Status of A Fish (*Sebastes yourfish*) Off the U.S. Pacific Coast in 2017

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Status of A Fish (*Sebastes yourfish*) Off the U.S. Pacific Coast in 2017

Contents

Executive Summary

executive-summary

Stock

stock

This assessment reports the status of the China rockfish (*Sebastes nebulosus*) resource in U.S. waters off the coast of ... using data through 2014.

Catches

catches

Information on historical landings of China rockfish are available back to xxxx... (Table a). Commercial landings were small during the years of World War II, ranging between 0 to 0 metric tons (mt) per year.

(Figures a-b)
(Figure c)

Since 2000, annual total landings of China rockfish have ranged between 2-4 mt, with landings in 2014 totaling 3 mt.

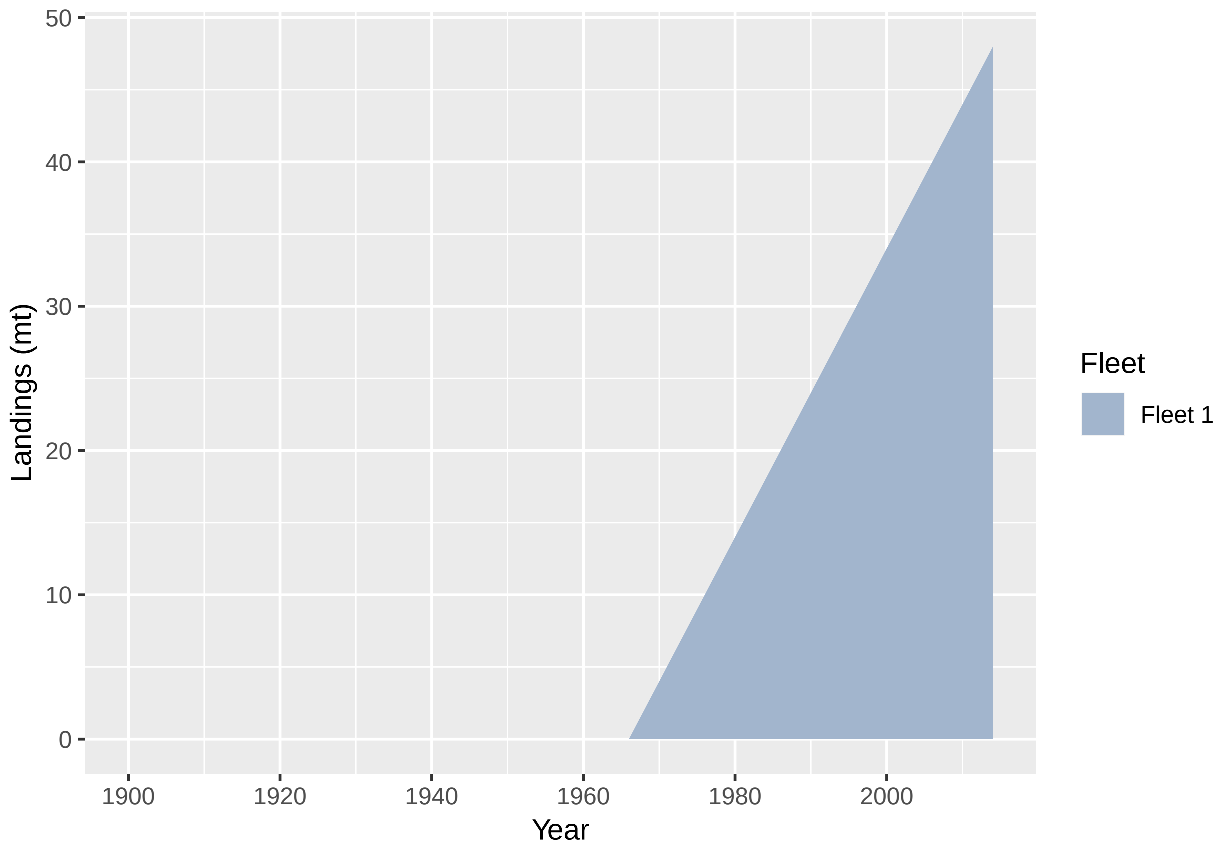

Figure a: China rockfish catch history for the recreational fleets. fig:Exec_catch1

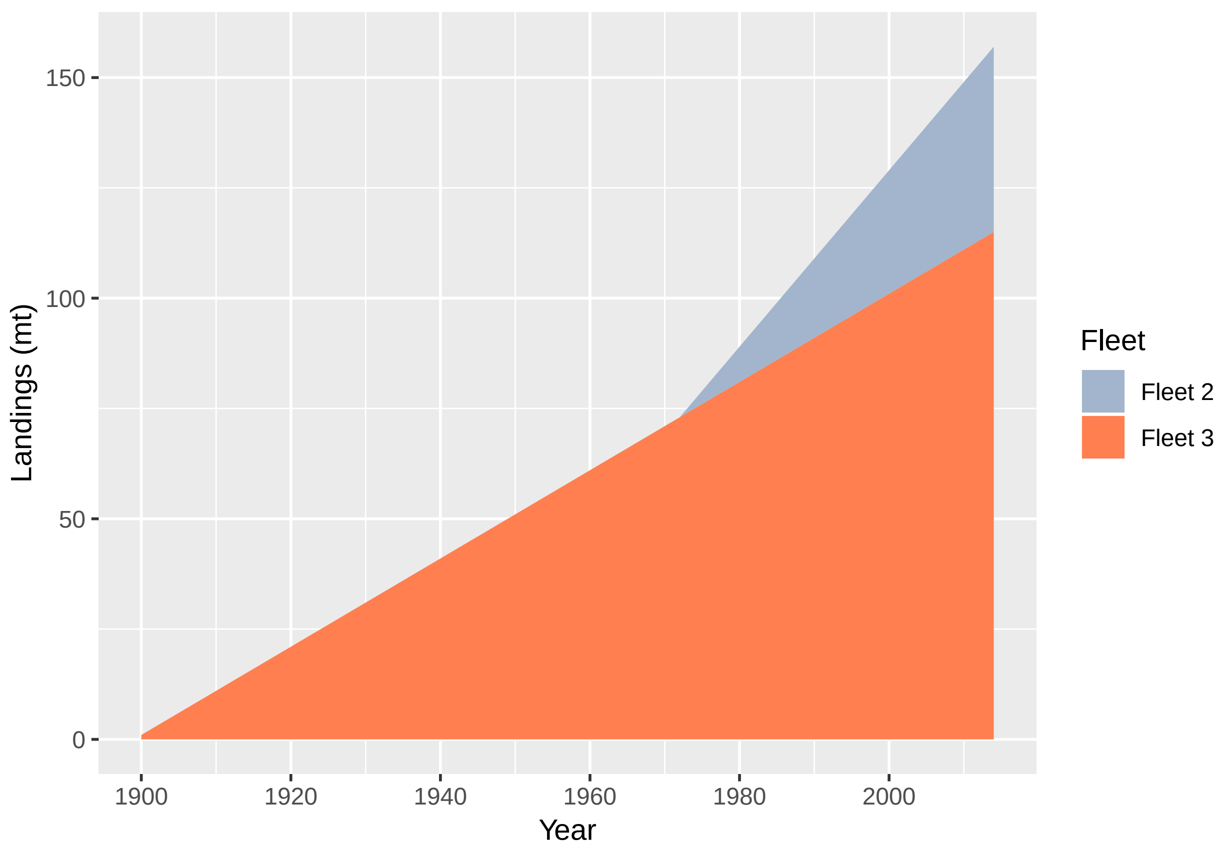

Figure b: Stacked line plot of China rockfish catch history for the commercial fleets. fig:Exec_catch2

Table a: Recent China rockfish landings (mt) by fleet.

tab:Exec_catch

Year	Landings 1	Landings 2	Landings 3	Landings 4	Landings 5	Total
2005	-	-	-	-	-	-
2006	-	-	-	-	-	-
2007	-	-	-	-	-	-
2008	-	-	-	-	-	-
2009	-	-	-	-	-	-
2010	-	-	-	-	-	-
2011	-	-	-	-	-	-
2012	-	-	-	-	-	-
2013	-	-	-	-	-	-
2014	-	-	-	-	-	-

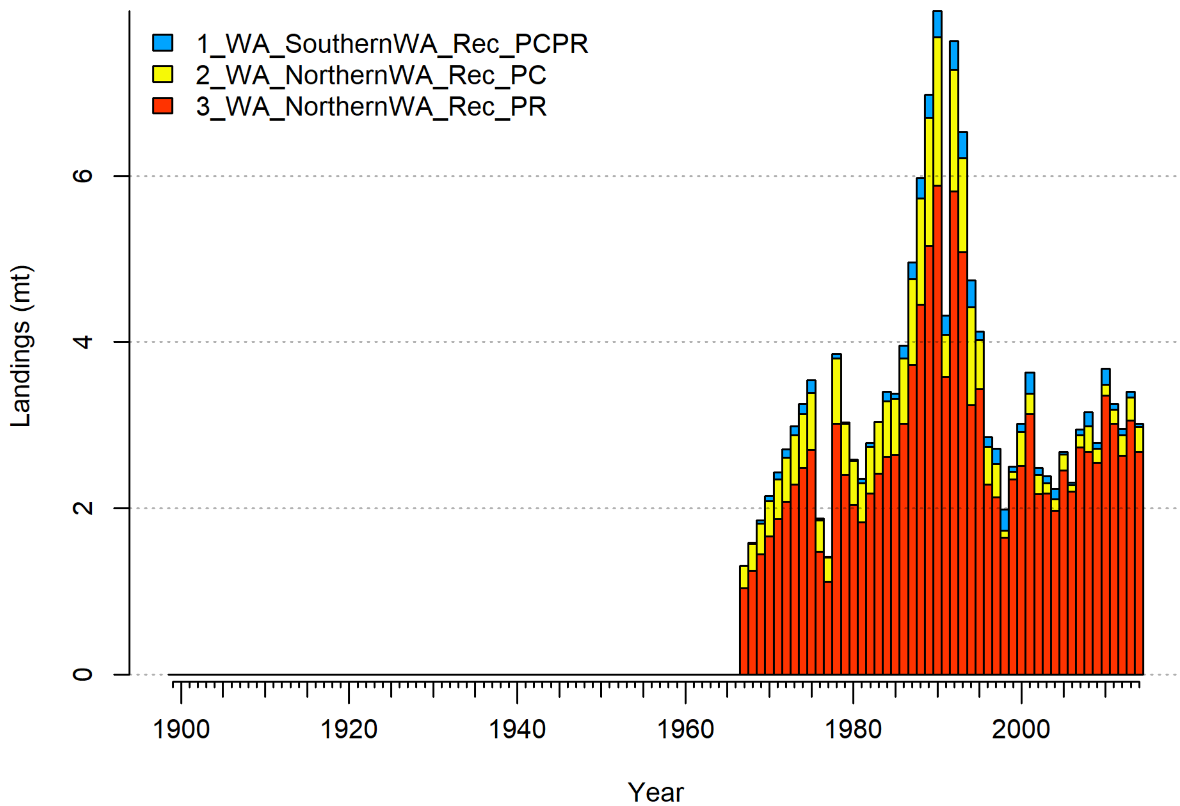

Figure c: Catch history of China rockfish in the Northern model. fig:r4ss_catches

Data and Assessment

data-and-assessment

This a new full assessment for China rockfish, which was last assessed in … using Stock Synthesis Version xx. This assessment uses the newest version of Stock Synthesis (3.30.xx). The model begins in 1900, and assumes the stock was at an unfished equilibrium that year.

(Figure d).

