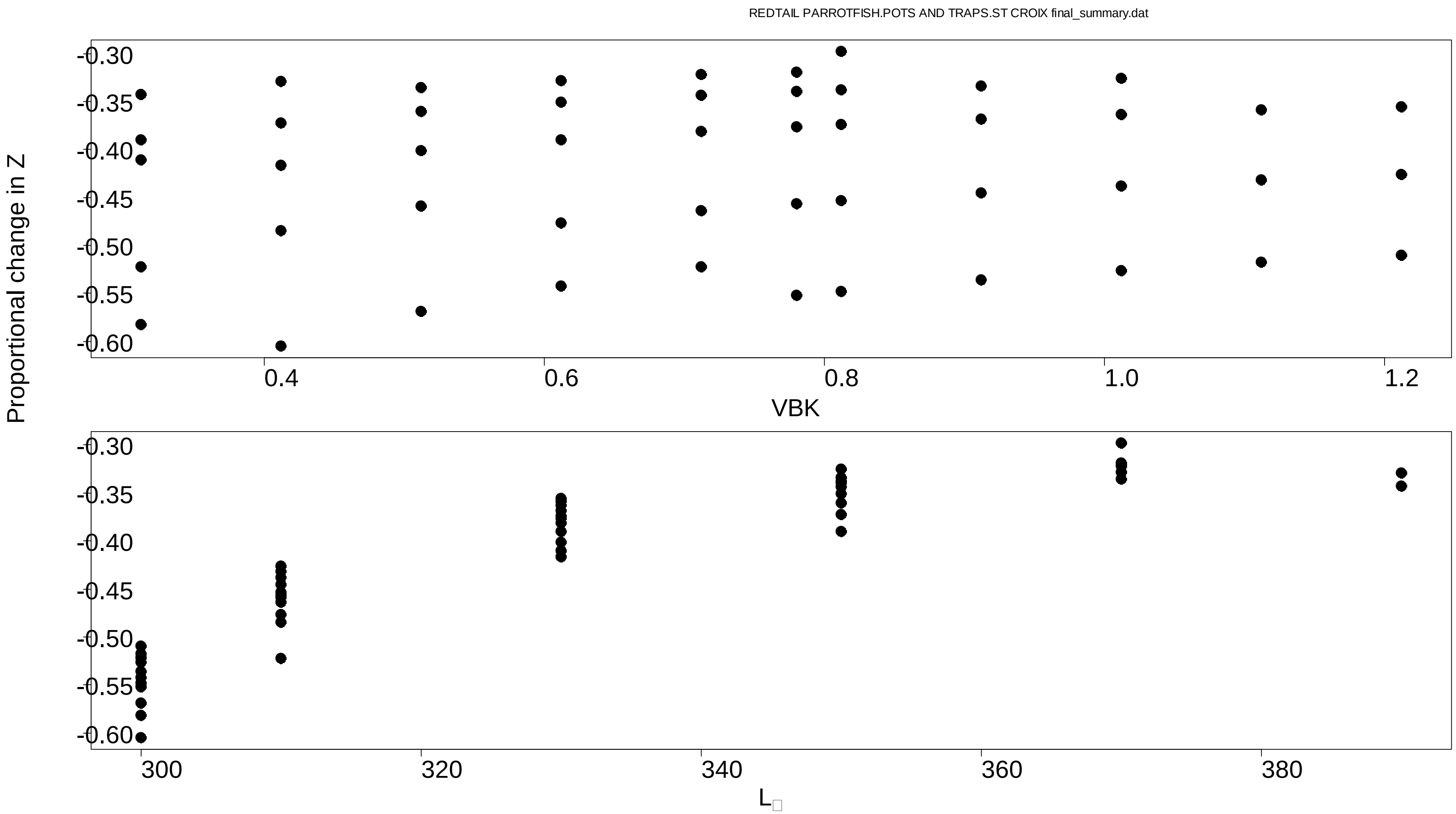

Figure 5.6.25. Current estimates of total mortality ($Z_{current}$) as a function of base case value for length at full vulnerability (L_c=262mm), the full sensitivity range of the von Bertalanffy growth coefficient (K, top panel), and a reduced range of the asymptotic length parameter (L_∞, bottom panel) from the time-series analysis for redtail parrotfish caught by pots and traps in St. Croix. Note that for all cases, the more complex model estimating a change in mortality was supported by an improvement in AIC (ΔAIC>5).

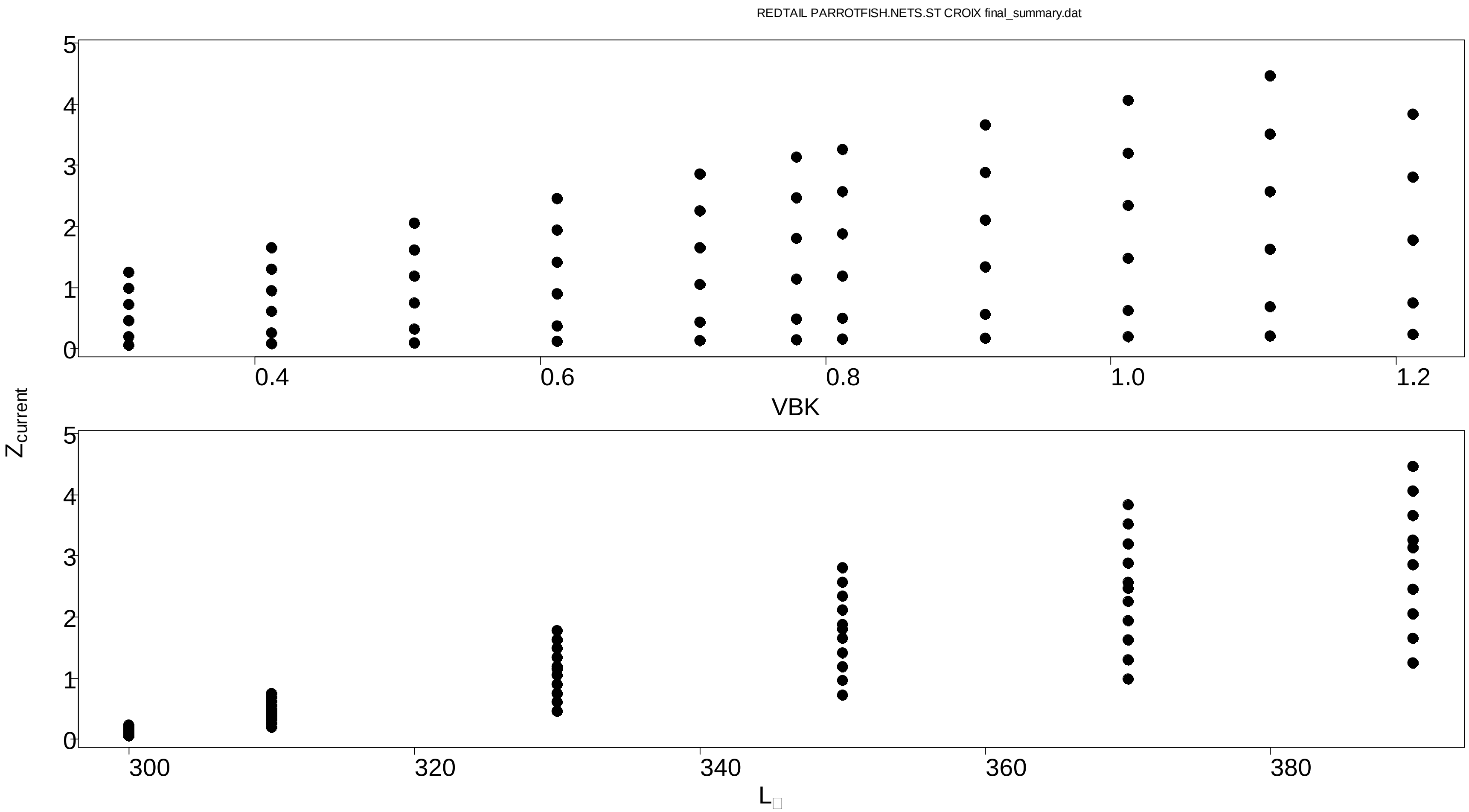

Figure 5.6.26. Current estimates of total mortality ($Z_{current}$) as a function of base case value for length at full vulnerability (L_c=272mm), the full sensitivity range of the von Bertalanffy growth coefficient (K, top panel), and a reduced range of the asymptotic length parameter (L_∞, bottom panel) from the time-series analysis for redtail parrotfish caught by nets in St. Croix. Note that for all cases, the more complex model estimating a change in mortality was not supported by AIC (ΔAIC>5).

