SEDAR 57 Stock Assessment Update:
St. Thomas and St. John Caribbean Spiny Lobster

SEFSC, Caribbean Fisheries Branch

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SEDAR 57 Stock Assessment Update

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Caribbean Fisheries Branch
Sustainable Fisheries Division
Southeast Fisheries Science Center

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1. Summary

In February of 2022, the Caribbean Fishery Management Council (CFMC) requested the assistance of the National Marine Fisheries Service (NOAA Fisheries), Southeast Fisheries Science Center (SEFSC) to conduct spiny lobster assessment updates outside the SouthEast Data, Assessment, and Review (SEDAR) process. The request was to provide calculations of the Overfishing Limit (OFL) and Acceptable Biological Catch (ABC) for 2024-2026 utilizing the already established methods from SEDAR 57 stock assessment for U.S. Caribbean Spiny Lobster (SEDAR 2019). This document provides the update of the SEDAR 57 assessment benchmark for St. Thomas and St. John and specifies 2021 as the terminal year for data inputs. This work was conducted by the Southeast Fisheries Science Center, Sustainable Fisheries Division, Caribbean Fisheries Branch.

There were two main steps in the update. First, the landings data from the SEDAR 57 assessment were updated through 2021. The stock assessment model parameters remained unchanged from those used in the benchmark stock assessments. The second step involved the sex and gear-specific carapace length data; these were updated through 2021 and subsequently the assessment model was run allowing parameters to be estimated. This two-step approach provisions for isolating the effect of updating each data input (e.g., landings, size composition).

This report provides a summary of the procedures defined for the SEDAR 57 benchmark assessment and presents the updated data inputs and model results. The report also provides OFL and ABC estimates for 2024-2026 using assumptions for 2022 and 2023 landings, as these are not yet known.

The subsequent sections of this report compare outputs of the successive steps described above. However, included first is a comparison of the OFL and ABC estimates for 2024-2026 compared to the 2021-2023 values that resulted from the SEDAR 57 benchmark assessment with input landings through 2020 (Figure 1.1 and Table 1.1). The percent difference between the 2021-2023 constant-catch ABC and the 2024-2026 constant-catch ABC is -6.6%. The projections for 2024-2026 are further described in the final chapter of this report (Chapter 5).

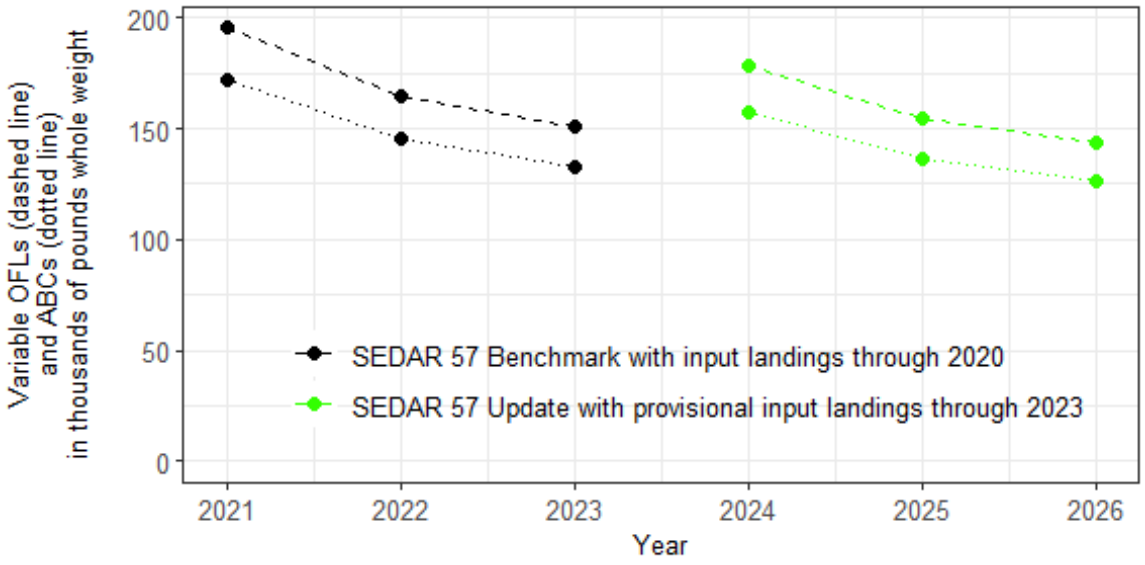

Figure 1.1: Caribbean Spiny Lobster variable-catch (annual) OFLs and ABCs for spiny lobster for St. Thomas and St. John plotted in pounds whole weight. The line color relates to the source of the data. The line type refers to the forecasted values plotted from the stock assessment model projections as OFLs (dashed lines) or ABCs (dotted line).