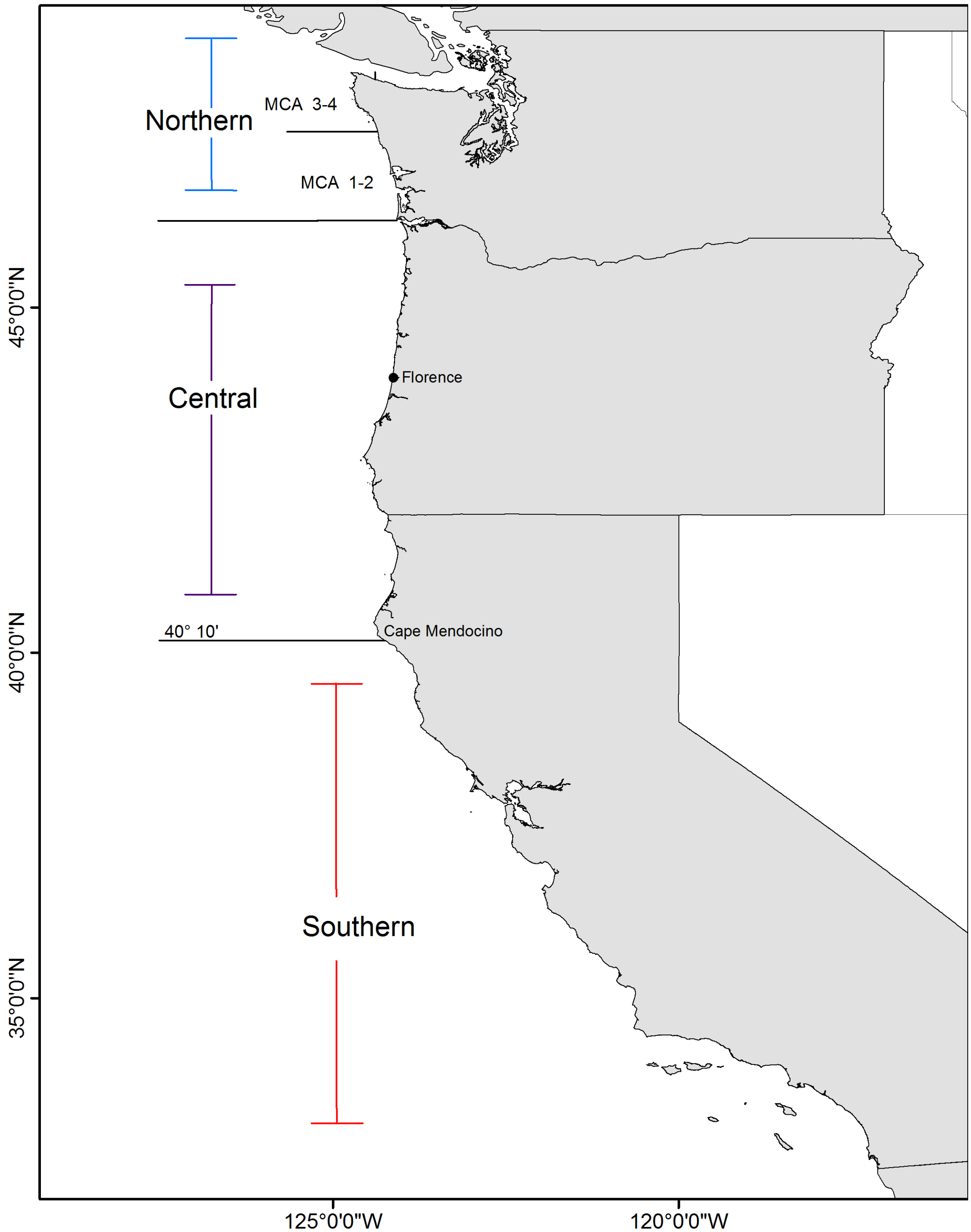

Figure d: Map depicting the distribution of California scorpionfish out to 600 ft. The stock assessment is bounded at Pt. Conception in the north to the U.S./Mexico border in the south. fig:assess_region_map

Stock Biomass

stock-biomass

(Figure e and Table b).

The 2014 estimated spawning biomass relative to unfished equilibrium spawning biomass is above the target of 40% of unfished spawning biomass at 73.4% (95% asymptotic interval: ± 63.7%-83.2%) (Figure f). Approximate confidence intervals based on the asymptotic variance estimates show that the uncertainty in the estimated spawning biomass is high.

Table b: Recent trend in beginning of the year spawning output and depletion for the Northern model for China rockfish.

tab:SpawningDeplete_mod1

Year	Spawning Output (billion eggs)	~ 95% confidence interval	Estimated depletion	~ 95% confidence interval
2006	17.942	(8.86-27.03)	0.734	(0.638-0.83)
2007	18.030	(8.94-27.12)	0.738	(0.642-0.833)
2008	18.044	(8.95-27.14)	0.738	(0.643-0.833)
2009	18.034	(8.93-27.13)	0.738	(0.642-0.833)
2010	18.062	(8.96-27.17)	0.739	(0.644-0.834)
2011	17.993	(8.89-27.1)	0.736	(0.64-0.833)
2012	17.971	(8.86-27.08)	0.735	(0.638-0.832)
2013	17.981	(8.87-27.09)	0.736	(0.639-0.833)
2014	17.944	(8.83-27.06)	0.734	(0.637-0.832)
2015	17.950	(8.83-27.07)	0.734	(0.637-0.832)

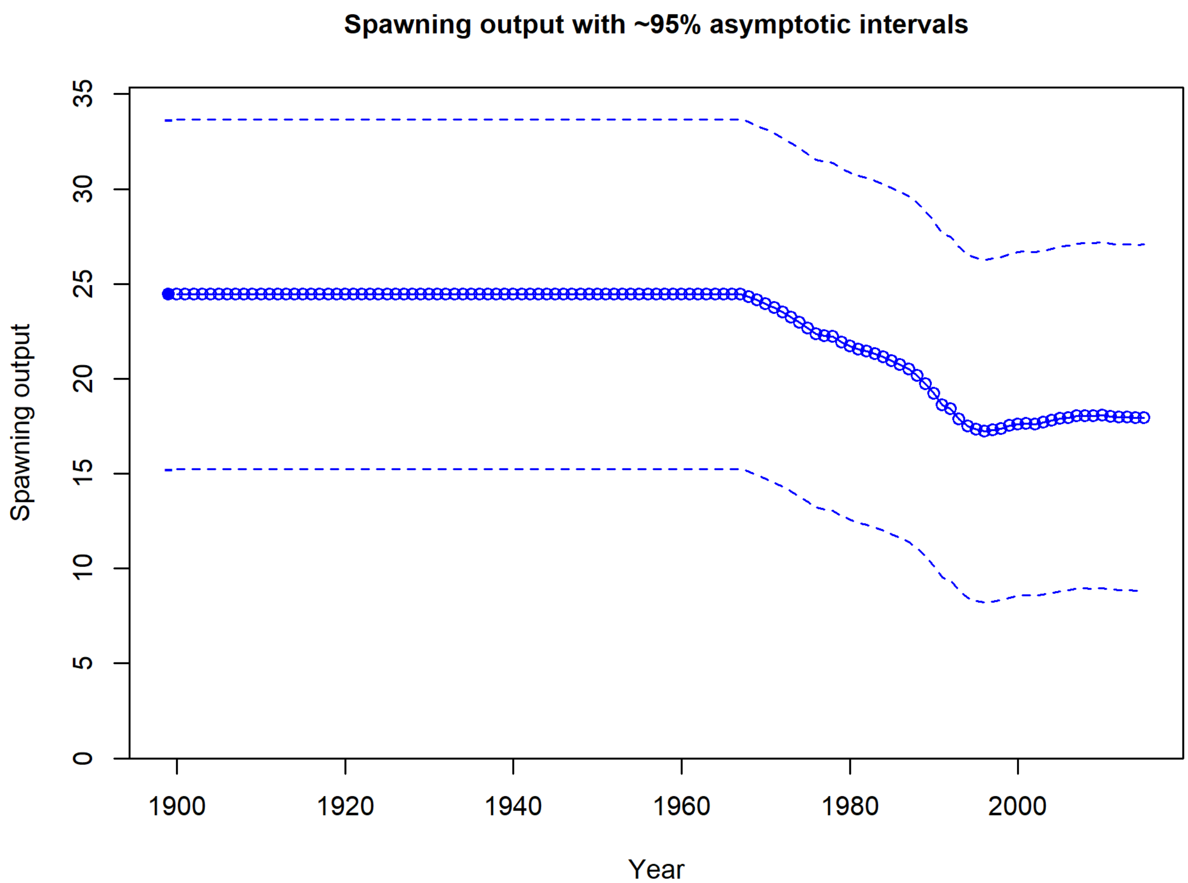

Figure e: Time series of spawning biomass trajectory (circles and line: median; light broken lines: 95% credibility intervals) for the base case assessment model. fig:Spawnbio_all

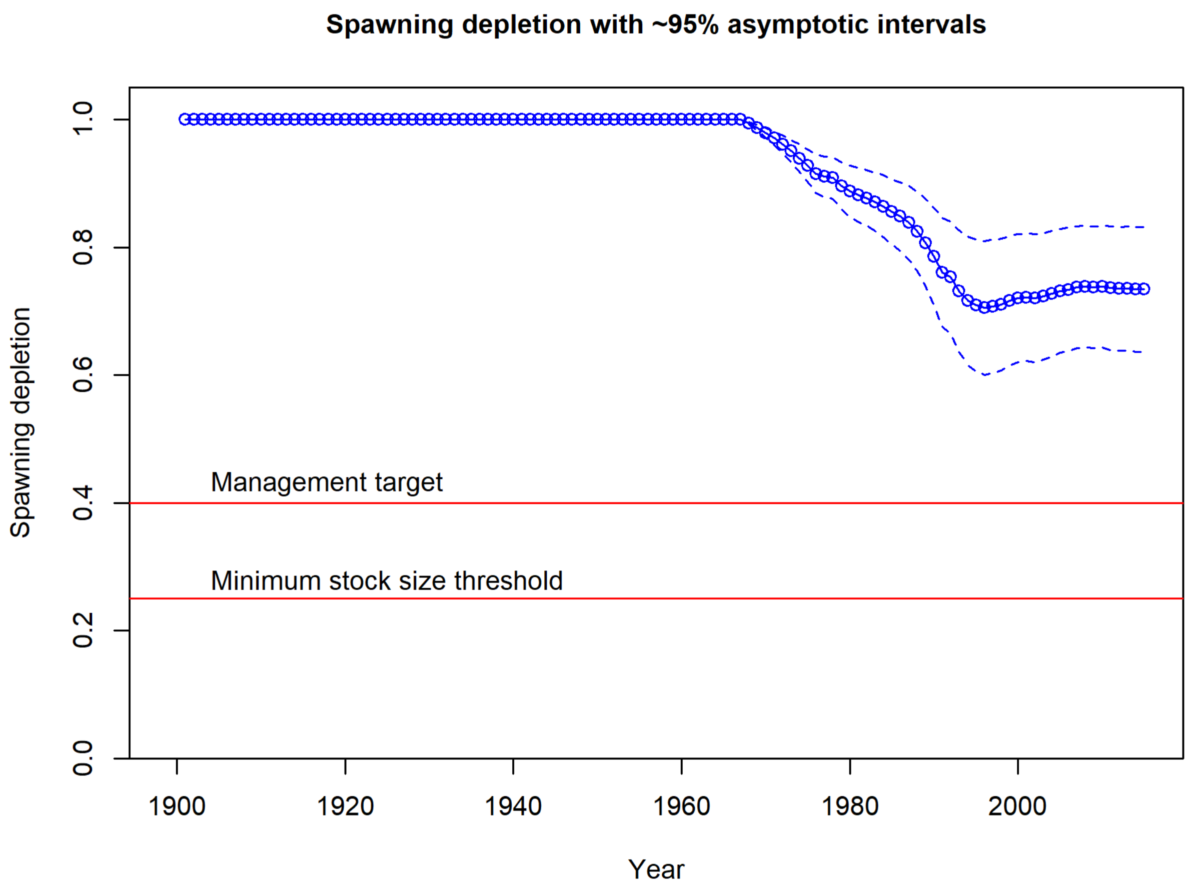

Figure f: Estimated relative depletion with approximate 95% asymptotic confidence intervals (dashed lines) for the base case assessment model. fig:RelDeplete_all

Recruitment

recruitment

Recruitment deviations were estimated from xxxx-xxxx (Figure g and Table c).

