SEDAR

Southeast Data, Assessment, and Review

SEDAR 91

Stock Assessment Report

US Caribbean Spiny Lobster – St. Croix

September 2025

SEDAR
4055 Faber Place Drive, Suite 201
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SEDAR

Southeast Data, Assessment, and Review

SEDAR 91

US Caribbean Spiny Lobster – St. Croix

SECTION I: Introduction

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Overview

SEDAR 91 addressed the stock assessment for US Caribbean Spiny Lobster – St. Croix. The process consisted of an in-person Data Workshop, with several webinars before and after the workshop and a series of assessment webinars. The Review Workshop was cancelled because the center for independent experts (CIE) were not able to participate in the review of the assessment. The assessment was conducted by the SEFSC.

The Stock Assessment Report is organized into 4 sections. Section I – Introduction contains a brief description of the SEDAR Process, Assessment and Management Histories for the species of interest, and the management specifications requested by the Cooperator. The Data Workshop Report can be found in Section II. It documents the discussions and data recommendations from the Data Workshop Panel. Section III is the Assessment Process report. This section details the assessment model, as well as documents any changes to the data recommendations that may have occurred after the data workshop. Consolidated Research Recommendations from all stages of the process can be found in Section IV for easy reference.

The final Stock Assessment Report (SAR) for US Caribbean Spiny Lobster – St. Croix was disseminated to the public in September 2025. The Council's Scientific and Statistical Committee (SSC) will review the SAR. The SSCs are tasked with recommending whether the assessments represent Best Available Science, whether the results presented in the SARs are useful for providing management advice and developing fishing level recommendations for the Council. An SSC may request additional analyses be conducted or may use the information provided in the SAR as the basis for their Fishing Level Recommendations (e.g., Overfishing Limit and Acceptable Biological Catch). The Caribbean Council's SSC will review the assessment at its September 2025 meeting, followed by the Council receiving that information at its December 2025 meeting. Documentation on SSC recommendations is not part of the SEDAR process and is handled through each Council.

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, 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; a representative from the Highly Migratory Species Division of NOAA Fisheries, and Interstate Commission representatives: Executive Directors of the Atlantic States and Gulf States Marine Fisheries Commissions.

SEDAR is normally 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 workshop and/or a series of webinars, during which assessment models are developed and population parameters are estimated using the information provided from the Data Workshop. The final step 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 stages 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.

2 MANAGEMENT OVERVIEW

A Management History Database is being compiled, cataloged, and standardized by the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), the Southeast Fisheries Science Center (SEFSC) Fisheries Statistics and Sustainable Fisheries Divisions in collaboration with the Cooperative Institute for Marine and Atmospheric Studies (CIMAS) of the University of Miami.

The Management History Database effort involves:

- Identifying Federal Register documentation associated with management actions affecting federally managed species throughout the Gulf of Mexico, South Atlantic, and U.S. Caribbean regions.
- Creating standardized records specifying the Fishery Management Plan (FMP), species, jurisdiction, and fishing sector (commercial and recreational) to which each management action is applied.

Once complete, the goal of the database is to provide a comprehensive and standardized record of published management actions to increase the efficiency of fisheries stock assessments, ACL monitoring, and ecosystem approaches. However, the database is still in development and is not yet available to the public. The intention of this working paper is not to replace current management history documents but to provide complementary tables of cited regulations.

We queried a prototype of the database for records related to Caribbean Spiny Lobster. The records associated with bag limits, size limits, prohibited gear, and closures were reviewed and are summarized here.

Table 1. Recreational bag limit regulations contained within the Management History Database for Caribbean Spiny Lobster.

Region Affected	Fishery	Start Year	Effective Date	End Date	Bag Limit	FR Reference(s)	Amendment Number or Rule Type
Caribbean	Recreational	2012	01/30/2012	Ongoing	3 per person per day	76 FR 82413	Final Amendment 5
		2012	01/30/2012	Ongoing	10 per vessel per day	76 FR 82413	Final Amendment 5

Table 2. Size limit regulations for the commercial fishery and recreational and commercial fisheries combined (All) contained within the Management History Database for Caribbean Spiny Lobster.

Region Affected	Fishery	Start Year	Effective Date	End Date	Size Limit	Length Type	FR Reference(s)	Amendment Number or Rule Type
Caribbean	All	1985	01/01/1985	Ongoing	3.5 inches[1]	Minimum Carapace Length	49 FR 50049	Final Original FMP
Caribbean	Commercial	2009	02/11/2009	Ongoing	6 ounce[2]	Tail Weight	74 FR 1148	Final Amendment 4

[1]Size limit applies to non-egg-bearing spiny lobster
[2]Size limit applies to imported spiny lobster

Table 3. Gear restrictions for commercial and commercial and recreational fisheries combined (All) contained within the Management History Database for Caribbean Spiny Lobster.

Region Affected	Fishery	Gear Type	Start Year	Effective Date	End Date	Gear/Harvesting Restrictions	FR Reference(s)	Amendment Number or Rule Type
Caribbean	All	All	2005	11/28/2005	Ongoing	Prohibited fileting fish at sea	70 FR 62073	Final
						Reef fish vessels required to recover anchor by its crown		
		Explosives	1985	01/01/1985	Ongoing	Prohibited for spiny lobster	49 FR 50049	Final Original FMP
		Gillnets or Trammel Nets	2005	11/28/2005	Ongoing	Prohibit gillnets or trammel net for reef species[1]	70 FR 62073	Final Amendment 2
		Hookah[2]	1997	01/13/1997	Ongoing	Prohibited hookah gear for harvesting conch	61 FR 65481	Final Original FMP
		Poison	1985	01/01/1985	Ongoing	Prohibited for spiny lobster	49 FR 50049	Final Original FMP
		Pots and Traps	1985	01/01/1985	09/19/1991	Include one degradable panel and/or door	49 FR 50049	Final Original FMP
			1986	09/22/1986	09/13/1991	Minimum mesh size 1 ¼"	50 FR 34850	Final Original FMP
			1991	09/14/1991	Ongoing	Minimum mesh size 2"	55 FR 46214	Final Amendment 1

Region Affected	Fishery	Gear Type	Start Year	Effective Date	End Date	Gear/Harvesting Restrictions	FR Reference(s)	Amendment Number or Rule Type
	All	Pots and Traps	1991	09/20/1991	11/14/1993	Include two degradable panels on opposite sides	56 FR 48755	Final
			1993	11/15/1993	11/27/2005	Include two degradable panels (sides no longer specified)	58 FR 53145	Final Amendment 2
			2005	11/28/2005	Ongoing	Include one degradable panel	70 FR 62073	Final
		Slurp Gun and Dip Nets	1993	11/15/1993	11/28/2005	Allow only slurp gun and hand-held dip nets for aquarium trade	58 FR 53145 70 FR 62073	Final Amendment 2 Final
		Spear	1985	01/01/1985	Ongoing	Prohibited for spiny lobster	49 FR 50049	Final Original FMP
	Commercial	Spear	2010	12/02/2010	Ongoing	Allow spear fishing for reef fish in the commercial sector	75 FR 67247	Final Regulatory Amendment
Caribbean Closed areas[3]	All	Bottom gears[4]	2005	11/28/2005	Ongoing	Prohibited year-round	70 FR 62073	Final
Caribbean Bajo de Sico	All	Anchoring	2010	12/02/2010	Ongoing	Anchoring by fishing vessels prohibited year-round	75 FR 67247	Final Regulatory Amendment

[1]Gill nets and trammel nets used to fish other species must be tended at all times

[2]Lang Bank (St. Croix) only starting 11/28/2005
[3]Bajo de Sico, Abrir La Sierra, Tourmaline, Mutton Snapper Spawning Aggregation Area, Lang Bank, Hind Bank Marine Conservation District, and Grammanik Bank
[4]Pots, traps, bottom longlines, gillnets, trammel nets

Table 4. Closure regulations for Caribbean Spiny Lobster contained within the Management History Database.

Region Affected	Start Year	End Year	Start Day	End Day	Restriction During Closure	FR Reference(s)	Amendment Number or Rule Type
Caribbean Red Hind Spawning Aggregation West of Puerto Rico - Abrir La Sierra Bank	1996	1996	12/7	12/31	All fishing prohibited	61 FR 64485	Final Regulatory Amendment
	1997	Ongoing	1/1	2/28	All fishing prohibited	61 FR 64485	Final Regulatory Amendment
	1997	Ongoing	12/1	12/31	All fishing prohibited	61 FR 64485	Final Regulatory Amendment

Region Affected	Start Year	End Year	Start Day	End Day	Restriction During Closure	FR Reference(s)	Amendment Number or Rule Type
Caribbean Red Hind Spawning Aggregation West of Puerto Rico - Bajo De Sico	1996	1996	12/7	12/31	All fishing prohibited	61 FR 64485	Final Regulatory Amendment
	1997	2010	1/1	2/28	All fishing prohibited	61 FR 64485	Final Regulatory Amendment
	1997	2009	12/1	12/31	All fishing prohibited	61 FR 64485	Final Regulatory Amendment
	2010	2010	12/2	12/31	Fishing for reef fish prohibited	75 FR 67247	Final Regulatory Amendment

Region Affected	Start Year	End Year	Start Day	End Day	Restriction During Closure	FR Reference(s)	Amendment Number or Rule Type
Caribbean Red Hind Spawning Aggregation West of Puerto Rico - Bajo De Sico	2011	Ongoing	1/1	3/31	Fishing for reef fish prohibited	75 FR 67247	Final Regulatory Amendment
	2011	Ongoing	10/1	12/31	Fishing for reef fish prohibited	75 FR 67247	Final Regulatory Amendment
Caribbean Grammanik Bank Reef Fish Fishery Management Area	2005	Ongoing	2/1	4/30	All fishing prohibited	70 FR 62073	Final Amendment 2
Caribbean Hind Bank Marine Conservation District (MCD) Reef Fish Fishery Management Area	1989	1989	12/6	12/31	All fishing prohibited	54 FR 50624	Emergency Interim Rule

Region Affected	Start Year	End Year	Start Day	End Day	Restriction During Closure	FR Reference(s)	Amendment Number or Rule Type
Caribbean Hind Bank Marine Conservation District (MCD) Reef Fish Fishery Management Area	1990	1999	1/1	2/28	All fishing prohibited	54 FR 50624	Emergency Interim Rule
	1990	1999	12/1	12/31	All fishing prohibited	55 FR 46214	Final Amendment 1
	2000	Ongoing	1/1	12/31	All fishing prohibited	64 FR 60132	Final
Caribbean Mutton Snapper Spawning Aggregation Reef Fish Fishery Management Area	1994	Ongoing	3/1	6/30	All fishing prohibited	58 FR 53145	Final Amendment 2
Caribbean Red Hind Spawning Aggregation East of St. Croix Reef Fish Fishery Management Area	1993	Ongoing	12/1	12/31	All fishing prohibited	58 FR 53145	Final Amendment 2

Region Affected	Start Year	End Year	Start Day	End Day	Restriction During Closure	FR Reference(s)	Amendment Number or Rule Type
Caribbean Red Hind Spawning Aggregation East of St. Croix Reef Fish Fishery Management Area	1994	Ongoing	1/1	2/28	All fishing prohibited	58 FR 53145	Final Amendment 2
Caribbean Red Hind Spawning Aggregation West of Puerto Rico - Tourmaline Bank	1993	Ongoing	12/1	12/31	All fishing prohibited	58 FR 53145	Final Amendment 2
	1994	Ongoing	1/1	2/28	All fishing prohibited	58 FR 53145	Final Amendment 2
Caribbean St. Croix Management Area	2013	2013	12/19	12/31	All fishing prohibited	78 FR 18247	Temporary Rule Accountability Measure
Caribbean Puerto Rico Management Area	2016	2016	12/10	12/31	All fishing prohibited	81 FR 34283	Temporary Rule Closure
	2017	2017	9/7	9/30	All fishing prohibited	82 FR 31489	Temporary Rule Closure
	2021	2021	8/22	9/30	All fishing prohibited	86 FR 40787	Temporary Rule Closure
	2022	2022	7/12	9/30	All fishing prohibited	87 FR 38008	Temporary Rule Closure

3 ASSESSMENT HISTORY AND REVIEW

Previous stock assessments for Spiny Lobster in the US Caribbean have attempted to quantify stock status using both traditional as well as data-limited stock assessment procedures. Morris et al. (2004) and also SEDAR (2005A) provide assessment histories that summarize various traditional assessment, e.g. stock production analyses (ASPIC), CPUE examinations, yield per recruit, landings and length frequency. During SEDAR 46, a data-limited management strategy evaluation was conducted to simulation-test mean-length, indicator-based control rules (2016). A table of past assessment model applications can be found in the SEDAR 57 Final Stock Assessment Report (2019). SEDAR 57 was the first application of Stock Synthesis 3 (SS3) in the US Caribbean (2019). During SEDAR 57, the Saint Croix spiny lobster stock assessment models were subject to numerous sensitivity analyses including assumptions related to natural mortality, growth, and selectivity (SEDAR, 2019). The St. Croix assessment models developed during SEDAR 57 were fit to catch time series and length composition information from dive and pot/trap fisheries; this is considered a data-limited to moderate implementation of SS3. SEDAR 57 resulted in a satisfactory stock status determination for providing management advice (2019). A data-only update was conducted in 2022 to provide ABCs and ACLs through May, 2025. One new data stream became available following the Data Workshop in November 2024: the SEAMAP-C dive survey (2022-2023). However, due to low sample size (n = 55), the Assessment Workshop Panel did not recommend fitting the model to those data.

REGIONAL MAPS

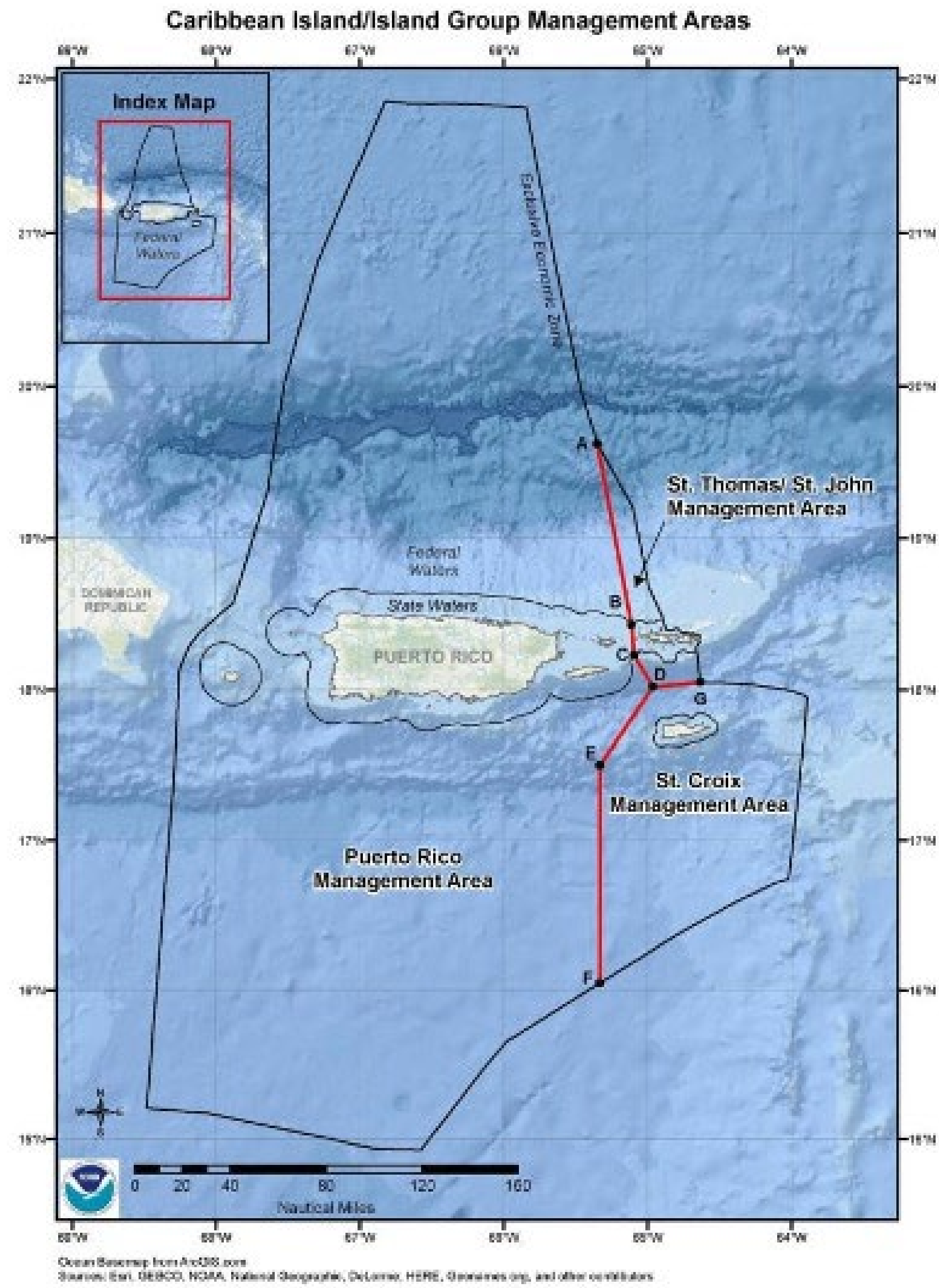

Figure 4.1 Jurisdictional boundaries of the Caribbean Fishery Management Council.

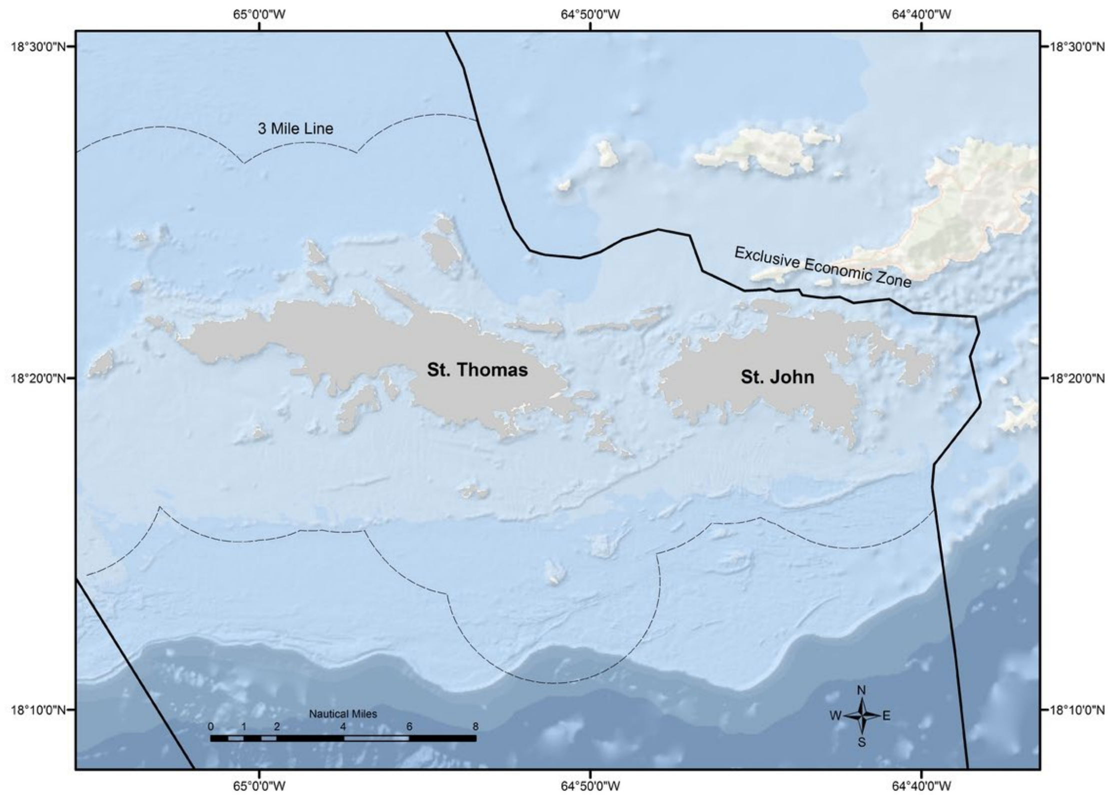

Figure 4.2: The U.S. Exclusive Economic Zone is defined as the federal waters ranging from 3 to 200 nautical miles (5.6 – 370 kilometers) from the nearest coastline point of the US Virgin Islands.