Table 1.1: Caribbean Spiny Lobster variable-catch (annual) and constant-catch (average) OFLs and ABCs for St. Thomas and St. John, based on the Tier 3 of the ABC Control Rule. The column titled "Source" indicates if the rows are associated with the SEDAR 57 benchmark with input landings through 2020 or with the SEDAR 57 update with input landings through 2023. All OFLs and ABCs are in pounds whole weight.

Source	Year	OFL	Avg. OFL	ABC	Avg. ABC
SEDAR 57 Benchmark with input landings through 2020	2021	195,222	170,246	172,168	150,142
	2022	165,020		145,534	
	2023	150,496		132,725	
SEDAR 57 Update with provisional input landings through 2023	2024	178,418	158,993	157,349	140,218
	2025	155,011		136,707	
	2026	143,550		126,598	

2. Assessment Background

SEDAR 57 addressed the stock assessment for three stocks of U.S. Caribbean Spiny Lobster (Puerto Rico, St. Thomas and St. John, and St. Croix). The SEDAR 57 assessment process consisted of two in-person workshops, as well as a series of webinars (SEDAR 2019). The Data Workshop was held June 20-July 2, 2018 in San Juan, Puerto Rico. Assessment webinars were held between September and December 2018. The Review Workshop took place January 29-31, 2019 in Miami, Florida.

The population dynamics model used in the SEDAR 57 assessments was Stock Synthesis (SS) version 3.30 (Methot and Wetzel 2013). The data limited to data moderate nature of the St. Thomas and St. John Caribbean Spiny Lobster stock assessment required various assumptions, including: recreational removals are either negligible (or constant) over time; no fishing mortality at the start of the data time series; known commercial removals; fixed steepness; no sex-specific retention processes; and non-varying growth and natural mortality. The SS model incorporated sex and gear-specific carapace length data that were collected over 42 years coupled with annual estimates of landings for the two main harvesting gears (diving and traps) through 2016.

The SEDAR 57 assessment for St. Thomas and St. John incorporated the CFMC's 4-tiered ABC control rule. The maximum sustainable yield (MSY) proxy, status determination criteria (SDC), and acceptable biological catch (ABC) were specified using the control rule's third-tier: "Data Limited: Accepted Assessment Available". The estimates of stock status relative to the Minimum Sustainable Stock Size (MSST) indicated that the stock was not overfished and was not undergoing overfishing in the model's terminal year (2016).

In February 2021, year-specific and constant catch projections for OFL were updated with landings for 2017-2020. Since the 2020 landings were not yet available, landings for 2020 were set equal to the average from 2017-2019 by fleet (diving and traps). Constant catch OFL projections were calculated as the three-year mean of the 2021-2023 year-specific projections. Finally, a probability of overfishing (P*) of 0.45 as determined by the Council and the sigma_min value of 0.5 determined by the Council SSC for the SEDAR 57 benchmark assessment were utilized to generate the ABC.

3. Updated Landings Data

3.1 Fleet-specific landings

In SEDAR 57, commercial fishery landings data for St. Thomas and St. John were available from self-reported fisher logbooks/sales receipts for the years 1975-2016. In February 2021, the SEDAR 57 benchmark assessment model with four additional years of landings data (2017-2020) was used to provide 2021-2023 projections. The 2020 landings were assumed and set equal to the average landings by gear from 2017-2019. The time series of available landings for the current SEDAR 57 assessment update includes 1975-2021.

