NOAA FISHERIES

SEDAR 57
Spiny Lobster

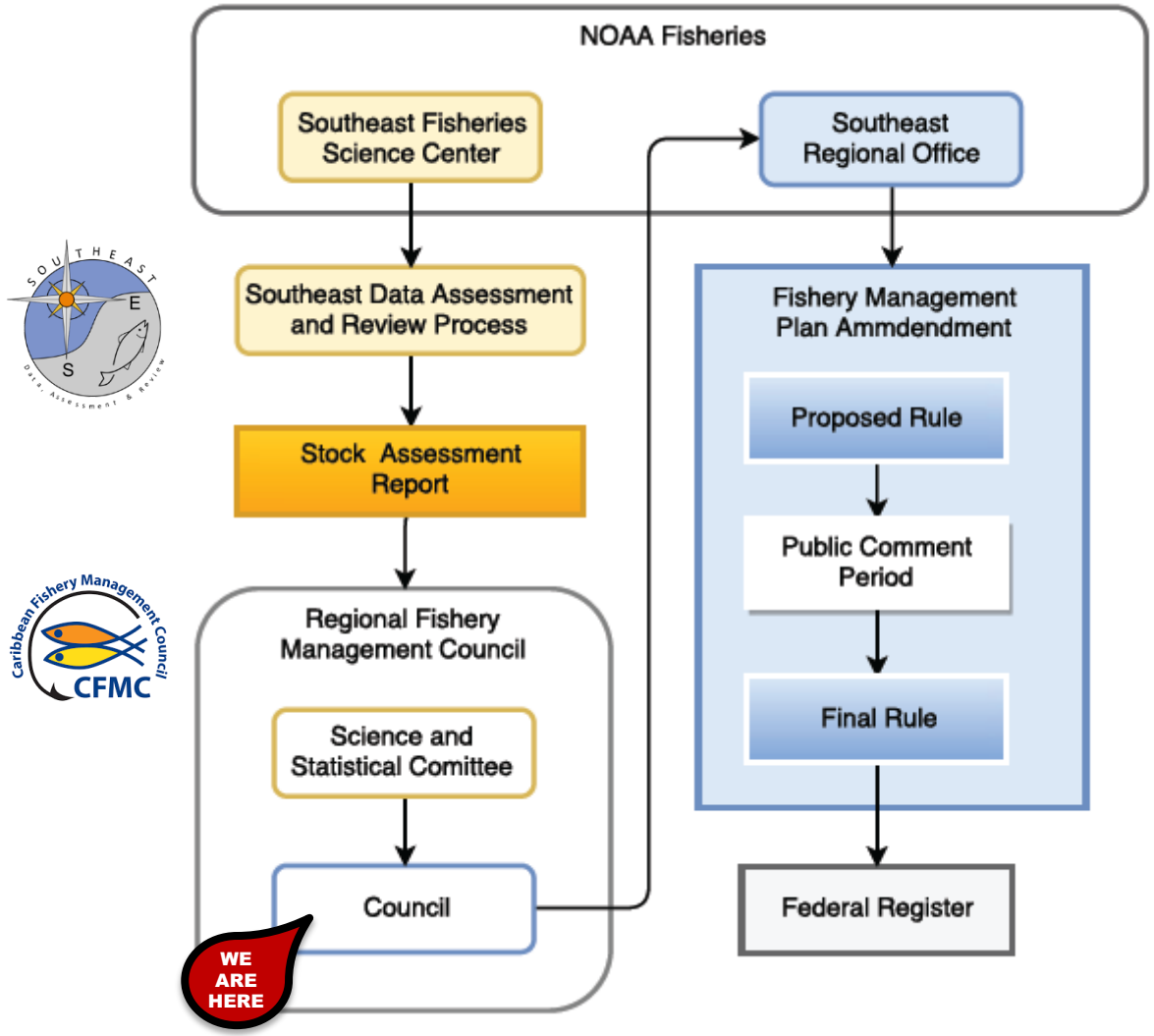
168th CFMC
Regular Meeting
Puerto Rico

December 10-11, 2019

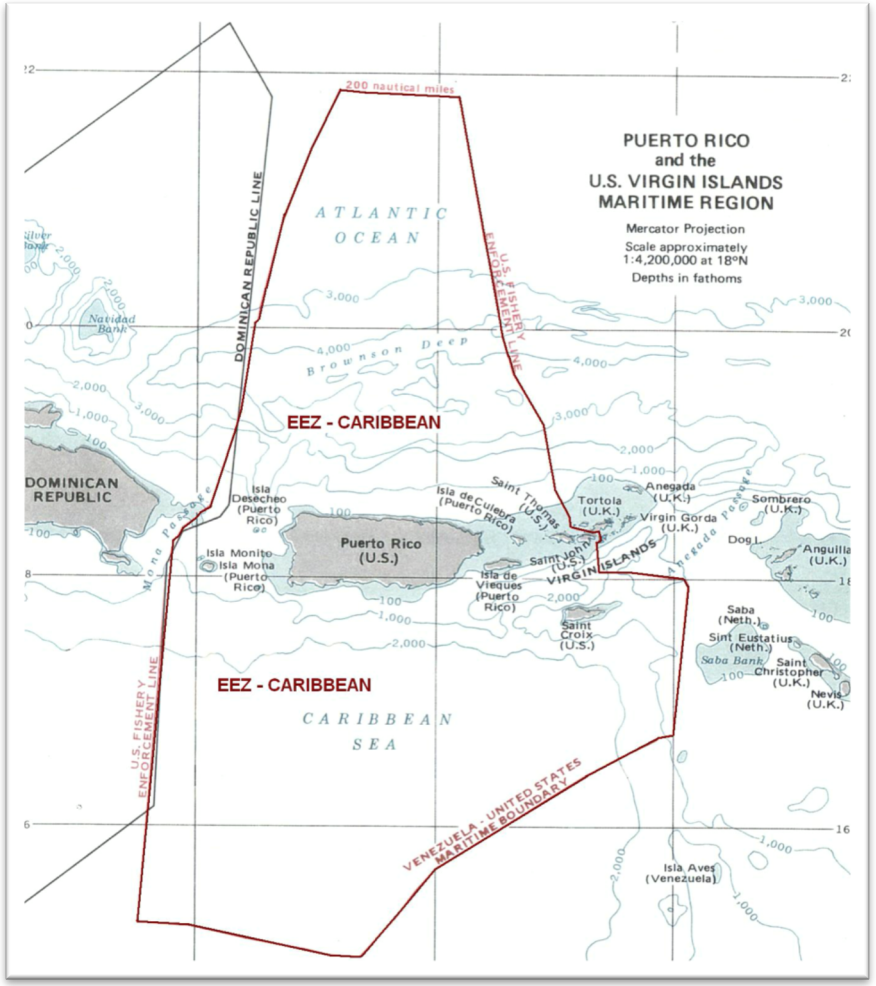
General Goals

Stock assessments use models and data to…

- determine if fishing yield is sustainable
- determine if stock size is above or below the level that can provide MSY
- quantify the uncertainty in the status of the stock
- provide management advice for optimizing resource utilization



Summary of Management Measures



Annual catch limits by island management areas (Puerto Rico, St. Croix, and St. Thomas/St. John).