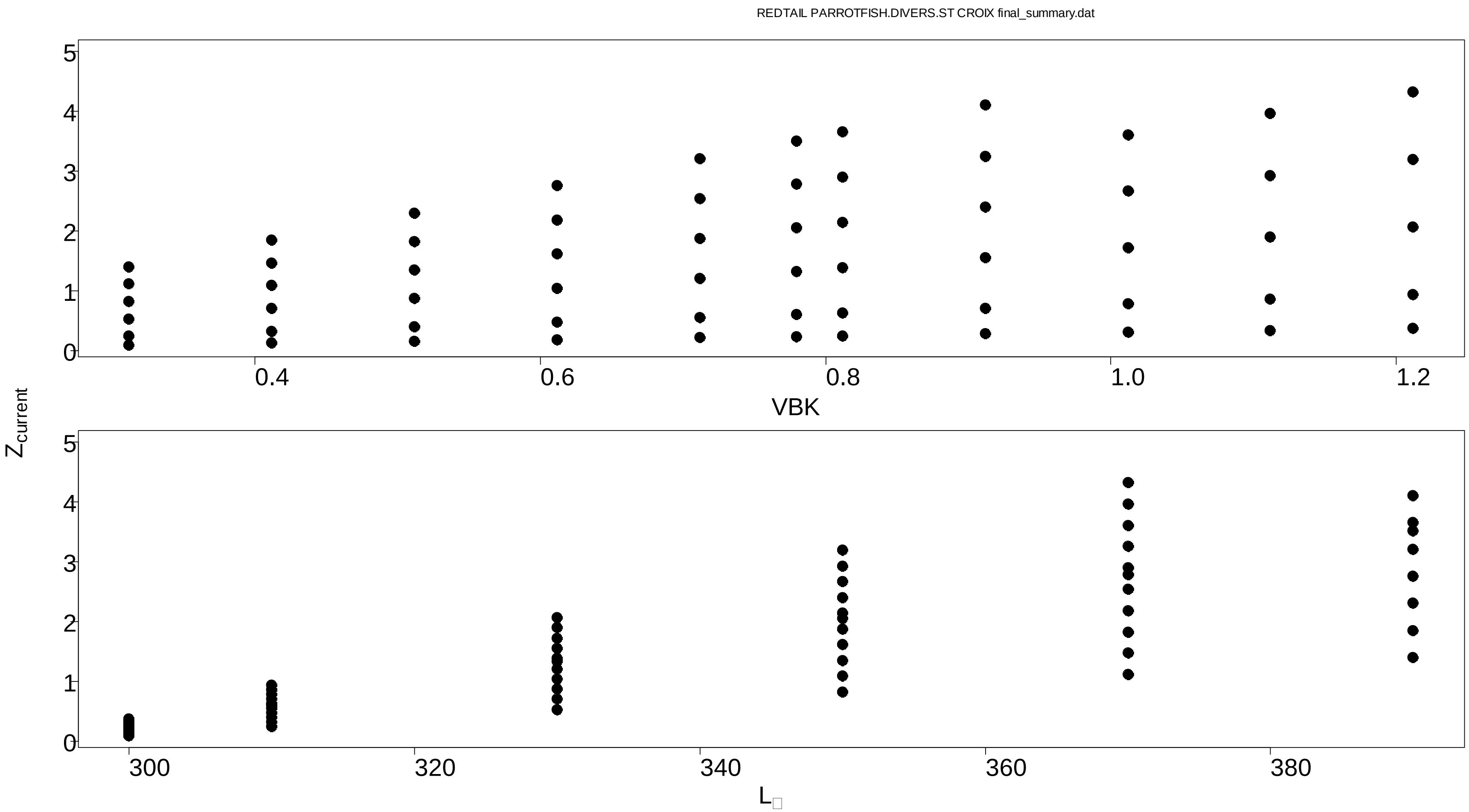

Figure 5.6.27. Current estimates of total mortality ($Z_{current}$) as a function of base case value for length at full vulnerability (L_c=272mm), the full sensitivity range of the von Bertalanffy growth coefficient (K, middle panel), and a reduced range of the asymptotic length parameter (L_∞, bottom panel) from the time-series analysis for redtail parrotfish caught by divers in St. Croix. Note that for all cases, the more complex model estimating a change in mortality was not supported by AIC (ΔAIC>5).

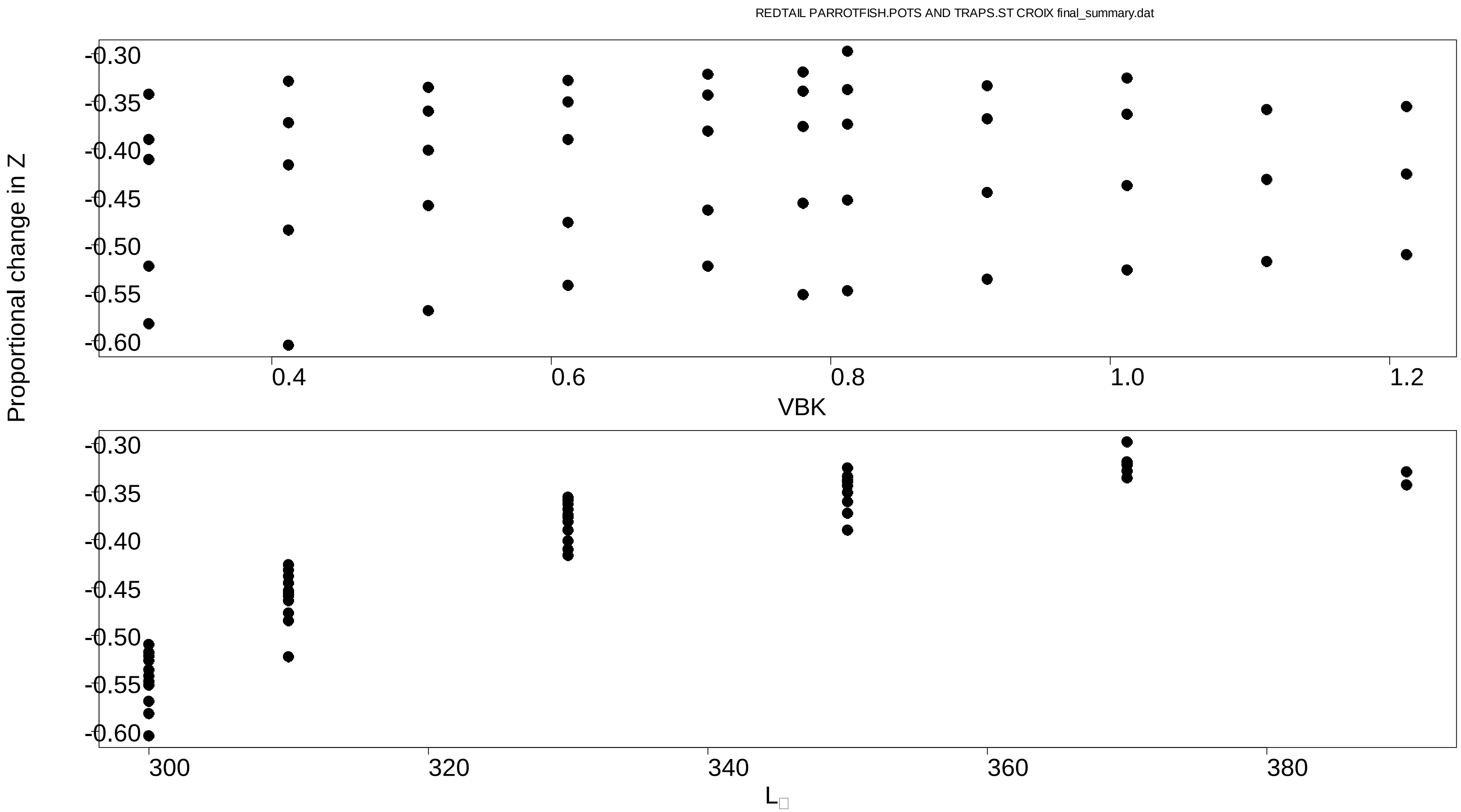

Figure 5.6.28. Proportional change in the estimates of total mortality as a function of base case value for length at full vulnerability (L_c=256mm), the full sensitivity range of the von Bertalanffy growth coefficient (K, top panel), and a reduced range of the asymptotic length parameter (L_∞, bottom panel) from the time-series analysis for redtail parrotfish caught by pots and traps in St. Croix. Note that for all cases, the more complex model estimating a change in mortality was supported by an improvement in AIC (ΔAIC>5).

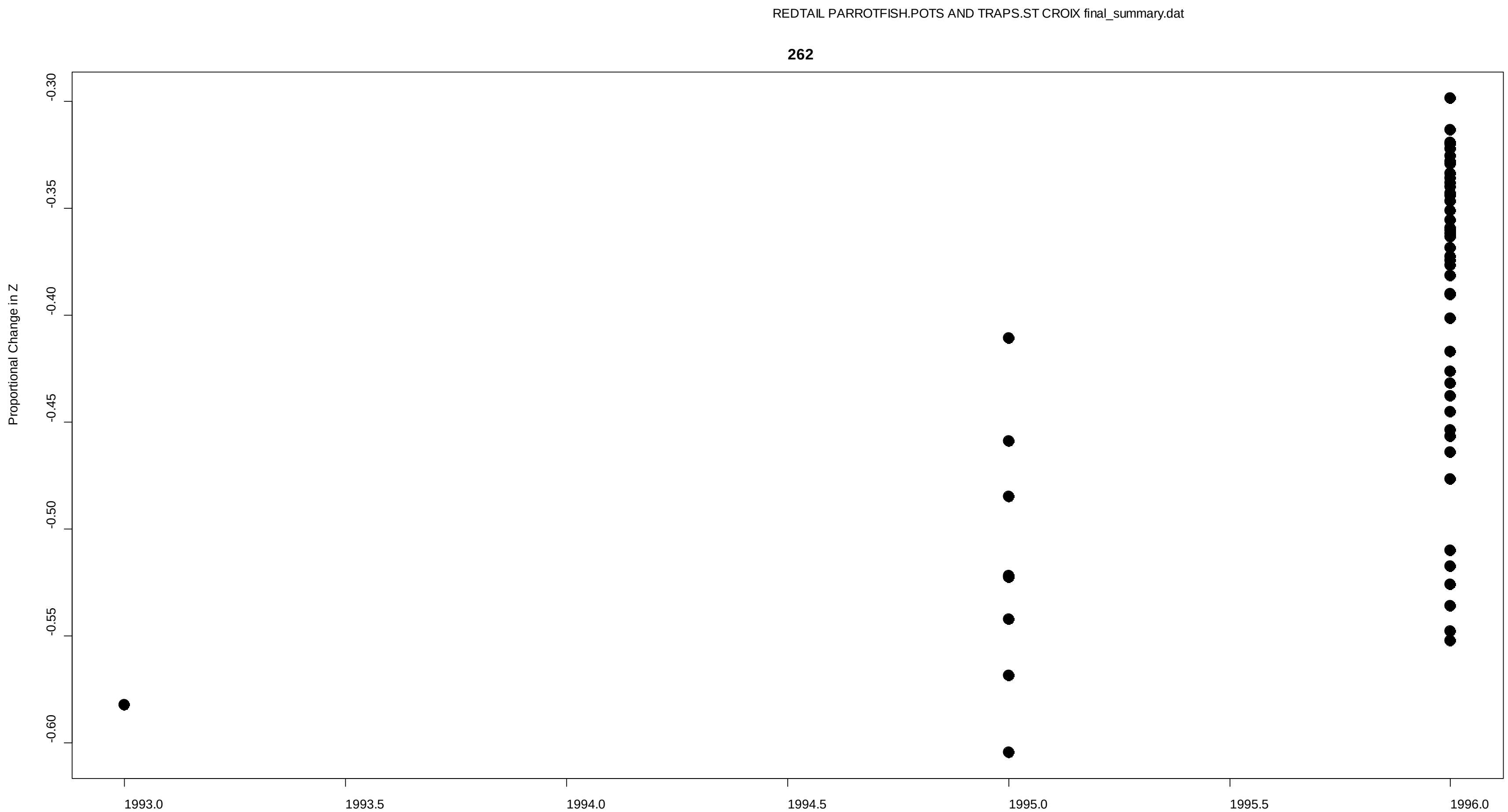

Figure 5.6.29. Proportional change in total mortality with respect to the predicted year of change for the base-case value of L_c, 262mm, for the pot and trap fishery in St. Croix.

6. Appendix

The figures included in this appendix summarize the full sensitivity analysis conducted to evaluate the influence of length-at-full vulnerability, L_c, and the von Bertalanffy growth parameters, K and L_∞, on total mortality estimates obtained using the Gedamke-Hoenig length-based total mortality estimator.