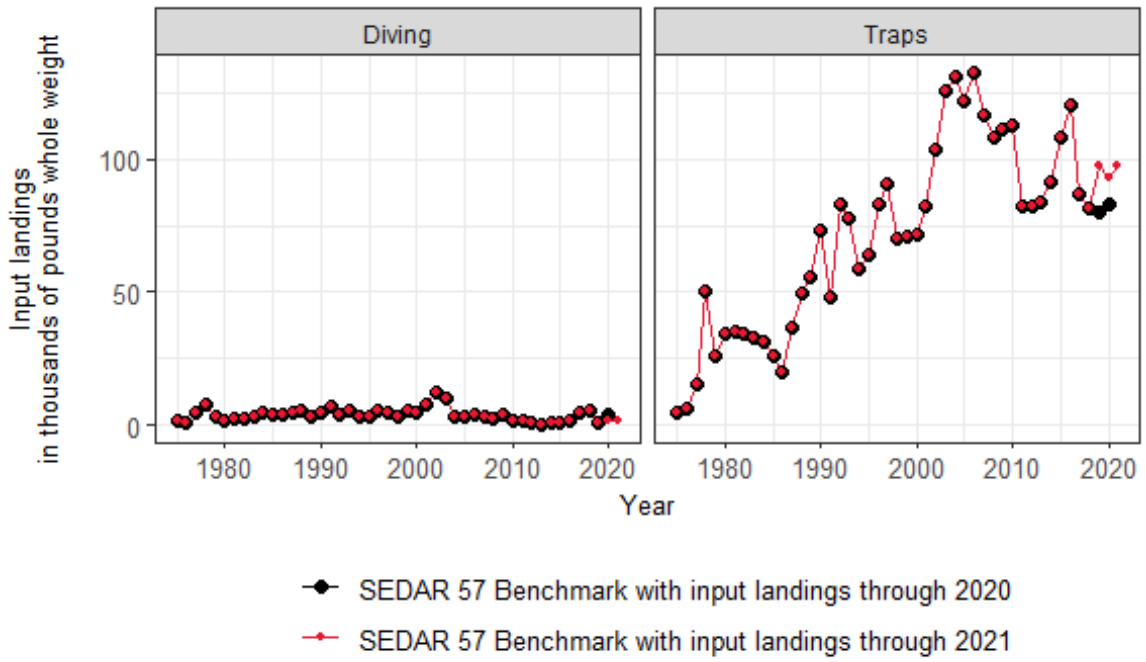

Figure 3.1: Caribbean Spiny Lobster landings from St. Thomas and St. John are plotted in pounds whole weight by year and fleet. The color relates to the source of the data. The landings through 2021 are shown in red and the landings from the benchmark assessment through 2020 are shown in black. The values plotted in red overlay the values plotted in black in all years except 2019, 2020, and 2021.

The updated data extraction through 2021 indicates a decrease in the landings for 2019 and 2020. The percent differences for 2019 are 42.1 percent for the diving fleet and 22 percent for the trap fleet. The percent differences for 2020 are -54.9 percent for the diving fleet and 12 percent for the trap fleet.

3.2 Updated projections with updated landings data

With the updated landings data through 2021, OFL projections could be compared with the projections provided previously, in February 2021. For this comparison, the model's estimated parameters remained identical to those used in the SEDAR 57 stock assessment.

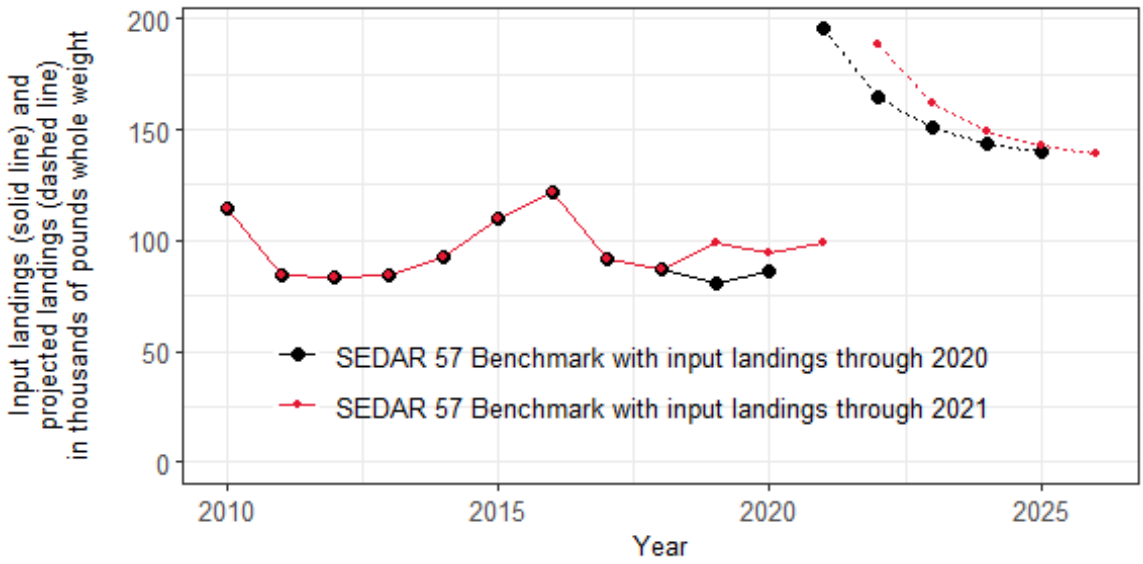

Figure 3.2: Caribbean Spiny Lobster landings and forecast OFLs for St. Thomas and St. John plotted in pounds whole weight by year. The line color relates to the source of the data. The line type refers to the status of the values plotted either as data inputs (solid lines) or as forecasted values from the stock assessment model projections (dashed lines). Prior to 2019, the values plotted in red exactly overlay the values plotted in black.