Minimum size limits of 3.5 (8.9 cm) carapace length.

Bag limits for recreational harvest in federal waters.

Gear restrictions:

- No spears, hooks, piercing devices, explosives, or poisons.
- No gillnets and trammel nets in federal waters.
- Traps, pots, buoys, and boats should be identified and marked.
- Non-wooden traps must have biodegradable escape panels.

Egg-bearing female lobsters cannot be aboard a vessel, may be kept in pots or traps until the eggs are shed.

Spiny lobsters must be whole when they are brought to port.

Similar restrictions on importing spiny lobsters.

Current ACLs

Effective 2012

STT: 104,199 lb (47,264 kg)

STX: 107,307 lb (48,674 kg)

PR: 327,920 lb (148,742 kg)

	Puerto Rico		St. Croix	St. Thomas/St. John
	Commercial Sector	Recreational Sector		
Fishery Management Unit (FMU)	Annual Catch Limit Pounds	Annual Catch Limit Pounds (Number of Fish)	Annual Catch Limit Pounds	Annual Catch Limit Pounds
Angelfish	8,984	4,492 (1,667)	305	7,897
Boxfish	86,115	4,616 (2,810)	8,433	27,880
Goatfishes	17,565	362 (814)	3,766	320
Grunts	182,396	5,028 (11,531)	36,881	37,617
Wrasses	54,147	5,050 (4,613)	7	585
Jacks	86,059	51,001 (37,945)	15,489	52,907
Scups & Porgies	24,739	2,577 (3,079)	4,638	21,819
Squirrelfish	16,663	3,891 (8,510)	121	4,241
Surgeonfish[1]	7,179	3,590 (5,365)	33,603	29,249
Triggerfish & Filefish	58,475	21,929 (11,620)	24,980	74,447
Spiny Lobster	327,920	N/A	107,307	104,199
	U.S. Caribbean Exclusive Economic Zone			
	Annual Catch Limit			
[1]Tilefish	14,642			
[1]Aquarium Trade	8,155			

* Pounds of whole fish

[1] The ACL for the Tilefish FMU and the aquarium trade species is a single value set for the entire Caribbean exclusive economic zone.

Assessment History

Spiny Lobster Stock Units Assessed	Assessment Method	Assessment Reference
St. Thomas/St. John trap fishery **St. Croix dive fishery**	Comparison of multiple data-limited models	**SEDAR 46 (2016)**
US Caribbean	Stock production analyses (ASPIC)	**SEDAR 8 (2005)**
US Caribbean	Yield per recruit analysis	Mateo 2004
Puerto Rico	Dynamic production model	Mateo and Die 2004
US Caribbean	Examining landings and length frequency	Bolden 2001
St. Croix	Production model (Schaefer and Fox)	Mateo and Tobias 2000
Puerto Rico	Examining CPUE and length frequency	Matos-Caraballo 1999
US Caribbean	Examining landings and CPUE	Bohnsack et al. 1990

- To date, stock assessment results have not been used as quantitative catch advice.

Stock Synthesis (SS) Version 3.30

- Integrated catch-at-age model (Methot and Wetzel 2013)
- The model simulates the dynamics of the stock (mortality, maturity, growth, etc.) and dynamics of the fishery (selectivity, effort, etc.)
- Flexible in ability to use diversity of age, size, and aggregate data from fisheries and surveys

SS – How does it work?

- The data we have give us pieces of information about reality.
- The model uses equations for various population and fishery dynamics to create a simulated reality. It searches over different parameter values (that are used in the equations) to try and match the simulated data with the real life data.
- We want to have a good match between the simulated data and the real data. We also want to have believable values in the equations used in the model to create the simulated data.
- We get to choose which values we want the model to try and solve for (those are the estimated parameters). We also get to choose which assumed values we want to force the model to use (fixed parameters).

Modeling Process - Summary

- Low complexity models were examined
- The model development process provided a plan for either **borrowing information** or **reducing complexity** when data limitations resulted in non-convergence
- Summary of modeling “steps” provided in SAR + Addendum

Inputs to Models for Each of the Three Island Platforms

Data

- Annual removals by Gear
- Annual length composition by Gear

Estimated Parameters

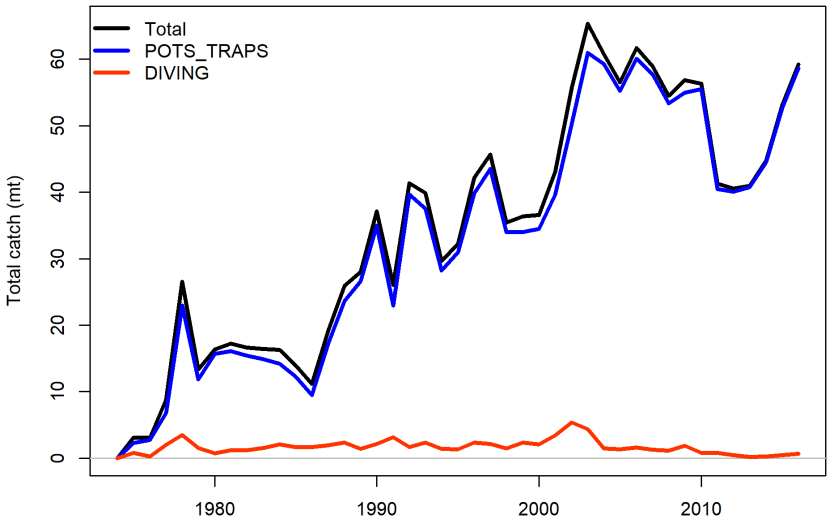
- Unfished recruitment (R0)
- Selectivity and Retention