Table c: Recent recruitment for the Northern model.

tab:Recruit_mod1

Year	Estimated Recruitment (1,000s)	~ 95% confidence interval
2006	33.29	(23.31 - 47.53)
2007	33.30	(23.33 - 47.54)
2008	33.30	(23.33 - 47.54)
2009	33.30	(23.33 - 47.54)
2010	33.31	(23.33 - 47.55)
2011	33.30	(23.32 - 47.54)
2012	33.29	(23.31 - 47.54)
2013	33.29	(23.32 - 47.54)
2014	33.29	(23.31 - 47.54)
2015	33.29	(23.31 - 47.54)

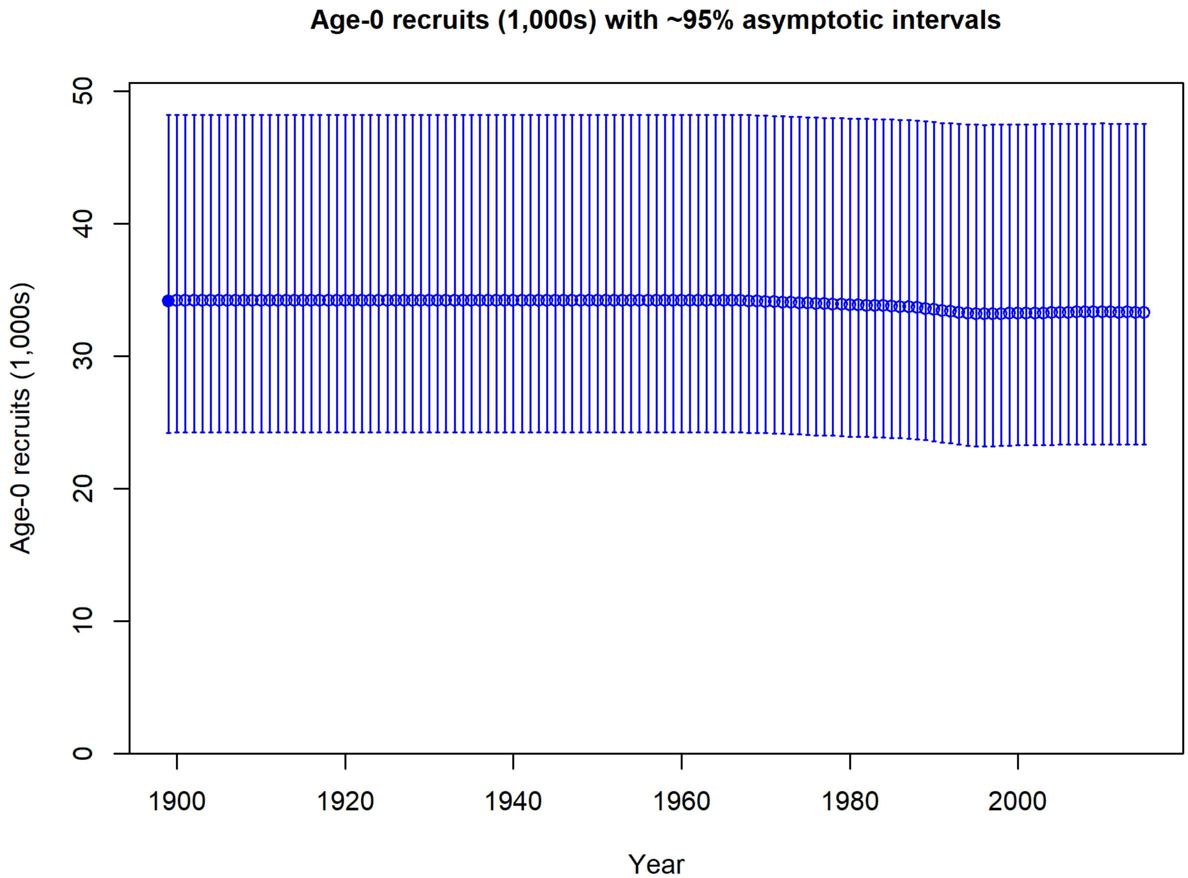

Figure g: Time series of estimated China rockfish recruitments for the base-case model with 95% confidence or credibility intervals. fig:Recruits_all

Exploitation status

exploitation-status

Harvest rates estimated by the base model ….. management target levels (Table d and Figure h).

Table d: Recent trend in spawning potential ratio and exploitation for China rockfish in the Northern model. Fishing intensity is (1-SPR) divided by 50% (the SPR target) and exploitation is F divided by F_{SPR}.

tab:SPR_Exploit_mod1

Year	Fishing intensity	~ 95% confidence interval	Exploitation rate	~ 95% confidence interval
2005	0.44	(0.27-0.61)	0.32	(0.17-0.47)
2006	0.39	(0.24-0.55)	0.28	(0.15-0.4)
2007	0.47	(0.3-0.65)	0.35	(0.19-0.51)
2008	0.50	(0.32-0.68)	0.38	(0.2-0.55)
2009	0.45	(0.28-0.63)	0.33	(0.18-0.49)
2010	0.56	(0.36-0.76)	0.44	(0.24-0.64)
2011	0.51	(0.32-0.7)	0.39	(0.21-0.57)
2012	0.48	(0.3-0.66)	0.35	(0.19-0.52)
2013	0.53	(0.34-0.72)	0.41	(0.22-0.59)
2014	0.48	(0.3-0.67)	0.36	(0.19-0.53)

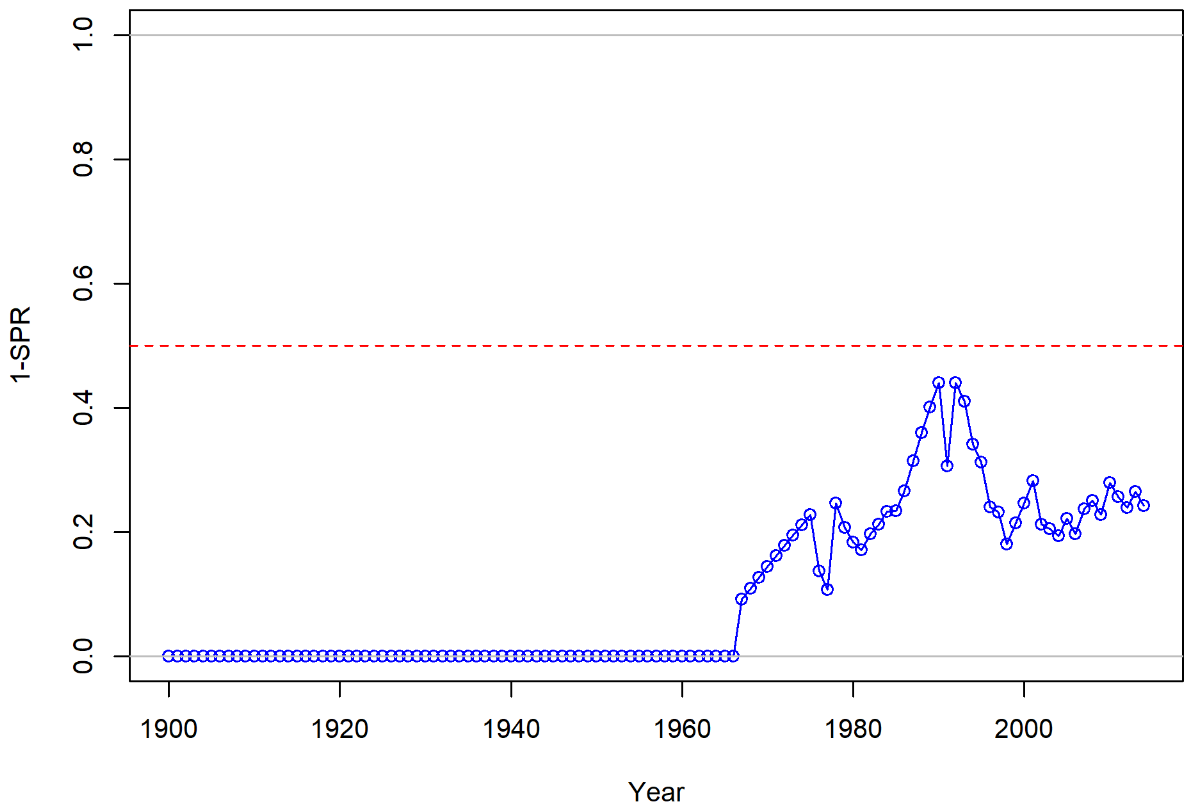

Figure h: Estimated spawning potential ratio (SPR) for the base-case model. One minus SPR is plotted so that higher exploitation rates occur on the upper portion of the y-axis. The management target is plotted as a red horizontal line and values above this reflect harvests in excess of the overfishing proxy based on the $SPR_{50\%}$ harvest rate. The last year in the time series is 2014. fig:SPR_all

Ecosystem Considerations

ecosystem-considerations

In this assessment, ecosystem considerations were not explicitly included in the analysis. This is primarily due to a lack of relevant data and results of analyses (conducted elsewhere) that could contribute ecosystem-related quantitative information for the assessment.

Reference Points

reference-points

This stock assessment estimates that China rockfish in the Northern model is above the biomass target ($SB_{40\%}$), and well above the minimum stock size threshold ($SB_{25\%}$). The estimated relative depletion level for the base model in 2015 is 73.4% (95% asymptotic interval: ± 63.7%-83.2%, corresponding to an unfished spawning biomass of 17.9497 billion eggs (95% asymptotic interval: 8.83-27.07 billion eggs) of spawning biomass in the base model (Table e). Unfished age 1+ biomass was estimated to be 240.8 mt in the base case model. The target spawning biomass ($SB_{40\%}$) is 9.8 billion eggs, which corresponds with an equilibrium yield of 6.3 mt. Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is 5.8 mt (Figure i).

Table e: Summary of reference points and management quantities for the base case Northern model.

tab:Ref_pts_mod1

Quantity	**Estimate**	**95% Confidence Interval**
Unfished spawning output (billion eggs)	24.4	(15.2-33.7)
Unfished age 1+ biomass (mt)	240.8	(153-328.7)
Unfished recruitment (R0, thousands)	34.2	(22.3-46)
Spawning output(2014 billion eggs)	17.9	(8.8-27.1)
Depletion (2014)	0.7342	(0.6367-0.8317)
Reference points based on $\mathbf{SB_{40\%}}$		
Proxy spawning output ($B_{40\%}$)	9.8	(6.1-13.5)
SPR resulting in $B_{40\%}$ ($SPR_{B40\%}$)	0.444	(0.444-0.444)
Exploitation rate resulting in $B_{40\%}$	0.0551	(0.0522-0.058)
Yield with $SPR_{B40\%}$ at $B_{40\%}$ (mt)	6.3	(4-8.5)
Reference points based on SPR proxy for MSY		
Spawning output	11.3	(7-15.5)
SPR_{proxy}	0.5	
Exploitation rate corresponding to SPR_{proxy}	0.0458	(0.0435-0.0482)
Yield with SPR_{proxy} at SB_{SPR} (mt)	5.8	(3.7-7.9)
Reference points based on estimated MSY values		
Spawning output at MSY (SB_{MSY})	5.6	(3.5-7.8)
SPR_{MSY}	0.2875	(0.2823-0.2927)
Exploitation rate at MSY	0.0924	(0.0863-0.0985)
MSY (mt)	7	(4.5-9.4)

Management Performance

management-performance

Table f

Unresolved Problems and Major Uncertainties

unresolved-problems-and-major-uncertainties

Table f: Recent trend in total catch and commercial landings (mt) relative to the management guidelines. Estimated total catch reflect the commercial landings plus the model estimated discarded biomass.

tab:mnmgt_perform

Year	OFL (mt; ABC prior to 2011)	ABC (mt)	ACL (mt; OY prior to 2011)	Estimated total catch (mt)
2007	-	-	-	-
2008	-	-	-	-
2009	-	-	-	-
2010	-	-	-	-
2011	-	-	-	-
2012	-	-	-	-
2013	-	-	-	-
2014	-	-	-	-
2015	-	-	-	-
2016	-	-	-	-
2017	-	-	-	-
2018	-	-	-	-

135 # Decision Table

decision-table

Table g: Projections of potential OFL (mt) for each model, using the base model forecast.

tab:OFL_projection

Year	OFL
2015	9.51
2016	9.57
2017	9.63
2018	9.29
2019	8.98
2020	8.69
2021	8.43
2022	8.20
2023	7.99
2024	7.80
2025	7.64
2026	7.49