The estimated landings in 2021 were below the forecast OFLs previously projected for that year. The percent difference for the estimate in 2021 was -49.2%. This resulted in higher forecast OFL values when compared to the benchmark projections for 2022 and the years thereafter

The next section documents the updated sex and gear-specific carapace length data and the outcome of re-estimating the parameters and projections using the assessment methods established in the SEDAR 57 benchmark assessment.

4. Updated Length Composition Data

4.1 Fleet and sex-specific carapace length data

Length samples were obtained from the NOAA Fisheries, Southeast Fisheries Science Center Trip Interview Program (TIP). TIP is a port sampling program that collects data on individual lobster size and weight, to complement landings information that is collected through the logbook reporting. Size frequency data, species composition information, and sometimes other biological information are collected. TIP data for 2017-2021 were extracted and processed for use in the SEDAR 57 update assessment on 08 August 2022. Data processing decisions followed those established in the SEDAR 57 benchmark assessment. Data were removed that were above 250 mm CL (9.8 in. CL) and less than 51 mm CL (2 in. CL). The number of samples per year from 2017 to 2021 ranged from 63 to 1,015.

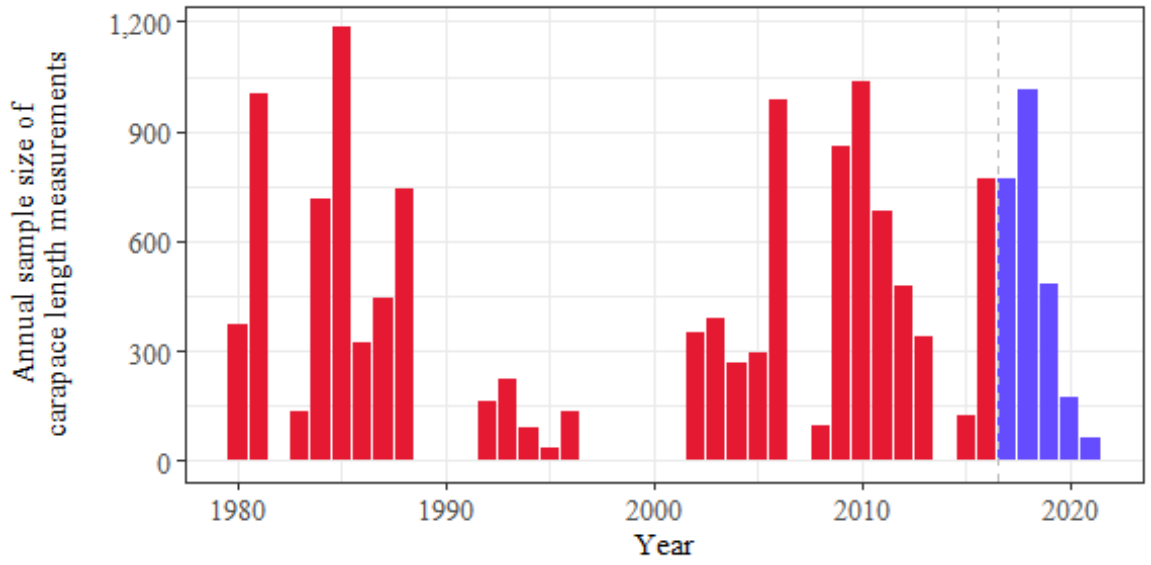

Figure 4.1: Annual counts of Caribbean Spiny Lobster carapace length samples from St. Thomas and St. John used in the SEDAR 57 benchmark assessment (red) and update assessment (red and purple). The dashed vertical line denotes the terminal year of the SEDAR 57 benchmark assessment.

Following the methods used in the SEDAR 57 update, sex and gear-specific carapace length data were binned to reflect 0.25 inch increments in millimeters.