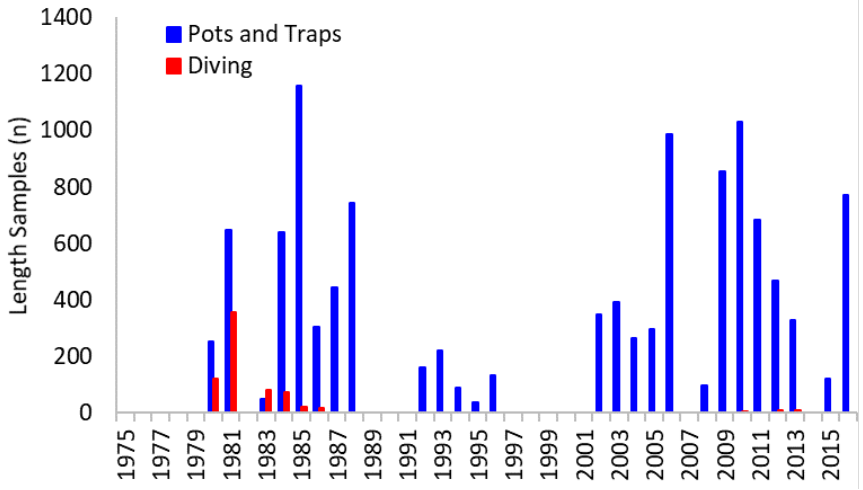
Fixed Parameters

- Growth
- Natural Mortality
- Maturity
- Steepness, h=0.95
- 50/50 sex ratio
- Time block to represent change in retention due to size limit

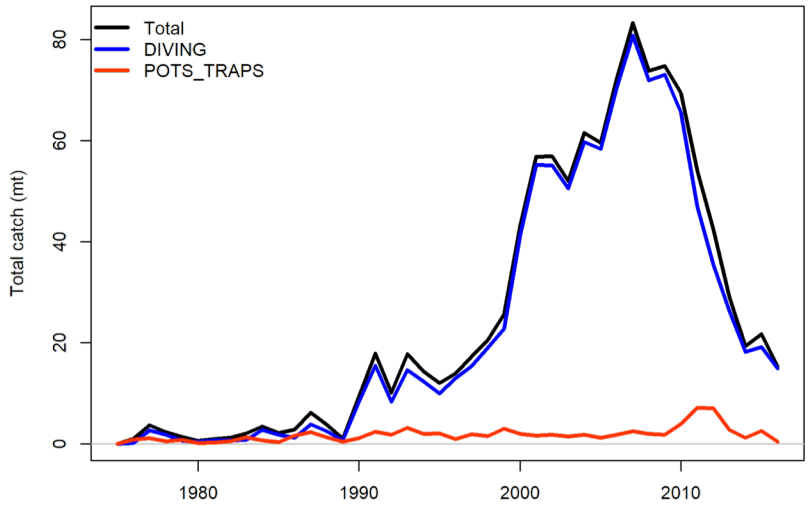
Data - Annual removals & number of length samples by gear