4 SEDAR ABBREVIATIONS

ABC	Acceptable Biological Catch
ACCSP	Atlantic Coastal Cooperative Statistics Program
ADMB	AD Model Builder (software program)
ALS	Accumulated Landings System: SEFSC fisheries data collection program
AMRD	Alabama Marine Resources Division
APAIS	Access Point Angler Intercept Survey
ASMFC	Atlantic States Marine Fisheries Commission
B	Biomass (stock) level
BAM	Beaufort Assessment Model
B_{msy}	B capable of producing MSY on a continuing basis
BSIA	Best Scientific Information Available
CHTS	Coastal Household Telephone Survey

CFMC	Caribbean Fishery Management Council
CIE	Center for Independent Experts
CPUE	Catch Per Unit Effort
EEZ	Exclusive Economic Zone
F	Fishing mortality (instantaneous)
FES	Fishing Effort Survey
FIN	Fisheries Information Network
F_{MSY}	F to produce MSY under equilibrium conditions
F_{OY}	F rate to produce OY under equilibrium
$F_{XX\%\ SPR}$	F rate resulting in retaining XX% of the maximum spawning production under equilibrium conditions
F_{max}	F maximizing the average weight yield per fish recruited to the fishery
F_o	F close to, but slightly less than, Fmax
FL FWCC	Florida Fish and Wildlife Conservation Commission
FWRI	Florida Fish 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
HMS	Highly Migratory Species
LDWF	Louisiana Department of Wildlife and Fisheries
M	natural mortality (instantaneous)
MARFIN	Marine Fisheries Initiative
MARMAP	Marine Resources Monitoring, Assessment, and Prediction
MDMR	Mississippi Department of Marine Resources
MFMT	Maximum Fishing Mortality Threshold: 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
MSA	Magnuson Stevens Act
MSST	Minimum Stock Size Threshold: 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
OST	Office of Science and Technology, NOAA

OY	Optimum Yield
SAFMC	South Atlantic Fishery Management Council
SC DNR	South Carolina Department of Natural Resources
SEAMAP	Southeast Area Monitoring and Assessment Program
SEDAR	Southeast Data, Assessment and Review
SEFIS	Southeast Fishery-Independent Survey
SEFSC	Southeast Fisheries Science Center, NMFS
SERFS	Southeast Reef Fish Survey
SERO	Southeast Regional Office, NMFS
SRFS	State Reef Fish Survey (Florida)
SRHS	Southeast Region Headboat Survey
SPR	Spawning Potential Ratio: B relative to an unfished state of the stock
SSB	Spawning Stock Biomass
SS	Stock Synthesis
SSC	Scientific and Statistical Committee
TIP	Trip Interview Program: biological data collection program of the SEFSC and Southeast States
TPWD	Texas Parks and Wildlife Department
Z	total mortality (M+F)

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US Caribbean Spiny Lobster St. Croix

SECTION II: Data Workshop Report

January 2025

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1. INTRODUCTION

1.1 WORKSHOP TIME AND PLACE

The SEDAR 91 Data Workshop was held November 13-15, 2024, in St Thomas, USVI. In addition to the in-person workshop, a series for webinars were held before (June and October 2024) the meeting.

1.2 TERMS OF REFERNCE

Data Workshop Terms of Reference:

1. Review available data inputs and provide tables and figures including, but not limited to:
    a. Commercial and recreational catches and/or discards.
    b. Length/age composition data
    c. Life history and ecological information
    d. Indices of abundance
    e. Include data through at least 2022.
2. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on research goals, data to be collected, and how the research will inform stock assessment.
3. Prepare the Data Workshop report providing complete documentation of workshop actions and decisions in accordance with project schedule deadlines (Section II of the SEDAR assessment report).

1.3 LIST OF PARTICIPANTS

Data Workshop Participants

Matt Damiano (Lead Analyst) .... NMFS/SEFSC
Adyan Rios .... NMFS/SEFSC
Sarah Beggerly .... NMFS/SEFSC
J.J. Cruz-Motta .... CFMC SSC, UPRM
Jorge R. Garciá .... CFMC SSC
Katherine Godwin .... UM-CIMAS
Sennai Habtes .... USVI DPNR
Daniel Matos-Caraballo .... PR DNER
Kevin McCarthy .... NMFS/SEFSC
Maggie Rios .... USVI DPNR
M. Refik Orhun .... NMFS/SEFSC
Wilson Santiago Soler .... PR Fisheries Liaison
Michelle Scharer .... CFMC SSC

Juan J. Agar .... SEFSC
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Eva M. Collazo Montarez .... DPNR/DFW
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Ana Medina .... UPRM
Abdiel Connelly .... SAMAR
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Staff

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Graciela Garcia-Moliner .... CFMC Staff
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Martha Prada ....
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Jesus Rivera ....
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Rachael Silvas .... SAFMC
Sarah Stephenson .... SERO
Ramirez Edgardo. ....
Casey Butler ....
Cindy Grace-McCaskey ....
Kimberly Johnson .... NMFS/SEFSC
May Lehmensiek ....
Jesus Leon ....
Martha Prada .... DRNA
Vanessa Ramirez ....
Noemi Peña Alvard .... PR DNER
Aida Rosario .... PR DNER

1.4 LIST OF DATA WORKSHOP WORKING PAPERS & REFERNCE DOCUMENTS

Document #	Title	Authors	Date Submitted
Documents Prepared for the Data Workshop			
SEDAR91-DW-01	Summary of participatory modeling workshops to understand ecological, social and economic dimensions of the U.S. Virgin Islands lobster fishery	Juan Agar, Mandy Karnauskas, Kelsi Furman, Matt McPherson, Manoj Shivlani	11/1/2024
SEDAR91-DW-02	Summary of participatory modeling workshops to understand ecological, social and economic dimensions of the Puerto Rican lobster fishery	Mandy Karnauskas, Juan Agar, Matt McPherson, Kelsi Furman, Manoj Shivlani	11/1/2024
SEDAR91-DW-03	PR/DNER/Commercial Fisheries Statistics Program Report Signs of the Abundance of Spiny Lobster Panulirus argus Observed by Commercial Landings Reported during 2014-2023	Daniel Matos-Caraballo, Jesús León-Fernández, Luis A. Rivera-Padilla, and Wilson Santiago-Soler	11/15/2024
SEDAR91-DW-04	SEDAR 91 Trip Interview Program (TIP) Size Composition Analysis of Caribbean Spiny Lobster (Panulirus argus) in Puerto Rico, U.S. Caribbean, 1981-2023	Katherine Godwin, Adyan Rios	11/20/2024
SEDAR91-DW-05	SEDAR 91 Trip Interview Program (TIP) Size Composition Analysis of Caribbean Spiny Lobster (Panulirus argus) in St. Thomas/St. John, U.S. Caribbean, 1981-2023	Katherine Godwin, Adyan Rios	11/20/2024
SEDAR91-DW-06	SEDAR 91 Trip Interview Program (TIP) Size Composition Analysis of Caribbean Spiny Lobster (Panulirus argus) in St. Croix, U.S. Caribbean, 1981-2023	Katherine Godwin, Adyan Rios	11/20/2024
SEDAR91-DW-07	SEDAR 91 Commercial Landings of Caribbean Spiny Lobster (Panulirus argus, Panulirus guttatus) in Puerto Rico, US Caribbean, 1983-2023	M. Refik Orhun, Katherine Godwin, Kim Johnson, and Stephanie Martínez Rivera	11/24/2024

SEDAR91-DW-08	SEDAR 91 Commercial Landings of Caribbean Spiny Lobster (Panulirus argus) in St. Thomas and St. John, US Caribbean, 1975-2023	M. Refik Orhun, Katherine Godwin, Kim Johnson, and Stephanie Martínez Rivera	11/24/2024
SEDAR91-DW-09	SEDAR 91 Commercial Landings of Caribbean Spiny Lobster (Panulirus argus) in St. Croix, US Caribbean, 1975-2023	M. Refik Orhun, Katherine Godwin, Kim Johnson, and Stephanie Martínez Rivera	11/24/2024
Reference Documents			
SEDAR91-RD01	On the productivity and technical efficiency of the Puerto Rican queen conch Aliger gigas fishery	Juan Agar and Daniel Solis	10/9/2024
SEDAR91-RD02	Socio-economic Profile of the Small-scale Dive Fishery in the Commonwealth of Puerto Rico	Juan J. Agar and Manoj Shivlani	10/9/2024
SEDAR91-RD03	Determining the age-size relationship of Panulirus argus in the southwest area of Puerto Rico	Ana G. Medina Martinez	10/9/2024
SEDAR91-RD04	Annual Juvenile Recruitment of Spiny Lobsters, Panulirus Argus (Decapoda, Palinuridae), in a Shallow Seagrass Bed and a Deeper Hard Bottom off Western Puerto Rico	Nilda M. Jiménez, Ernest H. Williams, Jr. and Aida Rosario	10/10/2024
SEDAR91-RD05	Patterns of Spiny Lobster (Panulirus argus) Postlarval Recruitment in the Carribbean: A CRTR Project	Mark J. Butler IV, Angela M. Mojica, Eloy Sosa-Cordero, Marines Millet and Paul Sanchez-Navarro	10/10/2024
SEDAR91-RD06	Developing a population assessment for Caribbean spiny lobster *Panulirus argus* in the United States Virgin Islands: lessons learned	Lee Richter[1] and Michael W Feeley[2]	11/7/2024
SEDAR91-RD07	Estimate of In-water Size Structure of Spiny Lobsters in St. Thomas	Tyler B. Smith, Sarah L. Heidmann, Rosmin S. Ennis, Viktor W. Brandtneris, Adeline Shelby,	11/7/2024

		Jeremiah Blondeau	
SEDAR91-RD08	Displaced juvenile and subadult Caribbean spiny lobsters show strong orientation toward home dens	Michael J. Childress a,*, Coral Holt a, Rodney D. Bertelsen b	11/14/2024
SEDAR91-RD09	Ocean acidification disrupts the orientation of postlarval Caribbean spiny lobsters	Philip M. Gravinese, Heather N. Pag, Casey B. Butler, Angelo Jason Spadaro, Clay Hewett, Megan Considine, David Lankes & Samantha Fisher	11/14/2024
SEDAR91-RD10	Relationships between postlarval settlement and commercial landings of Caribbean spiny lobster (Panulirus argus) in Florida (USA)	Emily Hutchinson, Thomas R. Matthews , Gabrielle F. Renchen	11/14/2024
SEDAR91-RD11	Gastric mill ossicles record chronological age in the Caribbean spiny lobster (*Panulirus argus*)	Emily Hutchinson, Thomas. R Matthews, Erica Ross, Samantha Hagedorn , Mark J. Butler IV,	11/14/2024
SEDAR91-12	Spiny Lobster SEAMAP Program Survey 2021-23	Department of Natural and Environmental Resources	11/14/2024
SEDAR91-13	Progress Report: Independent fishery data collection for lobster (Panulirus argus) and conch (Lobatus gigas) under the SEAMAP-C program	Juan J. Cruz Motta	11/14/2024

2. Life History

2.1 Overview

No new life history information was available for the SEDAR Panel to discuss during the data workshop. Therefore, sections 2.2-2.6 were carried over from SEDAR 57.

2.2 Stock Definition and Description

The Caribbean spiny lobster (hereafter referred to as spiny lobster), occurs in the Caribbean Sea, the Gulf of Mexico and the Western Central and South Atlantic Ocean. North Carolina marks its northernmost limit whereas Brazil marks its southernmost limit (Bliss 1982). The spiny lobster occurs from the extreme shallows of the littoral fringe to depths exceeding 100 meters (Kanciruk 1980; Munro 1974). CFMC (1981) reports that its distribution off Puerto Rico extends to the edge of the shelf, which is described as the 100−fathom contour (183 meters). Shallow areas with mangroves and seagrass (*Thalassia testudinum*) beds serve as nursery areas where available (Munro 1974). Generally, spiny lobsters move offshore when they reach reproductive size (Phillips et al. 1980). These animals are primarily carnivores, and serve as the major benthic carnivores in some ecosystems (Kanciruk 1980), feeding upon smaller crustaceans, mollusks and annelids (Cobb and Wang 1985).

2.3 Meristic & Conversion factors

Length-weight conversions were estimated using the Trip Interview Program (TIP) database. TIP records were filtered according to island platform (Puerto Rico, St. Thomas and St. John, and St. Croix). Records were further filtered such that retained records consisted only of those with paired length-weight measurements that had reported units of measure (e.g., mm or kg) and corresponding measurement type (e.g., carapace length or whole weight). A subsequent evaluation of data entry and/or measurement errors led to the removal of 1 record for St. Croix (Table 2.1)

Length-weight relationships were fit as log-linear functions in the R statistical computing software (Quinn and Deriso 1999, R Development Core Team 2012). The relationship for length (mm CL) to weight (kg whole weight) is:

$$W = aL^b$$

Model fitting was carried out using linear regression on the log transformed equation:

$$log(W) = log(a) + b * log(L)$$

Analyses were carried out separately for males, females, and for both sexes combined.
For St. Croix, a total of n=20,046 L-W observations were available from TIP (n male=11,684; n female=8,362) from 1981 to 2017 (Fig. 2.1). The largest individual by length was 212.2 mm CL (1.5 kg), while the largest individual by weight was 4.5 kg (183.5 mm CL). Carapace length to weight conversion for St. Croix spiny lobsters are provided in Table 2.2.

2.4 Natural Mortality

During SEDAR 8, various sources are referenced with respect to natural mortality, including Olsen and Koblic 1975, Medley and Ninnes 1996, and FAO 2001. Natural mortality was specified at 0.36 for adult lobsters and used for all ages during SEDAR 8. During SEDAR 46 (Spiny lobster St. Thomas and St. Croix), consideration was given to natural mortality estimates from tagging studies, with estimates typically occurring between 0.26 and 0.44 $year^{-1}$ for adult spiny lobster, with the most reliable estimates suggested to be in the range of 0.30 to 0.40 (FAO 2001). A point estimate of 0.34, calculated from a variant of Pauly's equation, is also widely reported (Cruz et al. 1981). Point estimates based on longevity were also considered, but require evidence of maximum age, which is difficult to obtain for lobsters (Kanciruk 1980). This issue is reinforced by additional statements made by Olsen and Koblic (1975). Further discussion about spiny lobster longevity can be found on pg 27, SEDAR 46, Data and Workshop report (SEDAR 2016). Several spiny lobster stock assessments in the Caribbean have used 0.34 to 0.36 $year^{-1}$ in base model runs (Cruz 2001; Gongora 2010; SEDAR 2005; Babcock et al. 2014). During the SEDAR 57 data workshop, participants identified a mark- recapture dataset from a study undertaken by the St. Thomas Fishermen's Association (Olsen et al. 2017). Analysts determined obtaining an estimate of natural mortality from this study for use in the assessment was not feasible; this was potentially due to an underestimate of reporting practices stated by Olsen et al. (2017), which resulted in an unreasonably high ($M > 2.0$ per year) estimate of natural mortality (see SEDAR 57 Final Assessment Report).

2.5 Reproduction

Die (2005) estimated a logistic maturity curve from TIP prior to 1990, when landing of egg bearing females was permitted. Data from Puerto Rico, St. Thomas, and St. John were aggregated for the purpose of model fitting. Two model parameterizations were considered, in both cases, length at 50% maturity were similar being either 91 mm or 92 mm CL.

For SEDAR 8 (2005), fecundity-at-length was obtained for Cuba spiny lobster (FAO 2001):

$$E = 0.5911L^{4.5677}$$

where E is number of eggs and L is carapace length in mm.

2.6 Age and Growth

During SEDAR 8, von Bertalanffy growth curves for males and females were obtained from Leon et al. (1994) for Cuba (SEDAR 2005). Since SEDAR 8, several additional publications have become available for von Bertalanffy growth curves from regions such as Cuba, Puerto Rico, and Mexico (Table 2.3). Also, during SEDAR 46 (Spiny lobster St. Thomas & St. Croix), von Bertalanffy growth parameters from Leon et al. (1995) were reviewed, noting similar values used in other stock assessment (i.e., Gongora 2010; Babcock et al. 2014). These point estimates were also compared to a more recent study by Leon et al. (2005) and analyses in SEDAR 46 were based on a single growth curve for both sexes. During the SEDAR 57 data workshop, participants identified a mark-recapture dataset from a study undertaken by the St. Thomas

Fishermen's Association (Olsen et al. 2017). During SEDAR 57, analysts determined that obtaining a growth curve from this study for use in the assessment was not feasible. This was due to an absence of the largest size classes in the data set, though results verified that growth in Puerto Rico (Table 2.3) was generally consistent with growth in St. Thomas (see SEDAR 57 Final Assessment Report).

Table 2.1 Records manually removed from St. Croix TIP prior to L-W model fitting.

L	W	Sex
1005	0.775	M

Table 2.2 Fitted conversion functions from length (mm CL) to weight (kg whole weight) by island platform.

Island platform	Year	n	a	b
St. Croix				
Males	1981-2017	11684	1.271E-05	2.413
Females	1981-2017	8362	2.323E-05	2.290
Males + Females	1981-2017	20046	1.821E-05	2.339

Table 2.3 von Bertalanffy growth parameters, noting values used in SEDARs 8 and 46 (i.e., Leon et al. (1995)) and with emphasis on studies that have been subsequently produced.

Study	Region/Country	Source	Sex	L∞ (mm)	K
Leon et al. (1995)	Cuba	Length frequency	M	184	0.24
			F	155	0.22
Leon et al. (2005)	Cuba	Length frequency	Both	184	0.24
Mateo (2004)	Puerto Rico	Length frequency	M (1999)	197	0.24
			M (2000)	195	0.24
			F (1999)	191	0.25
			F (2000)	185	0.23
Velazquez-Abunader et al. (2015)	Mexico, Yucatan	Length frequency	M	203	0.28
			F	189	0.34

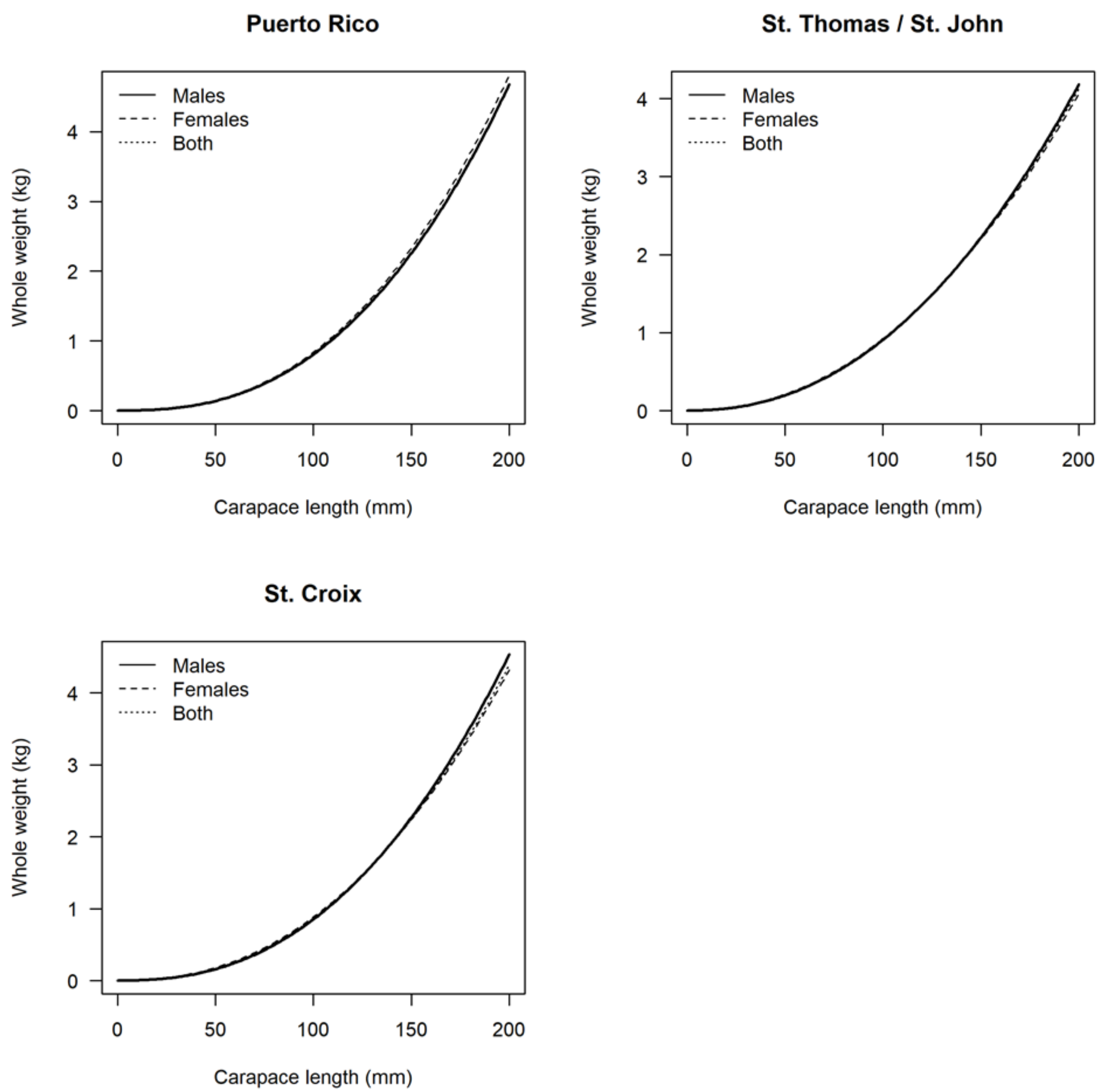

Figure 2.1 Length-weight curves for spiny lobster of Puerto Rico, St. Thomas/St. John, and St. Croix.

3. Commercial Fishery Statistics

3.1 Biological Sampling

3.1.1 Overview

The NOAA Fisheries, Southeast Fisheries Science Center Trip Interview Program (TIP) collects length and weight data from fish landed by commercial fishing vessels, along with information about fishing area and gear. Data collection began in the 1980s with frequent updates in best practices; the latest being in 2017. Data are collected by trained shore-based samplers (Beggerly et al., 2022).

3.1.2 Length Composition Sampling Intensity

The TIP data pertaining to Caribbean Spiny Lobster in St. Croix consists of 21,122 length observations across 1,642 unique port sampling interviews (Figure 3.1.1). Of the Caribbean spiny lobster measured, 21,100 were carapace length observations (99.9%). Plots and summary statistics of the currently available length frequency data of Caribbean spiny lobster sampled from the predominant gears in St. Croix are included in the working paper (Godwin et al. 2024).