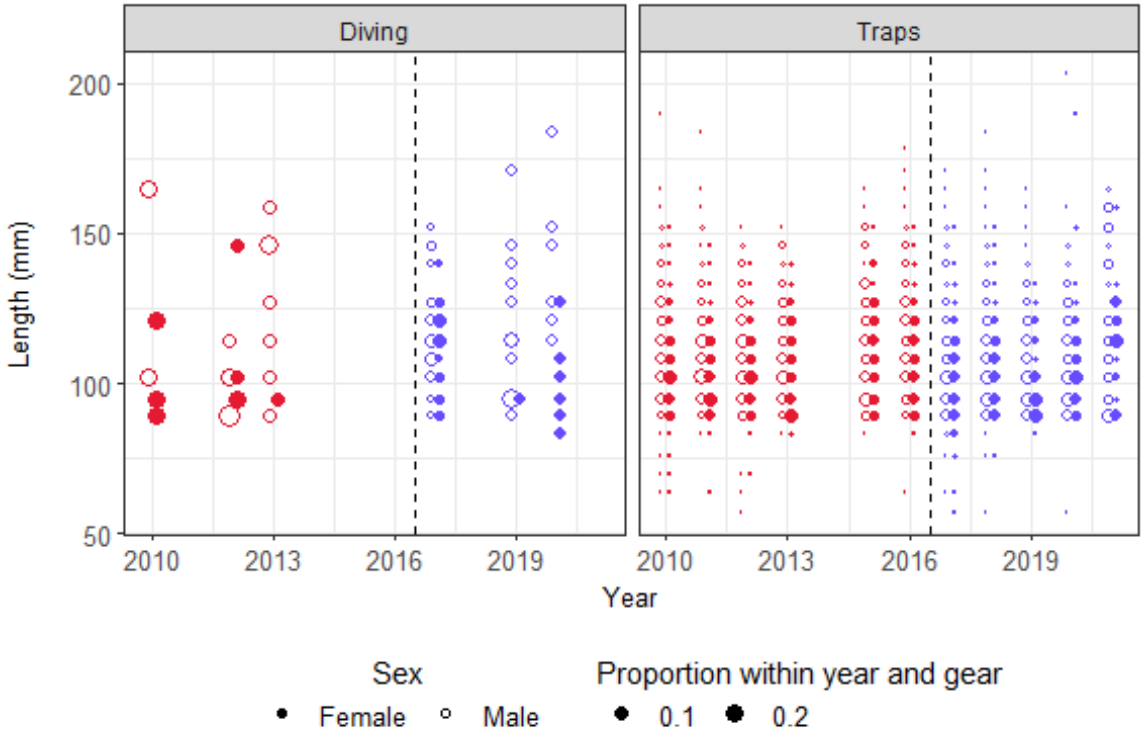

Figure 4.2: Relative proportion of male and female Caribbean Spiny Lobster carapace length samples by year and gear from St. Thomas and St. John used in the SEDAR 57 benchmark assessment (red) and update assessment (red and purple). The dashed vertical line denotes the terminal year of the SEDAR 57 benchmark assessment. The proportions plotted are relative to the number of samples by year and gear, therefore, this plot does not indicate which gears and years have more total samples. The purpose of this plot is to indicate that the length compositions by year and gear of the update assessment (2017-2021) shown in purple were not unlike those from the most recent years of the SEDAR 57 benchmark assessment (2010-2016) shown in red.

4.2 Model parameters with updated landings and length data

The updated sex and gear-specific carapace length data were applied following the methods established in SEDAR 57 benchmark. The resulting parameters are compared below in Table 4.1 to those reported in the SEDAR 57 stock assessment addendum. In the SEDAR 57 St. Thomas and St. John assessment, a total of four parameters were estimated. These include the three parameters of the exponential-logistic selectivity as well as virgin recruitment (R_0).

Table 4.1: Parameter estimates compared between the SEDAR 57 benchmark assessment and the SEDAR 57 update assessment for St. Thomas and St. John.

Type	Fleet	Parameter	Benchmark		Update		Percent Difference	
			Est.	SE	Est.	SE	Est.	SE
Base		$Log(R_0)$	5.63	0.13	5.60	0.12	-0.49	-13.90
Selectivity	Trap	Ascending rate	0.13	0.01	0.13	0.02	5.11	6.97
		Peak	0.40	0.01	0.40	0.01	-0.90	-7.69
		Descending rate	0.16	0.05	0.14	0.05	-10.30	-11.51

4.3 Derived quantities with updated landings and length data

Due to the lack of an estimable spawner-recruit relationship in the SEDAR 57 benchmark assessment, MSY could not be reliably estimated for the Caribbean Spiny Lobster stocks. Following the methods used in the SEDAR 57 benchmark assessment, a spawning potential ratio (SPR) proxy for MSY was used as the basis for management reference points. The SPR 30% proxy reflects the ratio of expected lifetime reproductive potential under fished conditions compared to virgin conditions. $S_{SPR\ 30\%}$ was defined as the spawning output associated with the stock at 30% of unfished stock size. $F_{SPR\ 30\%}$ was defined as the fishing mortality rate that would produce (in equilibrium) the same spawning output as the stock at 30% of unfished stock size.