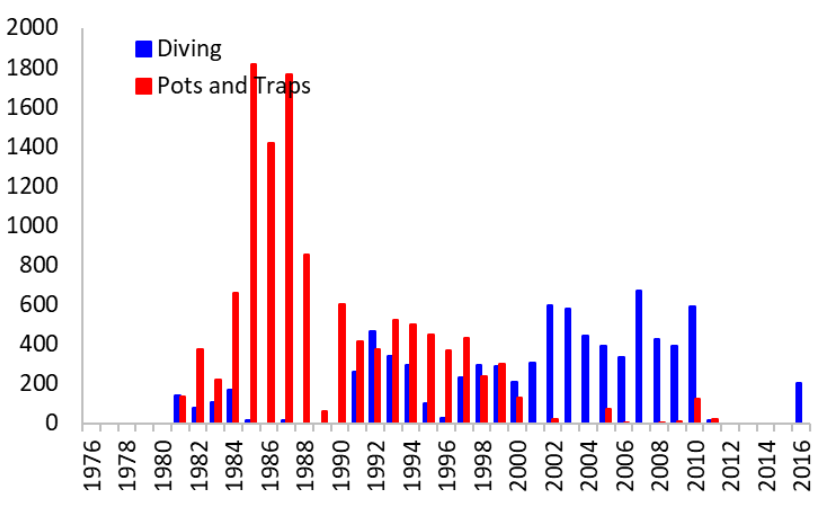
STT



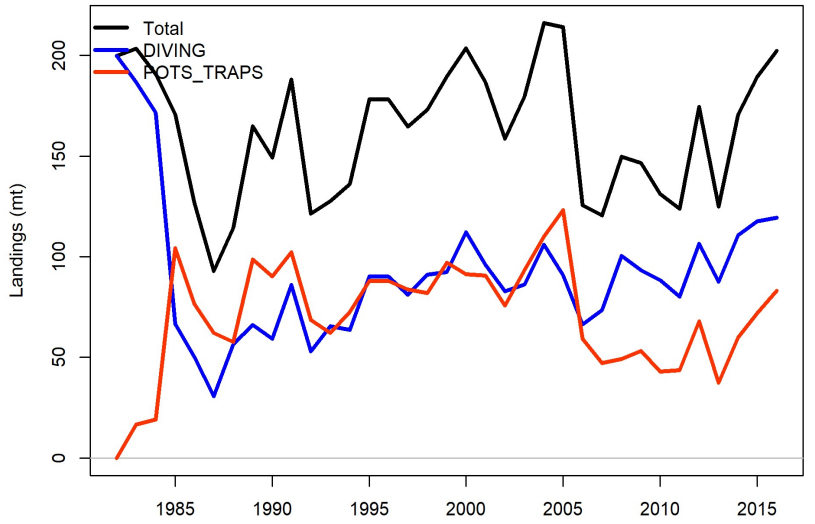


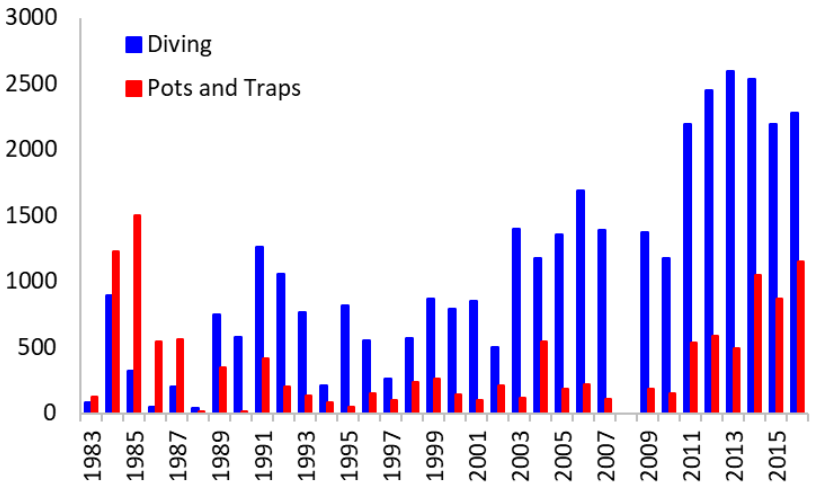
STX





PR



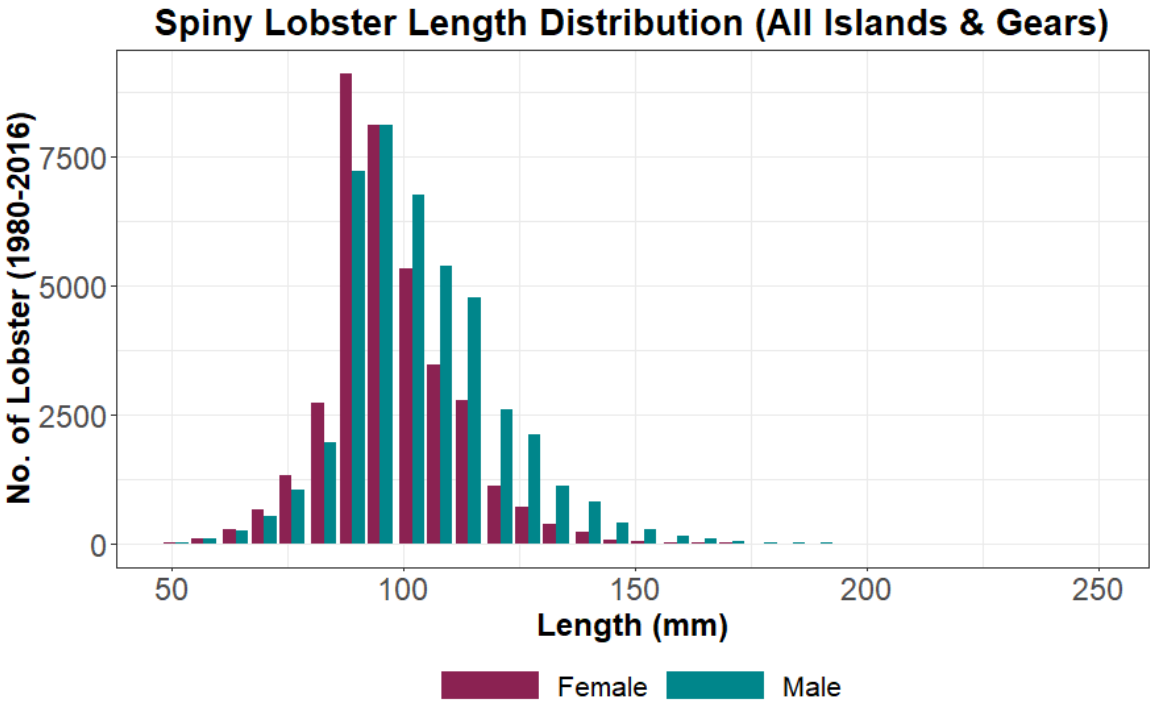


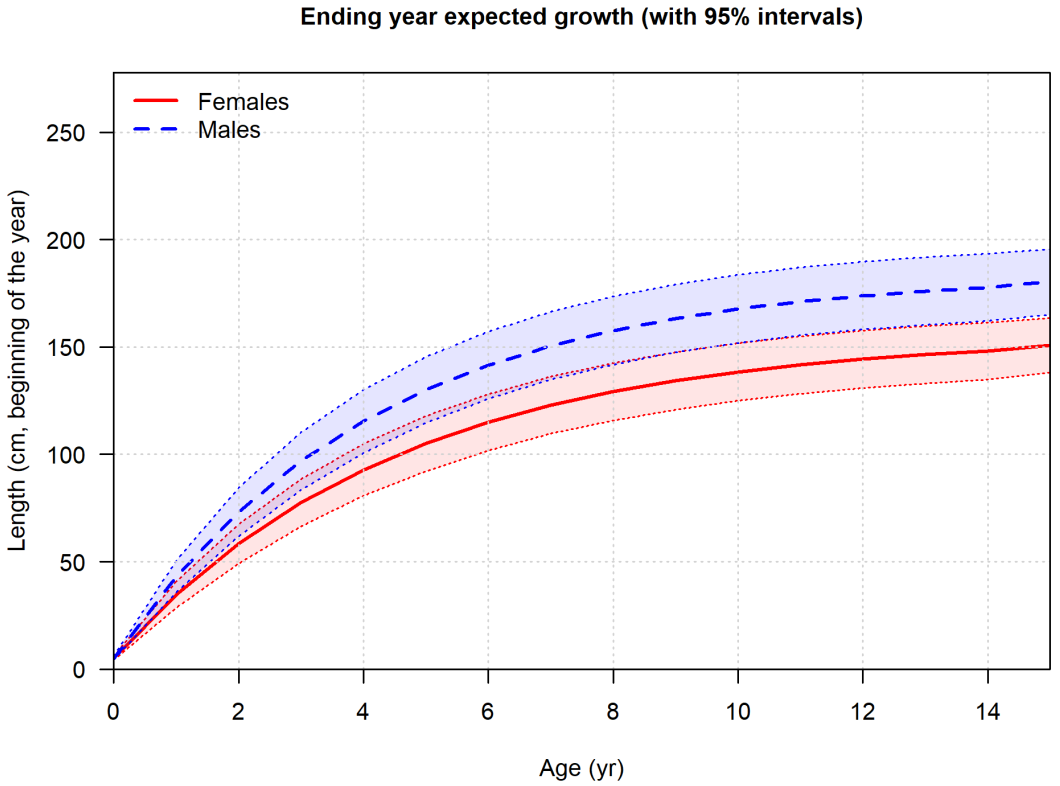
Fixed Parameters

Von Bertalanffy Growth

(Leon et al 1995)

	L_∞	K
Male	184 mm CL	0.24 $year^{-1}$
Female	155 mm CL	0.22 $year^{-1}$





Fixed Parameters

Natural Mortality (Cruz et al. 1981)

Point estimate of 0.34 $year^{-1}$

Within range 0.30 to 0.40 $year^{-1}$ (FAO 2001)

Similar to previous assessments in region

Release Mortality

Deemed negligible by SEDAR 57 Data Workshop

Diving considered highly selective

Limited handling associated with trap fisheries

Post-release predation mortality unknown

Fecundity at Length (FAO 2001; SEDAR 8)