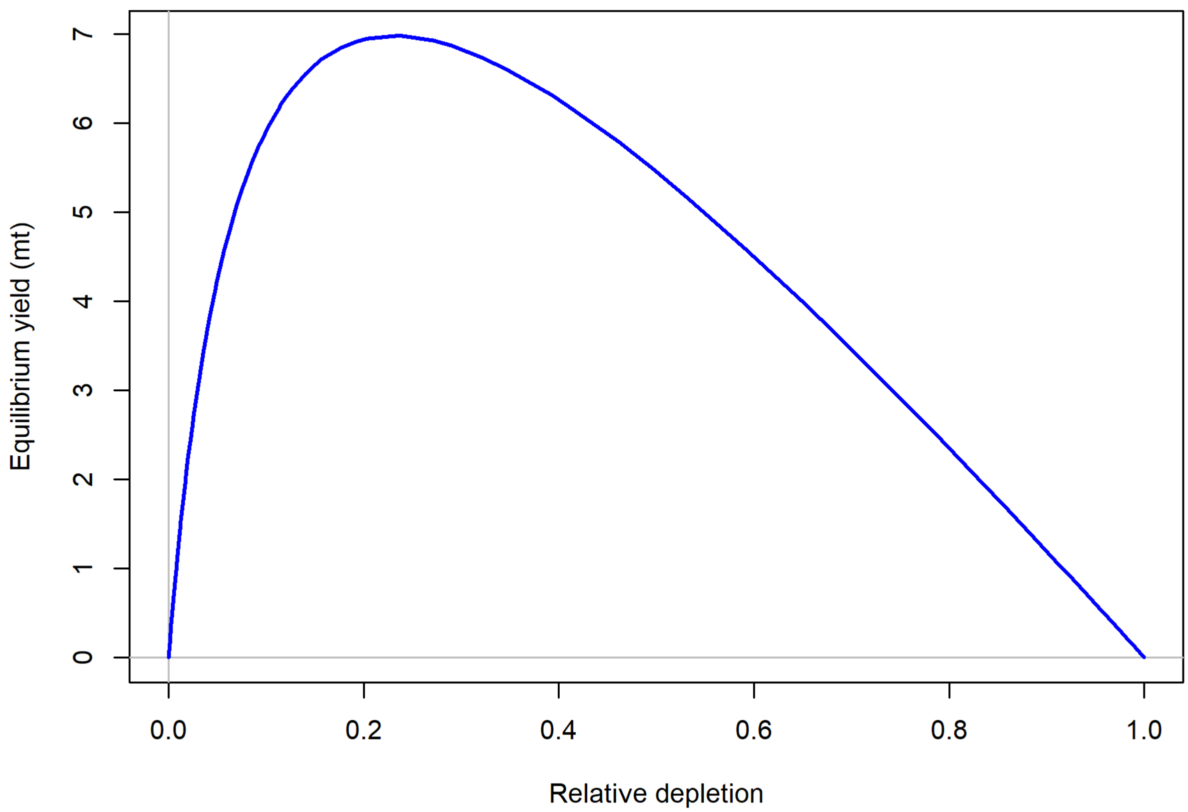

Figure i: Equilibrium yield curve for the base case model. Values are based on the 2014 fishery selectivity and with steepness fixed at 0.718. fig:Yield_all

Table h: Summary of 10-year projections beginning in 2016 for alternate states of nature based on an axis of uncertainty for the Northern model. Columns range over low, mid, and high states of nature, and rows range over different assumptions of catch levels. An entry of "–" indicates that the stock is driven to very low abundance under the particular scenario.
tab:Decision_table_mod1

			States of nature					
			Low M 0.05		Base M 0.07		High M 0.09	
	Year	Catch	Spawning Output	Depletion	Spawning Output	Depletion	Spawning Output	Depletion
40-10 Rule, Low M	2019	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-
	2021	-	-	-	-	-	-	-
	2022	-	-	-	-	-	-	-
	2023	-	-	-	-	-	-	-
	2024	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-
	2026	-	-	-	-	-	-	-
	2027	-	-	-	-	-	-	-
	2028	-	-	-	-	-	-	-
40-10 Rule	2019	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-
	2021	-	-	-	-	-	-	-
	2022	-	-	-	-	-	-	-
	2023	-	-	-	-	-	-	-
	2024	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-
	2026	-	-	-	-	-	-	-
	2027	-	-	-	-	-	-	-
	2028	-	-	-	-	-	-	-
40-10 Rule, High M	2019	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-
	2021	-	-	-	-	-	-	-
	2022	-	-	-	-	-	-	-
	2023	-	-	-	-	-	-	-
	2024	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-
	2026	-	-	-	-	-	-	-
	2027	-	-	-	-	-	-	-
	2028	-	-	-	-	-	-	-
Average Catch	2019	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-
	2021	-	-	-	-	-	-	-
	2022	-	-	-	-	-	-	-
	2023	-	-	-	-	-	-	-
	2024	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-
	2026	-	-	-	-	-	-	-
	2027	-	-	-	-	-	-	-
	2028	-	-	-	-	-	-	-

Table i: Base case results summary.

tab:base_summary

Quantity	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Landings (mt)										
Total Est. Catch (mt)										
OFL (mt)										
ACL (mt)										
(1-SPR)(1-$SPR_{50\%}$)	0.39	0.47	0.50	0.45	0.56	0.51	0.48	0.53	0.48	
Exploitation rate	0.28	0.35	0.38	0.33	0.44	0.39	0.35	0.41	0.36	
Age 1+ biomass (mt)	182.15	182.55	183.26	183.36	183.25	183.49	182.90	182.72	182.82	182.52
Spawning Output	17.9	18.0	18.0	18.0	18.1	18.0	18.0	18.0	17.9	17.9
95% CI	(8.86-27.03)	(8.94-27.12)	(8.95-27.14)	(8.93-27.13)	(8.96-27.17)	(8.89-27.1)	(8.86-27.08)	(8.87-27.09)	(8.83-27.06)	(8.83-27.07)
Depletion	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
95% CI	(0.638-0.83)	(0.642-0.833)	(0.643-0.833)	(0.642-0.833)	(0.644-0.834)	(0.64-0.833)	(0.638-0.832)	(0.639-0.833)	(0.637-0.832)	(0.637-0.832)
Recruits	33.29	33.30	33.30	33.30	33.31	33.30	33.29	33.29	33.29	33.29
95% CI	(23.31 - 47.53)	(23.33 - 47.54)	(23.33 - 47.54)	(23.33 - 47.54)	(23.33 - 47.55)	(23.32 - 47.54)	(23.31 - 47.54)	(23.32 - 47.54)	(23.31 - 47.54)	(23.31 - 47.54)

Research and Data Needs

research-and-data-needs

We recommend the following research be conducted before the next assessment:

1. **xxxx**:
2. **xxxx**:
3. **xxxx**:
4. **xxxx**:
5. **xxxx**:

1 Introduction

introduction

1.1 Basic Information and Life History

basic-information-and-life-history

1.2 Early Life History

early-life-history

1.3 Map

map

A map showing the scope of the assessment and depicting boundaries for fisheries or data collection strata is provided in Figure 1.

1.4 Ecosystem Considerations

ecosystem-considerations-1

In this assessment, ecosystem considerations were not explicitly included in the analysis. This is primarily due to a lack of relevant data and results of analyses (conducted elsewhere) that could contribute ecosystem-related quantitative information for the assessment.

1.5 Fishery Information

fishery-information

1.6 Summary of Management History

summary-of-management-history

1.7 Management Performance

management-performance-1

Table f

1.8 Fisheries Off Mexico or Canada

fisheries-off-mexico-or-canada

2 Assessment

assessment

2.1 Data

data

Data used in the China rockfish assessment are summarized in Figure 2. Descriptions of the data sources are in the following sections.

2.1.1 Commercial Fishery Landings

`commercial-fishery-landings`

2.1.2 Commercial Discards

`commercial-discards`

2.1.3 Commercial Fishery Length and Age Data

`commercial-fishery-length-and-age-data`

The input sample sizes were calculated via the Stewart Method (Ian Stewart, personal communication, IPHC):

$$\text{Input effN} = N_{\text{trips}} + 0.138 * N_{\text{fish}} \text{ if } N_{\text{fish}}/N_{\text{trips}} \text{ is } < 44$$

$$\text{Input effN} = 7.06 * N_{\text{trips}} \text{ if } N_{\text{fish}}/N_{\text{trips}} \text{ is } \geq 44$$

2.1.4 Sport Fishery Removals and Discards

`sport-fishery-removals-and-discards`

Biological samples from the recreational fleets are described in the sections below.

2.1.5 Fishery-Dependent Indices of Abundance

`fishery-dependent-indices-of-abundance`

Data Source 1

Data Source 1 Index Standardization

Data Source 1 Length Composition

Data Source 2

Data Source 3

2.1.6 Fishery-Independent Data Sources

`fishery-independent-data-sources`

Data Source 1

Data Source 1 Index Standardization

Data Source 1 Length Composition

Data Source 2

2.1.7 Biological Parameters and Data

`biological-parameters-and-data`

Love et al. (1987)

Length and Age Compositions

Length compositions were provided from the following sources:

- Source 1 (*type, e.g., commercial dead fish, research, recreational*, yyyy-yyyy)
- Source 2 (*type*, yyyy-yyyy)
- Source 3 (*research*, yyyy, yyyy, yyyy, yyyy)

The length composition of all fisheries aggregated across time by fleet is in Figure 3. Descriptions and details of the length composition data are in the above section for each fleet or survey.

Age Structures

von Bertalanffy growth curve (Bertalanffy 1938), $L_i = L_\infty e^{(-k[t-t_0])}$, where L_i is the length (cm) at age i, t is age in years, k is rate of increase in growth, t_0 is the intercept, and L_∞ is the asymptotic length.

Aging Precision and Bias

Weight-Length

Sex Ratio, Maturity, and Fecundity

Natural Mortality

2.1.8 Environmental or Ecosystem Data Included in the Assessment

`environmental-or-ecosystem-data-included-in-the-assessment`

In this assessment, neither environmental nor ecosystem considerations were explicitly included in the analysis. This is primarily due to a lack of relevant data and results of analyses (conducted elsewhere) that could contribute ecosystem-related quantitative information for the assessment.

2.2 Previous Assessments

previous-assessments

2.2.1 History of Modeling Approaches Used for this Stock

history-of-modeling-approaches-used-for-this-stock

2.2.2 yyyy Assessment Recommendations

yyyy-assessment-recommendations

Recommendation 1:

STAT response: xxxxx

Recommendation 2:

STAT response: xxxxx

Recommendation 3:

STAT response: xxxx

2.3 Model Description

model-description

2.3.1 Transition to the Current Stock Assessment

transition-to-the-current-stock-assessment

2.3.2 Summary of Data for Fleets and Areas

summary-of-data-for-fleets-and-areas

There are xxx fleets in the base model. They include:

Commercial: The commercial fleets include ...

Recreational: The recreational fleets include ...

Research: There are xx sources of fishery-independent data available ...

2.3.3 Other Specifications

other-specifications

2.3.4 Modeling Software

modeling-software

The STAT team used Stock Synthesis 3 version 3.30.05.03 by Dr. Richard Methot at the NWFSC. This most recent version was used, since it included improvements and corrections to older versions. The r4SS package (GitHub release number v1.27.0) was used to post-processing output data from Stock Synthesis.

2.3.5 Data Weighting

data-weighting

2.3.6 Priors

priors

The log-normal prior for female natural mortality were based on a meta-analysis completed by Hamel (2015), as described under "Natural Mortality." Female natural mortality was fixed at the median of the prior, 0.xxx for an assumed maximum age of xx. An uninformative prior was used for the male offset natural mortality, which was estimated.

The prior for steepness (h) assumes a beta distribution with parameters based on an update for the Thorson-Dorn rockfish prior (Dorn, M. and Thorson, J., pers. comm.), which was endorsed by the Science and Statistical Committee in 2018. The prior is a beta distribution with mu=0.xxx and $sigma$=0.xxx. Steepness is fixed in the base model at the mean of the prior. The priors were applied in sensitivity analyses where these parameters were estimated.