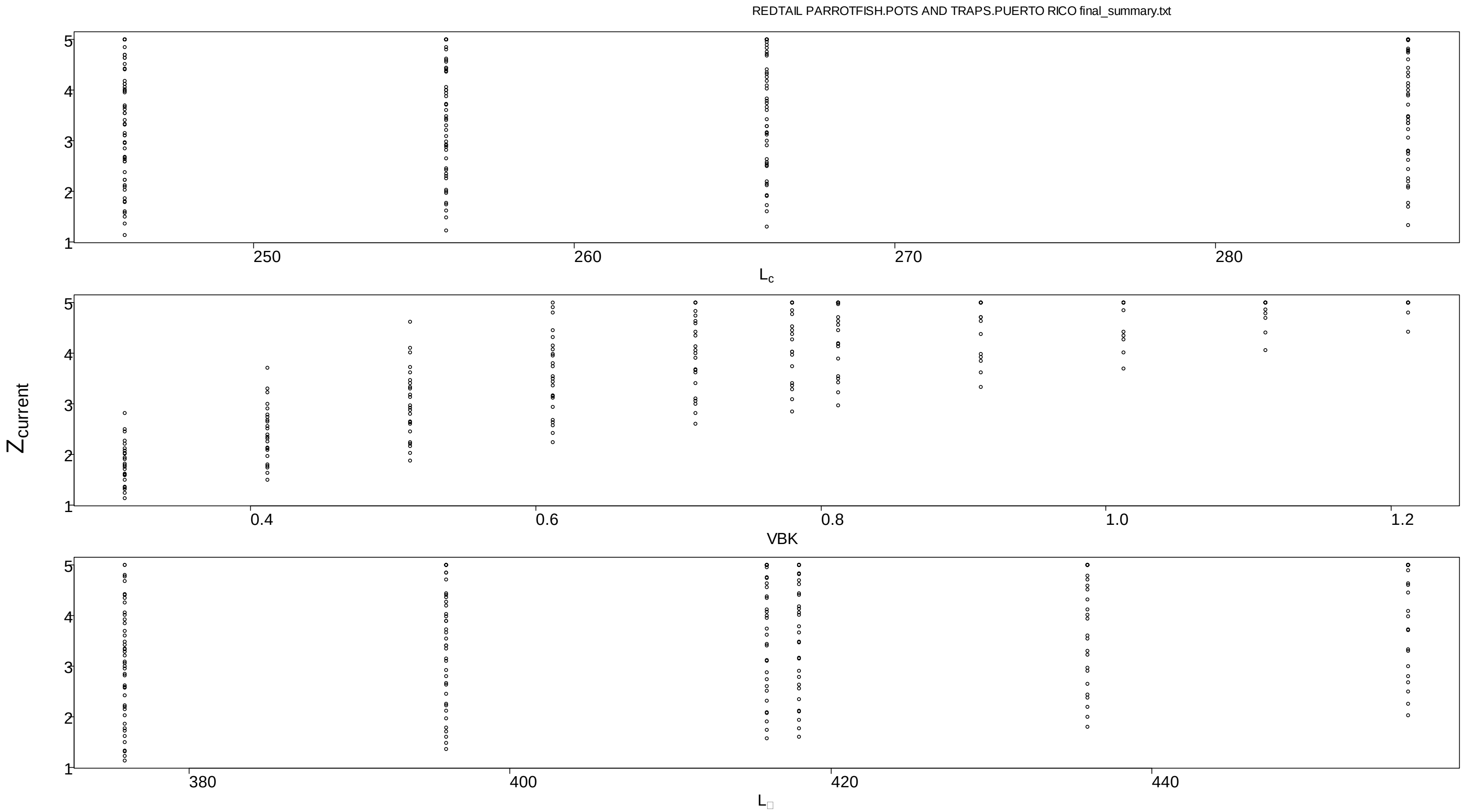

Figure 6.1. Current estimates of total mortality ($Z_{current}$) as a function of length at full vulnerability (L_c, top panel), the von Bertalanffy growth parameter (VBK, middle panel), and asymptotic length (L_∞, bottom panel) from the time-series analysis for Redtail parrotfish caught by pots and traps in Puerto Rico. Estimates of total mortality are from models that strongly support the model not predicting a change in total mortality over time (ΔAIC>5).

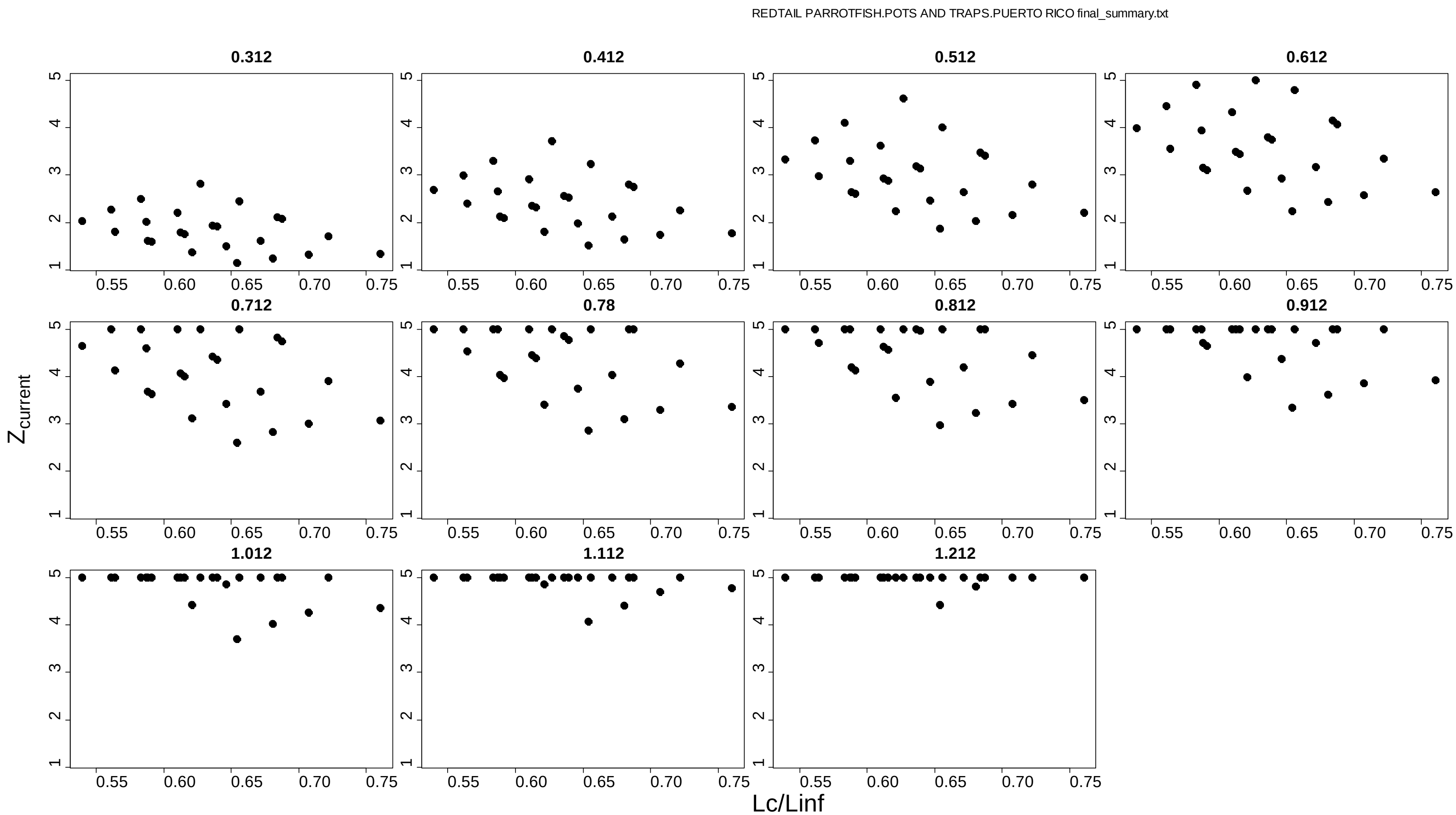

Figure 6.2. Estimates of current total mortality ($Z_{current}$) as a function of the von Bertalanffy growth parameter and the ratio between length at full vulnerability (L_c) and the asymptotic length (L_∞) for Redtail parrotfish caught by pots and traps in Puerto Rico. Each panel represents a unique 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_∞. Estimates of total mortality are from models that strongly support the model not predicting a change in total mortality over time (ΔAIC>5).

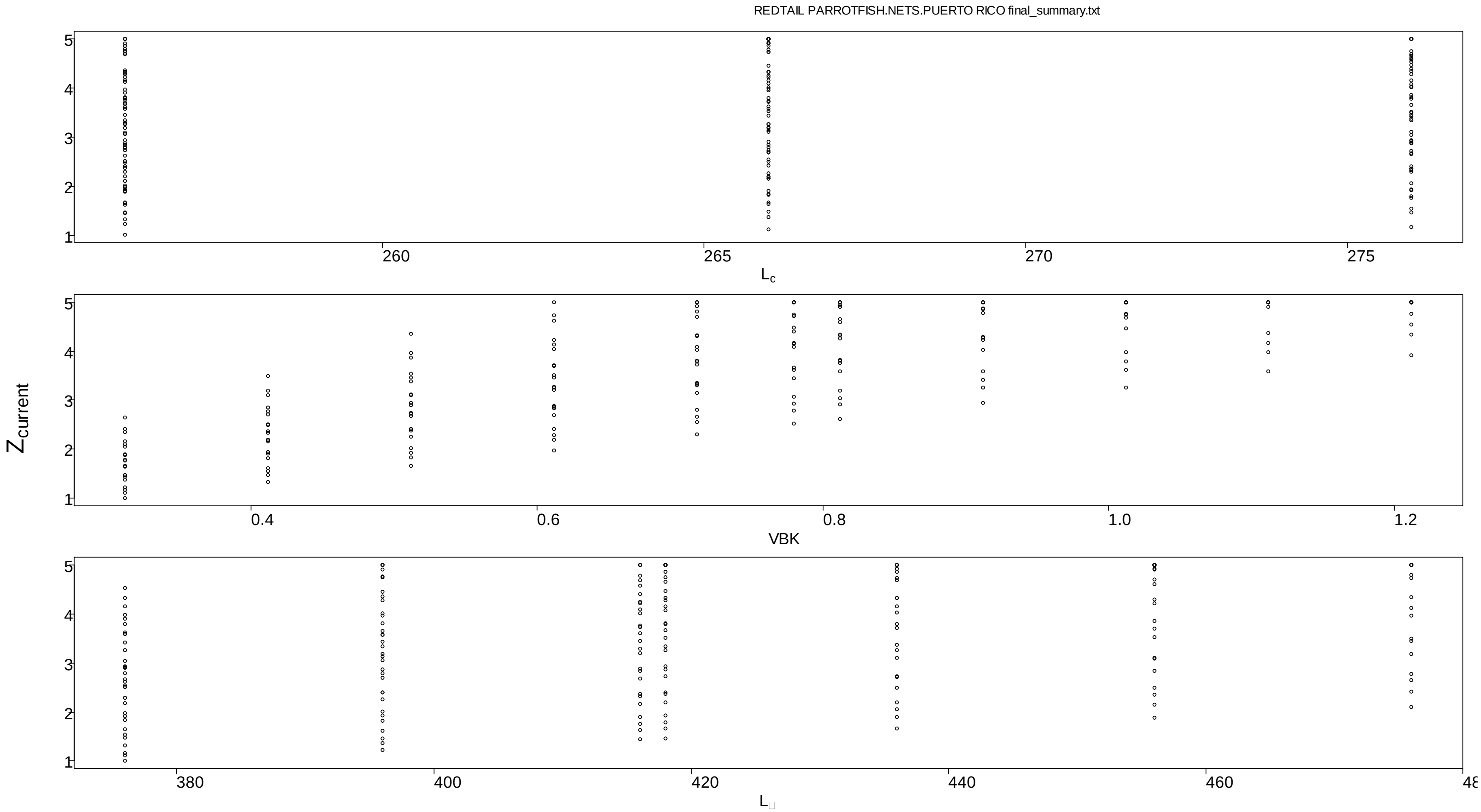

Figure 6.3. Current estimates of total mortality ($Z_{current}$) as a function of length at full vulnerability (L_c, top panel), the von Bertalanffy growth parameter (VBK, middle panel), and asymptotic length (L_∞, bottom panel) from the time-series analysis for Redtail parrotfish caught by nets in Puerto Rico. Estimates of total mortality are from models that strongly support the model not predicting a change in total mortality over time (ΔAIC>5).