3.1.3 Length Distributions

A variety of fishing gears were used by St. Croix commercial fishers to catch Caribbean spiny lobster. A generalized linear mixed model (GLMM) was fit to TIP data to compare mean size composition among gear types. The purpose of analysis was to identify gear groups among the commercial fishing gears with groups based upon Caribbean spiny lobster size composition. Gears with size compositions that were not significantly different were assigned to the same gear group. The analysis identified no difference between among gear specific size compositions and the gears with nonconfidential data are provided in Table 3.1.1. Summary statistics produced by the GLMM analysis of the available length frequency data from 1981 to 2023 are also found in Table 3.1.1. Gear groups were identified based on GLMM analysis using a gamma-distributed dependent variable and a covariate to account for changes in mean size over time. Random effects for interview ID and categorical year were included to account for non-independence of observations.

The aggregated density plot for all gears combined of Caribbean spiny lobster carapace lengths collected across the time series 1981-2023 are summarized in Figure 3.1.2. Aggregated density plots of Caribbean spiny lobster landed by nonconfidential gears are summarized in Figure 3.1.3.

3.1.4 Adequacy of Size Composition Data for Characterizing Catch

Due to reducing levels of available data throughout the time series, TIP data can be considered to inform selectivity, but likely will not be sufficient to inform annual population trends in the SEDAR 91 assessment. A weight-length analysis was not conducted to identify outliers in the TIP data. A cutoff of 2.5cm minimum and 25cm maximum length was implemented to remove notable outliers in the TIP dataset (Godwin et al 2024).

Decisions:

- Consider TIP data to inform selectivity in the assessment models and allow the assessment nalyst to explore the data for any evidence of annual population trends.
- Supply complete TIP time series for use in SEDAR 91 investigations.
- Compare aggregated length density of SEAMAP-C data with that of TIP data.

3.2 Commercial Landings

3.2.1 Overview

Commercial fishery landings in St. Croix, referred to as "STX" were obtained from self-reported fisher logbook data (Caribbean Commercial Logbook, CCL). Classification of Caribbean Spiny Lobster by species began in 1974, which was a partial year (Valle-Esquivel and Díaz 2004). Commercial fishery landings data for Caribbean Spiny Lobster in STX were available for the years 1975-2023.

3.2.2 Outlier Analysis

An outlier analysis was conducted by using a mean and standard deviation method. If the landings of Caribbean Spiny Lobster reported on a trip were greater than three standard deviations from the mean (i.e., 99.73% quantile), they were marked for removal from the dataset. Outliers were identified for each gear group across all years. Total landings with and without outliers are shown in Figure 3.2.1 and the percent change in landings with outliers removed is shown in Table 3.2.1.

Decisions:

- SEDAR 91 Panel decided to use the St. Croix commercial landings without removing the outliers.
- Panel recommended using the landings time series starting in 1975.

3.2.3 St. Croix Caribbean Spiny Lobster Fishery

Logbook data are recorded by fishing year, which runs from July 1 through June 30 of the following year. However, data in this report are recorded by calendar year. St. Croix's Caribbean Spiny lobster fishery was dominated by diving as the major gear and accordingly all gears, except for trap gear, were merged into a "diving all" gear group following the protocol of the prior Caribbean Spiny Lobster assessment and its update (SEDAR 57, 2019; SEDAR 57 Update, 2022) shown in Orhun et al. (2024). The commercial landings were presented in pounds by year and fishing gear group are shown in Table 3.2.2. Note that landings from 1975 to 1982 were confidential by year and gear.

3.3 Commercial Discards

Species-specific commercial discard reporting began in July 2003 and the first full year of reporting was 2004 in the USVI for Caribbean Spiny Lobster. Commercial discards were infrequently reported by fishers. Plenary group discussion resulted in the recommendation that discard mortality be considered minimal.

Decision:

- Discard mortality of spiny lobster was considered minimal and therefore represent a very minor source of mortality due to fishing (as per SEDAR 57)

3.4 Commercial Effort

Commercial trips with reported Caribbean Spiny Lobster landings per year and gear group were compiled from 1983 to 2023 (Table 3.4.1). Note that effort data from 1975 to 1982 were confidential by year and gear.

Table 3.1.1 GLMM analysis summary results for St. Croix TIP Caribbean Spiny Lobster lengths (cm) from 1981 to 2023. The column titled "group" indicates the group(s) where mean lengths are not statistically different from other gears with matching group number(s). The "n" column indicates the number of unique lengths recorded for each gear. The "Percentage" column indicates the percent of the total recorded lengths for each gear. Only nonconfidential data shown.

Gear	Mean	Estimated Marginal Mean	LCL	UCL	Group	Lobster (n)	Interview (n)	Percentage
POTS AND TRAPS; FISH	10.61	2.37	2.36	2.37	1	11,249	824	54.20
BY HAND; DIVING GEAR	10.56	2.36	2.35	2.37	1	8,162	693	39.33
POTS AND TRAPS; CMB	10.62	2.33	2.30	2.37	1	763	33	3.68

Table 3.2.1 Comparison of all reported landings and landings after outlier removal of commercial landings of Caribbean Spiny Lobster in pounds for St. Croix .

Year	Landings (lbs.)	Landings outlier removed (lbs.)	Difference (%)
1975	2,167	2,167	0.0
1976	2,217	2,217	0.0
1977	8,168	4,728	42.1
1978	4,981	4,646	6.7
1979	3,077	2,187	28.9
1980	1,288	1,288	0.0
1981	2,104	1,924	8.6
1982	2,693	2,693	0.0
1983	4,479	4,479	0.0
1984	7,564	7,564	0.0
1985	4,424	4,424	0.0
1986	5,969	5,969	0.0
1987	13,031	13,031	0.0
1988	8,012	8,012	0.0
1989	2,207	2,207	0.0
1990	19,472	19,135	1.7
1991	37,246	35,460	4.8
1992	21,132	20,982	0.7
1993	37,177	37,027	0.4
1994	29,789	29,789	0.0
1995	25,029	25,029	0.0
1996	28,841	28,841	0.0
1997	35,947	35,947	0.0
1998	42,791	42,349	1.0
1999	53,325	51,738	3.0
2000	89,025	85,886	3.5
2001	116,622	115,702	0.8
2002	116,275	116,275	0.0
2003	106,040	105,890	0.1
2004	125,414	125,285	0.1
2005	120,931	120,036	0.7
2006	146,589	145,108	1.0
2007	167,988	166,694	0.8
2008	148,001	146,231	1.2
2009	149,812	147,364	1.6
2010	139,684	138,099	1.1
2011	109,749	107,869	1.7
2012	87,074	85,024	2.4
2013	59,397	59,272	0.2
2014	39,724	39,604	0.3
2015	44,962	43,917	2.3
2016	31,582	31,381	0.6
2017	26,193	26,193	0.0
2018	10,970	10,700	2.5
2019	15,721	15,319	2.6

Year	**Landings (lbs.)**	**Landings outlier removed (lbs.)**	**Difference (%)**
2020	22,312	22,207	0.5
2021	39,782	38,799	2.5
2022	28,078	27,189	3.2
2023	42,542	38,476	9.6
Total	2,387,597	2,352,353	1.5

Table 3.2.2 Commercial landings of Caribbean Spiny Lobster in pounds by gear group that reported Caribbean Spiny Lobster landings in St. Croix .

YEAR	TOTAL TRAPS LBS	TOTAL DIVING ALL LBS	GRAND TOTAL LBS
1983	3,248	*	*
1984	1,591	*	*
1985	*	*	5,969
1986	*	*	7,564
1987	5,233	7,798	13,031
1988	3,367	4,645	8,012
1989	*	*	2,207
1990	2,859	16,276	19,472
1991	6,240	29,220	37,246
1992	6,325	14,657	21,132
1993	9,483	27,544	37,177
1994	5,528	24,261	29,789
1995	4,884	20,145	25,029
1996	2,331	26,510	28,841
1997	4,258	31,689	35,947
1998	3,457	38,892	42,791
1999	6,498	45,240	53,325
2000	4,260	81,626	89,025
2001	3,516	112,186	116,622
2002	3,886	112,389	116,275
2003	3,231	102,659	106,040
2004	3,900	121,385	125,414
2005	2,563	117,473	120,931
2006	3,993	141,115	146,589
2007	5,477	161,217	167,988
2008	4,226	142,005	148,001
2009	3,927	143,437	149,812
2010	8,359	129,740	139,684
2011	14,880	92,989	109,749
2012	14,403	70,621	87,074
2013	6,010	53,262	59,397
2014	2,564	37,040	39,724
2015	5,655	38,262	44,962
2016	951	30,430	31,582
2017	2,875	23,318	26,193
2018	*	10,007	10,970
2019	1,284	14,035	15,721
2020	1,924	20,283	22,312
2021	5,257	33,542	39,782
2022	2,797	24,392	28,078
2023	827	37,649	42,542

*Confidential data by year and gear were removed. Total landings (lb.) of confidential data is 42,347. The landings from 1975 to 1982 were confidential by year and gear.

Table 3.4.1 Commercial landings of Caribbean Spiny Lobster in pounds by gear group that reported Caribbean Spiny Lobster landings in St. Croix .

TRIP YEAR	TRIPS TRAPS	TRIPS DIVING ALL	TOTAL TRIPS
1983	204	*	*
1984	147	*	*
1985	*	*	*
1986	*	*	*
1987	214	322	536
1988	113	195	308
1989	*	*	*
1990	151	416	567
1991	228	842	1.080
1992	251	449	701
1993	376	830	1,207
1994	184	754	938
1995	192	796	988
1996	146	1,006	1,152
1997	183	1,203	1,386
1998	154	1,362	1,519
1999	225	1,419	1,656
2000	190	2,357	2,566
2001	112	3,168	3,286
2002	113	3,321	3,434
2003	101	3,217	3,319
2004	94	3,495	3,590
2005	137	3,423	3,567
2006	141	3,942	4,094
2007	215	4,249	4,474
2008	135	3,547	3,695
2009	93	3,741	3,842
2010	169	3,360	3,539
2011	196	2,313	2,519
2012	185	1,852	2,045
2013	113	1,470	1,584
2014	68	1,000	1,069
2015	97	907	1,008
2016	40	793	834
2017	57	651	708
2018	*	302	313
2019	32	360	395
2020	36	410	447
2021	52	868	925
2022	42	603	648
2023	33	907	949

*Confidential data by year and gear were removed. Total landings (lb.) of confidential data is 42,347. Total number of trips of confidential data is 1721. Data from 1975 to 1982 were confidential by year and gear.

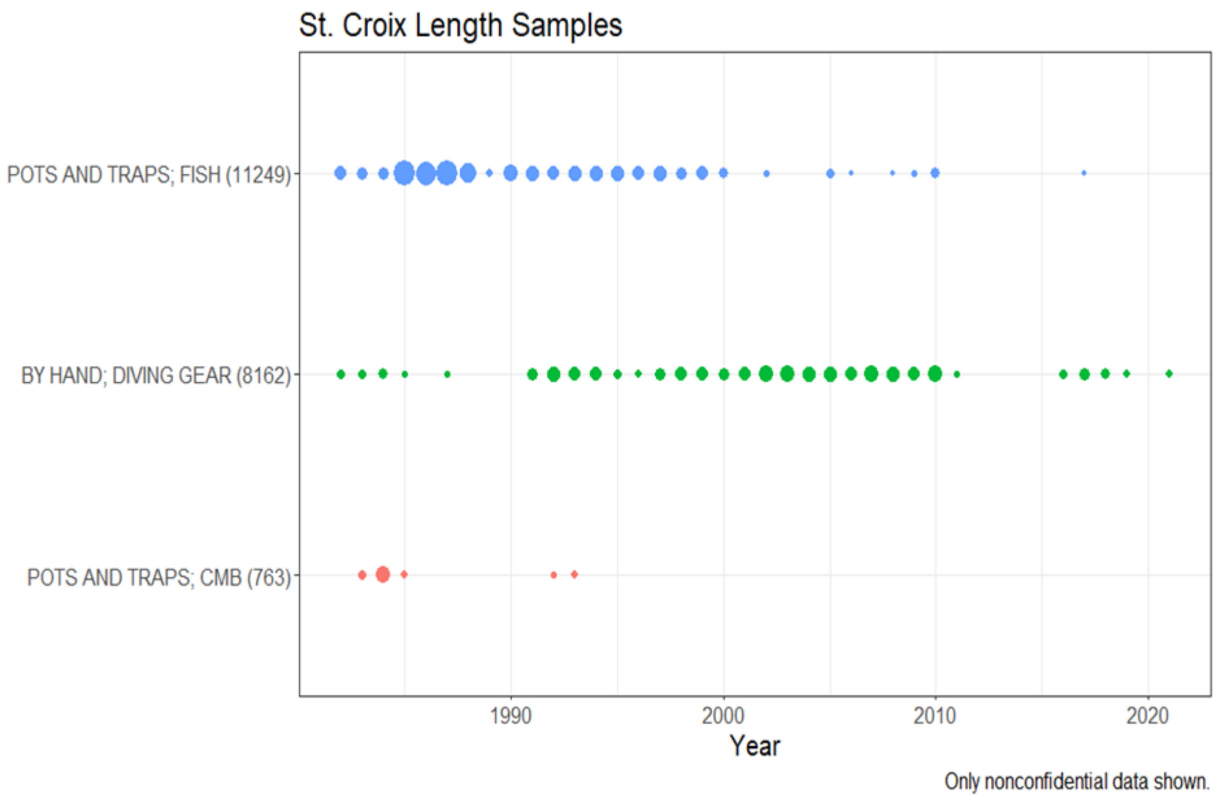

Figure 3.1.1 Plot showing relative number of Caribbean Spiny Lobster lengths in St. Croix across time collected. Each point is color specific to the gear it represents. Gears are arranged from most to least abundant.

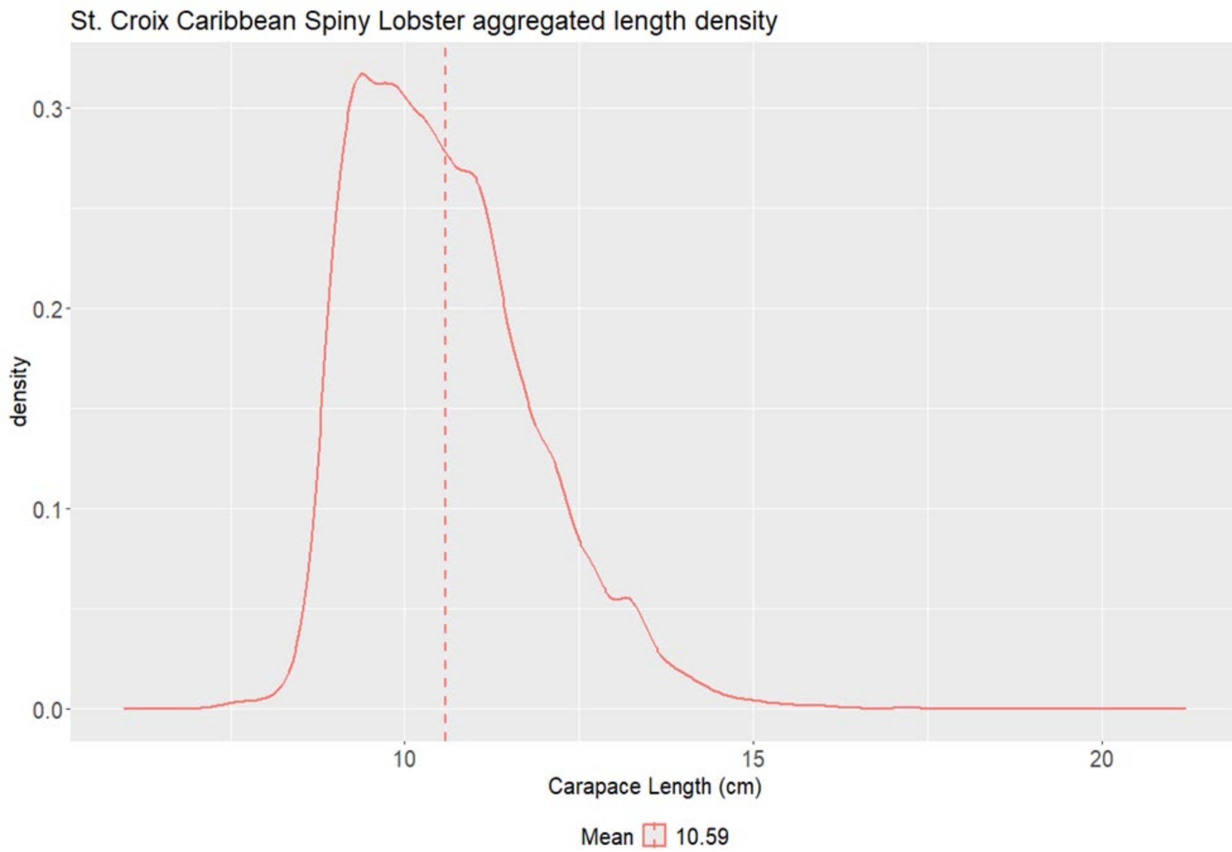

Figure 3.1.2 Aggregated density plot of lengths(cm) of Caribbean Spiny Lobster in St. Croix , all gears combined. Dotted line represents mean length.

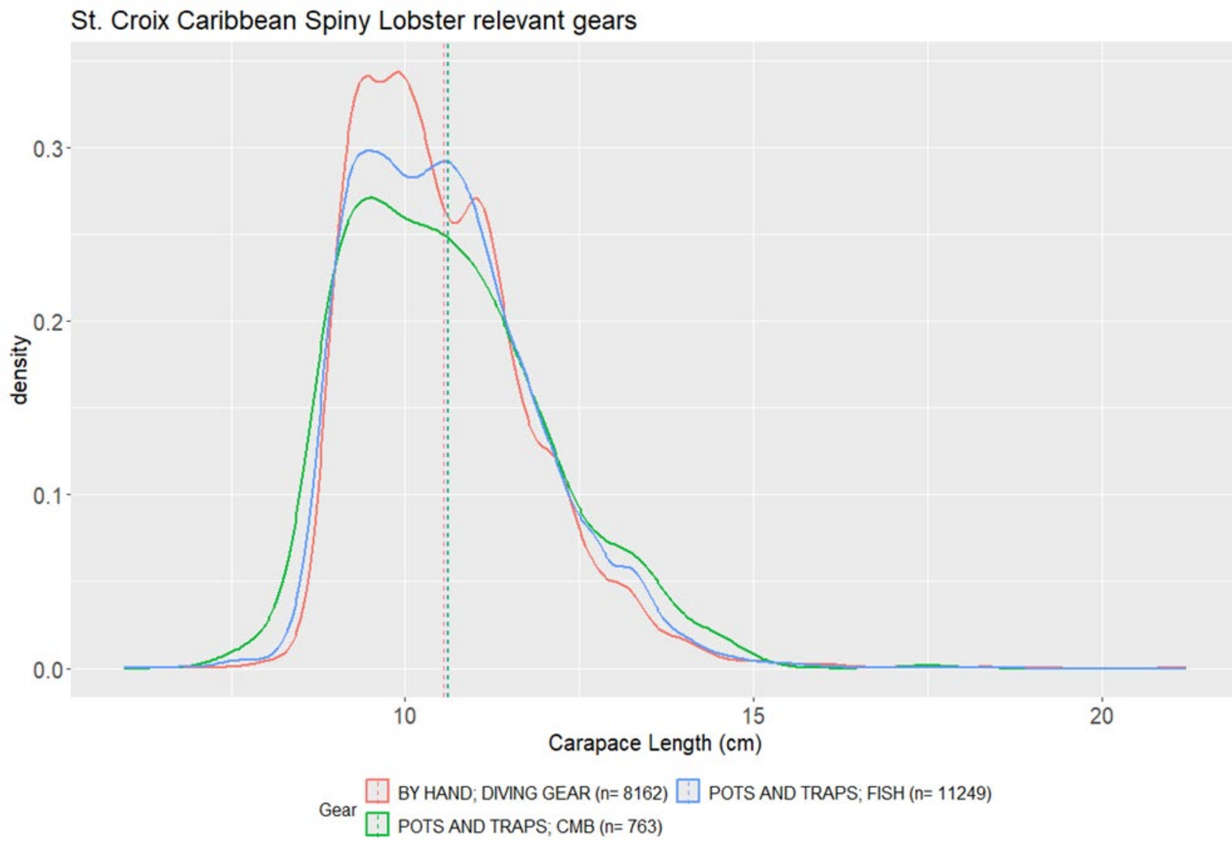

Figure 3.1.3 Aggregated density plot of lengths(cm) of nonconfidential gears recorded for Caribbean Spiny Lobster in St. Croix from 1981 to 2023 . Dotted line represents mean length. Mean lengths can be found in **Table 3.1.1**.