2.3.7 Estimated and Fixed Parameters

estimated-and-fixed-parameters

A full list of all estimated and fixed parameters is provided in Tables 2.

The base model has a total of xxx estimated parameters in the following categories:

- xxx,
- xxx
- xxx, and
- xxx selectivity parameters

The estimated parameters are described in greater detail below and a full list of all estimated and parameters is provided in Table 2.

Growth.

Natural Mortality.

Selectivity.

Other Estimated Parameters.

Other Fixed Parameters.

2.4 Model Selection and Evaluation

model-selection-and-evaluation

2.4.1 Key Assumptions and Structural Choices

key-assumptions-and-structural-choices

2.4.2 Alternate Models Considered

alternate-models-considered

2.4.3 Convergence

convergence

2.5 Response to the Current STAR Panel Requests

response-to-the-current-star-panel-requests

Request No. 1:

Rationale: xxx

STAT Response: xxx

Request No. 2:

Rationale: xxx

STAT Response: xxx

Request No. 3:

Rationale: x.

STAT Response: xxx

Request No. 4:

Rationale: xxx

STAT Response: xxx

Request No. 5:

Rationale: xxx

STAT Response: xxx

2.6 Base Case Model Results

base-case-model-results

The following description of the model results reflects a base model that incorporates all of the changes made during the STAR panel (see previous section). The base model parameter estimates and their approximate asymptotic standard errors are shown in Table 2 and the likelihood components are in Table 3. Estimates of derived reference points and approximate 95% asymptotic confidence intervals are shown in Table e. Time-series of estimated stock size over time are shown in Table 4.

2.6.1 Parameter Estimates

parameter-estimates

The additional survey variability (process error added directly to each year's input variability) for all surveys was estimated within the model.

(Figure 5).

The stock-recruit curve … Figure 6 with estimated recruitments also shown.

2.6.2 Fits to the Data

fits-to-the-data

Model fits to the indices of abundance, fishery length composition, survey length composition, and conditional age-at-length observations are all discussed below.

2.6.3 Uncertainty and Sensitivity Analyses

uncertainty-and-sensitivity-analyses

A number of sensitivity analyses were conducted, including:

1. Sensitivity 1
2. Sensitivity 2
3. Sensitivity 3
4. Sensitivity 4
5. Sensitivity 5, etc/

2.6.4 Retrospective Analysis

retrospective-analysis

2.6.5 Likelihood Profiles

likelihood-profiles

2.6.6 Reference Points

reference-points-1

Reference points were calculated using the estimated selectivities and catch distribution among fleets in the most recent year of the model, (2013). Sustainable total yield (landings plus discards) were 5.8 mt when using an $SPR_{50\%}$ reference harvest rate and with a 95% confidence interval of (3.7-7.9) mt based on estimates of uncertainty. The spawning biomass equivalent to 40% of the unfished level ($SB_{40\%}$) was 9.8 mt.

(Figure 7

The 2014 spawning biomass relative to unfished equilibrium spawning biomass is above/below the target of 40% of unfished levels (Figure 8). The relative fishing intensity, $(1 - SPR)/(1 - SPR_{50\%})$, has been xxx the management target for the entire time series of the model.

Table e shows the full suite of estimated reference points for the base model and Figure 9 shows the equilibrium curve based on a steepness value xxx.

3 Harvest Projections and Decision Tables

harvest-projections-and-decision-tables

The forecasts of stock abundance and yield were developed using the final base model, with the forecasted projections of the OFL presented in Table g.

The forecasted projections of the OFL for each model are presented in Table h.

4 Regional Management Considerations

regional-management-considerations

5 Research Needs

research-needs

There are a number of areas of research that could improve the stock assessment for China rockfish. Below are issues identified by the STAT team and the STAR panel:

1. **xxxx**:

2. xxxx:
3. xxxx:
4. xxxx:
5. xxxx:

6 Acknowledgments

acknowledgments

7 Tables

tables

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Table 1: Results from 100 jitters from the base case model.

`tab:jitter`

Description	Value	NA	NA
Returned to base case	-	-	-
Found local minimum	-	-	-
Found better solution	-	-	-
Error in likelihood	-	-	-
Total	100	100	100

Table 2: List of parameters used in the base model, including estimated values and standard deviations (SD), bounds (minimum and maximum), estimation phase (negative values indicate not estimated), status (indicates if parameters are near bounds, and prior type information (mean, SD).

No.	Parameter	Value	Phase	Bounds	Status	SD	Prior (Exp.Val, SD)
1	NatM_p_1_Fem_GP_1	0.070	-3	(0.01, 0.15)			Log_Norm (-2.94, 0.53)
2	L_at_Amin_Fem_GP_1	2.000	-2	(-10, 45)			Normal (2, 10)
3	L_at_Amax_Fem_GP_1	35.411	6	(20, 50)	OK	0.364	Normal (34, 10)
4	VonBert_K_Fem_GP_1	0.147	6	(0.01, 0.3)	OK	0.006	Normal (0.1, 0.8)
5	CV_young_Fem_GP_1	0.100	-6	(0.01, 0.25)			None
6	CV_old_Fem_GP_1	0.080	6	(0.01, 0.25)	OK	0.007	None
7	NatM_p_1_Mal_GP_1	0.000	-3	(-1, 0.15)			None
8	L_at_Amin_Mal_GP_1	0.000	-2	(-1, 45)			Normal (2, 10)
9	L_at_Amax_Mal_GP_1	0.000	-4	(-1, 50)			Normal (33.13, 10)
10	VonBert_K_Mal_GP_1	0.000	-4	(-1, 0.3)			Normal (0.2461, 0.8)
11	CV_young_Mal_GP_1	0.000	-3	(-1, 0.25)			None
12	CV_old_Mal_GP_1	0.000	-3	(-1, 0.25)			None
13	Wtlen_1_Fem	0.000	-3	(0, 1)			None
14	Wtlen_2_Fem	3.177	-3	(2, 4)			None
15	Mat50%_Fem	28.500	-3	(1, 100)			None
16	Mat_slope_Fem	-1.000	-3	(-9, 9)			None
17	Eggs/kg_inter_Fem	0.196	-3	(-3, 3)			None
18	Eggs/kg_slope_wt_Fem	0.057	-3	(-3, 3)			None
19	Wtlen_1_Mal	0.000	-3	(0, 1)			None
20	Wtlen_2_Mal	3.177	-3	(2, 4)			None
24	CohortGrowDev	0.000	-4	(0, 0)			None
25	SR_LN(R0)	3.531	1	(2, 12)	OK	0.177	None
26	SR_BH_steep	0.773	-3	(0.2, 1)			Full_Beta (0.773, 0.147)
27	SR_sigmaR	0.500	-3	(0, 2)			None
28	SR_envlink	0.100	-3	(-5, 5)			None
29	SR_R1_offset	0.000	-4	(-5, 5)			None

Continued on next page

Table 2: List of parameters used in the base model, including estimated values and standard deviations (SD), bounds (minimum and maximum), estimation phase (negative values indicate not estimated), status (indicates if parameters are near bounds, and prior type information (mean, SD).

No.	Parameter	Value	Phase	Bounds	Status	SD	Prior (Exp.Val, SD)
30	SR_autocorr	0.000	-99	(0, 0)			None
68	InitF_11_WA_SouthernWA_Rec_PCPR	0.000	-1	(0, 1)			None
69	InitF_22_WA_NorthernWA_Rec_PC	0.000	-1	(0, 1)			None
70	InitF_33_WA_NorthernWA_Rec_PR	0.000	-1	(0, 1)			None
71	Q_extraSD_3_3_WA_NorthernWA_Rec_PR	0.126	2	(0, 2)	OK	0.024	None
72	SizeSel_1P_1_1_WA_SouthernWA_Rec_PCPR	34.890	-4	(19, 36)			None
73	SizeSel_1P_2_1_WA_SouthernWA_Rec_PCPR	-4.000	-9	(-9, 5)			None
74	SizeSel_1P_3_1_WA_SouthernWA_Rec_PCPR	3.970	5	(0, 9)	OK	0.364	None
75	SizeSel_1P_4_1_WA_SouthernWA_Rec_PCPR	8.000	-9	(0, 9)			None
76	SizeSel_1P_5_1_WA_SouthernWA_Rec_PCPR	-8.000	-9	(-9, 9)			None
77	SizeSel_1P_6_1_WA_SouthernWA_Rec_PCPR	8.000	-9	(-9, 9)			None
78	SizeSel_2P_1_2_WA_NorthernWA_Rec_PC	34.862	4	(19, 36)	OK	1.001	None
79	SizeSel_2P_2_2_WA_NorthernWA_Rec_PC	-4.000	-9	(-9, 5)			None
80	SizeSel_2P_3_2_WA_NorthernWA_Rec_PC	2.925	5	(0, 9)	OK	0.347	None
81	SizeSel_2P_4_2_WA_NorthernWA_Rec_PC	8.000	-9	(0, 9)			None
82	SizeSel_2P_5_2_WA_NorthernWA_Rec_PC	-8.000	-9	(-9, 9)			None
83	SizeSel_2P_6_2_WA_NorthernWA_Rec_PC	8.000	-9	(-9, 9)			None

tab:model_params

Table 3: Likelihood components from the base model.

tab:like_components

Likelihood component	Value
TOTAL	1097.30
Catch	0.00
Survey	-98.12
Length composition	763.02
Age composition	421.52
Recruitment	10.88
Forecast recruitment	0.00
Parameter priors	0.00
Parmeter soft bounds	0.01

Table 4: Time-series of population estimates from the base-case model. Relative exploitation rate is $(1 - SPR)/(1 - SPR_{50\%})$.

Year	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative exploitation rate	SPR
1900	241	24	0.000	34	0	0.00	1.00
1901	241	24	0.000	34	0	0.00	1.00
1902	241	24	0.000	34	0	0.00	1.00
1903	241	24	0.000	34	0	0.00	1.00
1904	241	24	0.000	34	0	0.00	1.00
1905	241	24	0.000	34	0	0.00	1.00
1906	241	24	0.000	34	0	0.00	1.00
1907	241	24	0.000	34	0	0.00	1.00
1908	241	24	0.000	34	0	0.00	1.00
1909	241	24	0.000	34	0	0.00	1.00
1910	241	24	0.000	34	0	0.00	1.00
1911	241	24	0.000	34	0	0.00	1.00
1912	241	24	0.000	34	0	0.00	1.00
1913	241	24	0.000	34	0	0.00	1.00
1914	241	24	0.000	34	0	0.00	1.00
1915	241	24	0.000	34	0	0.00	1.00
1916	241	24	0.000	34	0	0.00	1.00
1917	241	24	0.000	34	0	0.00	1.00
1918	241	24	0.000	34	0	0.00	1.00
1919	241	24	0.000	34	0	0.00	1.00
1920	241	24	0.000	34	0	0.00	1.00
1921	241	24	0.000	34	0	0.00	1.00
1922	241	24	0.000	34	0	0.00	1.00
1923	241	24	0.000	34	0	0.00	1.00
1924	241	24	0.000	34	0	0.00	1.00
1925	241	24	0.000	34	0	0.00	1.00
1926	241	24	0.000	34	0	0.00	1.00
1927	241	24	0.000	34	0	0.00	1.00
1928	241	24	0.000	34	0	0.00	1.00
1929	241	24	0.000	34	0	0.00	1.00
1930	241	24	0.000	34	0	0.00	1.00
1931	241	24	0.000	34	0	0.00	1.00
1932	241	24	0.000	34	0	0.00	1.00
1933	241	24	0.000	34	0	0.00	1.00
1934	241	24	0.000	34	0	0.00	1.00
1935	241	24	0.000	34	0	0.00	1.00
1936	241	24	0.000	34	0	0.00	1.00

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tab:Timeseries_mo

Table 4: Time-series of population estimates from the base-case model. Relative exploitation rate is $(1 - SPR)/(1 - SPR_{50\%})$.