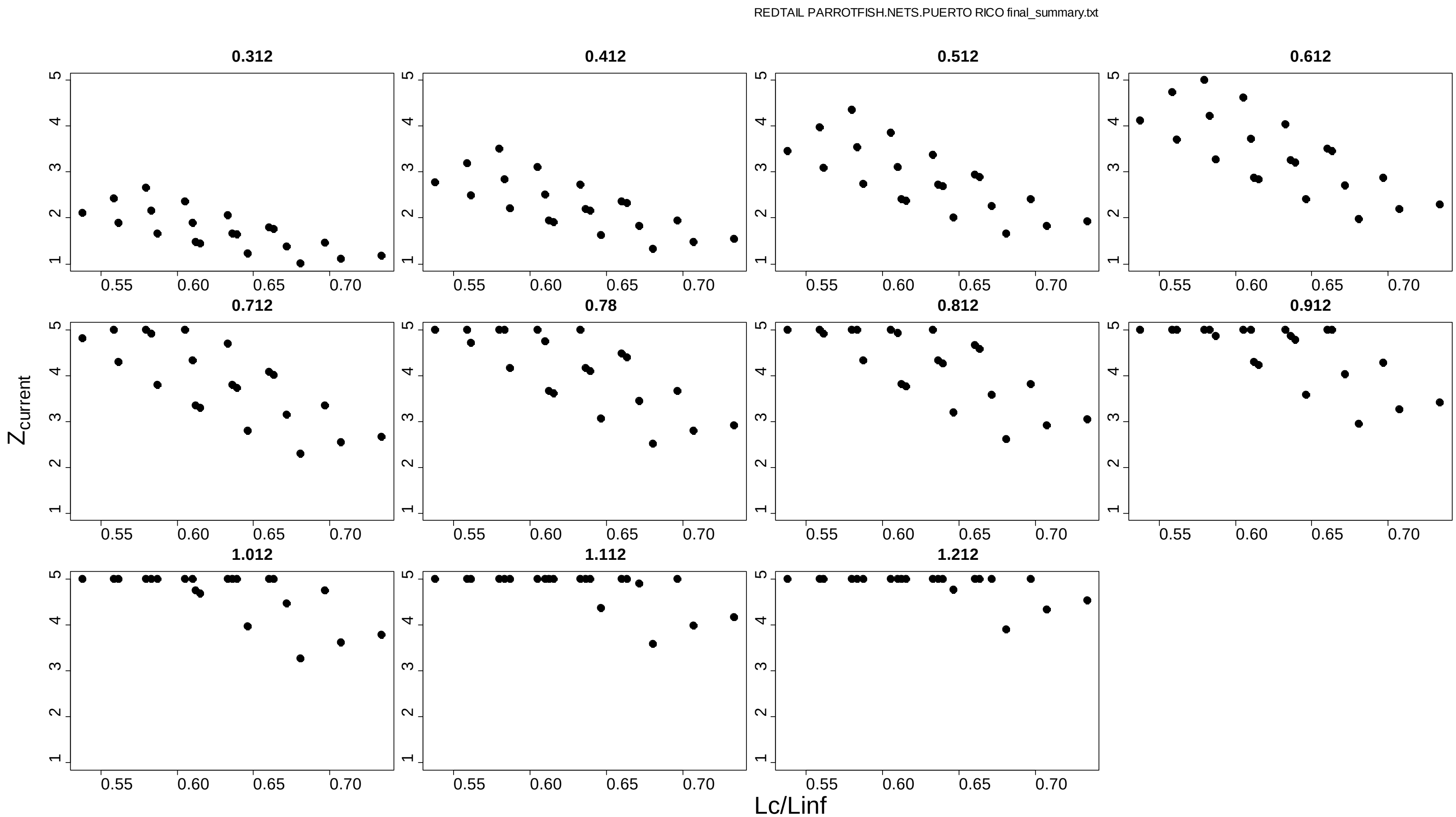

Figure 6.4. Estimates of current total mortality ($Z_{current}$) as a function of the von Bertalanffy growth parameter and the ratio between length at full vulnerability (L_c) and the asymptotic length (L_∞) for Redtail parrotfish caught by nets in Puerto Rico. Each panel represents a unique value of 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_∞. Estimates of total mortality are from models that strongly support the model not predicting a change in total mortality over time (ΔAIC>5).

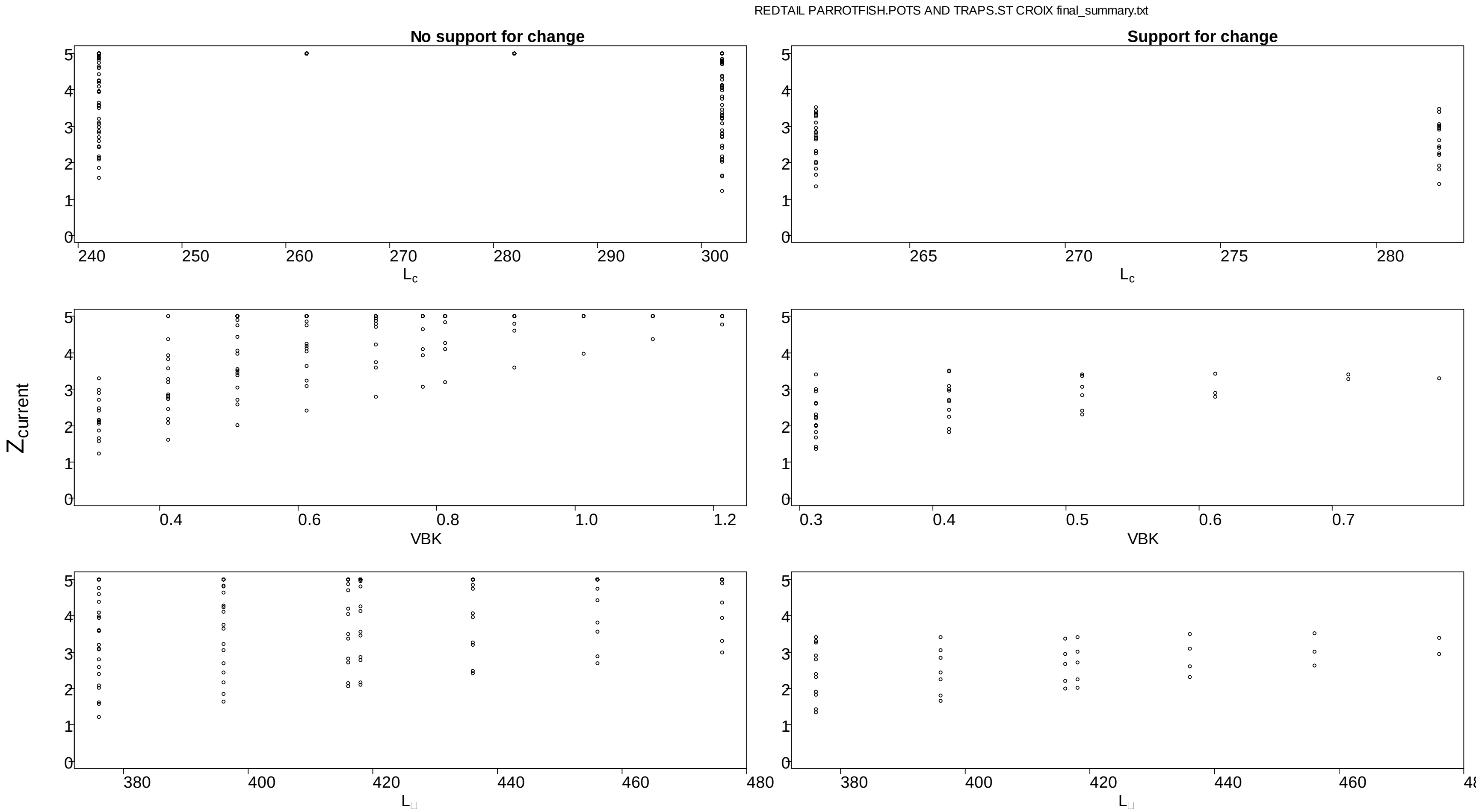

Figure 6.5. Current estimates of total mortality ($Z_{current}$) as a function of length at full vulnerability (L_c, top panel), the von Bertalanffy growth parameter (VBK, middle panel), and asymptotic length (L_∞, bottom panel) from the time-series analysis for Redtail parrotfish caught by pots and traps in St. Croix. Models not predicting or predicting a change in total mortality are strongly supported by AIC (ΔAIC>5).