The update assessment model results in identical interpretation as the SEDAR 57 benchmark results. The assessment models assume that Caribbean Spiny Lobster in St. Thomas and St. John was unfished in 1975. The stock approached the level corresponding to $F_{SPR\ 30\%}$ and $S_{SPR\ 30\%}$ during the mid to late 2000s. Since that time, a reduction in fishing mortality has allowed the stock spawning output to increase.

Applying the same management thresholds (i.e., MSST and MFMT) that were accepted for use in the SEDAR 57 benchmark, the stocks in St. Thomas and St. John in 2021 was not undergoing overfishing (i.e., current Fishing Mortality is below MFMT) and was not considered overfished (i.e., current Spawning Output is above MSST).

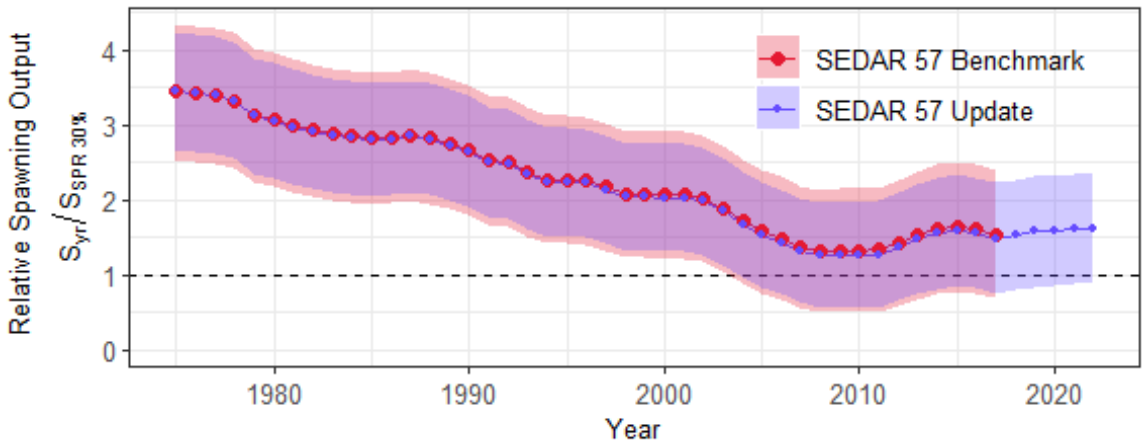

Figure 4.3: Relative spawning output of Caribbean Spiny Lobster for St. Thomas and St. John. The line color relates to the source of the data. The shaded ribbons bound the 95th percent confidence intervals. The values plotted in purple nearly overlay the values plotted in red. Values below the horizontal dashed line indicate that the spawning output in a given year was smaller than the estimated $S_{MSY\ Proxy}$, defined in the SEDAR 57 benchmark assessment as $S_{SPR\ 30\%}$; the spawning output associated with the stock at 30% of unfished stock size. Note: Unlike other Stock Synthesis estimates that are typically computed midyear, Stock Synthesis estimates of spawning output are "beginning of the year". Therefore, an additional year is provided in these time series.

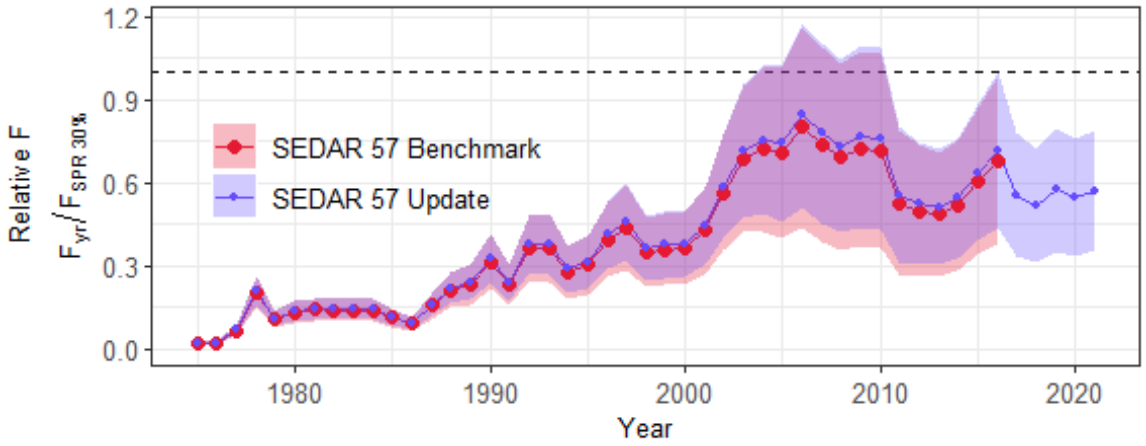

Figure 4.4: Relative fishing mortality of Caribbean Spiny Lobster for St. Thomas and St. John. The shaded ribbons bound the 95th percent confidence intervals. The line color relates to the source of the data. The values plotted in purple are slightly larger than the values plotted in red. Values above the horizontal dashed line indicate that the fishing mortality in a given year was larger than the estimated $F_{MSY\ Proxy}$, defined in the SEDAR 57 benchmark assessment as $F_{SPR\ 30\%}$; the fishing mortality rate that would produce (in equilibrium) the same spawning output as the stock at 30% of unfished stock size.