Year	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative exploitation rate	SPR
1937	241	24	0.000	34	0	0.00	1.00
1938	241	24	0.000	34	0	0.00	1.00
1939	241	24	0.000	34	0	0.00	1.00
1940	241	24	0.000	34	0	0.00	1.00
1941	241	24	0.000	34	0	0.00	1.00
1942	241	24	0.000	34	0	0.00	1.00
1943	241	24	0.000	34	0	0.00	1.00
1944	241	24	0.000	34	0	0.00	1.00
1945	241	24	0.000	34	0	0.00	1.00
1946	241	24	0.000	34	0	0.00	1.00
1947	241	24	0.000	34	0	0.00	1.00
1948	241	24	0.000	34	0	0.00	1.00
1949	241	24	0.000	34	0	0.00	1.00
1950	241	24	0.000	34	0	0.00	1.00
1951	241	24	0.000	34	0	0.00	1.00
1952	241	24	0.000	34	0	0.00	1.00
1953	241	24	0.000	34	0	0.00	1.00
1954	241	24	0.000	34	0	0.00	1.00
1955	241	24	0.000	34	0	0.00	1.00
1956	241	24	0.000	34	0	0.00	1.00
1957	241	24	0.000	34	0	0.00	1.00
1958	241	24	0.000	34	0	0.00	1.00
1959	241	24	0.000	34	0	0.00	1.00
1960	241	24	0.000	34	0	0.00	1.00
1961	241	24	0.000	34	0	0.00	1.00
1962	241	24	0.000	34	0	0.00	1.00
1963	241	24	0.000	34	0	0.00	1.00
1964	241	24	0.000	34	0	0.00	1.00
1965	241	24	0.000	34	0	0.00	1.00
1966	241	24	0.000	34	0	0.00	1.00
1967	241	24	0.000	34	1	0.00	0.91
1968	240	24	0.994	34	2	0.00	0.89
1969	238	24	0.987	34	2	0.17	0.87
1970	237	24	0.980	34	2	0.20	0.86
1971	235	24	0.971	34	2	0.23	0.84
1972	233	23	0.961	34	3	0.26	0.82
1973	231	23	0.951	34	3	0.29	0.80

Continues next page

Table 4: Time-series of population estimates from the base-case model. Relative exploitation rate is $(1 - SPR)/(1 - SPR_{50\%})$. tab:Timeseries_mo

Year	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative exploitation rate	SPR
1974	229	23	0.940	34	3	0.32	0.79
1975	226	23	0.928	34	4	0.35	0.77
1976	224	22	0.915	34	2	0.19	0.86
1977	223	22	0.911	34	1	0.14	0.89
1978	223	22	0.909	34	4	0.39	0.75
1979	220	22	0.896	34	3	0.31	0.79
1980	219	22	0.888	34	3	0.27	0.82
1981	217	22	0.882	34	2	0.24	0.83
1982	217	21	0.878	34	3	0.29	0.80
1983	215	21	0.871	34	3	0.32	0.79
1984	214	21	0.864	34	3	0.36	0.77
1985	212	21	0.856	34	3	0.36	0.77
1986	211	21	0.849	34	4	0.42	0.73
1987	209	20	0.839	34	5	0.53	0.69
1988	206	20	0.825	34	6	0.65	0.64
1989	202	20	0.807	34	7	0.77	0.60
1990	198	19	0.786	33	8	0.90	0.56
1991	193	19	0.761	33	4	0.50	0.69
1992	192	18	0.753	33	8	0.89	0.56
1993	187	18	0.732	33	7	0.78	0.59
1994	184	18	0.716	33	5	0.58	0.66
1995	183	17	0.709	33	4	0.51	0.69
1996	182	17	0.705	33	3	0.35	0.76
1997	183	17	0.708	33	3	0.33	0.77
1998	183	17	0.711	33	2	0.24	0.82
1999	185	18	0.717	33	2	0.30	0.79
2000	185	18	0.720	33	3	0.37	0.75
2001	186	18	0.722	33	4	0.44	0.72
2002	185	18	0.720	33	2	0.30	0.79
2003	186	18	0.724	33	2	0.29	0.80
2004	187	18	0.728	33	2	0.27	0.81
2005	188	18	0.732	33	3	0.32	0.78
2006	188	18	0.734	33	2	0.28	0.80
2007	189	18	0.738	33	3	0.35	0.76
2008	189	18	0.738	33	3	0.38	0.75
2009	189	18	0.738	33	3	0.33	0.77
2010	189	18	0.739	33	4	0.44	0.72

Continues next page

tab:Timeseries_mo

Table 4: Time-series of population estimates from the base-case model. Relative exploitation rate is $(1 - SPR)/(1 - SPR_{50\%})$.

Year	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative exploitation rate	SPR
2011	188	18	0.736	33	3	0.39	0.74
2012	188	18	0.735	33	3	0.35	0.76
2013	188	18	0.736	33	3	0.41	0.74
2014	188	18	0.734	33	3	0.36	0.76
2015	188	18	0.734	33			

Table 5: Sensitivity of the base model to dropping or down-weighting data sources and alternative assumptions about growth.

tab:Sensitivity_model1

Label	Base (Francis weights)	Default weights	Harmonic mean weights	Estimate equal M	Estimate equal M and h	Drop PR data	Drop PC data	Drop RecDD data
TOTAL_like	-	-	-	-	-	-	-	-
Catch_like	-	-	-	-	-	-	-	-
Equil_catch_like	-	-	-	-	-	-	-	-
Survey_like	-	-	-	-	-	-	-	-
Length_comp_like	-	-	-	-	-	-	-	-
Age_comp_like	-	-	-	-	-	-	-	-
Parm_priors_like	-	-	-	-	-	-	-	-
SSB_Unfished_thousand_mt	-	-	-	-	-	-	-	-
TotBio_Unfished	-	-	-	-	-	-	-	-
SmryBio_Unfished	-	-	-	-	-	-	-	-
Recr_Unfished_billions	-	-	-	-	-	-	-	-
SSB_Btgt_thousand_mt	-	-	-	-	-	-	-	-
SPR_Btgt	-	-	-	-	-	-	-	-
Fstd_Btgt	-	-	-	-	-	-	-	-
TotYield_Btgt_thousand_mt	-	-	-	-	-	-	-	-
SSB_SPRtgt_thousand_mt	-	-	-	-	-	-	-	-
Fstd_SPRtgt	-	-	-	-	-	-	-	-
TotYield_SPRtgt_thousand_mt	-	-	-	-	-	-	-	-
SSB_MSY_thousand_mt	-	-	-	-	-	-	-	-
SPR_MSY	-	-	-	-	-	-	-	-
Fstd_MSY	-	-	-	-	-	-	-	-
TotYield_MSY_thousand_mt	-	-	-	-	-	-	-	-
RetYield_MSY	-	-	-	-	-	-	-	-
Bratio_2015	-	-	-	-	-	-	-	-
F_2015	-	-	-	-	-	-	-	-
SPRratio_2015	-	-	-	-	-	-	-	-
Recr_2015	-	-	-	-	-	-	-	-
Recr_Virgin_billions	-	-	-	-	-	-	-	-
L_at_Amin_Fem_GP_1	-	-	-	-	-	-	-	-
L_at_Amax_Fem_GP_1	-	-	-	-	-	-	-	-
VonBert_K_Fem_GP_1	-	-	-	-	-	-	-	-
CV_young_Fem_GP_1	-	-	-	-	-	-	-	-
CV_old_Fem_GP_1	-	-	-	-	-	-	-	-

Table 6: Summary of the biomass/abundance time series used in the stock assessment.

tab:Index_summary

Fleet	Years	Name	Fishery ind.	Filtering	Method	Endorsed
4	2004-2016	Recreational PR dockside CPUE	No	trip, area, regulations, Stephens-MacCall	delta-GLM (bin-lognormal)	SSC
5	1980-2016	CPFV logbook CPUE	No	trip, gear, effort, species, depth, sample size	negative binomial	SSC
6	2002-2016	Onboard observer discard catch CPUE	No	habitat ,regulations, effort, boats	delta-GLM (bin-lognormal)	SSC
7	1970-2016	Sanitation district CPUE	Yes	sample size, depth, tow times	delta-GLM (bin-lognormal)	SSC
8	2003-2016	NWFSC trawl survey CPUE	Yes	depth, area	VAST	SSC
9	1995-2008	CSUN/VRG Gillnet survey CPUE	Yes	gear, site, month	delta-GLM (bin-lognormal)	SSC
11	1994; 1998; 2003; 2008; 2013	Southern California Bight trawl survey CPUE	Yes	depth, area	delta-GLM (bin-lognormal)	SSC
12	2002-2016	Onboard observer retained catch CPUE	No	habitat, regulations, effort, boats	delta-GLM (bin-lognormal)	SSC

Table 7: Summaries of key assessment outputs and likelihood values from the retrospective analysis. Note that male growth parameters are exponential offsets from female parameters, and depletion and SPR ratio are for the year of 2017. The base model includes all of the data. Retro1 removes the last year of data (2016), Retro2 removes the last two years of data, Retro3 removes three years and Retro4 removes four years.

tab:retro

Label	Base	Retro1	Retro2	Retro3	Retro4
Female natural mortality	0.26	0.26	0.26	0.26	0.26
Steepness	0.72	0.72	0.72	0.72	0.72
lnR0	8.16	8.09	8.07	8.04	8.08
Total Biomass (mt)	2796.86	2593.78	2568.77	2498.07	2650.36
Depletion	57.41	53.57	50.74	50.72	54.78
SPR ratio	0.72	0.76	0.79	0.80	0.74
Female Lmin	12.43	12.45	12.90	12.63	13.03
Female Lmax	33.31	33.50	33.39	33.37	33.46
Female K	0.25	0.24	0.24	0.25	0.23
Male Lmin (offset)	0.00	0.00	0.00	0.00	0.00
Male Lmax (offset)	-0.16	-0.16	-0.15	-0.16	-0.15
Male K (offset)	-0.29	-0.30	-0.43	-0.41	-0.56
Negative log-likelihood	1097.30	1047.56	1009.37	961.81	897.04
No. parameters	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	0.00	0.00	0.00
Equililibrium catch	-98.12	-92.00	-89.12	-81.75	-80.59
Survey	763.02	739.90	720.39	700.10	670.66
Length composition	421.52	390.56	369.97	336.26	299.84
Age composition	10.88	9.09	8.12	7.20	7.12
Recruitment	0.00	0.00	0.00	0.00	0.00
Forecast Recruitment	0.00	0.00	0.00	0.00	0.00
Parameter priors	0.01	0.01	0.01	0.01	0.01

Table 8: Summaries of key assessment outputs and likelihood values from selected likelihood profile runs on virgin recruitment (lnR0) and steepness. Note that male growth parameters are exponential offsets from female parameters, and depletion and SPR ratio are for the year of 2017.

tab:like_profiles

Label	R07400	R07800	R08200	R08600	R09000	h0410	h0570	h0710	h0870	h0990
Female M	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Steepness	0.72	0.72	0.72	0.72	0.72	0.41	0.57	0.71	0.87	0.99
lnR0	7.40	7.80	8.20	8.60	9.00	8.34	8.21	8.16	8.13	8.11
Total biomass (m)	1623.19	2113.03	2894.72	4173.95	6142.97	3313.42	2943.85	2802.69	2712.12	2667.97
Depletion (%)	46.83	49.83	58.31	66.23	71.80	51.20	55.27	57.32	58.81	59.60
SPR ratio	1.05	0.91	0.70	0.49	0.34	0.68	0.71	0.72	0.72	0.73
Female Lmin	12.16	12.41	12.43	12.39	12.36	12.43	12.44	12.43	12.43	12.43
Female Lmax	34.29	33.83	33.26	32.76	32.42	33.19	33.28	33.31	33.33	33.34
Female K	0.24	0.25	0.25	0.26	0.26	0.25	0.25	0.25	0.25	0.25
Male Lmin (offset)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Male Lmax (offset)	-0.18	-0.17	-0.16	-0.15	-0.15	-0.16	-0.16	-0.16	-0.16	-0.16
Male K (offset)	-0.22	-0.31	-0.29	-0.24	-0.21	-0.27	-0.29	-0.29	-0.30	-0.30
Negative log-likelihood										
TOTAL	1117.15	1101.02	1097.33	1099.69	1102.95	1101.35	1098.58	1097.35	1096.72	1100.21
Catch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equil_catch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Survey	-100.10	-99.20	-97.99	-97.00	-96.37	-98.27	-98.18	-98.12	-98.06	-98.03
Length_comp	761.18	760.12	763.44	767.61	770.76	765.11	763.69	763.05	762.58	762.33
Age_comp	437.32	427.37	421.09	418.57	417.98	420.58	421.24	421.51	421.68	421.77
Recruitment	18.74	12.72	10.80	10.50	10.58	12.55	11.40	10.90	10.56	10.38
Forecast_Recruitment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Parm_priors	0.00	0.00	0.00	0.00	0.00	1.38	0.42	0.01	-0.04	3.76
Parm_softbounds	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Parm_devs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Crash_Pen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 9: Summaries of key assessment outputs and likelihood values from selected likelihood profile runs on female natural mortality. Note that male growth parameters are exponential offsets from female parameters, and depletion and SPR ratio are for the year of 2017.