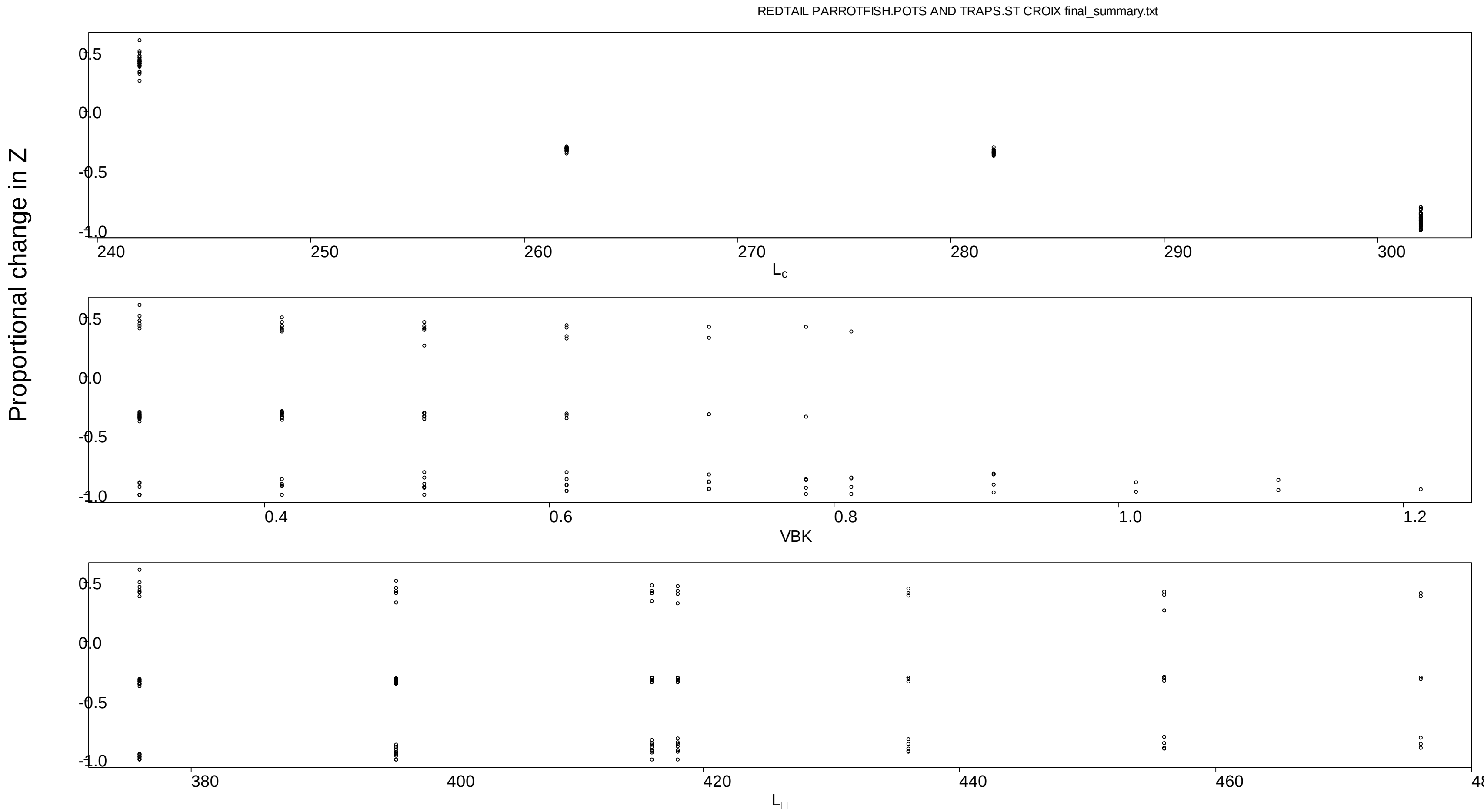

Figure 6.6. Estimates of proportional change in total mortality as a function of length at full vulnerability (L_c, top panel), the von Bertalanffy growth parameter (VBK, middle panel), and asymptotic length (L_∞, bottom panel) from the time-series analysis for Redtail parrotfish caught by pots and traps in St. Croix. Strong support.

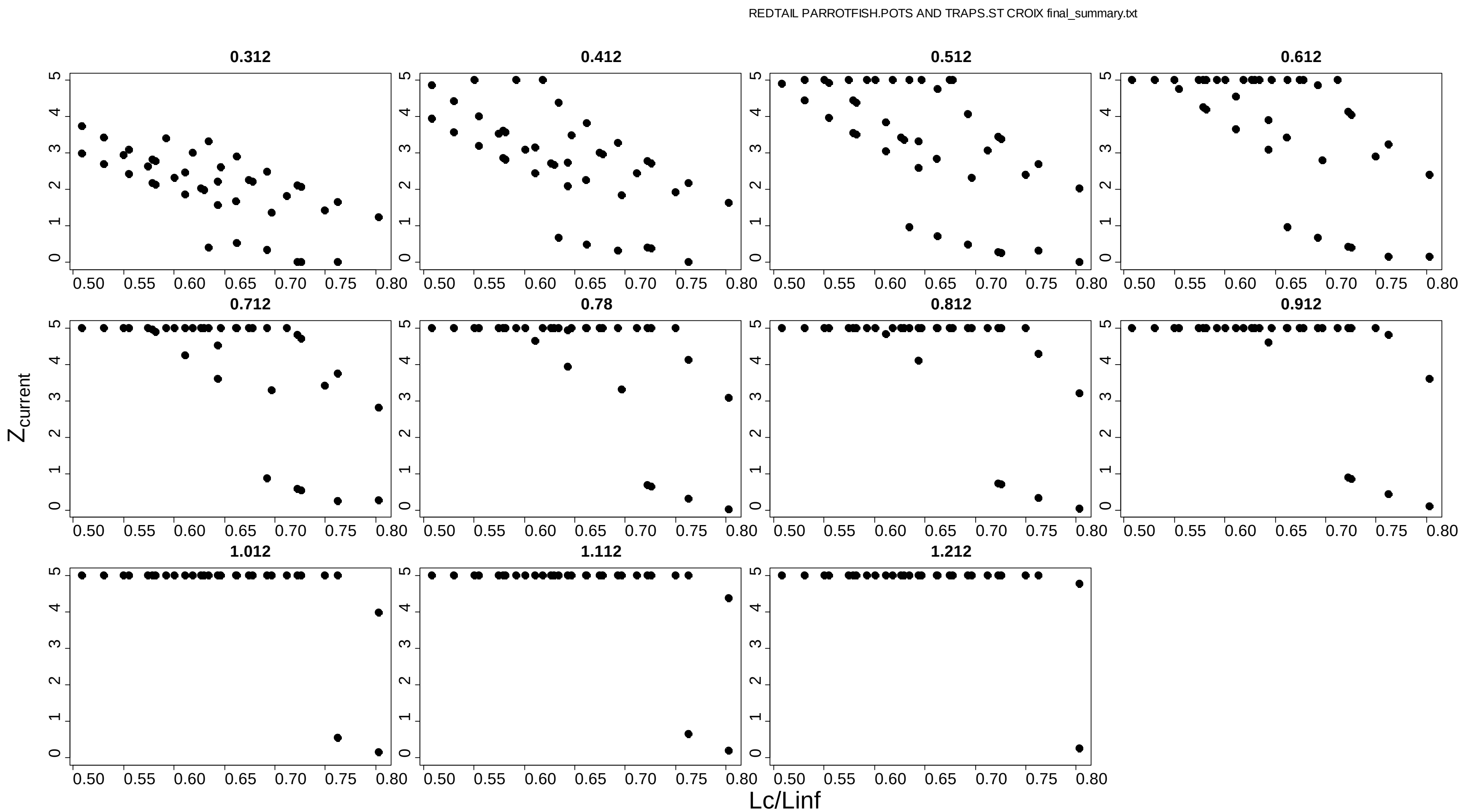

Figure 6.7. Estimates of current total mortality ($Z_{current}$) as a function of the von Bertalanffy growth parameter and the ratio between length at full vulnerability (L_c) and the asymptotic length (L_∞) for Redtail parrotfish caught by pots and traps in St. Croix. Each panel represents a unique 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_∞. Models not predicting or predicting a change in total mortality are strongly supported by AIC (ΔAIC>5).

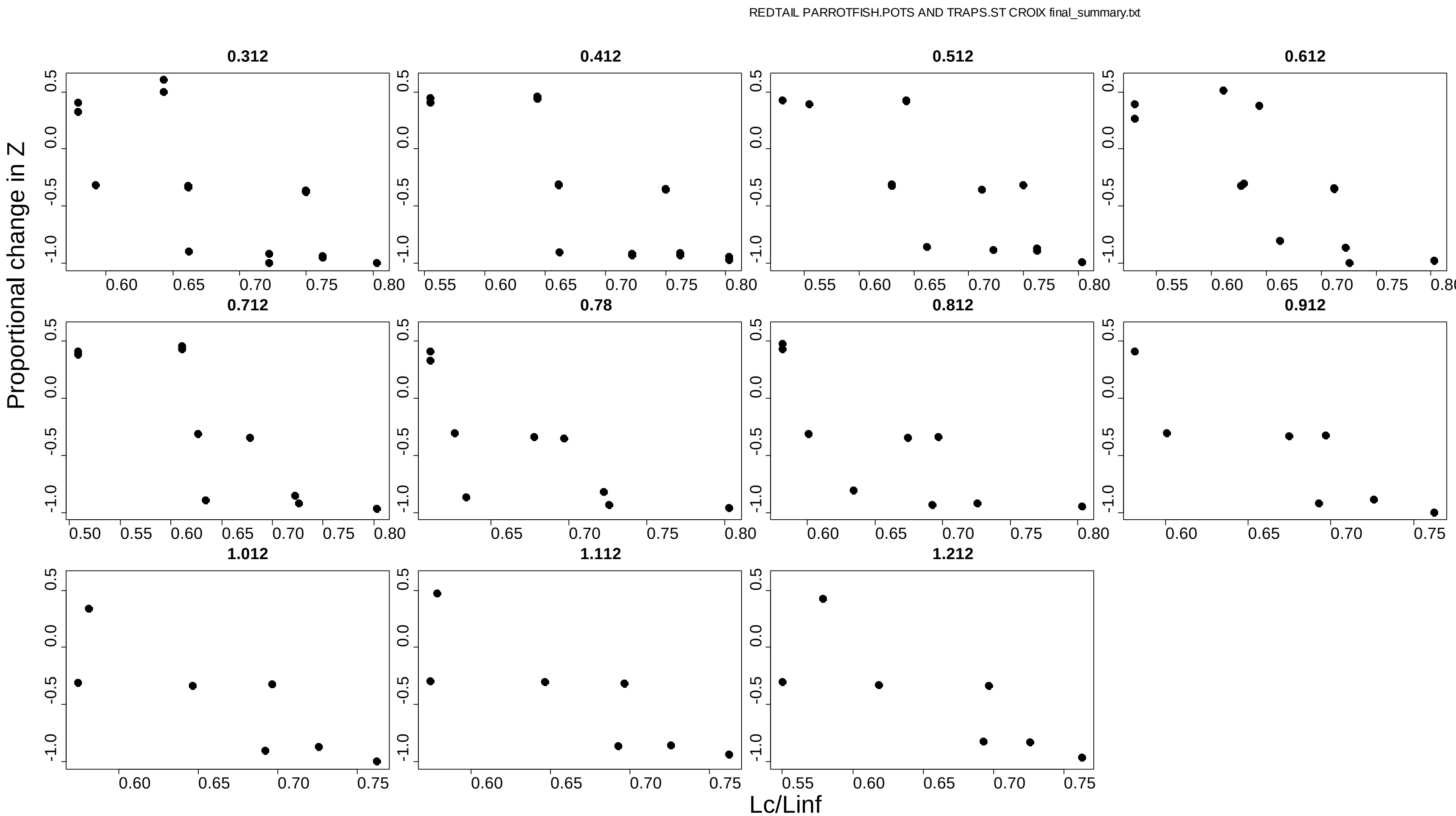

Figure 6.8. Estimates of proportional chance in mortality as a function of the von Bertalanffy growth parameter and the ratio between length at full vulnerability (L_c) and the asymptotic length (L_∞) for Redtail parrotfish caught by pots and traps in St. Croix. Each panel represents a unique value of 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_∞.