Table 4.2: Derived quantities compared between the SEDAR 57 benchmark assessment and the SEDAR 57 update assessment.

Value	Definition	Type	Benchmark	Update	Units
TY	Terminal year	Value	2016	2021	
MSY	Equilibrium retained yield at proxy of $S_{SPR\ 30\%}$	Value	1.34e+05	1.30e+05	Pounds Whole Weight
		StdDev	1.67e+04	1.37e+04	
S_0	Unfished stock output	Value	9.79e+07	9.52e+07	1000s eggs
		StdDev	1.31e+07	1.10e+07	
S_{MSY}	Spawning output using proxy of $S_{SPR\ 30\%}$	Value	2.84e+07	2.77e+07	
		StdDev	3.81e+06	3.19e+06	
MSST	Min. stock size threshold (75% of $S_{SPR\ 30\%}$)	Value	2.13e+07	2.08e+07	
$S_{Current}$	Spawning output at beginning of forecast	Value	4.40e+07	4.45e+07	
		StdDev	1.25e+07	1.04e+07	
$S_{Current}/S_0$	Calculated from definitions above	Value	0.450	0.468	Proportion
$S_{Current}/S_{MSY}$		Value	1.547	1.609	
$S_{Current}$/MSST		Value	2.062	2.145	
F_{MSY}	Fishing mortality that produces MSY in equilibrium using proxy of $S_{SPR\ 30\%}$	Value	0.244	0.243	Proportion of stock removed by fishing
		StdDev	0.005	0.005	
MFMT	Max. fishing mortality threshold ($F_{SPR\ 30\%}$)	Value	0.244	0.243	
		StdDev	0.005	0.005	
$F_{Current}$	Fishing mortality in terminal year	Value	0.166	0.139	
		StdDev	0.038	0.027	
$F_{Current}/F_{MSY}$	Calculated from definitions above	Value	0.682	0.573	Proportion
$F_{Current}$/MFMT		Value	0.682	0.573	

4.4 Projections with updated landings and length data

With the landings and lengths data through 2021, OFL projections could be compared with the projections provided in Chapter 3 (SEDAR 57 Benchmark with input landings through 2021), where only the landings data were updated through 2021. The inclusion of the length data through 2021, results in OFL projections that are slightly lower than the OFL projections when only the landings data were updated through 2021.