tab:like_profiles

Label	M0220	M0260	M0300	M0350	M0400
Female M	0.22	0.26	0.30	0.35	0.40
Steepness	0.72	0.72	0.72	0.72	0.72
lnR0	7.67	8.20	8.95	12.21	31.00
Total biomass (m)	2259.39	2861.79	4632.81	89473.50	9753570000000.00
Depletion (%)	47.72	58.15	68.08	79.27	79.74
SPR ratio	0.97	0.70	0.41	0.02	0.00
Female Lmin	12.39	12.44	12.43	12.39	12.24
Female Lmax	33.23	33.31	33.31	33.25	33.73
Female K	0.25	0.25	0.25	0.25	0.24
Male Lmin (offset)	0.00	0.00	0.00	0.00	0.00
Male Lmax (offset)	-0.16	-0.16	-0.15	-0.15	-0.15
Male K (offset)	-0.27	-0.30	-0.31	-0.32	-0.36
Negative log-likelihood					
TOTAL	1102.66	1096.96	1092.96	1089.92	1091.52
Catch	0.00	0.00	0.00	0.00	0.00
Equil_catch	0.00	0.00	0.00	0.00	0.00
Survey	-97.79	-98.14	-98.33	-98.33	-98.95
Length_comp	765.50	762.85	760.88	759.19	755.26
Age_comp	422.97	421.41	420.05	418.75	425.16
Recruitment	11.91	10.82	10.30	10.05	9.54
Forecast_Recruitment	0.00	0.00	0.00	0.00	0.00
Parm_priors	0.06	0.00	0.06	0.25	0.51
Parm_softbounds	0.01	0.01	0.01	0.00	0.00
Parm_devs	0.00	0.00	0.00	0.00	0.00
Crash_Pen	0.00	0.00	0.00	0.00	0.00

Table 10: Projection of potential OFL, spawning biomass, and depletion for the base case model.

tab:Forecast_mod1

Yr	OFL contribution (mt)	ACL landings (mt)	Age 5+ biomass (mt)	Spawning Biomass (mt)	Depletion
2015	9.505	1.970	182.580	17.950	0.734
2016	9.570	2.030	183.586	18.068	0.739
2017	9.629	8.815	184.496	18.177	0.744
2018	9.289	8.503	179.232	17.554	0.718
2019	8.977	8.217	174.479	16.983	0.695
2020	8.691	7.956	170.207	16.465	0.674
2021	8.433	7.719	166.384	15.997	0.655
2022	8.199	7.506	162.976	15.577	0.637
2023	7.990	7.314	159.934	15.200	0.622
2024	7.803	7.142	157.222	14.864	0.608
2025	7.636	6.990	154.802	14.566	0.596
2026	7.488	6.854	152.641	14.302	0.585

8 Figures

figures

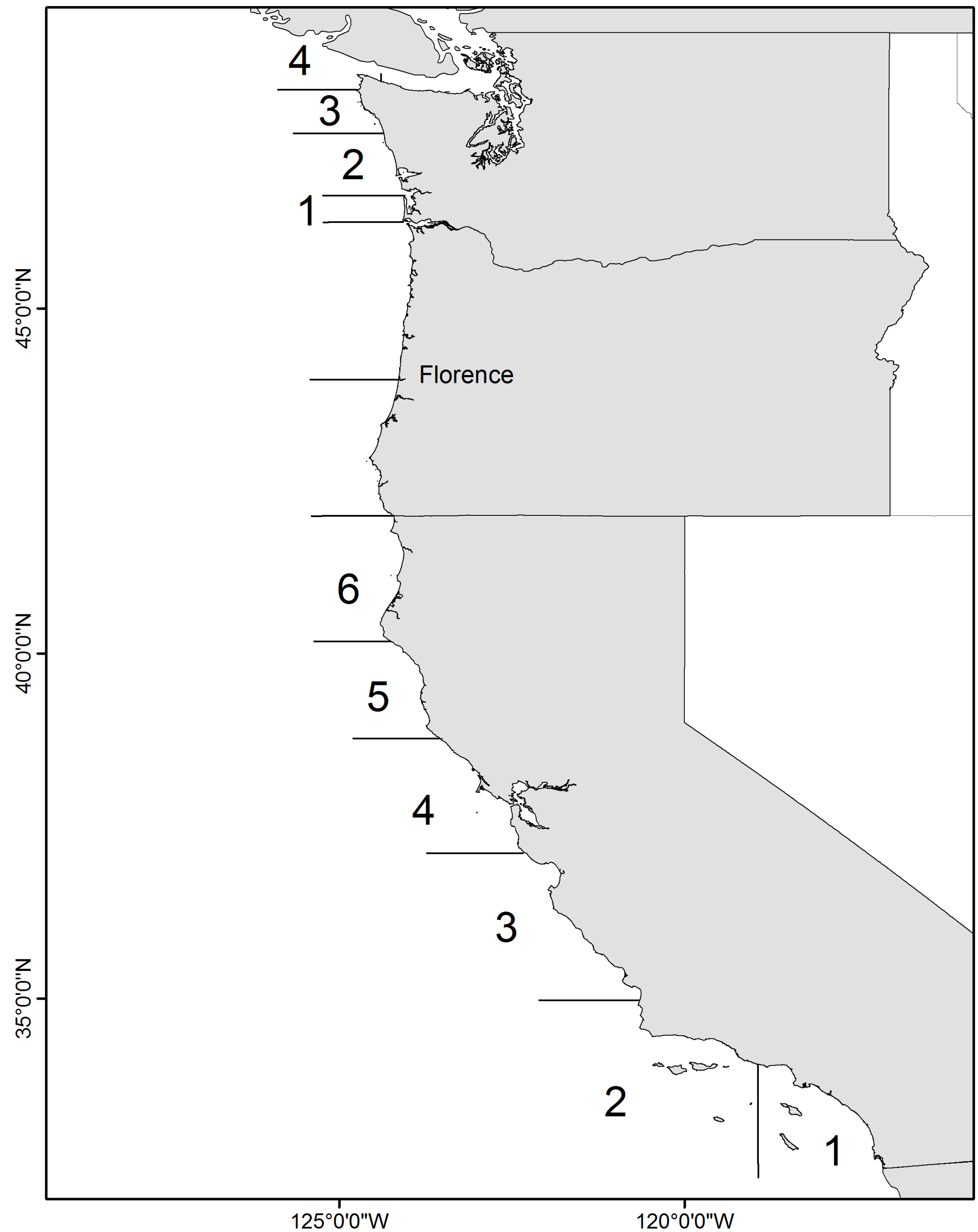

Figure 1: Map showing the state boundary lines for management of the recreational fishing fleets fig:boundary_map

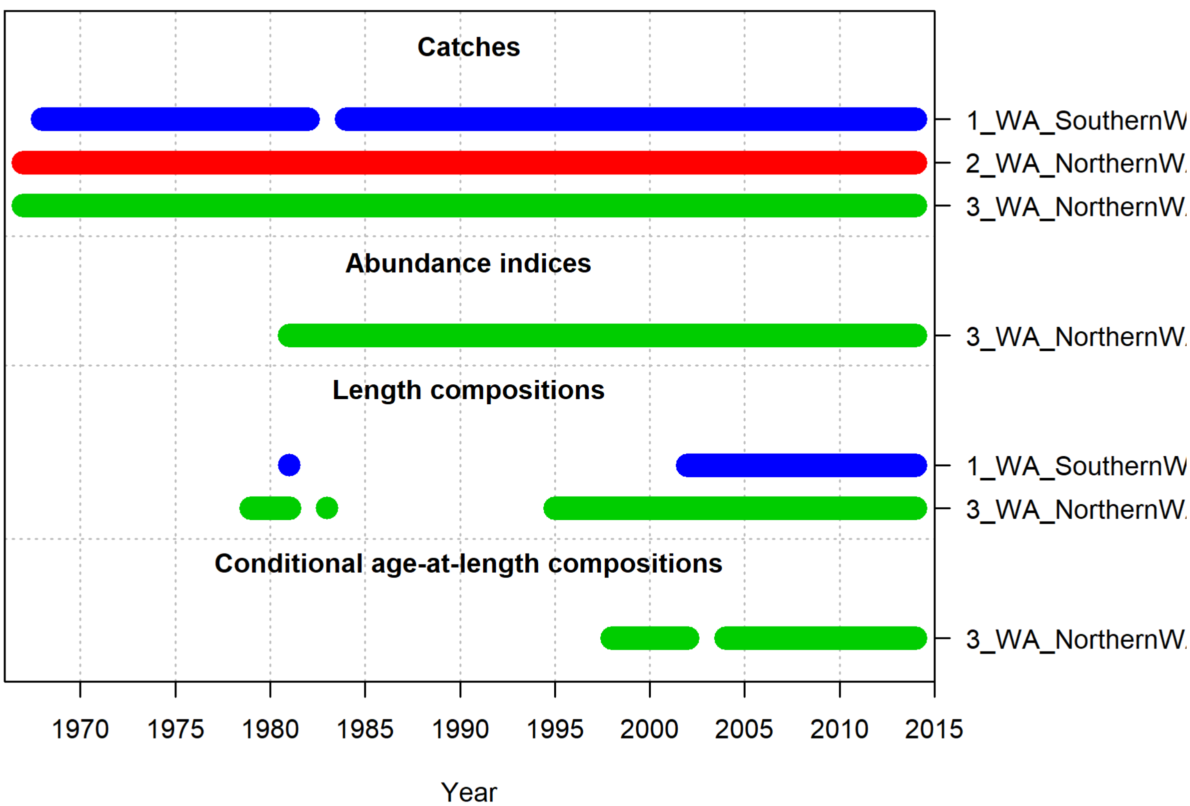

Figure 2: Summary of data sources used in the Northern model. fig:data_plot

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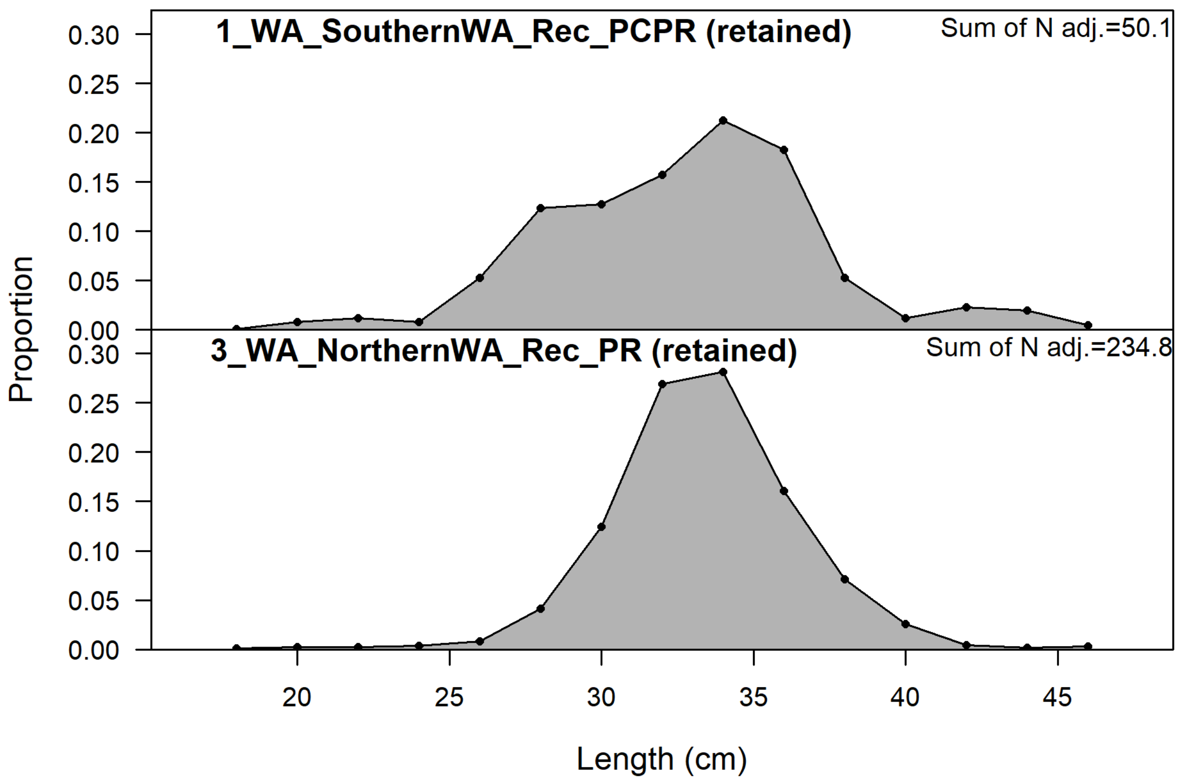