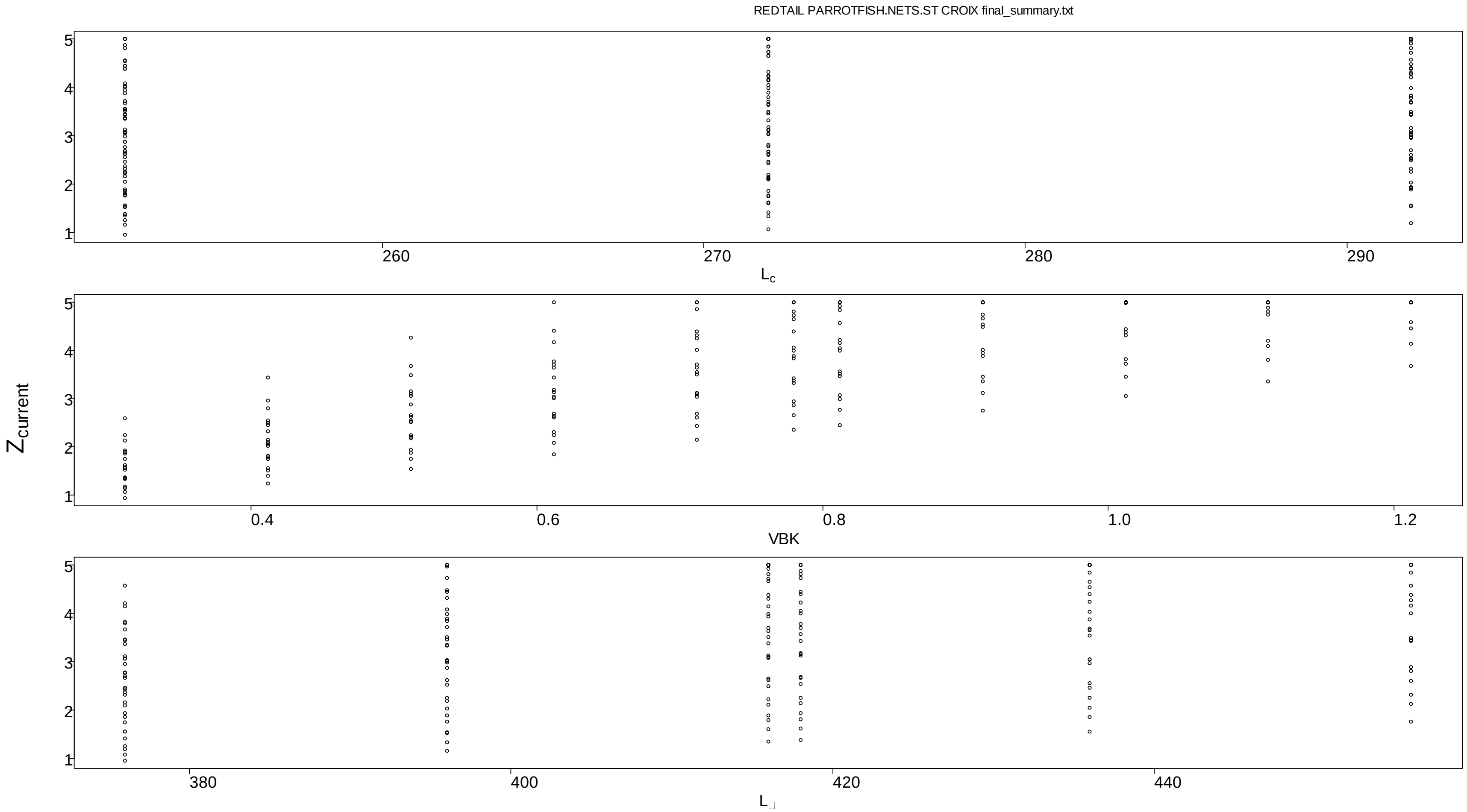

Figure 6.9. Current estimates of total mortality ($Z_{current}$) as a function of length at full vulnerability (L_c, top panel), the von Bertalanffy growth parameter (VBK, middle panel), and asymptotic length (L_∞, bottom panel) from the time-series analysis for Redtail parrotfish caught by nets in St. Croix. The models not predicting change in total mortality was strongly supported by AIC (ΔAIC>5).

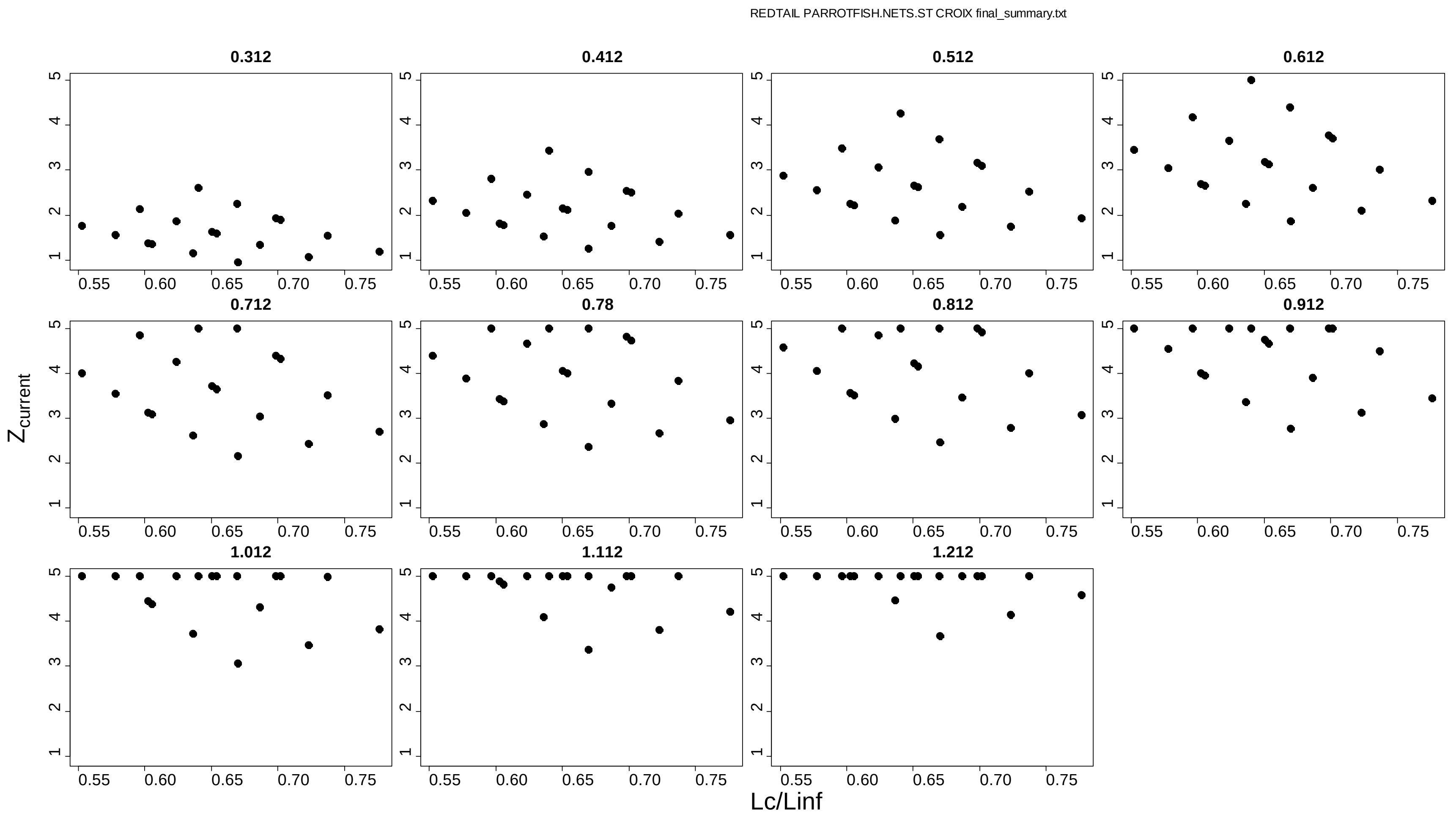

Figure 6.10. Estimates of current total mortality ($Z_{current}$) as a function of the von Bertalanffy growth parameter and the ratio between length at full vulnerability (L_c) and the asymptotic length (L_∞) for Redtail parrotfish caught by nets in St. Croix. Each panel represents a unique value of 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_∞.