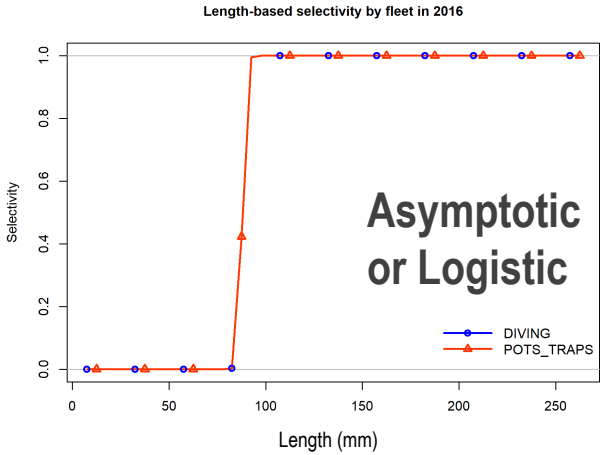
$$Eggs = 0.5911 * L_{CL}{}^{2.9866}$$

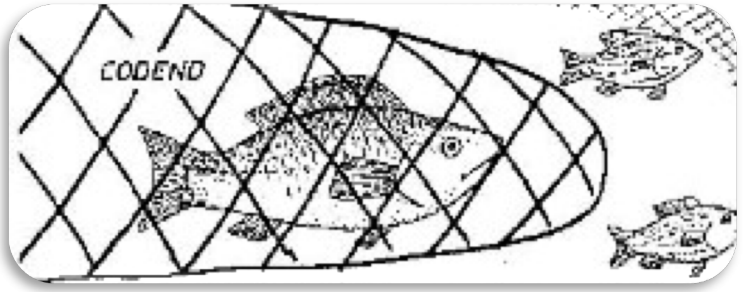
Maturity at Length (Die 2005)*

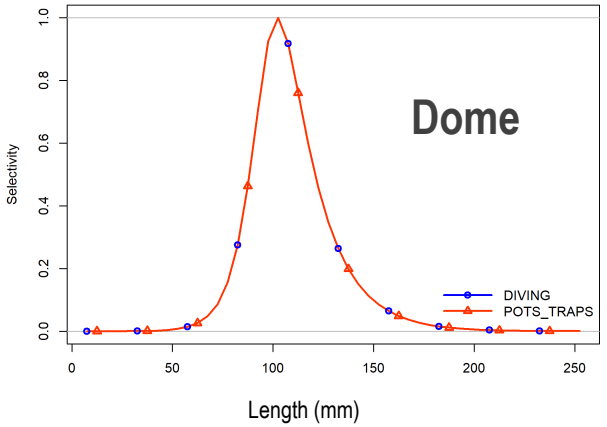
$$mat = \frac{1}{\left(1 - exp\left(\alpha\left(L_{CL} - L_{50}\right)\right)\right)}$$

where L_{50} = 92 mm; α = -0.102

Estimated Parameters: Selectivity





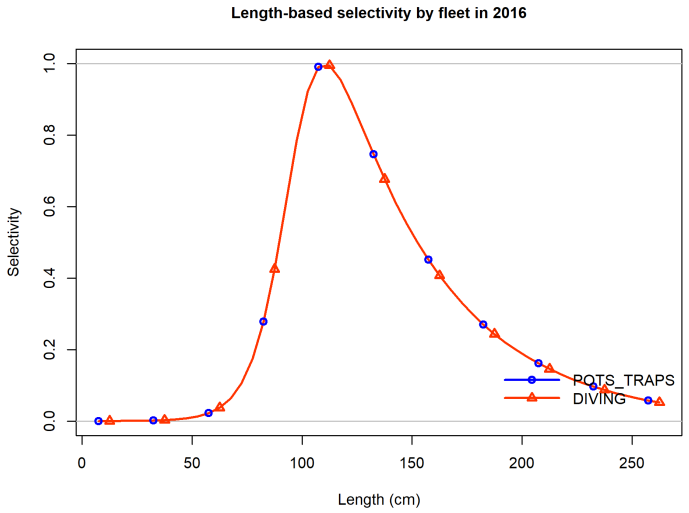


Model Selectivity Pattern: exponential-logistic in size

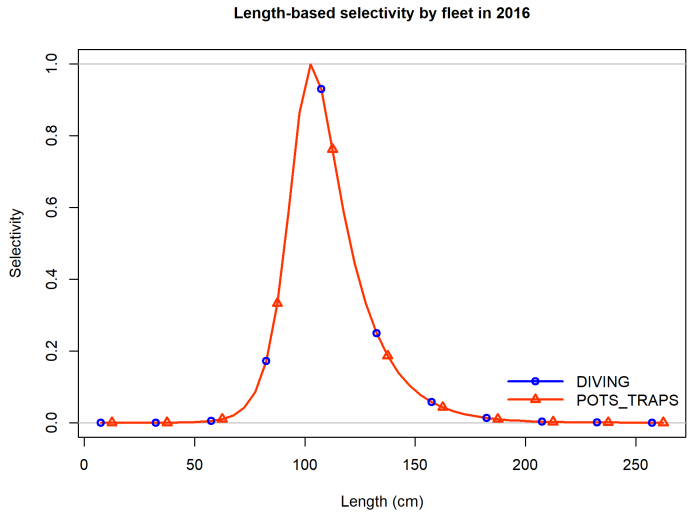
- Tables of modeling “steps” provided in SAR
- Better fit = Lower Negative Loglikelihood

NLL	STT	STX	PR
RW Base	**105.2**	**158.5**	**182.1**
Logistic	113.0	298.4	273.8

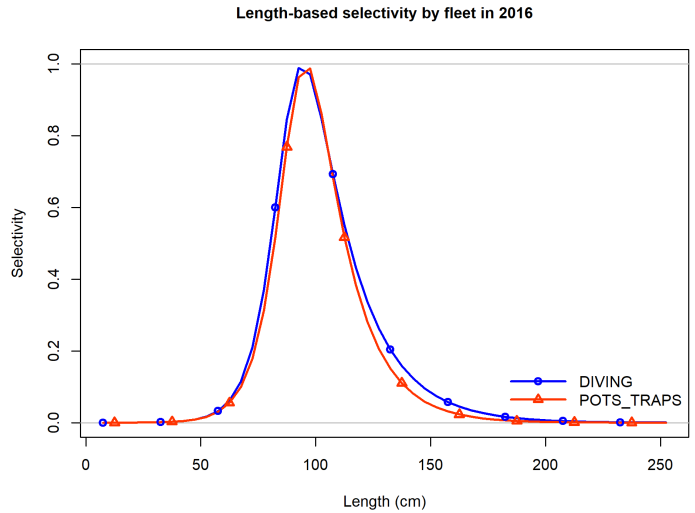
STT



STX



PR



St. Thomas - Model Structure

Two fisheries:

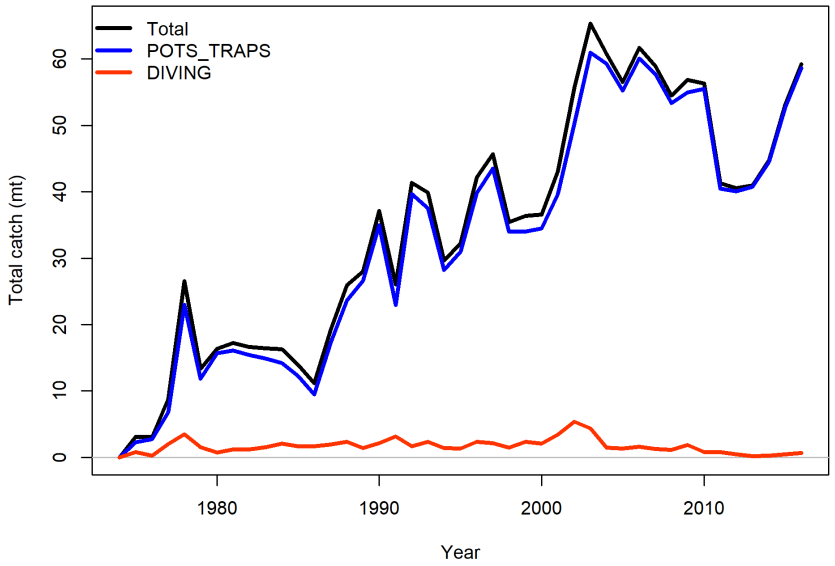
- Pots and traps, diving
- Selectivity at length: estimated for Pots/traps, mirrored for diving
- F initial = 0

Retention blocks:

- Minimum size limit 89 mm (3.5”) introduced in 1985
- Time block for retention over years: 1985-2003, 2007-2016

Estimated quantities:

- Unfished recruitment (R0)
- Selectivity – 3 parameters



ST. Croix - Model Structure

Two fisheries:

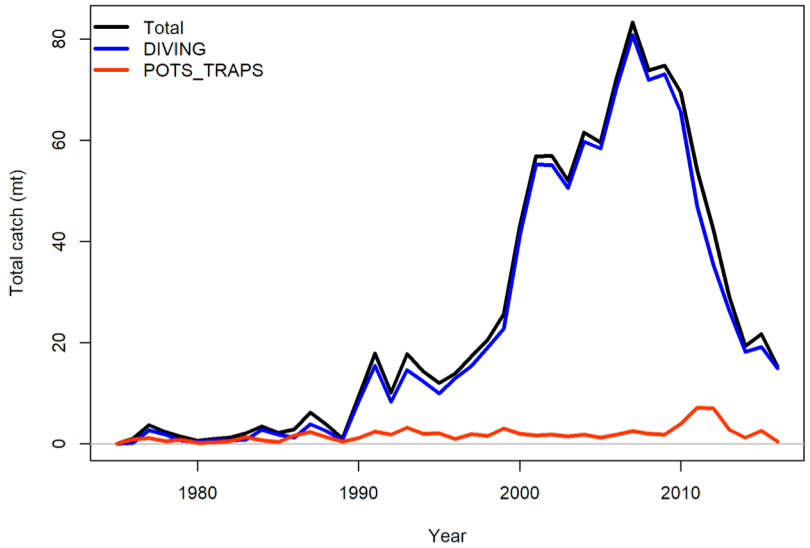
- Diving, Pots and Traps
- Selectivity at length: informative prior “borrowed” from STT, mirrored for trap fishery
- F initial = 0

Retention blocks:

- Minimum size limit 89 mm (3.5”) introduced in 1985
- Time block for retention over years: 1985-2016

Estimated quantities:

- Unfished recruitment (R0)
- Selectivity – 3 parameters with informed priors



Puerto Rico - Model Structure

Two fisheries:

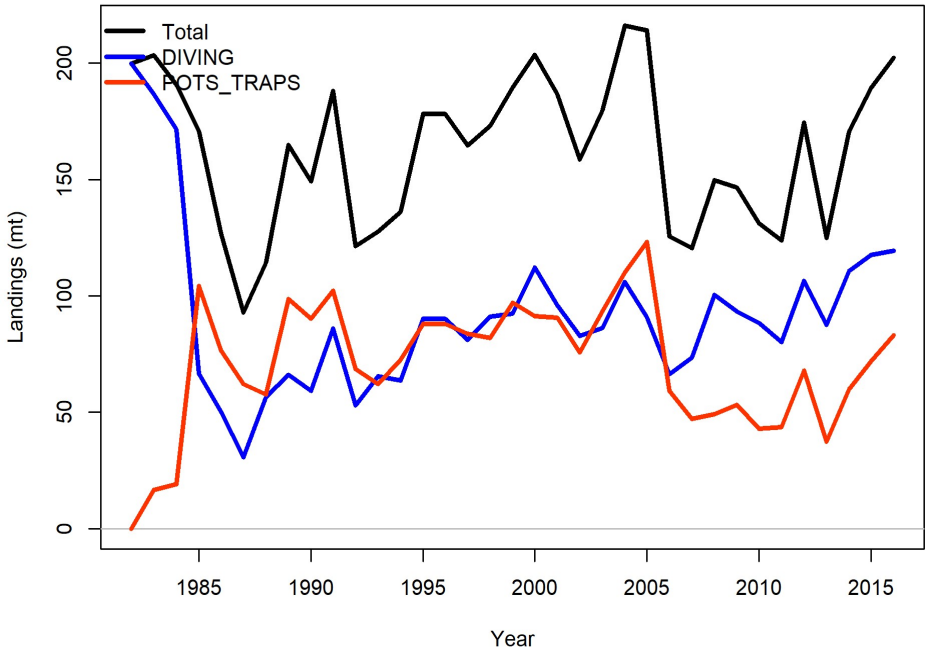
- Pots and traps, diving
- Selectivity at length: estimated for each fleet
- F initial = 0 for pots and traps; estimated for diving

Retention blocks:

- Minimum size limit introduced in 1985, enforced 1999+
- Time block for retention: 1999-2016

Estimated quantities:

- Unfished recruitment (R0)
- Initial F
- Selectivity – 3 parameters for each fleet (3*2)
- Retention – 1 parameter for each fleet (1*2)



Derived Quantities

Proportion of the stock killed by fishing (i.e., harvest rate in biomass landed / total biomass) and associated 95% confidence intervals (vertical lines).