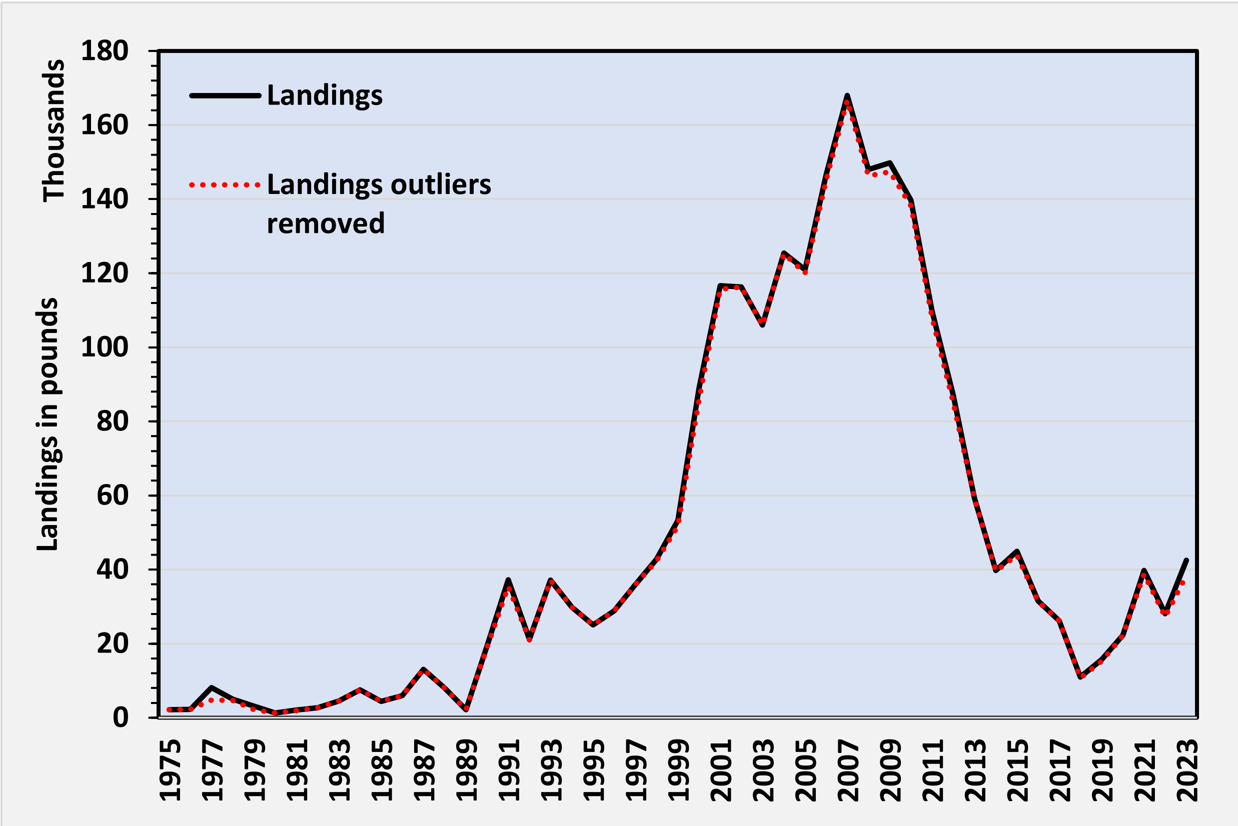

Figure 3.2.1 Commercial landings of Caribbean Spiny Lobster landings of St. Croix with and without the outliers removed.

4. Recreational Fishery Statistics

There are currently no data available on recreational landings in St. Croix.

5. Measures of Population Abundance

5.1 Overview

The panel was presented with summaries of the fishery-independent research conducted by The University of the Virgin Islands in cooperation with the Southeast Fisheries Science Center (RD-05), and by the National Park Service in Buck Island Reef National Monument and Salt River National Historical Park in St. Croix, US Virgin Islands and St. John, US Virgin Islands (RD-06). The panel discussed concerns about using data collected from the two studies for indices of relative abundance, principally due to short time series and small sample sizes, and recommended they not be considered for use in either the STX or STTJ assessment models.

6. Research Recommendations

- When developing new research projects, consider how those projects can be designed to include data collection and/or analyses that would inform ecosystem models and analyses. The original objectives of the project should not be compromised, however.

6.1 Life History Research Recommendations

- Life history studies focused on the US Caribbean – generate region-specific parameters for growth, fecundity, natural mortality.
- Look for ongoing growth/aging work via SEAMAP-C
- Merge selectivity studies, life history data collection, and fishery-independent survey frameworks to determine how to get best data for stock assessment.

6.2 Commercial Fishery Statistics Research Recommendations

6.2.1 Length Composition Research Recommendations

- Compare SEAMAP-C to TIP size composition

6.2.2 Commercial Landings Research Recommendations

- Track number of fishers per year in relation to annual landings.
- Support connectivity studies – consider spiny lobster as one stock vs. by island (metapopulation).
- Investigate weak/lack of correlation between TIP and landings data
- Demand analysis: look at price per pound (survey), market preferences, trends and correlation with landings, and for all islands.
- Investigate recruitment connectivity between island platforms, e.g., STX seeding PR, and other "hypotheses."
- Survey to determine the presence/absence of large lobsters in STX – are they available and not harvested?
- Market survey to determine whether the size of the lobster being landed is a response to the market preference/availability.
- Increase funding for port samplers to improve TIP data collection in PR and USVI.
- Propose new gear type of "diving on traps" in TIP reports (larger conversation to be had among those collecting and collating data):
    - a) Recommended this be a conversation including all jurisdictions,
    - b) Periodically review gears on forms to ensure they are accurate.

6.2.3 Discards and Discard Mortality Research Recommendations

- Discard information in the catch reports doesn't include data on length or sex in current reporting schema

6.3 Indices Research Recommendations

- The panel recommended moving forward with planned lobster trap surveys in the US Virgin Islands.

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SEDAR

Southeast Data, Assessment, and Review

SEDAR 91

US Caribbean Spiny Lobster – St. Croix

SECTION III: Assessment Process Report

August 2025

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

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1. EXECUTIVE SUMMARY

The SEDAR 91 St. Croix spiny lobster (*Panulirus argus*) stock assessment workshop consisted of four webinars between January 2025 and April 2025. The data available for the assessment included:

- An annual species-specific catch time series from commercial logbooks
- Fishery-dependent length compositions from commercial port sampling
- Life history information carried over from the SEDAR 57 and SEDAR 57 update assessments

The assessment used Stock Synthesis, a statistical catch-at-age model (Methot et al., 2020). Stock Synthesis V3.30.12 models were fit to annual catch time series and annual length composition information for two fleets: dive and trap/pot fisheries and two sexes: females and males. Model development included stepwise fitting to catch and length composition sequentially, i.e., catch and then catch and length models were built, to ensure an analytical understanding of data impacts on model results. Two sensitivity analyses were conducted: each fleet selectivity was assigned a logistic ("flat-topped") pattern, which was fixed or estimable, respectively.

Model diagnostics assessed convergence, fit, and consistency using gradients, residuals, likelihood profiles, hindcast cross-validation, and jitter analyses. Those diagnostics illustrated that despite the models' relative lack of flexibility with respect to parameter estimation, the model estimates were consistent and relatively robust.

Sensitivity analyses determined that fleet selectivity is dome-shaped for both dive and trap/pot fisheries. Initializing exponential logistic selectivity models with flat-topped selectivity patterns and allowing the model to estimate selectivity parameters resulted in the same dome-shaped selectivity patterns estimated when selectivity models were initialized as dome-shaped. This suggests that the length composition information can inform fleet selectivity parameter estimation. Island-specific and US Caribbean region-wide estimates of length-weight parameters produced similar population dynamics for St. Croix spiny lobster.

1.1 Background

US Caribbean spiny lobster (*Panulirus argus*) is a marine invertebrate that inhabits pelagic, nearshore vegetation, and coral reef habitats throughout its life history. Spiny lobsters inhabit the southeast US coast, Gulf of America, and greater Caribbean region. The St. Croix fishery targets adult spiny lobster on reef habitats.

2. INTRODUCTION

2.1 Workshop Time and Place

The SEDAR 91 Assessment Process was held via webinars from January to April 2025.

2.2 Terms of Reference

Assessment Process Terms of Reference

1. Develop and apply assessment tools that are compatible with available data and consistent with standard practices. Document input data, model assumptions and configuration, and equations for each approach considered.
2. Characterize uncertainty in the assessment and estimated values.
    a. Consider uncertainty in input data, modeling approach, and model configuration.
    b. Provide appropriate measures of model performance, reliability, and ‘goodness of fit’.
    c. Provide measures of uncertainty for estimated parameters and derived quantities such as biological reference points and stock status if feasible.
3. To the extent possible given data limitations, provide management benchmarks and status determination criteria, including:
    a. Maximum Fishing Mortality Threshold (MFMT) = F_{MSY} or proxy
    b. MSY proxy = yield at MFMT
    c. Minimum Stock Size Threshold (MSST) = SSB_{MSY} or proxy
    d. If alternative status determination criteria are recommended, provide a description of their use and a justification.
4. To the extent possible, develop projections to support estimates of maximum sustainable yield (MSY, the overfishing limit (OFL) and acceptable biological catch (ABC) as described below. If projections are not possible, and alternative management procedures are recommended, provide

a description of their use and a justification.

   a. Unless otherwise recommended, use the geometric mean of the three previous years' fishing mortality to determine $F_{Current}$
   b. Project F_{MSY} or proxy
   c. If the stock is overfished:
      i. Project F_0
      ii. Project $F_{Rebuild}$

5. Provide recommendations for future research and data collection.
6. Provide an Assessment Workshop Report to address these Terms of reference and fully document the input data and results.

2.3 List of Participants

Assessment Panel

Matt Damiano (Lead Analyst) .... NMFS/SEFSC
Kevin McCarthy .... NMFS/SEFSC
Erik Williams .... NMFS/SEFSC
Jason Cope .... NMFS/NWFSC

Appointed Observers

Nelson Crespo .... CFMC Industry Rep
Julian Magras .... CFMC Industry Rep
Gerson Martinez .... CFMC Industry Rep

Observers

Adyan Rios .... NMFS/SEFSC
Juan Agar .... NMFS/SEFSC
Mandy Karnauskas .... NMFS/SEFSC
Maria Lopez-Mercer .... NMFS/SEFSC
Stephanie Martinez .... NMFS/SEFSC
Sarah Stephenson .... NMFS/SEFSC
Katherine Godwin .... UM-CIMAS
Rachel Banton .... UM-CIMAS
Sarah Beggerly .... NMFS/SEFSC
M. Refik Orhun .... NMFS/SEFSC
Sennai Habtes .... USVI DPNR
Maggie Rios .... USVI DPNR
J.J. Cruz-Motta .... CFMC SSC, UPRM
Hannah Jacobs .... UM
Manuel Coffill-Rivera .... University of South AL
Veronica Seda Matos .... PR DNER

Aida Rosario ....PR DNER
Daniel Matos-Caraballo ....PR DNER
Wilson Santiago Soler.. PR Fisheries Liaison
Cristina Olan ....CFMC Staff

Staff
Emily Ott.. SEDAR
Julie A. Neer .... SEDAR
Graciela Garcia-Moliner ....CFMC Staff

2.4 List of Assessment Process Working Papers and Reference Documents

Document #	Title	Authors	Date Submitted
Documents Prepared for the Assessment Process			
SEDAR91-AP-01	Summary of Management Actions for Caribbean Spiny Lobster 1985-2023	Gaitlyn Malone	31 January 2025
Reference Documents			
SEDAR91-RD14	Catch curve stock-reduction analysis: an alternative solution to the catch equations	James Thorson, Jason Cope	
SEDAR91-RD15	Accounting for variable recruitment and fishing mortality in length-based stock assessments for data-limited fisheries	Merill Rudd, James Thorson	
SEDAR91-RD16	A 50-Year Reconstruction of Fisheries Catch in Puerto Rico	Richard Appeldoorn, Isle Sanders, Leonie Farber	
SEDAR91-RD17	Final stock assessment and fishery evaluation (SAFE) report for the workshop on spiny lobster resources in the U.S. Caribbean San Juan, Puerto Rico, September 11-13, 1990	James Bohnsack, Stephen Meyeres, Richard Appeldoorn, Jim Beets, Daniel Matos, To	
SEDAR91-RD18	Reflections of the way life used to be: Anthropology, History and the Decline of the Fish Stocks in Puerto Rico	Manuel Valdés-Pizzini	

2.5 Stock Structure and Management Unit

St. Croix spiny lobster is managed under the St. Thomas/St. John Fishery Management Plan (Crabtree, 2019). In 2023, the Caribbean Fisheries Management Council transitioned from regional species-based to island-specific species-based fisheries management (Figure 9.1). The management measures in the new island-based fishery management plans became effective on October 13, 2022.

The St. Croix spiny lobster stock is managed as an independent population. Catch limits for St. Croix spiny lobster are based on a tiered acceptable biological catch (ABC) control rule; it is currently managed under Tier 3: acceptable assessment available, using the models developed during SEDAR 57 (2019) and SEDAR 57 update (2022) processes. The most recent annual catch limit (ACL) is 137,254 lbs., whole weight.

A SEDAR 91 Assessment Process working paper summarizes federal management actions for spiny lobster in St. Croix (Malone, 2025). On January 1, 1985, a 3.5-inch federal size limit was instituted as part of the original fishery management plan. The size limit applies to the U.S. Exclusive Economic Zone (EEZ) surrounding St. Croix, which is defined as the federal waters ranging from 3 to 200 nautical miles (nm) (5.6 – 370 kilometers [km]) from the nearest coastline point of the U.S. Virgin Islands (Figure 9.1).

3 DATA INPUT AND MODEL CONFIGURATIONS

3.1 Modeling Framework

Stock Synthesis V3.30.12 was the modeling approach applied in the current SEDAR 91 assessment because of compatibility with the available data and consistency with standard practices.

SS3 is a statistical catch-at-age model that uses a population model, an observation model, and an estimation model that applies a likelihood function in the estimation process (Methot et al., 2020). SS3 has been applied extensively worldwide for stock assessment evaluations (Methot & Wetzel, 2013). It has also been used for previous data-limited and data-moderate SEDAR assessments, including the SEDAR 57 assessments and subsequent updates for Caribbean spiny lobster (*Panulirus argus*), and the SEDAR 80 assessments for Queen Triggerfish (*Balistes vetula*) (SEDAR, 2019, 2022).

The SS3 modeling framework is a compatible tool for SEDAR stock assessments in the U.S. Caribbean because it can accommodate a wide range of model complexities, from data-limited to highly detailed assessments (Cope, 2024). SS3 allows for the characterization of stock, fishing fleet, and survey dynamics through various parameters, which can be either fixed based on external data or estimated when sufficient assessment data are available. Finally, R packages such as r4ss and ss3diags facilitate critical evaluations of model reliability and model comparisons (Carvalho et al., 2021; Taylor et al., 2021). For example, r4ss provides visualization and diagnostic tools to summarize and interpret fit, convergence, and key output metrics; ss3diags focuses on retrospective analyses, hind-casting, and residual pattern evaluations. The integration of these tools allows rigorous uncertainty analysis, streamlined sensitivity analyses, and enhanced transparency in decision-making.

3.2 Data-Informed Modeling Decisions

The data available for use in the current assessment are documented in the SEDAR 91 US Caribbean spiny lobster St. Croix Data Workshop Report (SEDAR, 2025). Provided here is a summary of those data with a focus on the associated model configurations explored using SS3. Throughout this report, bolded text is used to highlight and summarize the model settings and configurations relevant to the various phases of model development. Additional details for each data input are available in their respective references:

1. **Landings** from self-reported commercial fisher logbooks (Orhun et al., 2024)
2. **Length compositions** from shore-based port sampling (Godwin and Rios., 2024)

Based on the available data, the assessment was configured with one area, one season, two sexes, and two commercial fleets.

3.3 Commercial Fleet Data

3.3.1Catch

Commercial fishery landings in St. Croix (STX) were obtained from self-reported fisher logbook data (Caribbean Commercial Logbook, CCL) (Orhun et al. 2024). Logbook reporting began in 1974 (partial year of reporting, not included in the landings time series), however, during the SEDAR 57 update assessment, the decision was made to omit 1975 (2022). Commercial fishery landings data for Caribbean Spiny Lobster in STX were available for the years 1976-2023 (Figures 9.2 and 9.3). Potential outliers were discussed during the Data Workshop and the decision was made to retain them as valid trips.

In the SEDAR 91 SS3 models, **the catch was input as biomass (in metric tons) and was treated as if it occurred over an entire fishing season; i.e., each fishing year. Catches are assumed to be known with a standard error of 0.01 (i.e., highly certain catch inputs) for each fleet.**

The years of the available species-specific self-reported commercial fisher logbook landings and effort data determined the start and end years of the SS3 models. **The start and end years of the model were 1976 and 2023, respectively.** Although it is considered likely that fishing for spiny lobster occurred prior to 1976, the magnitude of catches is considered negligible. Therefore, **the model assumes that the stock is in an unexploited state during the first year**.

3.3.2 Size Composition and Quantile Analyses

Gear-specific annual length frequencies for the commercial fleet came from the commercial shore-based port-sampling Trip Interview Program (Godwin and Rios, 2024). The Puerto Rico Department of Natural and Environmental Resources (PR DRNA), as part of the Trip Interview Program (TIP), collects length and weight data from fish landed by commercial fishing vessels, along with information about fishing areas and gears. Data collection began in the 1980s and are available for STX spiny lobster during 1982-2023.

Data availability and sample sizes vary over time and by fleet. Overall, there are more years of data available with higher sample sizes for the dive fishery. Data are sparse and have low sample sizes for the pot/trap fishery following 2000, and sample sizes are generally low for the dive fishery following 2018 (Figure 9.3). **The relative model weighting, i.e., sample size, of each commercial fleet's length compositions was based on the number of trips sampled**.

From 1982 - 2023, the TIP data contain 21,122 length observations across 1,642 unique port sampling interviews. **The Trip Interview Program length compositions of the commercial fleets were assumed to be representative of the total catch.** Although non-commercial fishing is reported to occur, it is assumed to be constant over time.

An analysis of the length composition quantiles was conducted for each fleet by sex to determine the relative estimability of fishing mortality and recruitment deviations (Figures 9.4:9.7). Weighted 10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} quantiles for female and male lobster were measured per year for each fishery (Akinshin 2023). Weighted quantiles in the dive fishery over time are distributed consistently around the average size of spiny lobster with little or no trend (Figures 9.4, 9.5); this suggests that recruitment deviations are not likely to be estimable, and that fishing has not generated changes in the size distribution over time. Weighted 10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} quantiles for female (Figure 9.6) and male (Figure 9.7) lobster in the pot/trap fishery over time show similar results until the year 2000, after which data scarcity make inference about information content impossible.

An exponential logistic function (Equation 1, Methot et al. 2020) was used to model the relative vulnerability of capture by length for the dive fleet (Figure 9.8)**:**

$$\text{Selectivity } = \frac{e^{2nd\ limb*1st\ limb(asymptote-length)}}{1-2nd\ limb(1-e^{1st\ limb*(asymptote-length)})} \ (1).$$

The three-parameter exponential logistic function can be used to model both dome and logistic and flat-topped selectivity patterns. The dive fleet is the dominant fishery for STX spiny lobster, and the lack of length composition data since 2000 makes estimation of selectivity for the pot/trap fishery infeasible. Therefore, the pot/trap fleet exponential logistic parameters were assumed to mirror those of the dive fleet, as in SEDAR 57 (2019). Additionally, a fixed time-varying knife-edged retention function was included to model the minimum-size limit and retention of male spiny lobsters in the dive fishery; this model assumes that discarding of under-sized lobster occurs following the implementation of the size limit (2000), but that no mortality from discarding occurs (Figure 9.9). The assumption from SEDAR 57 that the STX pot/trap fishery selectivity mirrors that of the dive fishery is maintained in SEDAR 91.

The initial exponential logistic function parameters estimated for the dive fleet assume a dome-shaped selectivity pattern. The exponential logistic function requires three parameters: a 1st limb, an asymptote (peak), and a 2nd limb. Due to the lack of resolution (contrast) in the length composition quantiles, the Assessment Panel requested a model in which the exponential logistic is initialized with a logistic/flat-topped selectivity and then allowed to estimate all three selectivity parameters. An additional sensitivity was explored in which the exponential logistic function parameters were fixed to a logistic selectivity pattern.

3.4 Life History Data

The life history data used in the assessment included an island-specific length-weight conversion estimated from 20,046 length-weight observations in the TIP data. No other empirical life history information was used in the model. See the STX Data Workshop Report for additional detail. Based on the available information, **the spiny lobster population was modeled from age 0 through age 15, which was treated as a plus group, and from 5 to 250-millimeters (mm) carapace length**. **Note that only lobsters 51 mm or larger were observed in the TIP data.**

3.4.1 Growth

The SS3 growth formulation requires five parameters:

1. Length at the youngest age
2. Length at the maximum age
3. Von Bertalanffy growth parameter (K)
4. Coefficient of variation at the youngest age
5. Coefficient of variation at the maximum age

Based on feedback from the Data Workshop, growth model parameters were carried over from SEDAR 57 with no recommended changes. Von Bertalanffy growth function parameters were sex-specific and assumed fixed. Length at the youngest age was fixed at 5 mm for both males and females, and the length at the maximum age was fixed at 155 and 184 mm, respectively. K was fixed at 0.22 and 0.24 for males and females, respectively. The coefficient of variation at the youngest age was set to 0.1, and oldest age at 0.043 for both males and females. Note that the length at maximum age for each sex is treated as an average by the model; larger lobsters have been observed in the data and can be estimated by the model.
No alternative growth models were explored for STX spiny lobster.

3.4.2 Length-Weight Conversion

The relationship between weight in kilograms and carapace length in millimeters was estimated using a linear regression on the log-transformed exponential equation fit to the TIP data.

The length-weight relationship for males was $W = 1.271 \times 10^{-5} * L^{2.413}$ and was $W = 2.29 \times 10^{-5}$ millimeters * $L^{2.323}$ for females with weight (W) in kilograms and length (L) in millimeters. Note that SS3 assumes that inputs are in centimeters. However, when length data and life history relationships are input and parameterized using millimeters, SS3 will produce consistent results. This was the approach in both SEDAR 57 and the update (SEDAR 2019, 2022). Also note that length-related SS3 outputs will automatically generate figures with centimeter units, but for the purposes of this assessment, should be interpreted in millimeters.