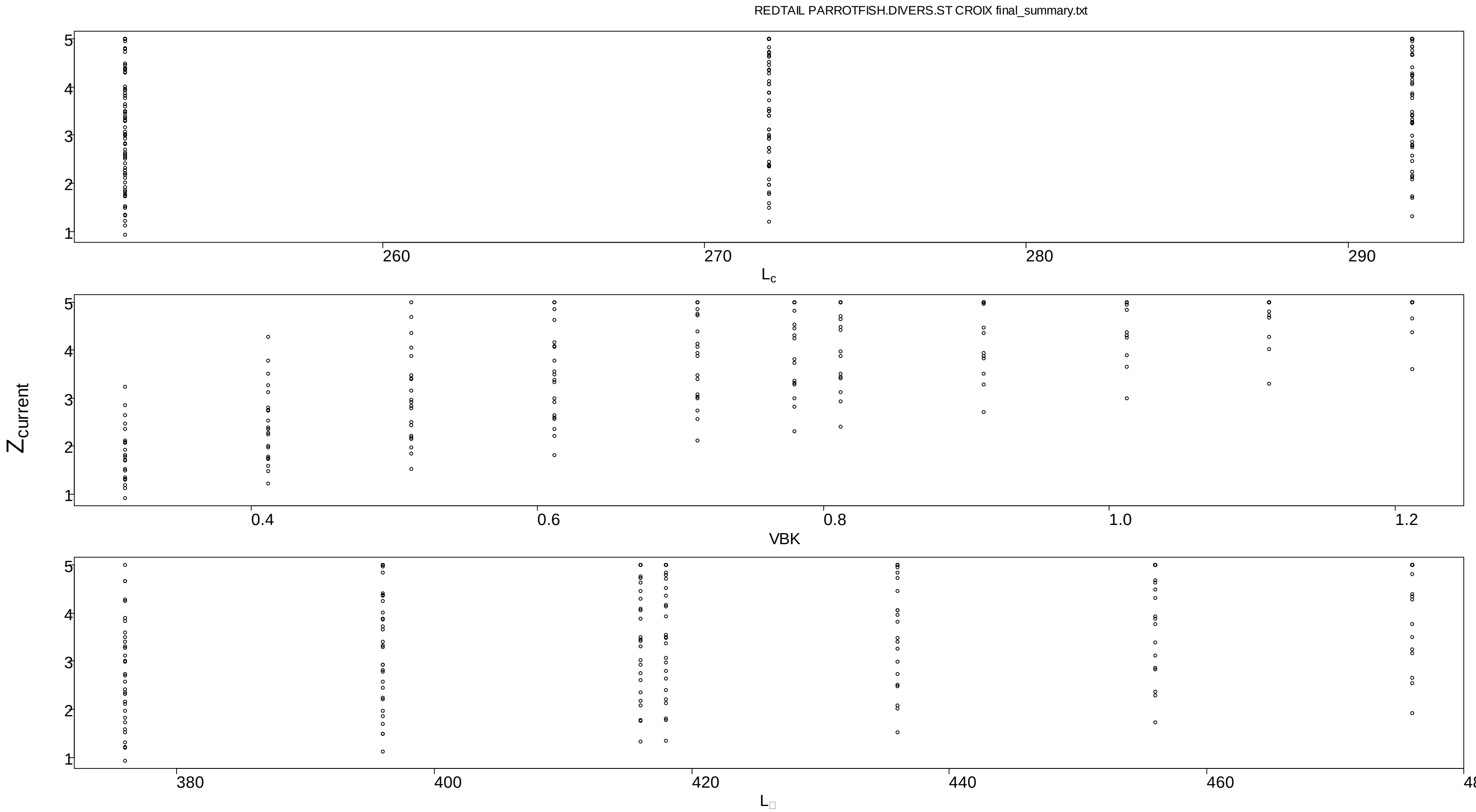

Figure 6.11. Current estimates of total mortality ($Z_{current}$) as a function of length at full vulnerability (L_c, top panel), the von Bertalanffy growth parameter (VBK, middle panel), and asymptotic length (L_∞, bottom panel) from the time-series analysis for redtail parrotfish caught by divers in St. Croix. The model not predicting a change in total mortality are strongly supported by AIC (ΔAIC>5).

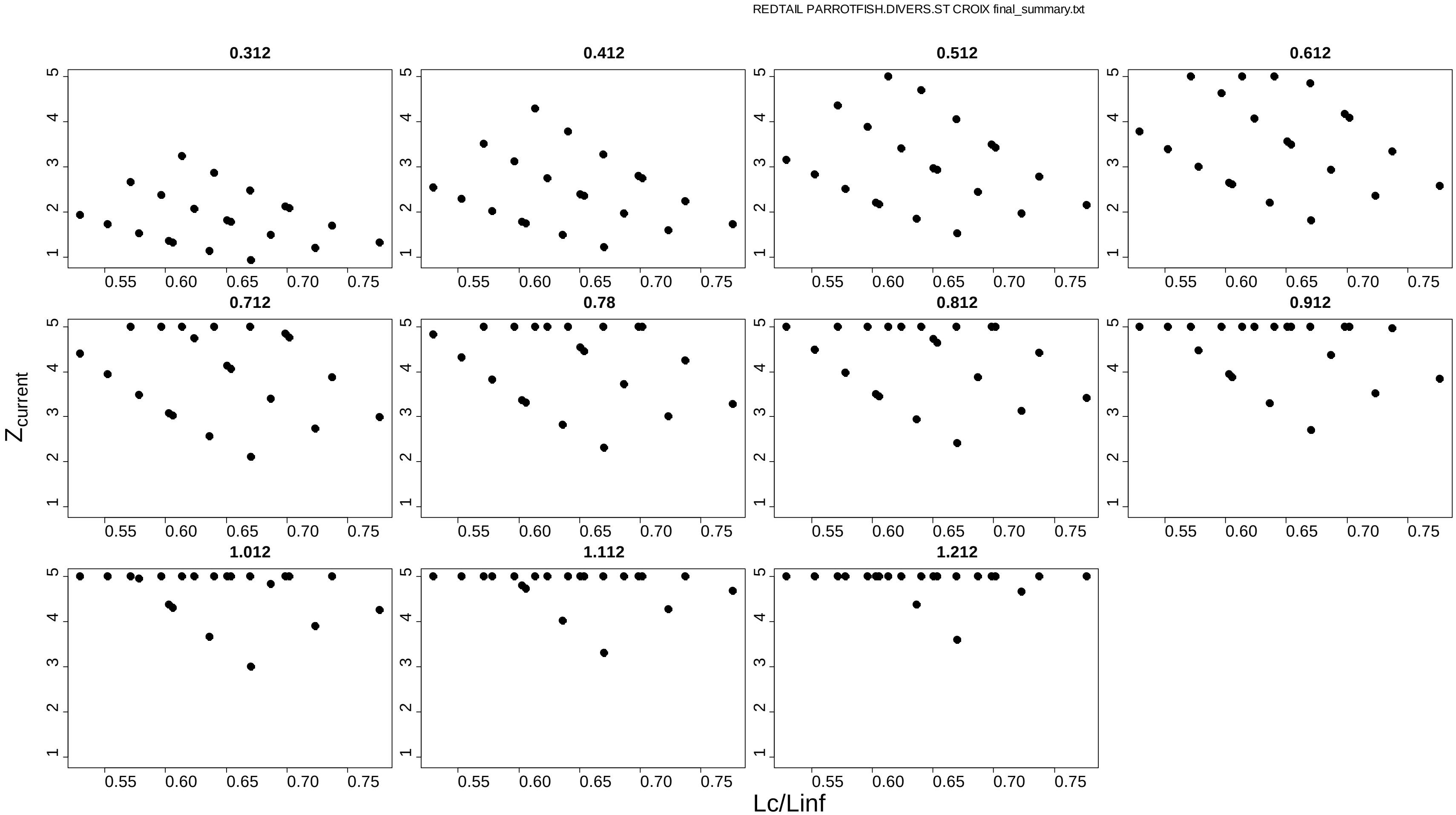

Figure 6.12. Estimates of current total mortality ($Z_{current}$) as a function of the von Bertalanffy growth parameter and the ratio between length at full vulnerability (L_c) and the asymptotic length (L_∞) for Redtail parrotfish caught by divers in St. Croix. Each panel represents a unique value of 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_∞.

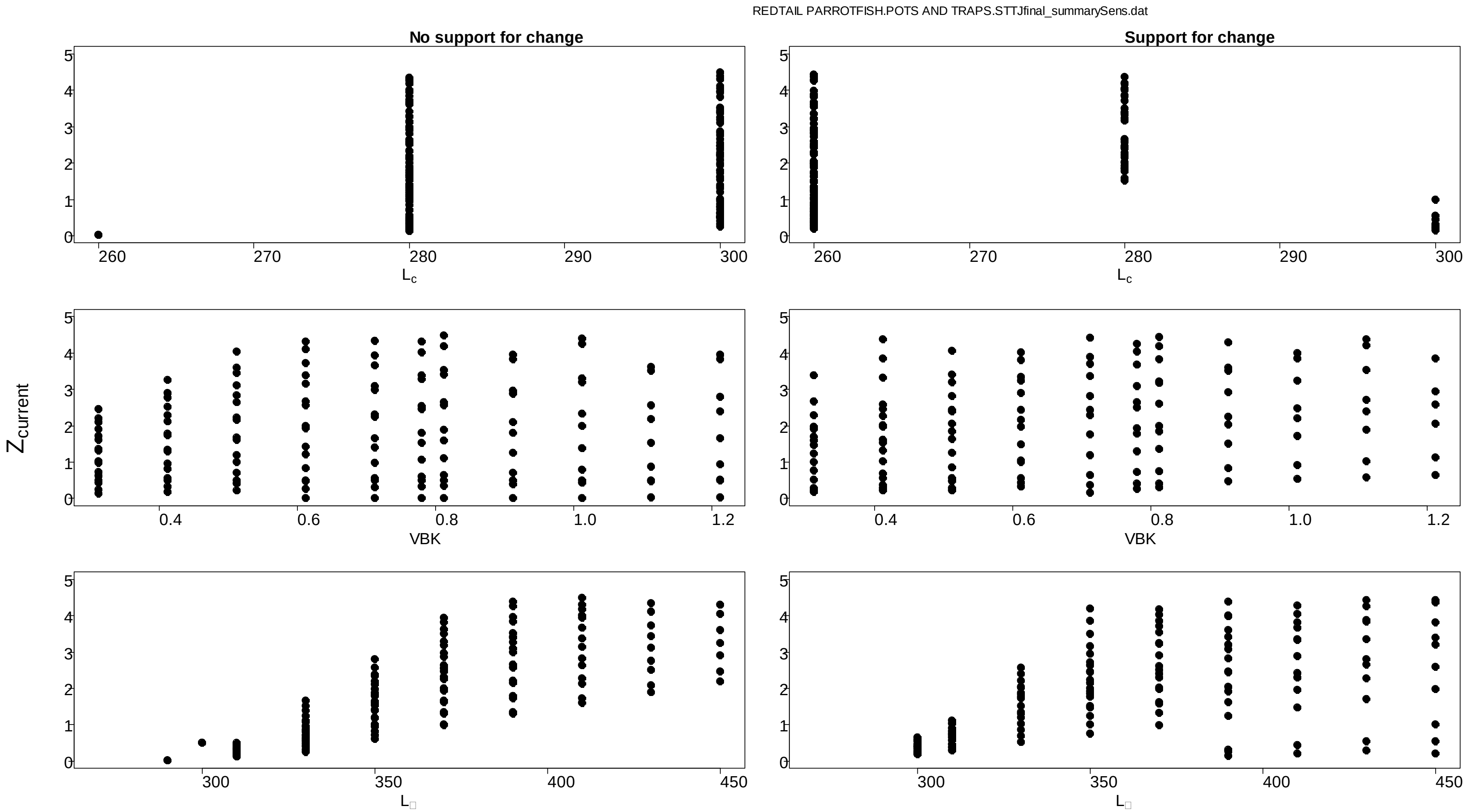

Figure 6.13. Current estimates of total mortality ($Z_{current}$) as a function of length at full vulnerability (L_c, top panel), the von Bertalanffy growth parameter (VBK, middle panel), and asymptotic length (L_∞, bottom panel) from the time-series analysis for Redtail parrotfish caught by pots and traps in St. Thomas. Models predicting or not predicting a change in total mortality were strongly supported by AIC (ΔAIC>5).