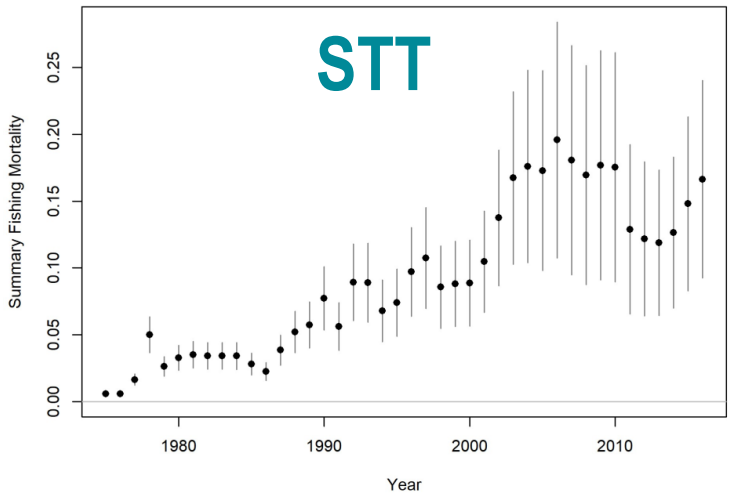


Figure 27. St. Thomas/St. John, proportion of the stock killed by fishing (i.e., harvest rate in biomass landed / total biomass) and associated 95% confidence intervals (vertical lines).

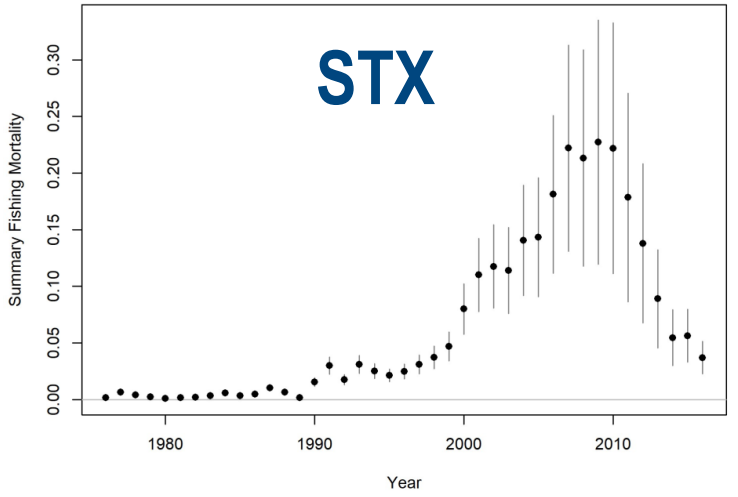


Figure 26. St. Croix, proportion of the stock killed by fishing (i.e., harvest rate in biomass landed / total biomass) and associated 95% confidence intervals (vertical lines).

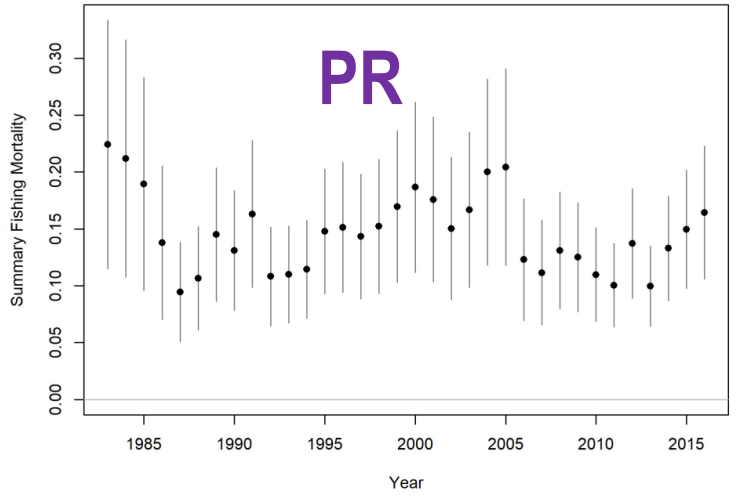
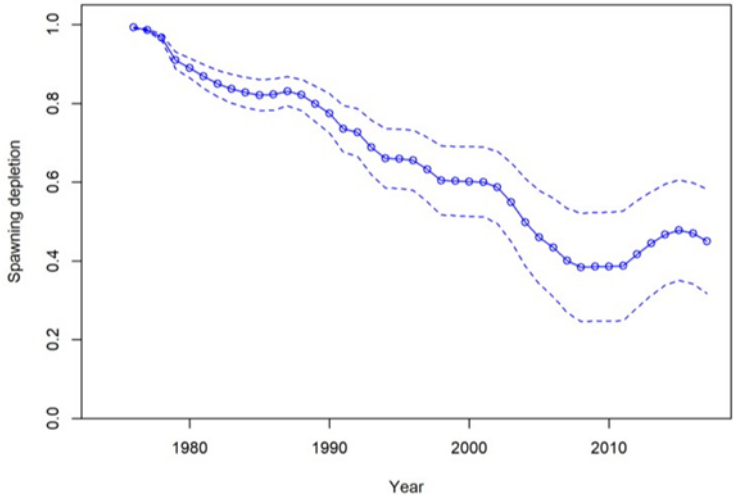
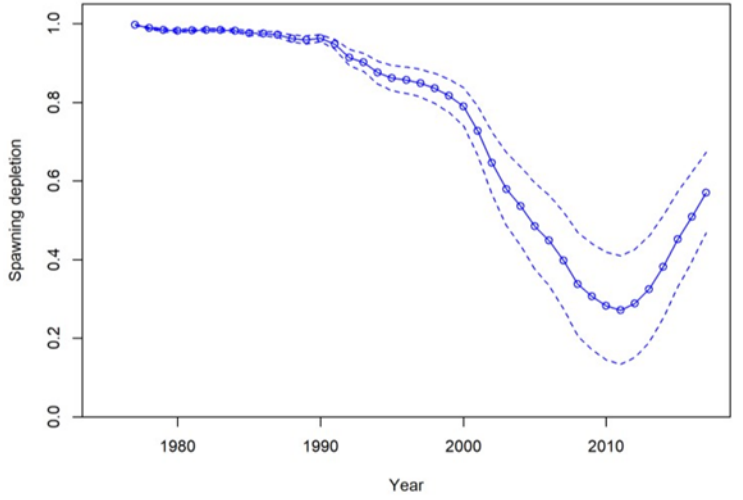
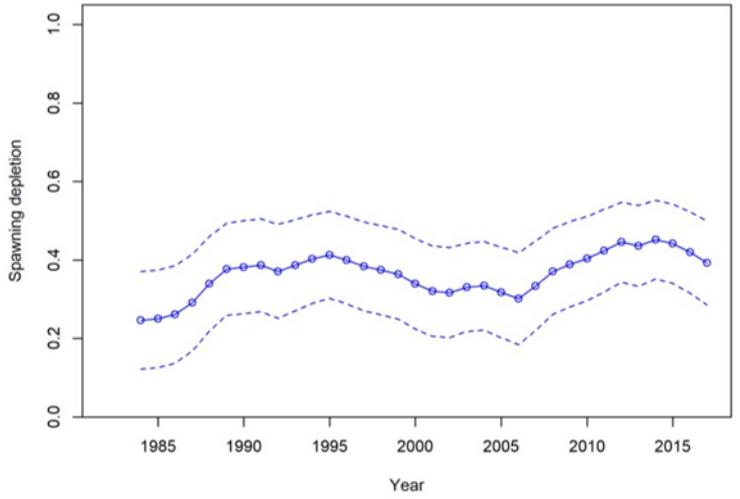