One sensitivity model was explored for the length-weight relationship. Length-weight parameters for the entire US Caribbean region were estimated using the log-scale linear regression method described in the STX Data Workshop Report (SEDAR 2025), but applied to data from St. Thomas/St. John during 1980-2024, Puerto Rico during 1985-2024, and STX during 1980-2024. The sensitivity analysis applied these regional length-weight parameter estimates to determine if there are population-level differences when island-specific vs. regional estimates of length-weight parameters are applied. **The regional length-weight relationship for males was $W = 1.1 \times 10^{-5} * L^{2.44}$, and was $W = 9.4 \times 10^{-6}$ millimeters. * $L^{2.475}$ for females with weight (W) in kilograms and length (L) in millimeters.**

3.4.3 Maturity and Fecundity

Maturity was modeled as a logistic function and parameters were treated as fixed inputs to the model. Parameter estimates for maturity were estimated using TIP data prior to 1990 when landing egg bearing females was allowed (Die 2005). **The fecundity of spiny lobster is modeled as a power function** with parameter estimates from Cuba spiny lobster (FAO 2001):

$$E = 0.5911L^{4.5677}$$

where E is number of eggs and L is carapace length in mm. **Fecundity parameters were treated as fixed inputs to the model.**

3.4.4 Stock Recruitment

A Beverton-Holt stock-recruit function was used to parametrize the relationship between spawning output and resulting recruitment of age-0 lobster. The stock-recruit function requires three parameters:

- Steepness (h) characterizes the initial slope of the ascending limb (i.e., the fraction of recruits produced at 20% of the unfished spawning biomass).
- The virgin recruitment (R_0; estimated in log space) represents the asymptote or unfished recruitment levels.
- The variance term (sigma R) is the standard deviation of the log of recruitment and describes the amount of year-to-year variation in recruitment.

Only the virgin recruitment (R_0) was estimated. **Sigma R and steepness were fixed at 0.7 and 0.99, respectively.** The 0.7 sigma R reflects slightly high variation in recruitment. A sigma R value of 0.6 is a moderate level of recruitment variability, with lower values indicating lower variability and more predictable year-to-year recruitment. The primary assumption for steepness was that this stock is not a closed population, so recruitment may not be strongly tied to the local spawning stock biomass. **Due to the lack of contrast in length composition data, annual deviations from the stock-recruit function were not estimated.** A sensitivity run indicated that recruitment deviations cannot be estimated well and resulted in nearly identical estimates of the four model parameters**.** Steepness and R_0 were explored via likelihood profiling.

3.4.5 Maximum Age and Natural Mortality

Natural mortality was treated as a fixed model input set to 0.34: the same value used in SEDAR 57 (2019). This value is based on a point estimate calculated from a variant of Pauly's equation (Cruz et al. 1981). Past considerations of natural mortality are discussed in the Data Workshop Report Section 2.4.

Empirical estimates of natural mortality (M) can be derived using life history information such as longevity, growth, and maturity. The Assessment Panel recommended that the Natural Mortality Tool (Cope & Hamel, 2022) be used to determine if 0.34 is still a reasonable value for natural mortality. Parameters for maximum age, the von Bertalanffy growth parameter (K), and asymptotic size (L_∞), for females and males that are used in the current assessment were treated as inputs to the Natural Mortality Tool to obtain values of M from various empirical estimators. Maximum age was assumed to be 16 to approximate the age 15 plus group, and a lognormal coefficient of variation of 0.2 was included for uncertainty. The empirical estimators can be broken into two groupings: those based on maximum age ("Then_nls," "Then_lm," "Hamel_Amax") and those based on the von Bertalanffy growth function ("Then_VGBF," "Hamel_k," "Jensen_k1," "Jensen_K2"; see Cope and Hamel, 2022 for additional details on estimators). The average estimated natural mortality across estimators was very close to 0.34 for both sexes (Figures 9.10, 9.11), and therefore no changes to the fixed parameter input were considered.

3.5 Summary of Data-Informed Modeling Configurations

Based on the available data, the assessment was configured with one area, one season, two sexes, and two commercial fleets. SS3 models were configured using annual commercial catch time series and size compositions by fleet.

3.5.1 Commercial Fleet

- The catch was input as biomass (in metric tons) and was treated as if it occurred over the entire calendar year.

- The start and end years of the model were 1976 and 2023, respectively.
- The input standard error for the landings was set to 0.01
- The relative model weighting of the commercial fleet length compositions was based on the number of trips sampled.
- Due to low sample sizes, the fishery-dependent commercial fleet length composition data were combined across all years.
- The length compositions of the commercial fleets were assumed to be representative of the total catch.
- An exponential logistic function was used to model the relative vulnerability of capture by length for the dive fleet.
- Pot/trap fleet selectivity was assumed to mirror that of the dive fleet.
- A sensitivity run was conducted in which the exponential logistic function parameters were initialized with a logistic selectivity pattern and only the ascending limb was estimated, i.e., the logistic pattern is fixed.
- A sensitivity run was conducted in which the exponential logistic function was initialized with a logistic selectivity pattern and allowed to estimate all three selectivity parameters.
- The assessment assumed a time-varying retention function for the dive fishery, but assumed no mortality from discards.

3.5.2 Life History

- The spiny lobster population was modeled from age 0 through age 15, which was treated as a plus group, and from 5 to 250-milimeters carapace length, in 5-milimeter bins.
- Growth parameters for females and males were treated as fixed model inputs and carried over from SEDAR 57.
- Coefficients of variation for younger and older ages were initially set to 0.1 and 0.043 for both sexes.
- The length-weight relationship for male lobster was W = 1.271 x 10^-5 L^2.413, and W = 2.29 x 10^-5 L^ 2.323 for female lobster, with weight in kilograms and length in millimeters.
- A natural mortality value of 0.34 was used in the initial model runs.
- Maturity was modeled as a logistic function and fecundity was modeled as a power function with parameters treated as fixed model inputs.
- A Beverton-Holt stock-recruit function was used to parametrize the relationship

between spawning output and resulting recruitment of age-0 lobster.

- Sigma R and steepness were fixed at 0.7 and 0.99, respectively.
- In model configurations, annual deviations from the stock-recruit function were not estimated.
- A sensitivity run was conducted in which regional length-weight parameter estimates were applied instead of the STX island-specific parameters.

4 STOCK ASSESMENT MODEL RESULTS

SS3 models were configured using annual commercial catch time series and size compositions by fleet.

4.1 Overview

The SEDAR 91 model is essentially a data-only update from the SEDAR 57 update assessment, however, important life history parameters such as natural mortality and the length-weight relationship were re-evaluated and determined to be appropriate. Excluding the SEAMAP-C dive survey data, there were no additional data introduced during SEDAR 91 beyond updated landings and length composition time series. The assessment workshop panel did not recommend any deviation from other SEDAR 57 life history assumptions, or any further sensitivity analyses related to life history. The stock assessment analyst investigated alternative stock assessment modeling frameworks designed specifically for marine invertebrates, however, the lack of an index of relative abundance for spiny lobster precluded the application of alternative frameworks to SS3. Therefore, the SS3 models remain the best benchmark stock assessment approach for US Caribbean spiny lobster.

This report summarizes and discusses the results of four stock assessment models: the *base* model described in Section 3, the two sensitivities that explore logistic selectivity patterns, and one sensitivity to explore an alternate parameterization of the length-weight relationships by sex (Table 8.1). The *selex1* model refers to the sensitivity in which the exponential logistic function is initialized with a logistics selectivity pattern and the asymptote and 2nd limb parameters are fixed for the dive fleet, and *selex2* refers to the model in which the logistic selectivity pattern is initialized but all three parameters are estimated within the model. Finally, the *lw* model refers to the sensitivity analysis in which the length-weight relationship parameters were set to region-level estimates for female and male lobster, respectively.

4.2 Model Diagnostics

Model diagnostics aimed to follow the conceptual process described by Carvalho et al. (2021). Their approach includes evaluating goodness of fit, information sources and structure, prediction skill, convergence, and model plausibility. Although Carvalho et al. (2021) advise detours and additional model explorations when initial diagnostic tests fail, advanced diagnostics, such as likelihood profiles, retrospective, and jitter analyses, were conducted even when initial tests failed to comprehensively communicate the various model configurations explored.

4.3 Convergence

Three approaches were used to check for model convergence. They were investigating for the presence of (1) bounded parameters, (2) high final gradients, and (3) a positive definite hessian. As described by Carvalho et al. (2021) checking for bounded parameters can indicate discrepancies with data or model structure. Additionally, small final gradients and a positive definite hessian can indicate that the objective function achieved good convergence.

The models presented in this report all had a positive definite Hessian, indicating that each reached a local minimum and a locally optimal fit. None of the models had parameters that were bounded, suggesting the optimization was not constrained by parameter limits. Finally, the parameter gradients in all models were small and well below 0.001 (Table 8.3).

4.4 Correlation Analysis

High correlation among parameters can lead to flat response surfaces and poor model stability. By performing a correlation analysis, modeling assumptions that lead to inadequate configurations can be identified. Because of the highly parameterized nature of stock assessment models, some parameters are expected to be correlated (e.g., stock recruit parameters). However, many strongly correlated parameters suggest reconsidering modeling assumptions and parameterization. Correlations between all selectivity parameters were moderately high in the *base* model (~0.9, -0.9) (Table 8.2). These high correlations were expected.

4.5 Evaluating Variance

To check for parameters with high variance, parameter estimates are reported with their resulting standard deviations. Table 8.3 presents the model-estimated values and standard deviations for the main active parameters. Selectivity parameters for the *base* model were estimated with precision, although the probability density of the 1st limb of the exponential logistic function demonstrates some uncertainty (Figure 9.12). Log-scale R_0 was not estimated with precision, and is relatively uncertain (Table 8.3, Figure 9.12). The estimated log-scale R_0 from the *selex2* sensitivity model was substantially lower than the *base* model and associated with an unrealistically small standard deviation (Table 8.3). The uncertainty in log-scale R_0 is explored with likelihood profiling, and lower log-scale R_0 value from *selex2* is explored in the jitter analysis.

4.6 Jitter Analysis

Jitter analysis is a relatively simple method that can be used to assess model stability and to determine whether the search algorithm has found a global, as opposed to local, solution. The premise is that all starting values are randomly altered (or 'jittered') by an input constant value, and the model is rerun from the new starting values. If the resulting population trajectories across many runs converge to the same solution, this provides support that a global minimum has been obtained. This process is not fault-proof; no guarantee can ever be made that the 'true' solution has been found or that the model does not contain misspecification. However, if the jitter analysis results are consistent, it provides additional support that the model is performing well and has come to a stable solution. Furthermore, jitter analyses, when jittered at appropriately high values, can provide insight into whether a more optimal solution space exists, i.e., a lower total negative log-likelihood. For this assessment, a jitter value of 0.5 was applied to the starting values, and 40 runs were completed. The jitter value defines a uniform distribution in cumulative normal space to generate new initial parameter values (Methot et al., 2020).

Consistent with earlier results indicating that the models reached local minima (positive definite Hessian), the jitter analysis also performed well, with most models converging on the same solution; a small number of jitters produced higher likelihoods (Figure 9.14). Importantly, no jitter runs produced a lower likelihood than the best fit already identified for each model. The lower values of log-scale R_0 estimated in the *selex2* selectivity, for example, was associated with a higher likelihood than the *base* model.

4.7 Residual Analysis

The primary approach to investigate model performance was a residual analysis of model fit to each data set. Any temporal trend in model residuals or disproportionately high residual values can indicate model misspecification and poor performance. Ideally, residuals are randomly distributed, conform to the assumed error structure for that data source, and are not of extreme magnitude. Any extremely positive or negative residual patterns indicate poor model performance and potential unaccounted-for process or observation error.

4.7.1 Catch

SS3 uses a hybrid implementation of Pope’s approximation to internally tune the model such that fishing mortality need not be an estimated parameter, but an internally-tuned coefficient to produce values of fishing mortality associated with a perfect fit to catch data (Figure 9.13c) (Richard Methot, NOAA Fisheries Directorate, personal communication). Therefore, observed and predicted catches match more or less exactly.

4.7.2 Length compositions

Figure 9.15 shows the cumulative fit across all years between the observed and predicted length composition for the *base* model by sex, and Figures 9.16 and 9.17 show the individual fits to length composition by year for the dive and pot/trap fleets, respectively. Note that SS3 assumes that length composition data are in centimeters (cm) and generates plots to this effect; all measurements are in mm. Cumulative fits were reasonable with some overestimation of 100 mm females (Figure 9.15); this pattern was likely driven by poor model fits to data during years with low sample sizes (Figure 9.16, 9.17). Years in which sample sizes were sufficiently large resulted in close fits to the length composition data (Figure 9.16, 9.17).

4.8 Retrospective Analysis

A retrospective analysis is a helpful approach for investigating the consistency of terminal year model estimates (e.g., SSB) and is often considered a sensitivity exploration of impacts on key parameters from changes in data. The analysis sequentially removes a year of data and reruns the model. For example, suppose the resulting estimates of derived quantities such as SSB or recruitment differ significantly. In such a case, serial over- or underestimation of important quantities can indicate that the model has an unidentified process error and could require reassessing model assumptions. It is expected that removing data will lead to slight differences between the new terminal year estimates and the estimates for that year in the model with the complete time series of data. Estimates in years before the terminal year may have increasingly reliable information on cohort strength. Therefore, slight differences are usually expected between model runs as more years of size composition data are sequentially removed. Ideally, the difference in estimates will be slight and randomly distributed above and below the estimates from the model with complete data set time series. The results of a five-year retrospective analysis for SSB are plotted in Figure 9.18, which shows no evidence of a retrospective pattern.

4.9 Hindcast Cross-validation

Hindcast cross-validation uses SS3's forecast file to calculate the expected values of the observed data based on forward projections (Carvalho et al. 2021), which can be used to test the model's ability to predict mean values, e.g., length composition, by projecting a number of years backward from the terminal year. Model prediction ability is diagnosed with mean absolute square error (MASE) scores. Scores less than 1.0 indicate some predictive ability while values of 1.0 or greater indicate that the model performs equivalently with a random walk model, i.e., does not have predictive ability.

Hindcast cross-validation was applied to the length composition data for each commercial fleet in the *base* model. MASE scores indicate that the model can predict mean length composition for the dive fleet, but not for the pot/trap fleet due to sporadic data availability, especially toward the end of the time series (Figure 9.19).

4.10 Likelihood Profiles

Profile likelihoods are used to assess the stability of parameter estimates by examining changes in the negative log-likelihood for each data source and evaluating the influence of each source on the estimate. The analysis is performed by holding a given parameter at a constant value and rerunning the model. The model is run repeatedly over a range of reasonable parameter values. Ideally, the graph of change in likelihood values against parameter values will yield a well-defined minimum. When the profile plot shows conflicting signals or is flat across its range, the given parameter may be poorly estimated. Typically, profiling is carried out for key parameters, particularly those defining the stock-recruit relationship (steepness, virgin recruitment, and sigma R). However, due to the small number of parameters estimated in the model, and extensive sensitivity analyses conducted during SEDAR 57

(2019), profiles were exclusively explored for unfished recruitment (R_0) and steepness.

4.10.1 Unfished Recruitment (R_0)

Figure 9.20 shows the profile likelihood for the natural log of the unfished recruitment parameter of the Beverton – Holt stock-recruit function for STX spiny lobster (*base* model only). The *base* model log-scale R_0 profile indicates a relatively flat likelihood for log-scale values of approximately 5.3 or larger; this suggests that values lower than 5.3 are not probable, but any value greater than 5.3 is equally probable according to the model.

4.10.2 Steepness

Figure 9.21 shows the profile likelihood for the natural log of the unfished recruitment parameter of the Beverton – Holt stock-recruit function for STX spiny lobster (*base* model only). The *base* model steepness profile indicates that 0.99 is the global minimum parameter value, though this is also a common result when there is little information in the data streams on steepness, thus the ultimate need to pre-specify this parameter

4.11 Sensitivity Runs

Two sensitivity analyses were conducted to determine the estimability of selectivity for the dive fishery. *Selex1* explored initializing the dive fleet's exponential logistic function with parameters that generate a logistic selectivity pattern, and treats the asymptote and 2nd limb parameters as fixed inputs. *Selex2* explored initializing the dive fleet's exponential logistic function with parameters that generate a logistic selectivity pattern, but allows the model to estimate all three parameters. Estimated selectivity patterns each of the SEDAR 91 models (*base, selex1, selex2, lw*) are provided in Figure 9.8. Despite the relative lack of resolution in the median quantiles of the length composition data, the exponential logistic function in *selex1* estimates nearly identical parameters as the base model, resulting in the same dome-shaped selectivity pattern (Figure 9.8). *Selex2* resulted in identical population dynamics to those of the base model (Table 8.3, 8.4, 8.5; Figure 9.22). The fixed logistic selectivity parameters of *selex1* resulted in a lower R_0 (Table 8.3), likely due to retention of any large lobster that would be discarded alive under the baseline dome-shaped selectivity patterns for each fleet.

One sensitivity was conducted in which the length-weight parameters were fixed at the US Caribbean region-wide estimates for males and females. The *lw* sensitivity resulted in nearly identical population dynamics to those of the base and *selex2* models (Tables 8.3, 8.4, 8.5, Figure 9.22). *Lw* sensitivity selectivity parameters were identical, but R_0 was slightly higher than that of the base (Table 8.3). The estimated MSY proxy yield was very slightly less than the *base* model (Table 8.4), but did not result in a different stock status (Table 8.5).

5. DISCUSSION

This assessment presents three model configurations, using an integrated framework and several model diagnostics in order to characterize the stock status of STX spiny lobster. The results broadly indicate that overfishing is not occurring and the stock is not overfished (Figure 9.13a, Table 8.5). The base model assumes the values of many important parameters (i.e., only the four that are being estimated) because this is a data-restricted length-based application of an integrated statistical-catch-at-age model, thus is restricted in estimating uncertainty. Sources of uncertainty include the relative lack of contrast in the length composition demonstrated by the median quantile analyses; the lack of lobsters smaller than 51 mm in the length composition data to anchor the model predictions for lobsters between 5-46 mm; the lack of an index of relative abundance; fixed parameters for most model functions; and a high degree of uncertainty in the model's most influential parameter estimate: R_0. However, despite the limitations of the available data and rigidity of the model, model diagnostics suggest that the results are generally robust to alternative model specifications. In other words, the model is not allowed to change much, but when it does, the answer (i.e., solution) does not change. Due to the assumption that the model begins when the fishery began, estimates of unfished biomass and initial biomass do not differ (Table 8.6).

The SEDAR 91 model for STX spiny lobster is essentially a data-only update of a data-only update (SEDAR 57 update assessment); the model has already been subjected to host of analyses designed to test the sensitivity of the model to uncertainty in the landings data, and the influence of critical life history function parameters such as growth and natural mortality during SEDAR 57 (2019). Sensitivities from SEDAR 57 not explicitly analyzed during SEDAR 91 nonetheless hold for SEDAR 91 because the underlying SS3 model framework is identical.

This assessment is, however, an advancement in terms of determining the extent to which the TIP data are informative to model: for example, the selex2 model results suggest that there is enough information content for dome-shaped selectivity to be estimated. Furthermore, estimability of selectivity, and the likelihood profiles for R_0 (Figure 9.20) and steepness (9.21) illustrate the importance of the length composition data to estimating model parameters. The median quantile analyses suggest that fishing has not had an effect on the size structure of the STX spiny lobster population over time. What remains uncertain however, is the scale of biomass (Figure 9.13b).

The models assume a Beverton-Holt stock-recruitment relationship with a steepness values of 0.99 – this effectively decouples spawning stock biomass and recruitment and defaults to a "null" stock-recruitment relationship (Brooks, 2024), but it also allows for very high productivity at very small population sizes. Assuming this null relationship, coupled with the inability to estimate annual recruitment deviations (Figure 9.13d) from the TIP data, log-scale R_0 becomes the most influential model parameter with respect to magnitude of the stock (scale) and stock status in the terminal year; alternative steepness values do not alter the value of R_0 greatly, nor stock status (sensitivity not summarized here). Even if R_0 were truly around 5.3 on the log scale per selex1 and selex2 sensitivities, the population would not be overfished and overfishing would still not be occurring in the terminal year of the assessment (Table 5, Figure 9.22). The likelihood profile of log-scale R_0 suggests that there are a broad range of equally probable values that could produce the same estimated population dynamics, but only above approximately 5.3 on the log scale (Figure 9.20). The total likelihood associated with selex1 was larger and therefore a less probable solution than the base model, selex2, or lw model. The lw model however, resulted in a nearly identical total likelihood. Given that the lw model also resulted in identical stock status (Table 8.5 Figure 9.22), and similar selectivity parameter estimates, it is possible that using region-level estimates length-weight parameters results in an equally probable solution.

There are several avenues for future US Caribbean spiny lobster research worth considering. Continued collection of length composition data from the SEAMAP-C dive survey, or sampling efforts focused on collecting information on juvenile or sub-adult lobster, will be important to provide the model information on smaller lobsters that are either not vulnerable to the gear of the fishery, or caught and discarded for being undersized. Further investigation into age structure of Caribbean spiny lobster via gastric ossicle mills, such studies conducted by Hutchinson et al. (2024) and Medina Martinez (2024), provide a specific age-length key for spiny lobster should length-based statistical catch-at-age models continue to be the primary tool for assessing stock status. Given the generally discrete growth process of marine invertebrate, i.e., molting, should future analysts wish to consider a size-based assessment, there are generalized and lobster-specific frameworks available. For example, the Alaska Fisheries Science Center developed A Generalized Size-Based Assessment Modeling Approach for Alaskan Crab Stocks (GMACS) that may be worth applying to spiny lobster should an index of relative abundance become available in the future. Multiple stock assessment methods for Northeast American lobster (*Homarus americanus*) are also currently in development, but require an index of relative abundance (Burton Shank, NEFSC, personal communication), and would similarly benefit from more information on smaller lobsters.