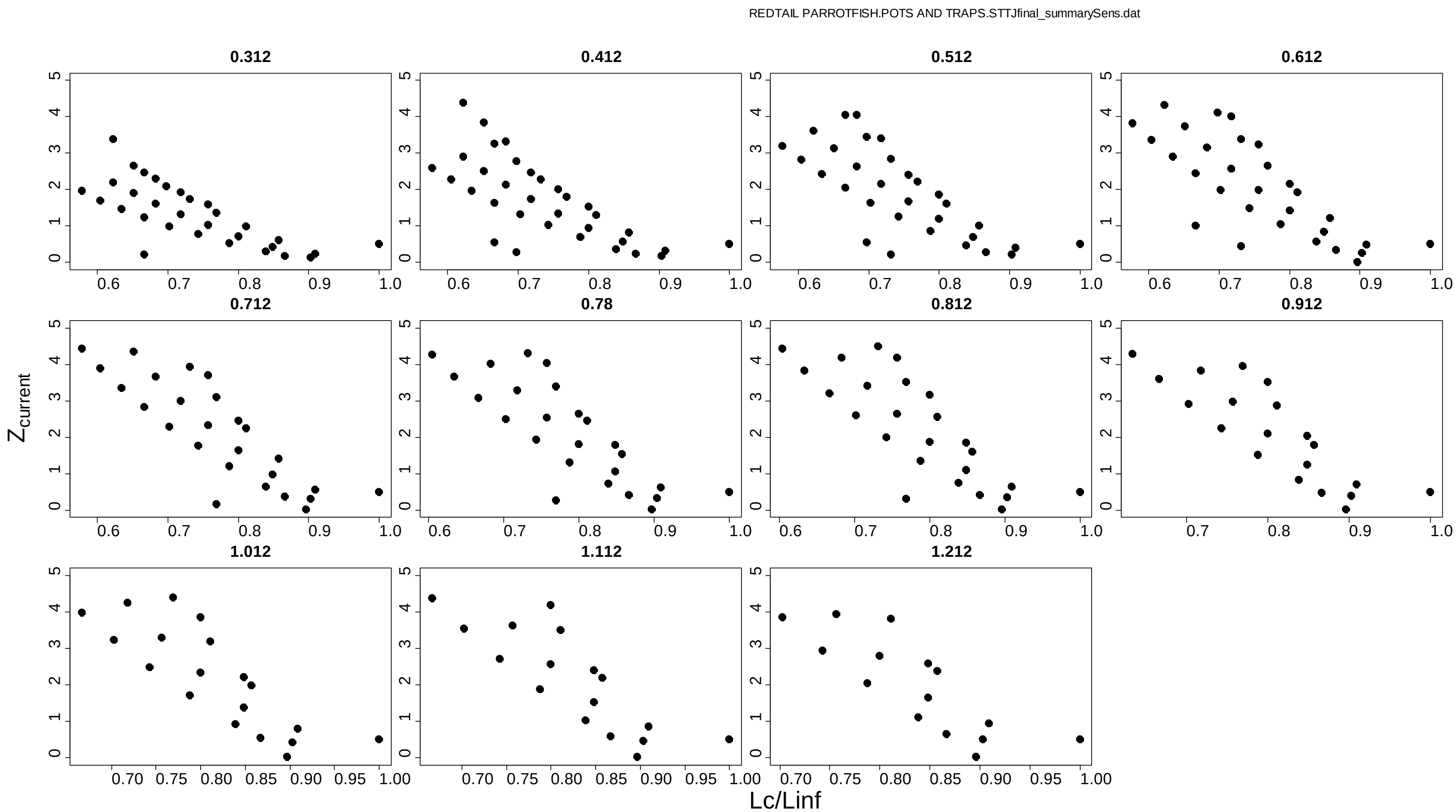

Figure 6.14. Estimates of current total mortality ($Z_{current}$) as a function of the von Bertalanffy growth parameter and the ratio between length at full vulnerability (L_c) and the asymptotic length (L_∞) for Redtail parrotfish caught by pots and traps in St. Thomas+. Each panel represents a unique 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_∞. Values that represented convergence problems were removed for this presentation.

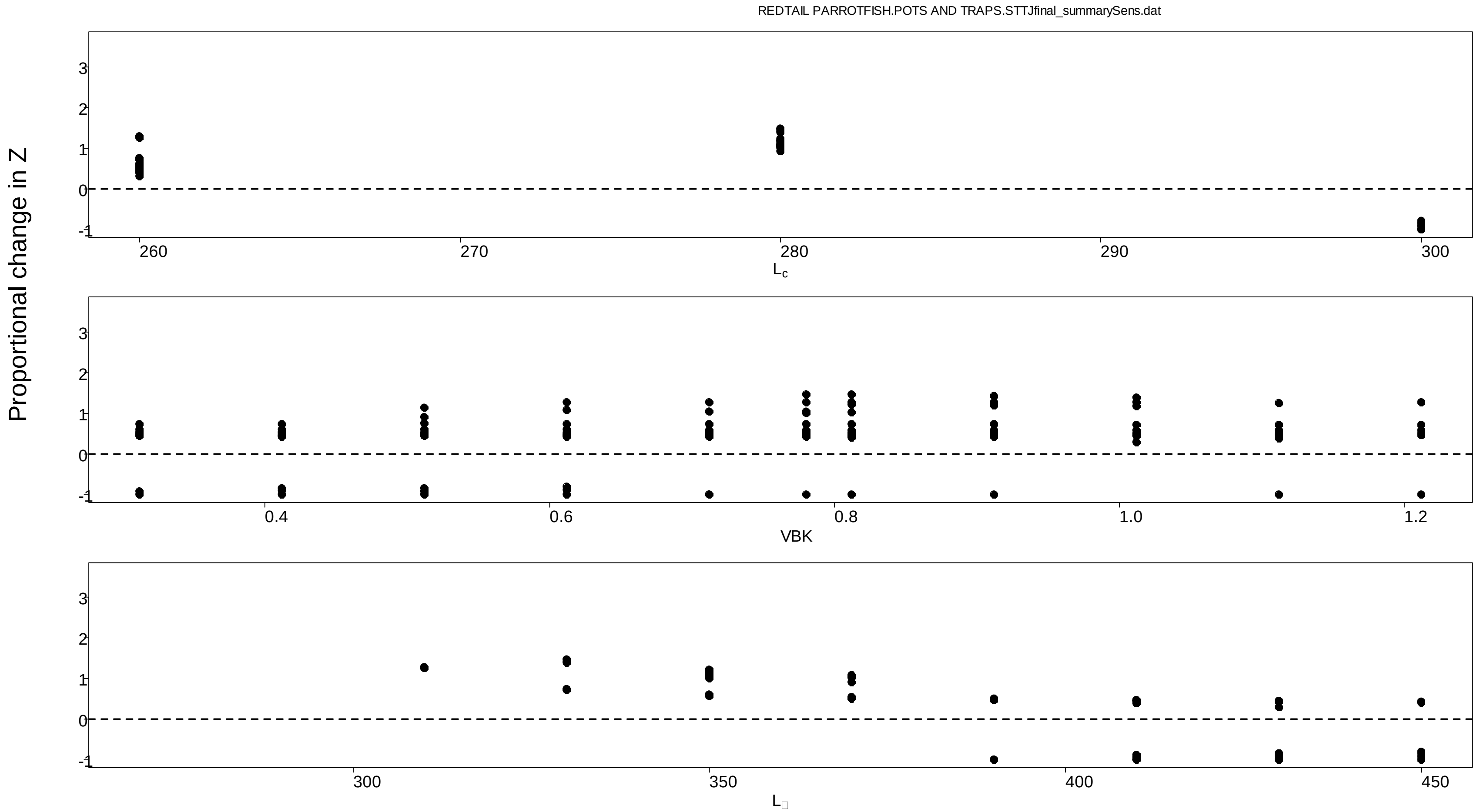

Figure 6.15. Current estimates of total mortality ($Z_{current}$) as a function of length at full vulnerability (L_c, top panel), the von Bertalanffy growth parameter (VBK, middle panel), and asymptotic length (L_∞, bottom panel) from the time-series analysis for Redtail parrotfish caught by pots and traps in St. Thomas. Strong support. Values that reflect convergence problems were removed from this presentation. Please note that all observations for the lower range of L_∞, 270mm, 290mm, and 300mm, reflect convergence problems

SEDAR

Southeast Data, Assessment, and Review

SEDAR 26

U.S. Caribbean Redtail Parrotfish

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 should 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.

Length-frequency data and the corresponding age-growth relationships will likely serve as the primary source of information for assessments in the US Caribbean in the near future. A direct focus on increasing sampling intensity with a well-designed program (as being developed in the current Caribbean Data Improvement Plan) should be placed as a top priority.

Reliable estimates of the von Bertalanffy growth parameters, required inputs for length-based mortality estimators, should be another research priority. Deriving age-growth relationships from data collected from the region would also allow stronger conclusions to be drawn from the TIP data. Well-designed age and growth studies in Puerto Rico and the USVI should be instated to meet this research objective.

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

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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.

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.

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.

[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.

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.

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.

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 ~0.3 to ~ 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 ~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.

References

Gedamke, T. and J.M. Hoenig. 2006. Estimating mortality from mean length data in nonequilibrium situations, with application to the assessment of goosefish. Transactions of the American Fisheries Society, 135: 476-487.

Punt, A. E., Smith, D. C., and Smith, A. D. M. 2011. Among-stock comparisons for improving stock assessments of data-poor stocks: the "Robin Hood" approach. ICES Journal of Marine Science, 68: 972–981.

SEDAR 26 Review Workshop Participants

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SEDAR

Southeast Data, Assessment, and Review

SEDAR 26

U.S. Caribbean Redtail Parrotfish

Section VI: Addenda and Post-Review Updates

October 2011

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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 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 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 that overfishing is occurring on redtail parrotfish in the US Caribbean. This conclusion is based on the following aspects of our results:

- The majority of fish sampled in the TIP database are above the size at maturity.

- Redtail parrotfish have high growth rates, mature at a young age, spawn year round, and have relatively short population doubling times so would be expected to be resilient to fishing pressure.

- The size structure of individuals fully vulnerable to the individual gear types has remained unchanged over time suggesting that exploitation rates have been sustainable. The only detectable change in size structure suggests that a reduction in mortality occurred in the St. Croix pot and trap fishery in the mid 1990's.

- Redtail parrotfish have been one of the most common species encountered in the TIP database throughout the time series.

- Recreational fishing pressure on parrotfish is believed to be relatively low, although some subsistence fishing is occurring.

In terms of differences between the three islands, a couple points are worth noting:

- The reported landings in St. Croix are, and have been, significantly higher than the other two islands. These levels are being used as the MSY-proxy in the 2010 amendment and assumed to be sustainable. Given the realized productivity per square mile in St. Croix, and the fact that fishable shelf area is much larger in St. Thomas and Puerto Rico, there is no evidence to suggest that stocks are overfished or undergoing overfishing in St. Thomas and Puerto Rico.

- In St. Croix, the magnitude of landings in comparison to the shelf size and the appearance of smaller individuals in recent years in the catch warrant a less definitive interpretation. However, given that the general belief that these levels of harvest have been maintained over a long period of time (i.e. sustainable), harvest is primarily on individuals above the size at maturity, and increases in mean length of fully vulnerable fish, there is no evidence to support that overfishing is occurring.

In addition, the scientific interpretation of these results should consider that the proposed Annual Catch Limits for parrotfish in the US Caribbean included an additional buffer due to concerns regarding the ecosystem function of this family group (i.e. >20% versus 15% for the other species in the 2010 amendment). Our conclusions do not include these considerations and are based solely on the principles of surplus production theory and single species assessments. If stock size has been reduced due to fishing pressure in St. Croix, the population would be expected to respond quickly to reductions in landings.