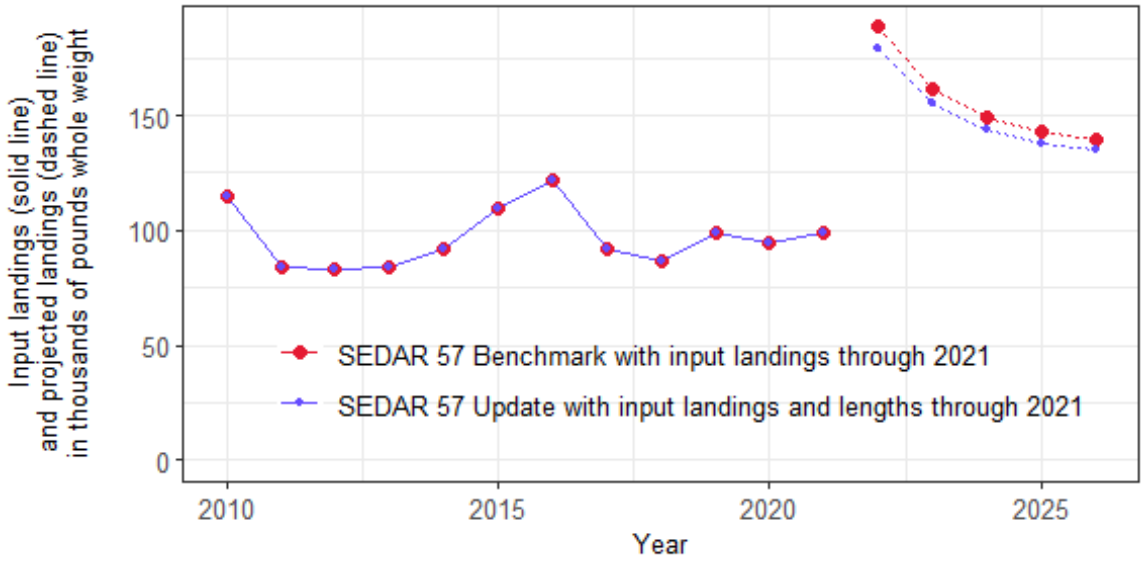

Figure 4.5: Caribbean Spiny Lobster landings and forecast OFLs for St. Thomas and St. John plotted in pounds whole weight by year. The line color relates to the source of the data. he SEDAR 57 benchmark had input landings through 2021 and input lengths through 2016. The SEDAR 57 update had input landings and lengths through 2021. The line type refers to the status of the values plotted either as data inputs (solid lines) or as forecasted values from the stock assessment model projections (dashed lines). Prior to 2022, the values plotted in purple exactly overlay the values plotted in red in all years.

5. OFL for 2024-2026

5.1 Projection specifications

Projections for 2024-2026 required assuming removals by fleet for 2022 and 2023. The projections shown below assume that the landings in 2022 and 2023 would be identical to the most recent year of landings data, 2021.

5.2 Projections starting in 2024

After assuming landing data inputs for 2022 and 2023, OFL projections for 2024-2026 could be calculated. The inclusion of the landings data inputs through 2023 results in OFL projections that are similar but two years delayed compared to when the data inputs were updated through 2021 (Figure 5.1). The variable-catch (annual) and constant-catch (2024-2026 average) OFLs and ABCs for St. Thomas and St. John, based on Tier 3 of the ABC Control Rule, are also plotted in Figure 1.1 and tabulated in Table 1.1.

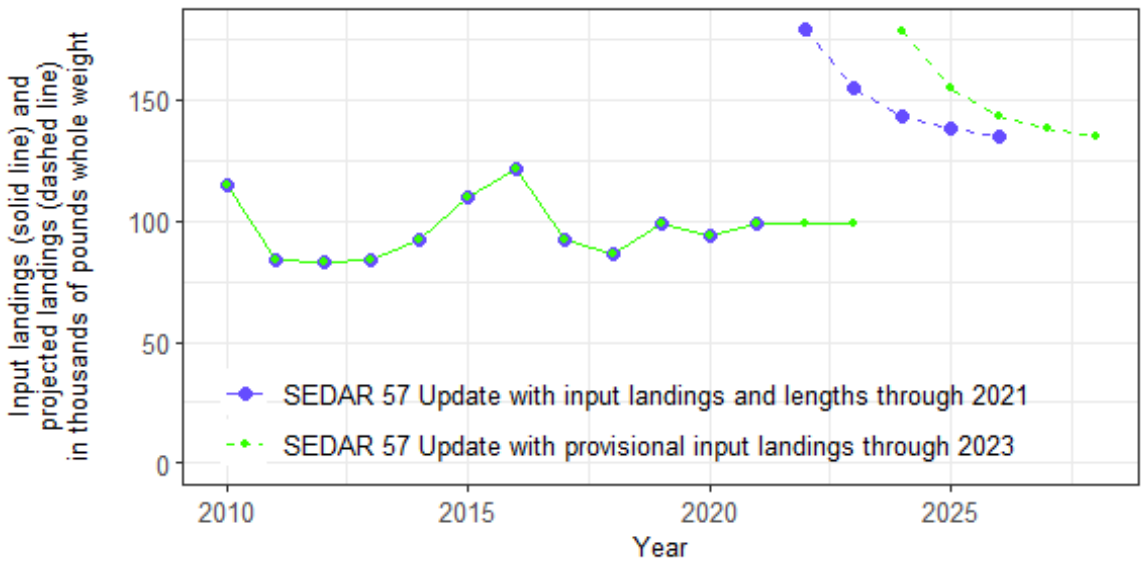

Figure 5.1: Caribbean Spiny Lobster landings and forecast OFLs for St. Thomas and St. John plotted in pounds whole weight by year. The line color relates to the source of the data. The line type refers to the status of the values plotted either as data inputs (solid lines) or as forecasted values from the stock assessment model projections (dashed lines). Prior to 2022, the values plotted in green exactly overlay the values plotted in purple.

References

Methot, Richard D., and Chantell R. Wetzel. 2013. “Stock Synthesis: A Biological and Statistical Framework for Fish Stock Assessment and Fishery Management.” *Fisheries Research* 142 (May): 86–99. https://doi.org/10.1016/j.fishres.2012.10.012.

SEDAR. 2019. “SEDAR 57 Stock Assessment Report u.s. Caribbean Spiny Lobster.” North Charleston SC. http://sedarweb.org/sedar-57.