Other sources of uncertainty suggest that US Caribbean spiny lobster may also benefit from a management strategy evaluation (MSE) approach. MSE is warranted when uncertainty threatens the efficacy of the current management approach (Walter et al. 2023). The magnitude of non-commercial harvest in STX waters remains highly uncertain, and that harvest remaining stable over time is a fundamental assumption of the SEDAR 91 model. MSE would offer an appropriate means of testing this assumption, and a simulated non-commercial fleet and associated selectivity in the operating models could be informed by expert opinion. Additionally, should local ecological knowledge-based data streams such as an index of relative perceived abundance (Shaff et al. 2023) become available, MSE is an appropriate framework for testing their utility in future stock assessment. Furthermore, environmental drivers of lobster population dynamics and the effects of market dynamics on the fisheries were primary concerns identified during participatory modeling in the US Virgin Islands (Agar et al. 2024). The effects of environmental nonstationarity on the performance of management procedures can be tested using MSE, as can the effects of market dynamics on fishing (Damiano et al., in prep).

6. RESEARCH RECOMMENDATIONS

- Continue the SEAMAP-C data collection program for collecting spiny lobster size composition data.
- Consider the use of management strategy evaluation to explore the uncertainty in non-commercial catches.

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8. TABLES

Table 8.1: Summary of models for SEDAR 91.

Stage	Code	Model description
Initial/Base case	*base*	Model fit to catch and length composition data updated through 2023; all model parameters remain unchanged from SEDAR 57
Sensitivity	*selex1*	Model exponential logistic function for dive fishery is initialized with logistic selectivity pattern; only first limb parameter allowed to estimate
Sensitivity	*selex2*	Model exponential logistic function for dive fishery is initialized with logistic selectivity pattern; all three parameters are allowed to estimate
Sensitivity	*lw*	Same as the *base* model but uses the length-weight parameters estimated for the entire US Caribbean region

Table 8.2: St. Croix spiny lobster correlations between estimated parameters for the *base* model scenario. The table shows correlations greater than 0.9 or less than -0.9. Correlations that are greater than 0.95 or less than -0.95 are shown in red.

Scenario	Estimated Parameters		Correlation Coefficient
base	Dive selectivity 2nd limb	Dive selectivity 1st limb	-0.936
base	Dive selectivity asymptote	Dive selectivity 1st limb	-0.906
base	Dive selectivity 2nd limb	Dive selectivity asymptote	0.875
base	Dive selectivity asymptote	Unfished Recruitment (R_0)	-0.243
base	Dive selectivity 1st limb	Unfished Recruitment (R_0)	0.157
base	Dive selectivity 2nd limb	Unfished Recruitment (R_0)	-0.016

Table 8.3: St. Croix spiny lobster parameters, standard deviations (SD), and coefficient of variation (CV) by model scenario (*base, selex1, selex2, lw*). CV is calculated as the SD divided by the parameter estimate.

Parameter	Scenario	Estimate	SD	CV	Gradient
Dive selectivity 1st limb	*base*	0.45	0.07	0.15	-1.5-05
	selex1	0.04	0.001	0.02	1.9e-07
	selex2	0.45	0.07	0.15	-2.3e-07
	lw	0.45	0.07	0.15	-5.4e-07
Dive selectivity asymptote	*base*	0.37	0.003	0.01	-9.1e-05
	selex1	NA	NA	NA	NA
	selex2	0.37	0.003	0.01	-4.5e-06
	lw	0.36	0.01	0.003	-6.5e-06
Dive selectivity 2nd limb	*base*	0.11	0.02	0.19	-6.4e-06
	selex1	NA	NA	NA	NA
	selex2	0.11	0.02	0.19	-6.0e-07
	lw	0.11	0.02	0.19	-6.5e-06
Unfished Recruitment (R_0)	*base*	5.95	0.24	0.04	-3.1e-06
	selex1	5.30	0.02	0.003	3.9e-08
	selex2	5.95	0.24	0.04	1.5e-07
	lw	6.01	0.24	0.04	-3.7e-07

Table 8.4: St. Croix spiny lobster derived quantities of the MSY proxy (based on SPR 30%) in metric tons for the *base* model and *selex1* and *selex2*, and *lw* selectivities. CV is calculated as the SD divided by the parameter estimate.

Scenario	**MSY Proxy**	**SD**	**CV**
base	75.23	17.62	0.23
selex1	46.27	0.82	0.02
selex2	75.23	17.62	0.23
lw	74.83	17.44	0.23

Table 8.5: St. Croix spiny lobster fishing mortality rate and spawning stock biomass ratios relative to the rate and biomass of the stock associated with the MSY proxy (based on SPR 30%) for the *base* model, and *selex1* and *selex2* sensitivities. The relative fishing mortality ratio is expressed as a three-year geometric mean of the annual fishing mortality rates for 2021-2023 divided by the fishing mortality rate associated with MSY SPR 30%. The relative stock biomass ratio is expressed as the 2023 spawning biomass divided by the spawning stock biomass at MSY SPR 30%.

Metric	**Scenario**	**Value**
F Current / F SPR 30%	*base*	0.12
	selex1	0.20
	selex2	0.12
	lw	0.12
SSB 2023 / SSB SPR 30%	*base*	2.83
	selex1	2.56
	selex2	2.83
	lw	2.82

Table 8.6: St. Croix spiny lobster derived quantities for unfished and initial spawning stock biomass in metric tons (mt) along with standard deviations (SD) and coefficient of variation (CV) for the *base* model. CV is calculated as the SD divided by the parameter estimate.

Derived Quantity	**Scenario**	**Estimate**	**SD**	**CV**
SSB Unfished (mt)	*base*	1.36x10^8	3.24x10^7	4.2
SSB Initial (mt)	*base*	1.36x10^8	3.24x10^7	4.2
Ratio SSB Initial: Unfished	*base*	1.0		

9. FIGURES

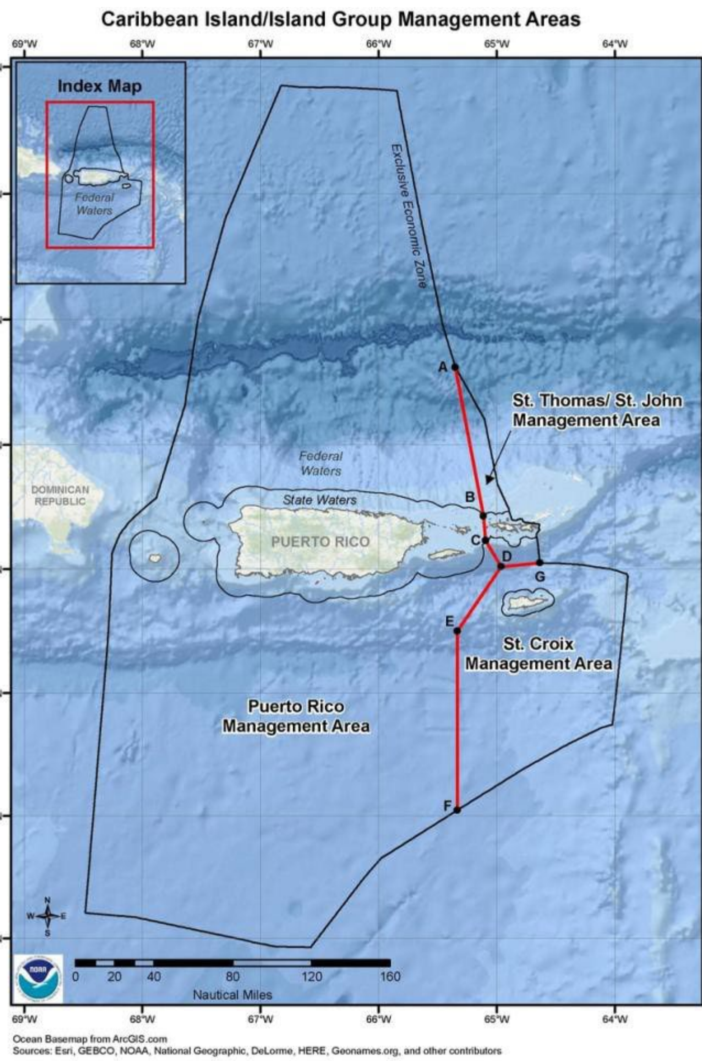


Figure 9.1: Jurisdictional boundaries of the Caribbean Fishery Management Council.

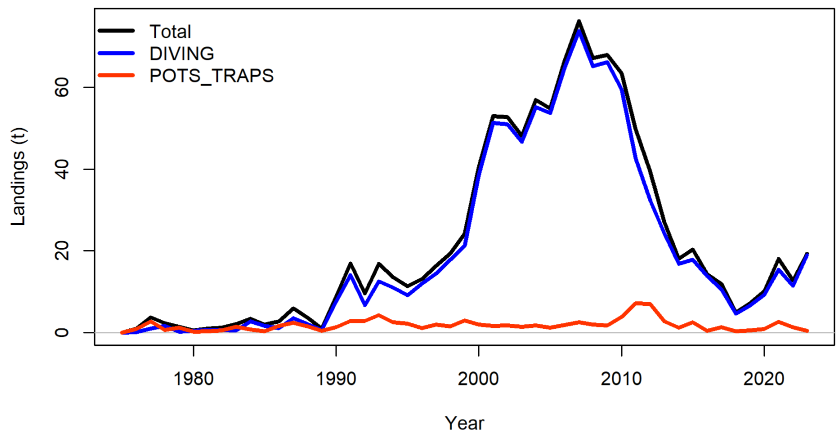


Figure 9.2: St. Croix spiny lobster landings (mt) during 1976-2023 by fleet: dive (blue), pot/trap (red), total (black).

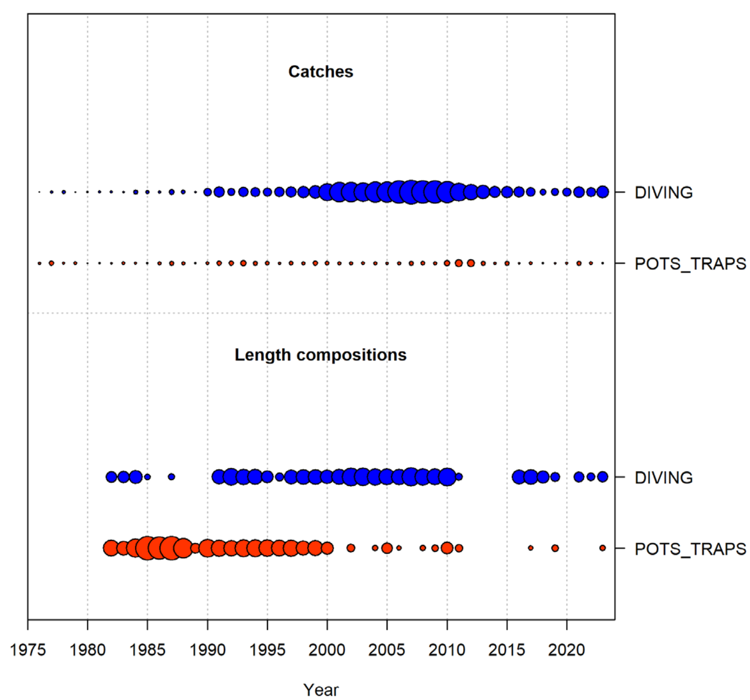


Figure 9.3: St. Croix spiny lobster catch (top) and length composition (bottom) data by fleet: dive (blue), pot/trap (red); circle size is indicative of the magnitude of catches (top) and sample sizes (bottom), respectively.

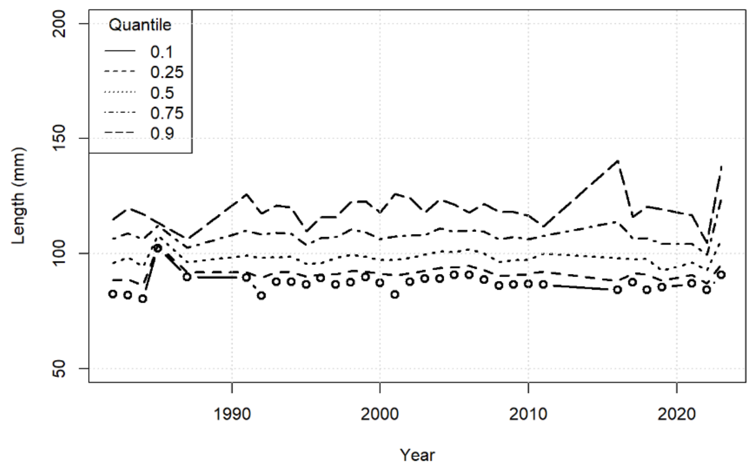


Figure 9.4: Weighted 10th, 25th, 50th, 75th, and 90th quantiles of length composition data (mm) for female St. Croix spiny lobster in the dive fishery during 1982-2023.

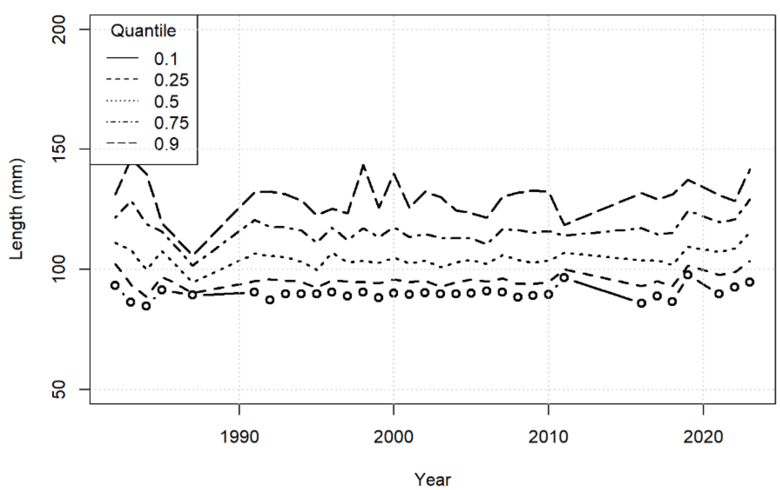


Figure 9.5: Weighted 10th, 25th, 50th, 75th, and 90th quantiles of length composition data (mm) for male St. Croix spiny lobster in the dive fishery during 1982-2023.

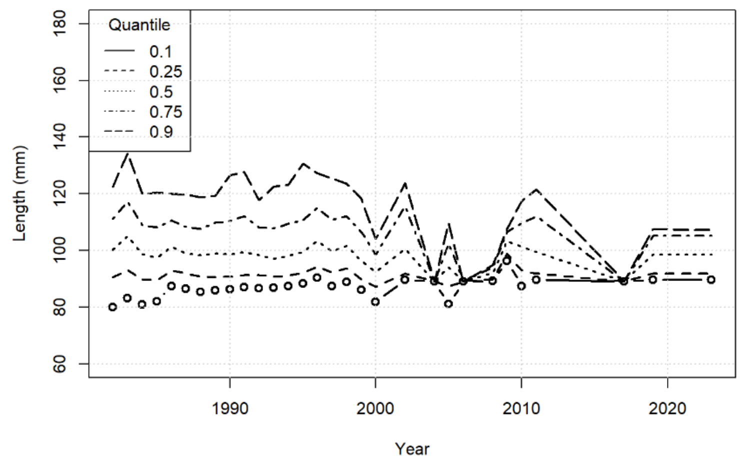


Figure 9.6: Weighted 10th, 25th, 50th, 75th, and 90th quantiles of length composition data (mm) for female St. Croix spiny lobster in the pot/trap fishery during 1982-2023.

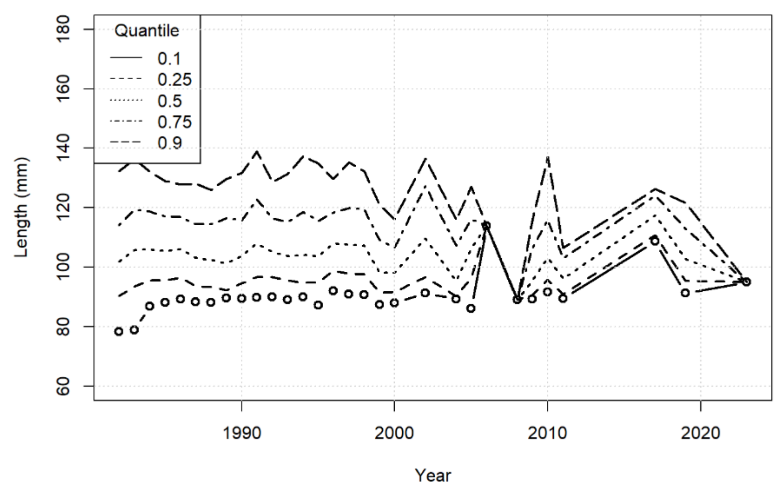
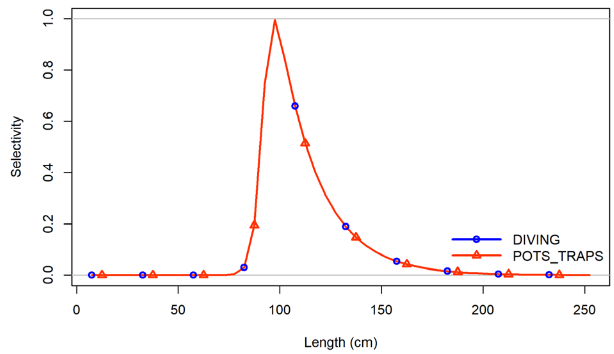
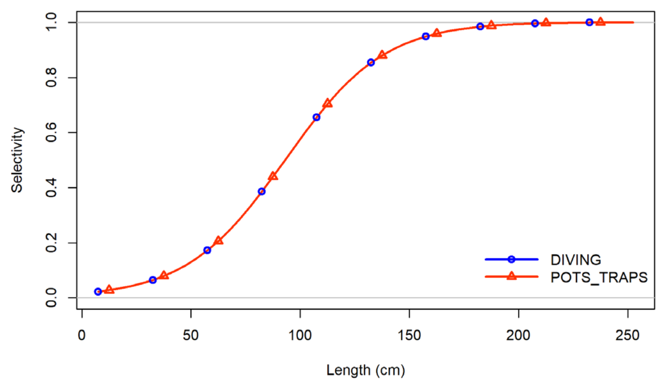


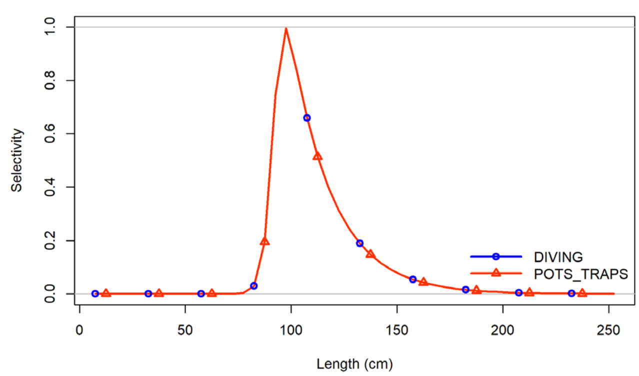
Figure 9.7: Weighted 10th, 25th, 50th, 75th, and 90th quantiles of length composition data (mm) for male St. Croix spiny lobster in the pot/trap fishery during 1982-2023.



(*base*)



(selex1)



(selex2)

Figure 9.8: St. Croix spiny lobster fleet selectivity by model scenario: *base* (top), *selex1* (middle), *selex2* (bottom), and by fleet: dive (blue), pot/trap (red).

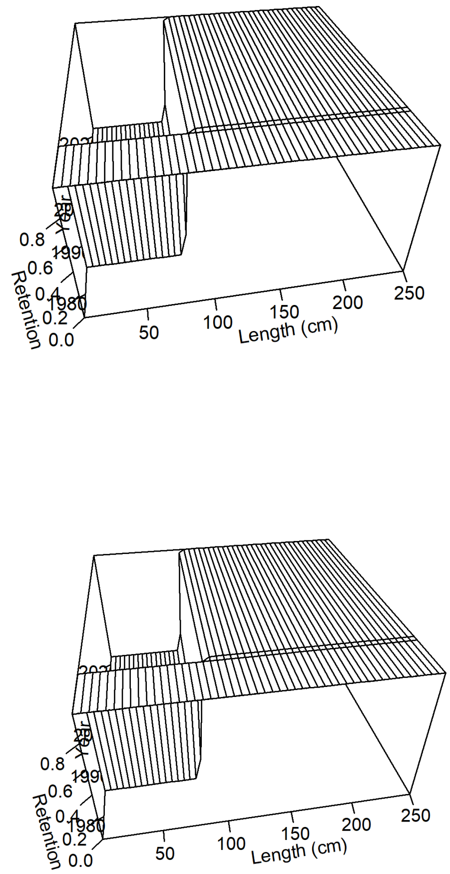


Figure 9.9: Time-varying retention curve surface for the first time-block (front) and second time- block (back) for female (top) and male (bottom) St. Croix spiny lobster during 1981 (front left) – 2023 (back left).