Figure 28. Puerto Rico, proportion of the stock killed by fishing (i.e., harvest rate in biomass landed / total biomass) and associated 95% confidence intervals (vertical lines).

Spawning depletion with 95% confidence interval







Peer Review

Sensitivities explored:

- Assumptions of natural mortality, growth, initial F, and selectivity options

Diagnostics reviewed:

- Retrospective, jitter, correlation analyses and likelihood profiles (not shown today, but included in reports)

Panel recommended:

- Status not overfished and not overfishing for **RW base case** using proxy SPR30%
- Research areas for improvement (from each reviewer) → → →

1. Dome shaped selectivity supported, however, given importance, **further research on selectivity recommended as a priority**. Also recommended **work on PR expansion factors** and **indices of abundance**

2. Recommended **research to quantify other sources of mortality** (i.e., recreational, IUU and discards) as a priority followed by improving data and parameters. Caution due to STT trajectory towards MFMT.

3. Primary recommendation to be completed before the next stock assessment is to **develop one or more abundance indices**

Conclusions

Not overfished and not overfishing for the recommended base case.

Estimates provided using placeholder proxy of SPR of 30%.

Value	Definition	Units	STT	STX	PR
S_{MSY}	Spawning Output using proxy of SSPR30	1000s eggs	2.84E+07 (3.81E+06)	3.06E+07 (3.78E+06)	1.13E+08 (1.19E+07)
F_{MSY}	Fishing Mortality that produces MSY in equilibrium using proxy of S_{SPR30}	Proportion of Stock removed by fishing	0.244 (0.005)	0.203 (0.002)	0.197 (0.003)
MSST	Min. Stock Size Threshold (75% of SSPR30)	1000s eggs	2.13E+07	2.30E+07	8.48E+07
MFMT	Max. Fishing Mortality Threshold (F_{SPR30})	Proportion of Stock removed by fishing	0.244 (0.005)	0.203 (0.002)	0.197 (0.003)
MSY	Equilibrium Retained Yield at proxy of S_{SPR30}	lbs	1.34E+05 (1.67E+04)	1.28E+05 (1.54E+04)	4.33E+05 (4.15E+04)
S_0	Unfished Stock Output	1000s eggs	9.79E+07 (1.31E+07)	1.05E+08 (1.30E+07)	3.88E+08 (4.10E+07)
$S_{Current}$	Spawning Output at Beginning of 2017	1000s eggs	4.40E+07 (1.25E+07)	6.00E+07 (1.29E+07)	1.52E+08 (3.71E+07)
$S_{Current}/S_0$	Calculated from definitions above	proportion	0.449	0.571	0.392
$S_{Current}/S_{MSY}$	Calculated from definitions above	proportion	1.549	1.961	1.345
$S_{Current}$/MSST	Calculated from definitions above	proportion	2.066	2.609	1.792
$F_{Current}$	Fishing Mortality in 2016	Proportion of Stock removed by fishing	0.166 (0.038)	0.037 (0.007)	0.164 (0.030)
$F_{Current}/F_{MSY}$	Calculated from definitions above	proportion	0.680	0.182	0.832
$F_{Current}$/MFMT	Calculated from definitions above	proportion	0.680	0.182	0.832

Projections

Provisional OFL projections (and standard deviations). Estimates provided using placeholder proxy of SPR of 30%.

Currently, not a lot of uncertainty is incorporated into the OFL PDF.

	St. Thomas	St. Croix	Puerto Rico
2017*	91,801	25,671	286,081
2018*	91,801	25,671	286,081
2019	185,943 (37,743)	191,834 (26,257)	515,017 (71,033)
2020	160,433 (28,087)	155,412 (21,142)	469,402 (57,739)
2021	148,088 (24,119)	141,965 (19,886)	452,682 (54,807)
2022	142,134 (22,443)	136,512 (19,489)	445,728 (53,594)
ACL 2012	104,307	107, 307	327,920
ABC IBFMPs	220,221	207,925	554,981
ACL IBFMPs	**209,210**	**197,528**	**527,232**
SEDAR 57 MSY	134,000	128,000	433,000

Summary of Model Inputs

Data

- Annual removals by Gear
- Annual length composition by Gear

Estimated Parameters

- Unfished recruitment (R0)
- Selectivity and Retention

Fixed Parameters

- Growth
- Natural Mortality
- Logistic Maturity
- Steepness, h=0.95
- 50/50 sex ratio
- Time block for retention due to size limit

Summary of Recommendations

- Further research on selectivity
- Improve PR expansion factors
- Quantify other sources of mortality (recreational, IUU and discards)
- Develop one or more abundance indices
- Improving life history data and parameters
- Update projections

Questions?

Links to SEDAR 57 Documents @ SEDARWeb.org

- SEDAR 57 US Caribbean Spiny Lobster Final Stock Assessment Report
- CIE Reviewer Report – Dichmont
- CIE Reviewer Report – Frusher
- CIE Reviewer Report - Medley
- SEDAR 57 Caribbean Spiny Lobster Project Schedule
- SEDAR 57 Caribbean Spiny Lobster Terms of Reference

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