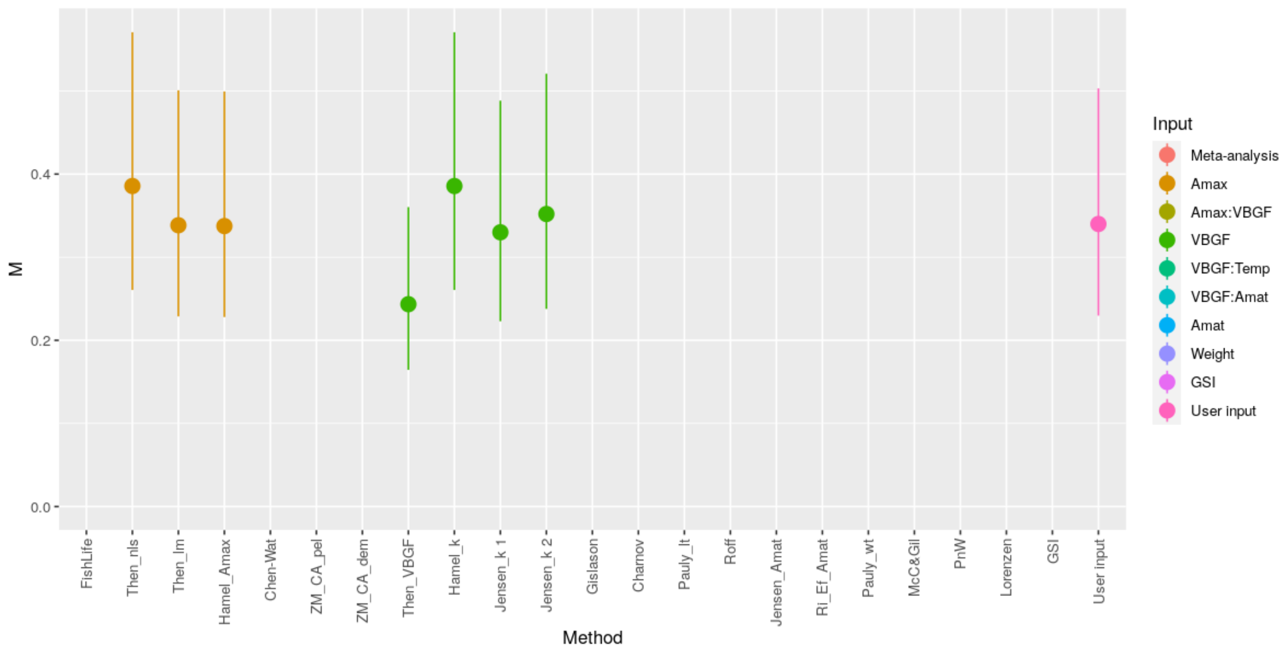


Figure. 9.10: Empirical estimates of natural mortality (M) based on maximum age and von Bertalanffy parameters for female Caribbean spiny lobster.

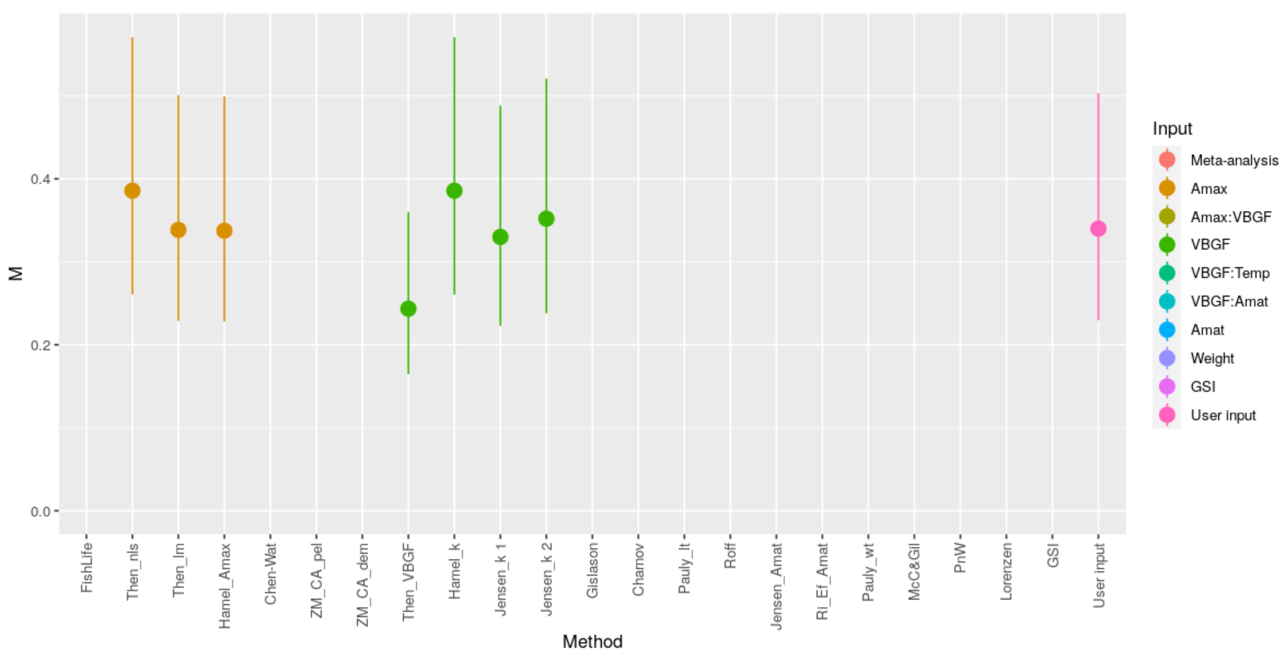


Figure 9.11: Empirical estimates of natural mortality (M) based on maximum age and von Bertalanffy parameters for male Caribbean spiny lobster.

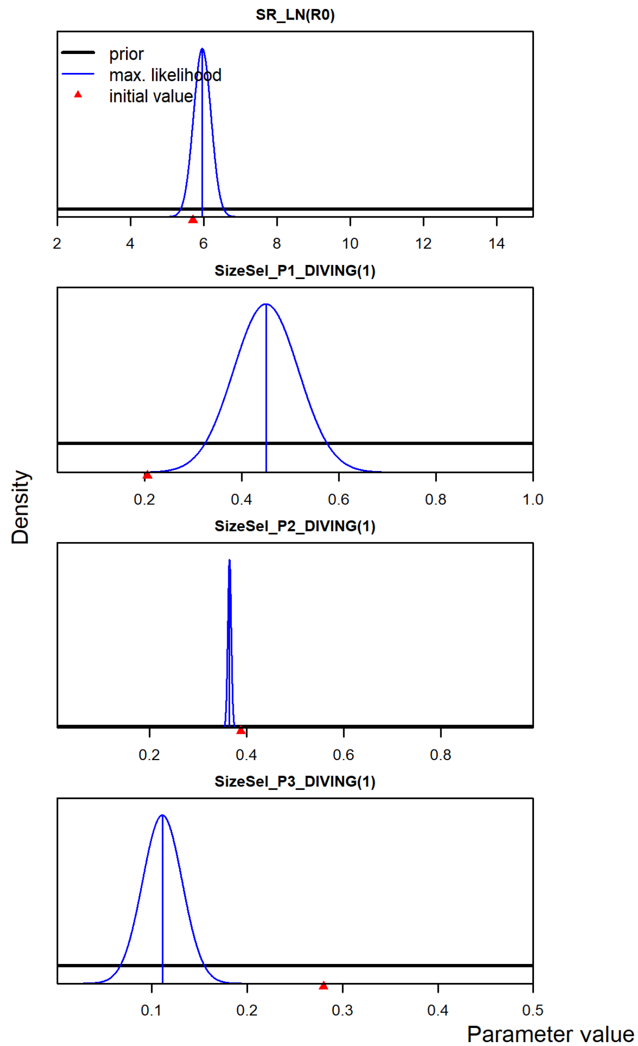
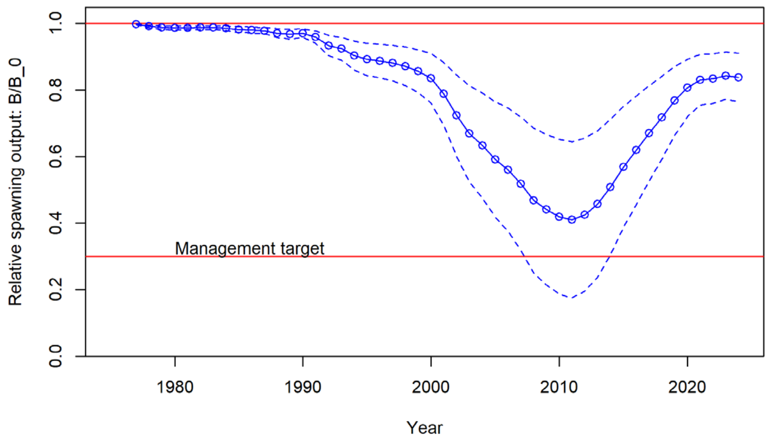
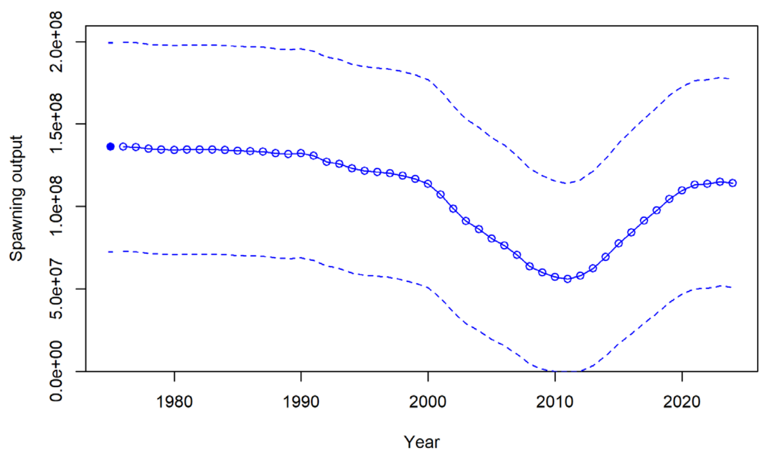


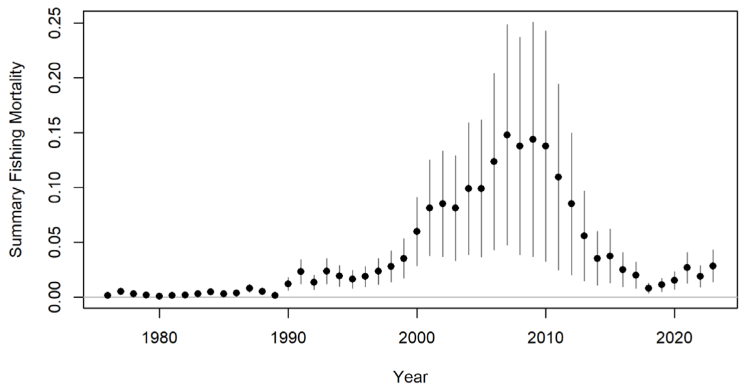
Figure 9.12: St. Croix spiny lobster parameter distribution for, in descending order, the natural log of the unfished recruitment parameter of the Beverton – Holt stock-recruit function, the 1st limb parameter of the exponential logistic selectivity function for the dive fleet, the asymptote parameter of the exponential logistic selectivity function for the dive fleet, and the 2nd limb parameter of the exponential logistic selectivity function for the dive fleet.



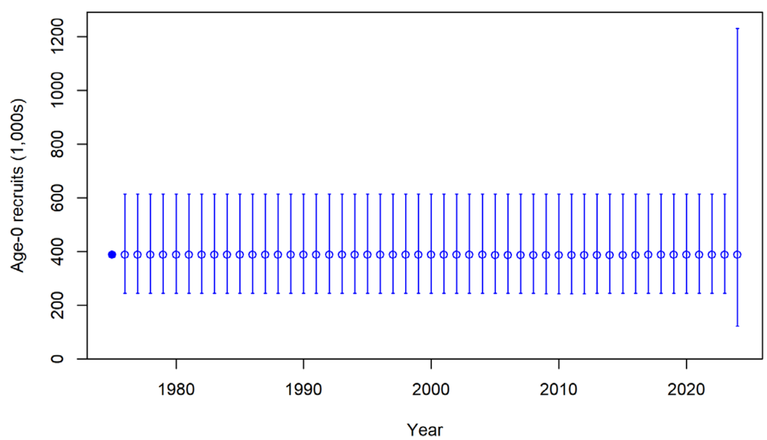
a. Spawning Biomass Ratio



b. Spawning Biomass



c. Fishing Mortality



d. Recruitment

Figure 9.13: St. Croix spiny lobster derived quantity time series from the *base* model. Derived quantities plotted over time for (a) the spawning biomass ratio (total biomass / unfished spawning stock biomass), (b) spawning stock biomass in metric tons, (c) fishing mortality (total biomass killed / total biomass), (d) and recruitment in thousands of fish. The dashed lines and vertical bars in the derived quantities time series represent 95% confidence intervals.

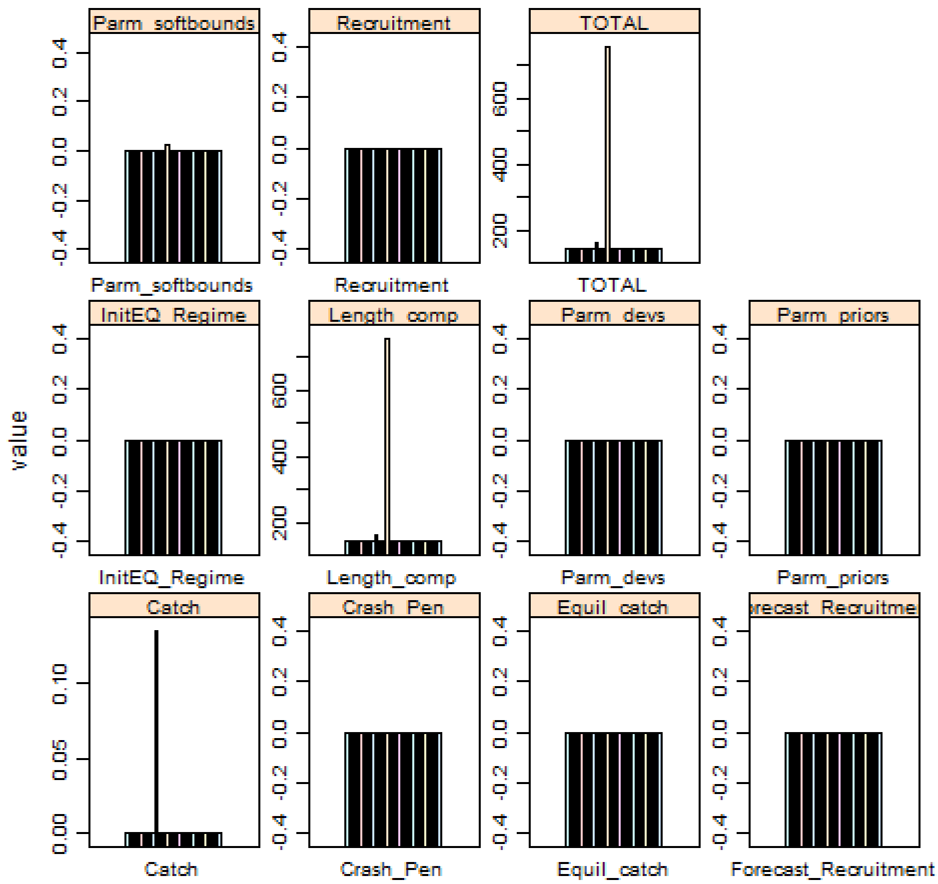


Figure 9.14: St. Croix spiny lobster jitter analysis total likelihood for the *base* model. Each panel gives the results of 40 runs of the corresponding model scenario where the starting parameter values for each run were randomly changed by 50% from each model's predicted values using a uniform distribution in cumulative normal space.

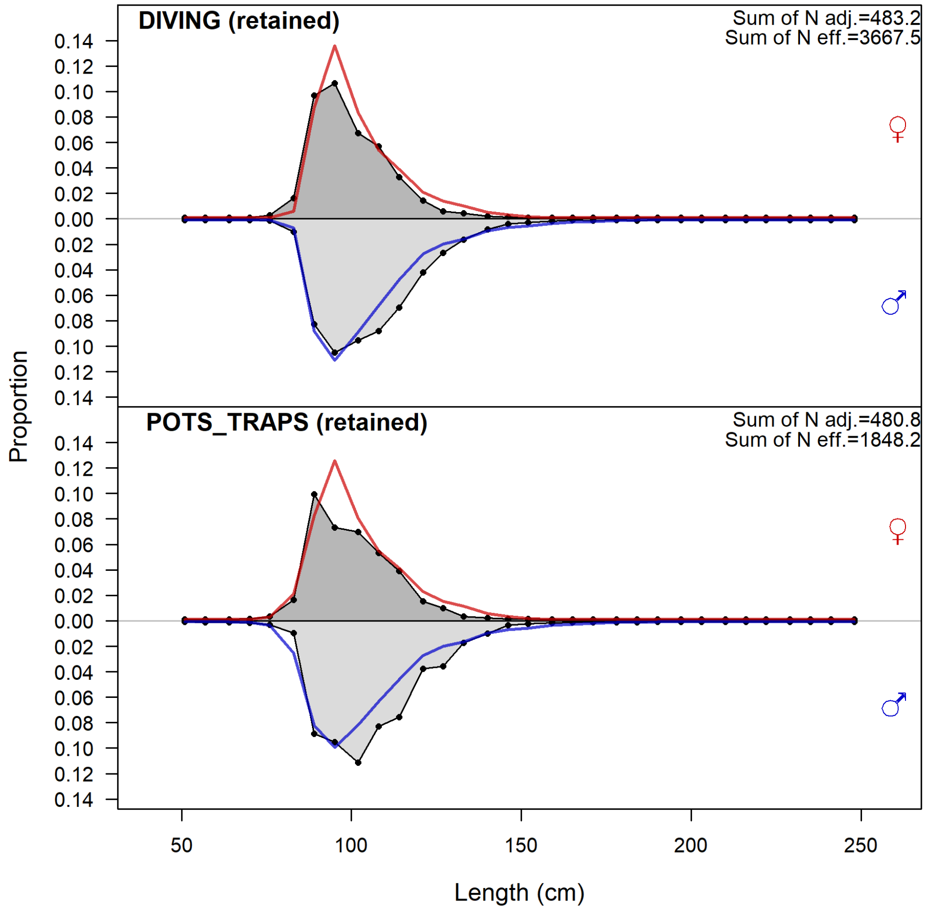


Figure 9.15: St. Croix spiny lobster observed and predicted length distributions in millimeters. Red and blue solid lines represent predicted length compositions, while gray regions represent observed length compositions. The effective sample sizes used to weight the length composition data are provided by N adj (the input sample size) and N eff (the calculated effective sample size) and are shown in the upper right corners.

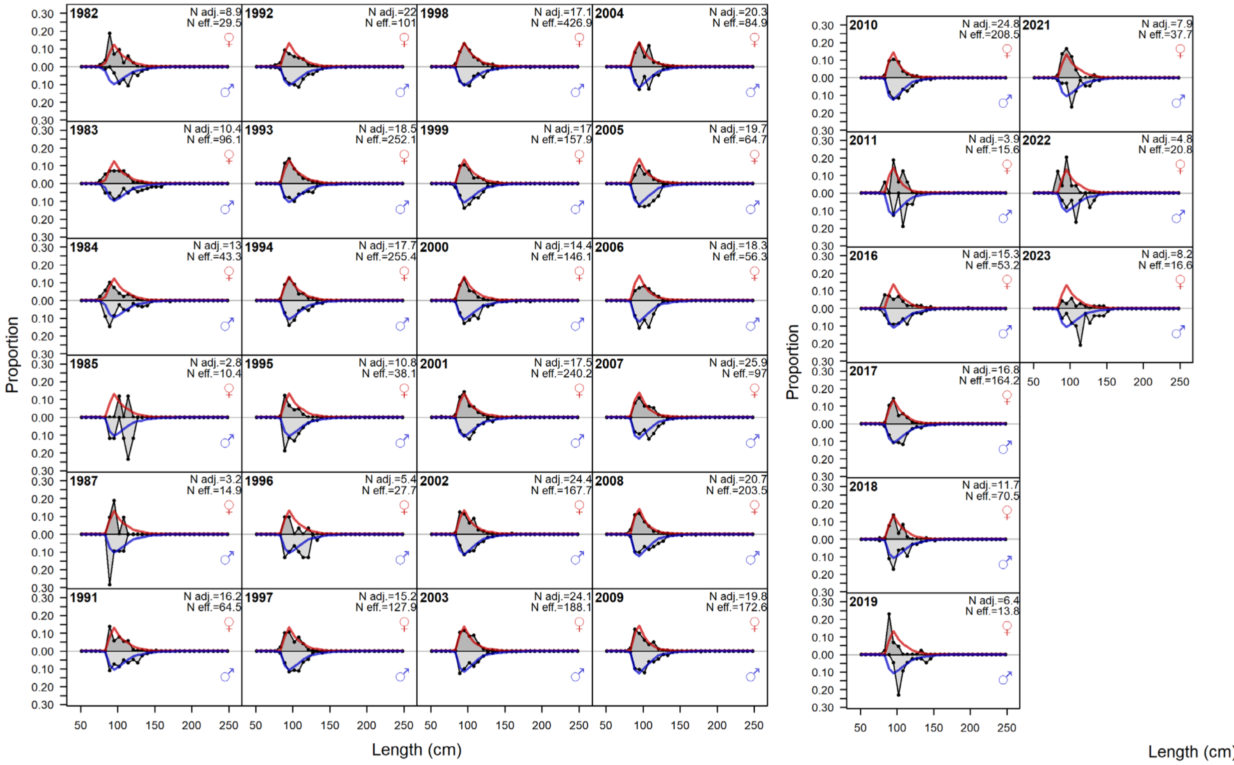


Figure 9.16: St. Croix spiny lobster observed (grey) and predicted (solid line) dive fleet length composition by individual year and sex: females (red) and males (blue).

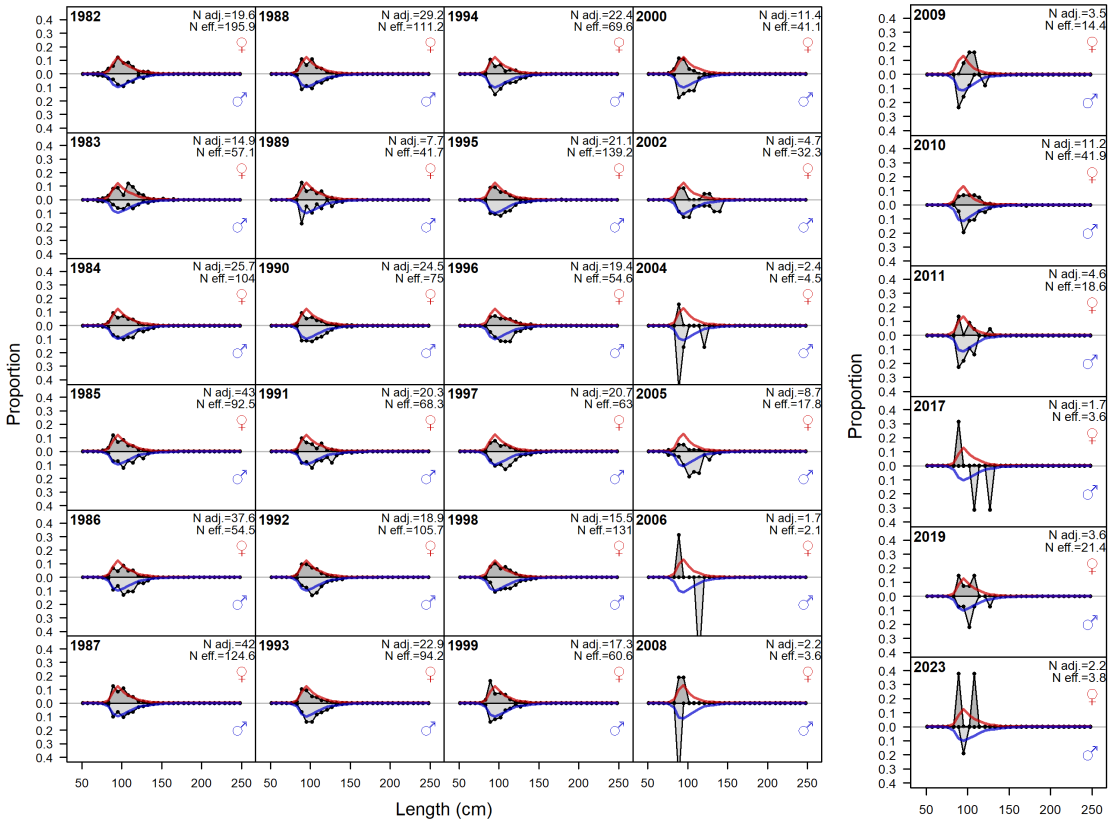


Figure 9.17: St. Croix spiny lobster observed (grey) and predicted (solid line) pot/trap fleet length composition by individual year and sex: females (red) and males (blue).

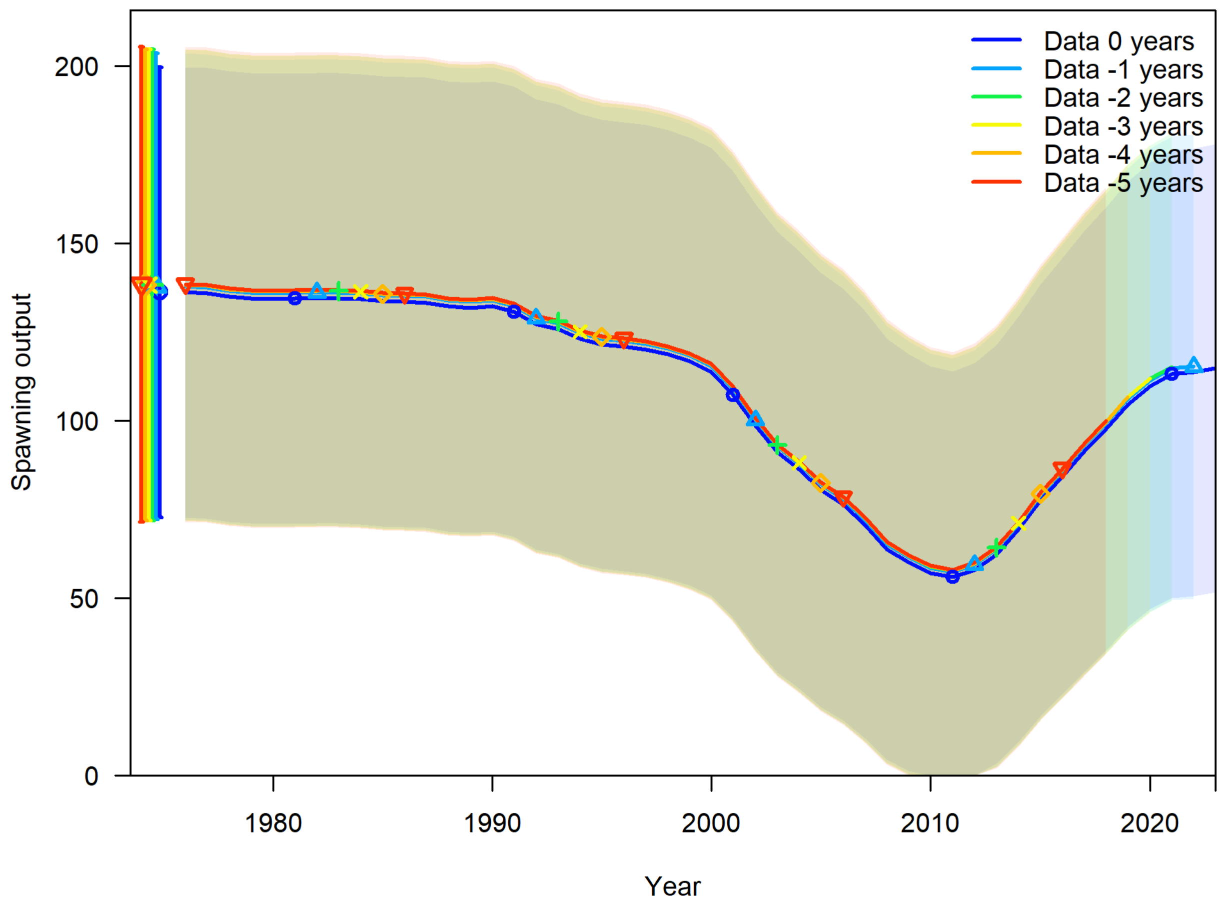


Figure 9.18: St. Croix spiny lobster retrospective analysis of spawning stock biomass (SSB) (*base* model) conducted by refitting models after removing five years of observation, one year at a time sequentially. Grey shaded areas are the 95% confidence intervals.

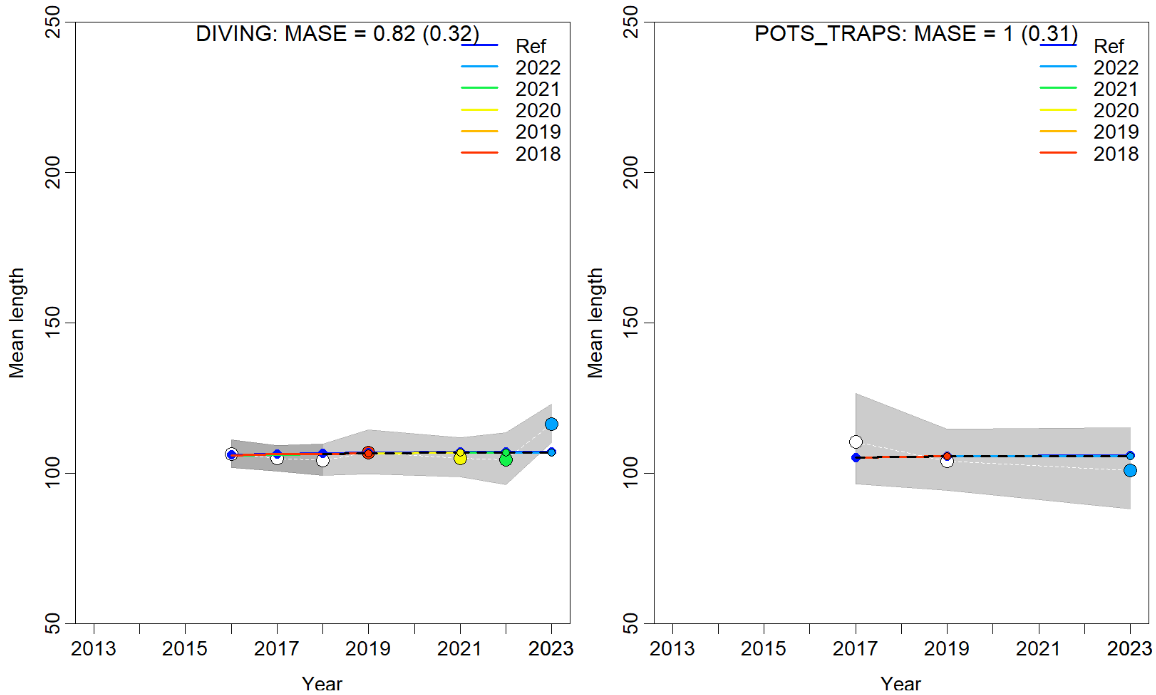


Figure 9.19: St. Croix spiny lobster hindcast cross-validation plots of mean absolute scaled error (MASE) (*base* model) associated with length composition time series by fleet: dive fleet (left) and pot/trap fleet (right).

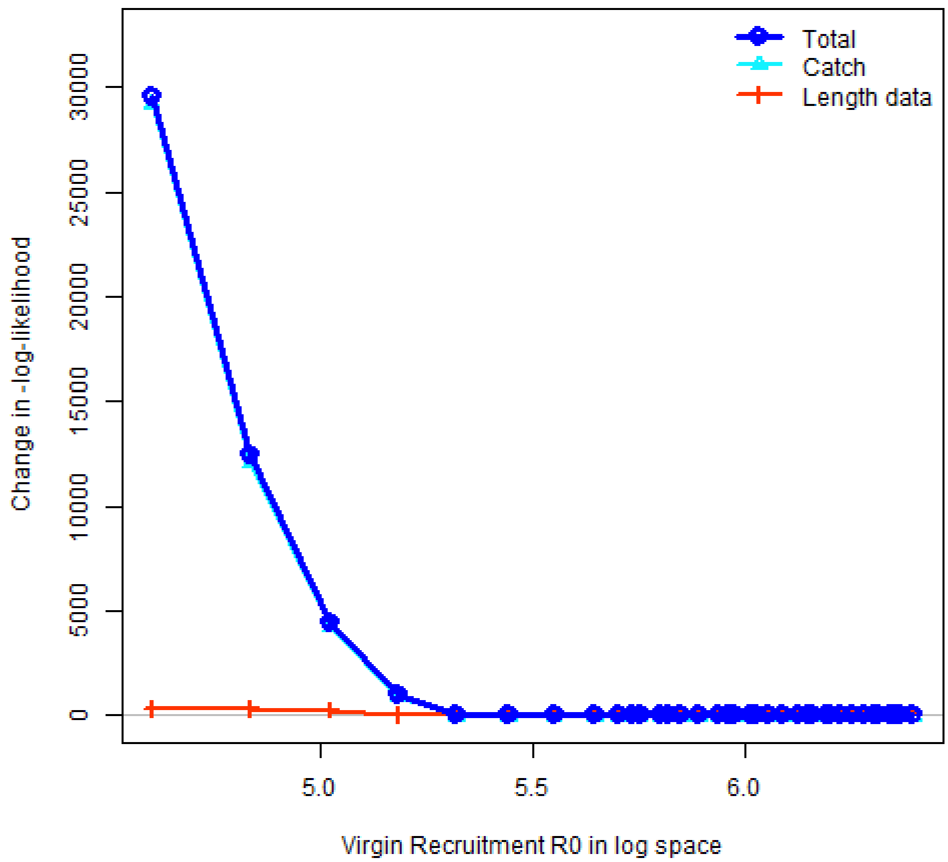


Figure 9.20: The profile likelihood for the natural log of the unfished recruitment parameter of the Beverton – Holt stock-recruit function for St. Croix spiny lobster (*base* model). Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed unfished recruitment values tested in the profile diagnostic run.

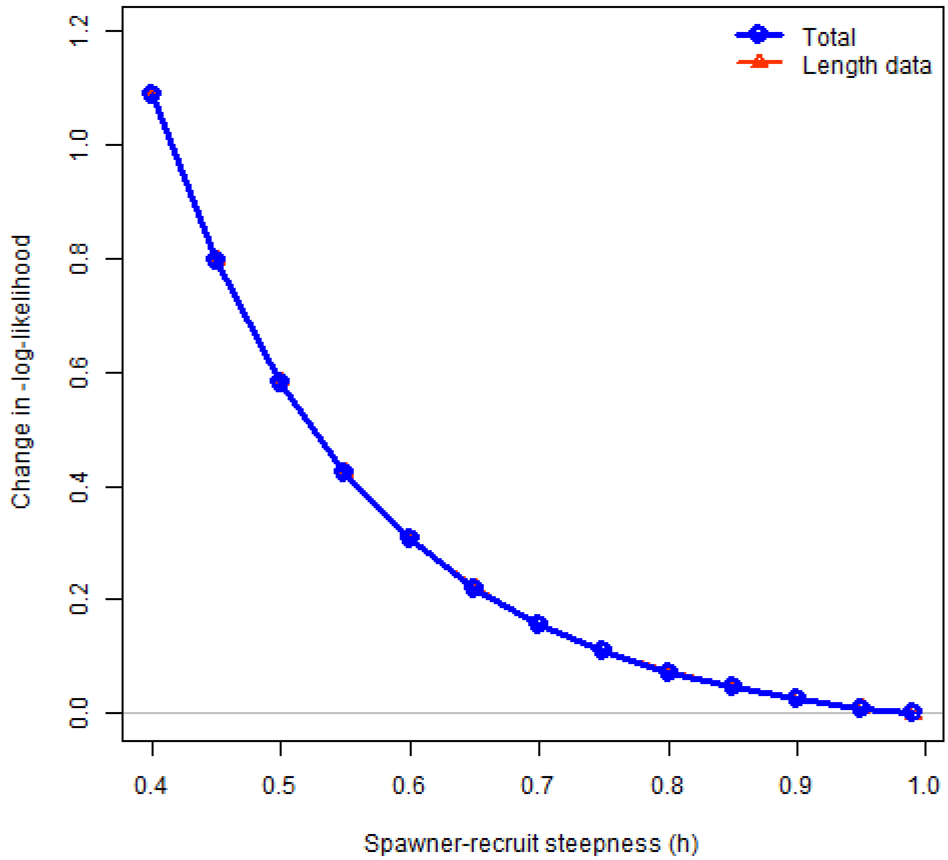
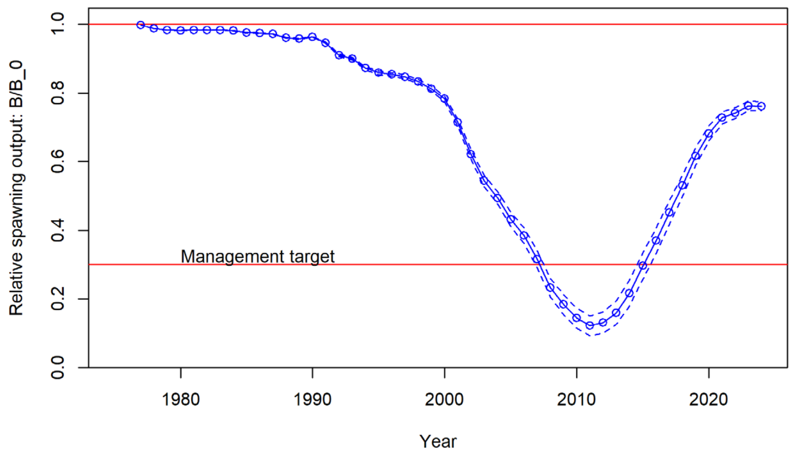
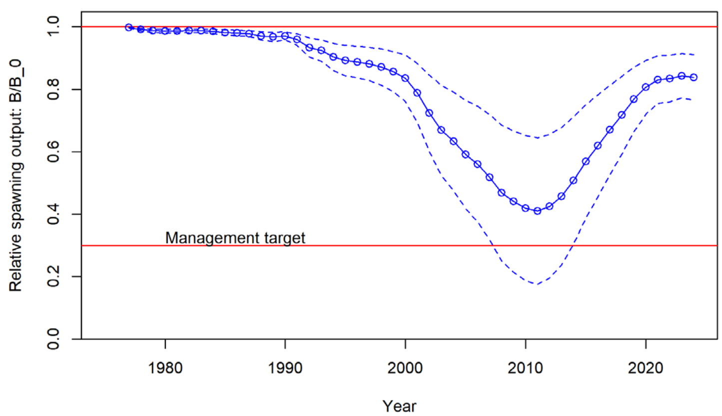


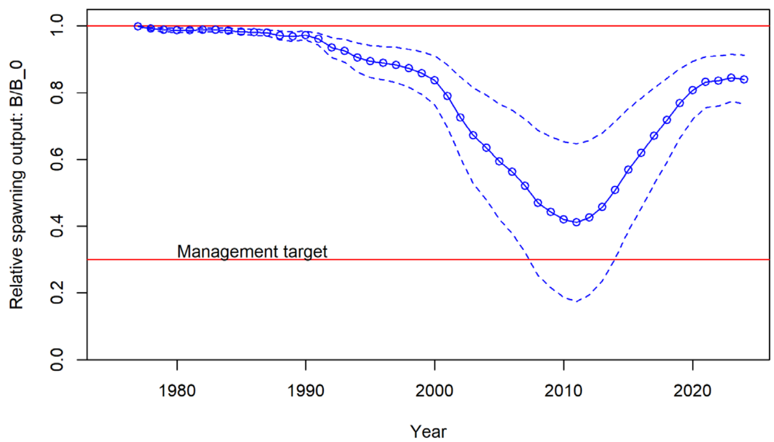
Figure 9.21: The profile likelihood for the steepness parameter of the Beverton – Holt stock-recruit function for St. Croix spiny lobster (*base* model). Each line represents the change in negative log-likelihood value for each of the data sources fit in the model across the range of fixed steepness values tested in the profile diagnostic run.



(*selex1*)



(*selex2*)



(*lw*)

Figure 9.22: St. Thomas spiny lobster estimated relative spawning output (biomass/unfished biomass) from *selex1* (top) and *selex2* (middle) and *lw* (bottom) sensitivities.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 91

US Caribbean Spiny Lobster – St. Croix

SECTION IV: Research Recommendations

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

Table of Contents

1. DATA WORKSHOP RESEARCH RECOMMENDATIONS

1.1 LIFE HISTORY RESEARCH RECOMMENDATIONS

- Life history studies focused on the US Caribbean – generate region-specific parameters for growth, fecundity, natural mortality.
- Look for ongoing growth/aging work via SEAMAP-C
- Merge selectivity studies, life history data collection, and fishery-independent survey frameworks to determine how to get best data for stock assessment.

1.2 COMMERCIAL FISHERY STATISTICS RESEARCH RECOMMENDATIONS

1.2.1 Length Composition Research Recommendations

- Compare SEAMAP-C to TIP size composition

Commercial Landings Research Recommendations

- Track number of fishers per year in relation to annual landings.
- Support connectivity studies – consider spiny lobster as one stock vs. by island (metapopulation).
- Investigate weak/lack of correlation between TIP and landings data
- Demand analysis: look at price per pound (survey), market preferences, trends and correlation with landings, and for all islands.
- Investigate recruitment connectivity between island platforms, e.g., STX seeding PR, and other “hypotheses.”
- Survey to determine the presence/absence of large lobsters in STX – are they available and not harvested?

- Market survey to determine whether the size of the lobster being landed is a response to the market preference/availability.
- Increase funding for port samplers to improve TIP data collection in PR and USVI.
- Propose new gear type of "diving on traps" in TIP reports (larger conversation to be had among those collecting and collating data):
    - a) Recommended this be a conversation including all jurisdictions,
    - b) Periodically review gears on forms to ensure they are accurate.

1.2.2 Discards and Discard Mortality Research Recommendations

- Discard information in the catch reports doesn't include data on length or sex in current reporting schema

1.3 RECREATIONAL FISHERY STATISTICS RESEARCH RECOMMENDATIONS

No research recommendations were provided.

1.4 MEASURES OF POPULATION ABUNDANCE RESEARCH RECOMMENDATIONS

- The panel recommended moving forward with planned lobster trap surveys in the US Virgin Islands.

2. ASSESSMENT PROCESS RESEARCH RECOMMENDATIONS

- Continue the SEAMAP-C data collection program for collecting spiny lobster size composition data.
- Consider the use of management strategy evaluation to explore the uncertainty in non-commercial catches.

3. REVIEW PANEL RESEARCH RECOMMENDATIONS

The Review Workshop was cancelled so there were not review panel research recommendations compiled.