Figure 3: Length comp data, aggregated across time by fleet. Labels 'retained' and 'discard' indicate discarded or retained sampled for each fleet. Panels without this designation represent the whole catch. fig:comp_lendat_aggregated_across_time

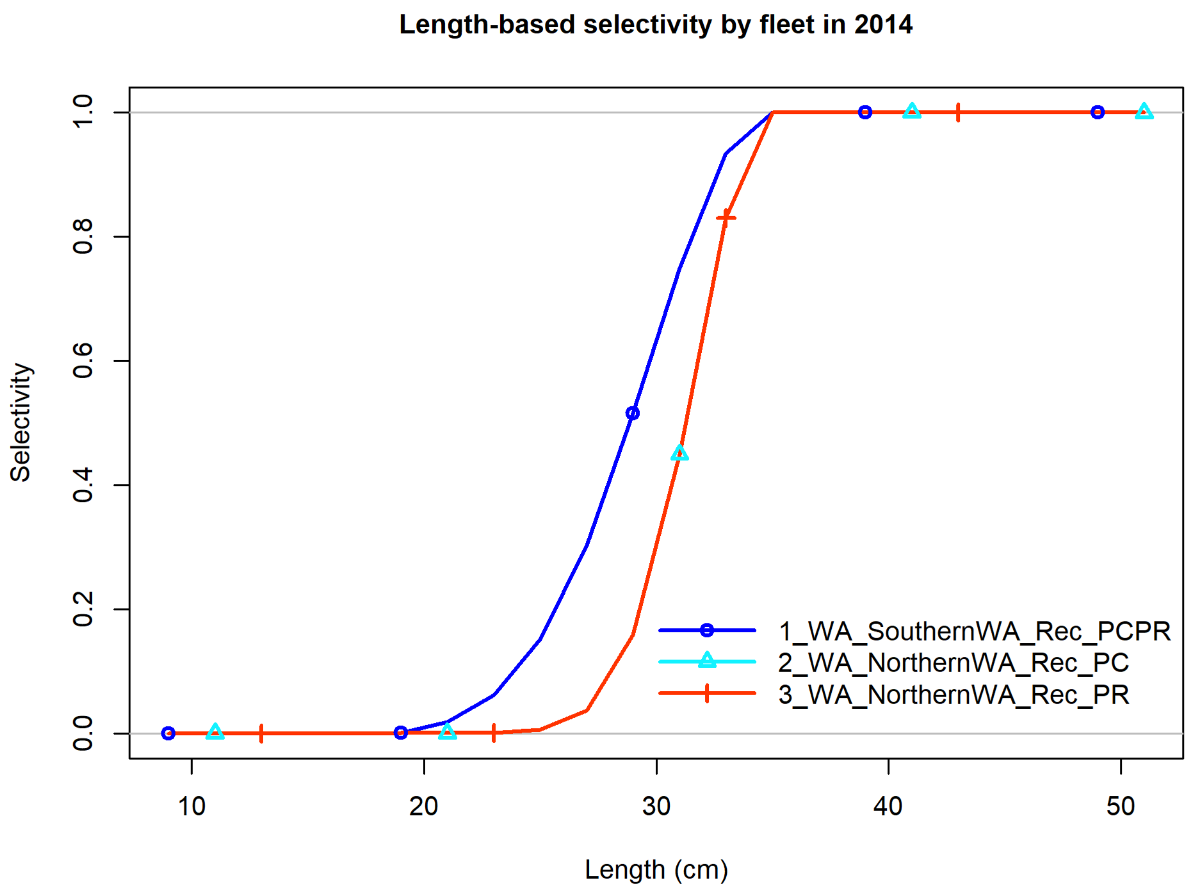


Figure 4: Selectivity at length for all of the fleets in the base model. fig:sel01_multiple_flee

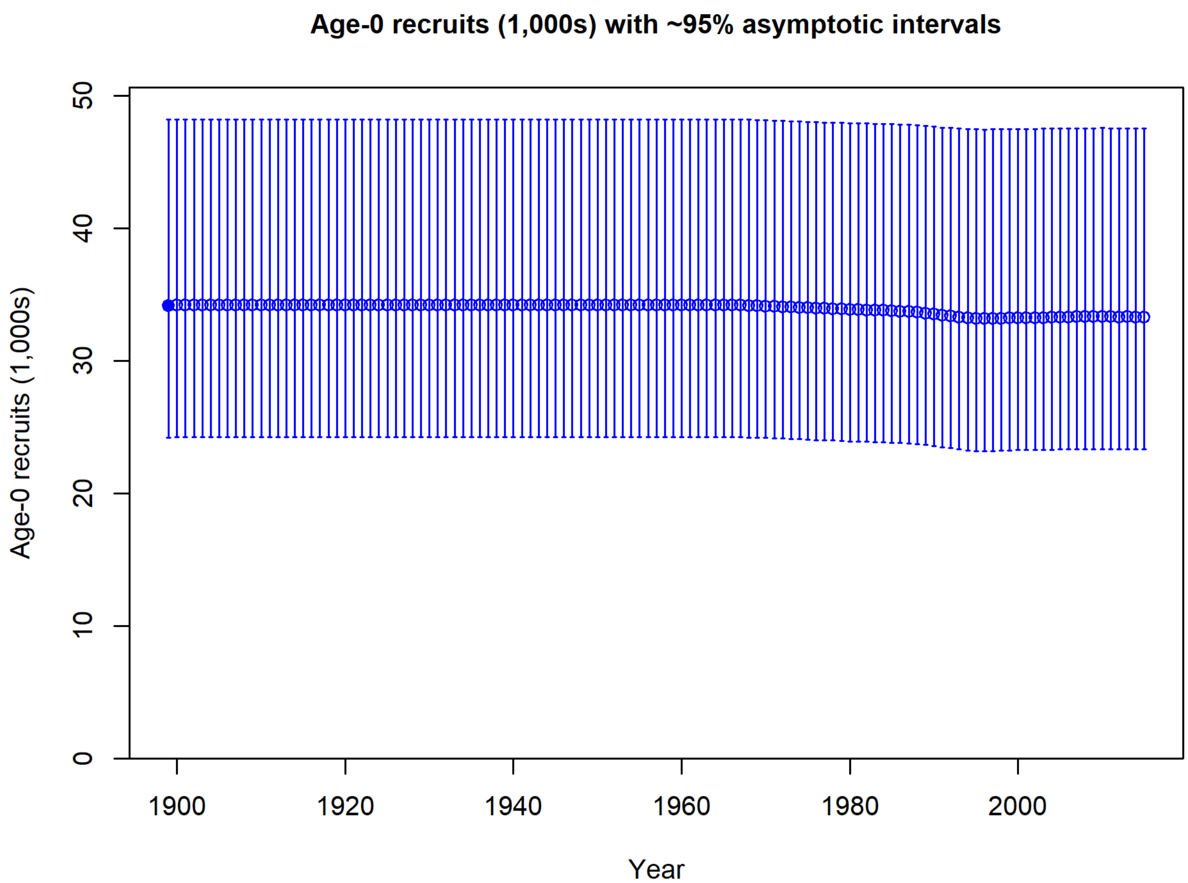


Figure 5: Estimated time-series of recruitment for China rockfish. fig:ts11_Age-0_recruits_

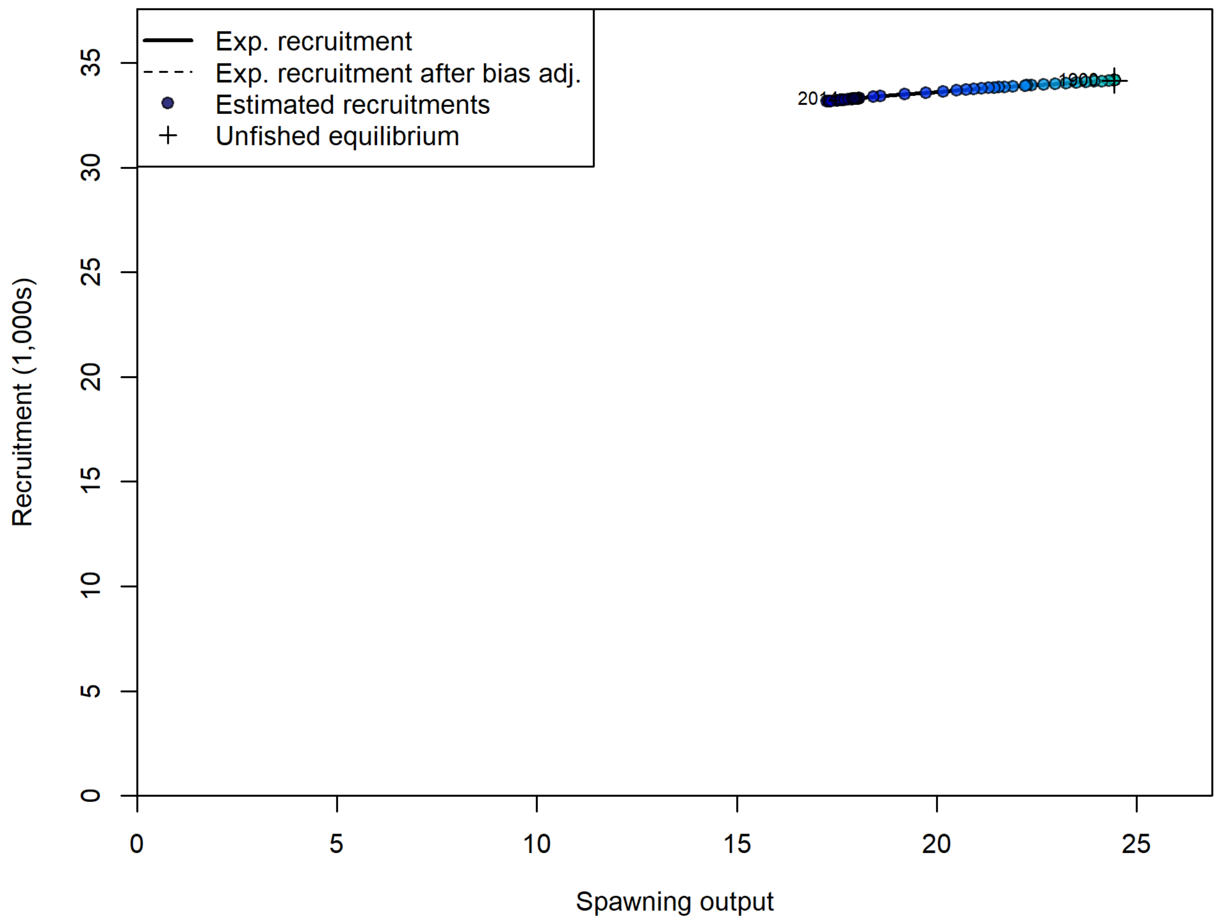
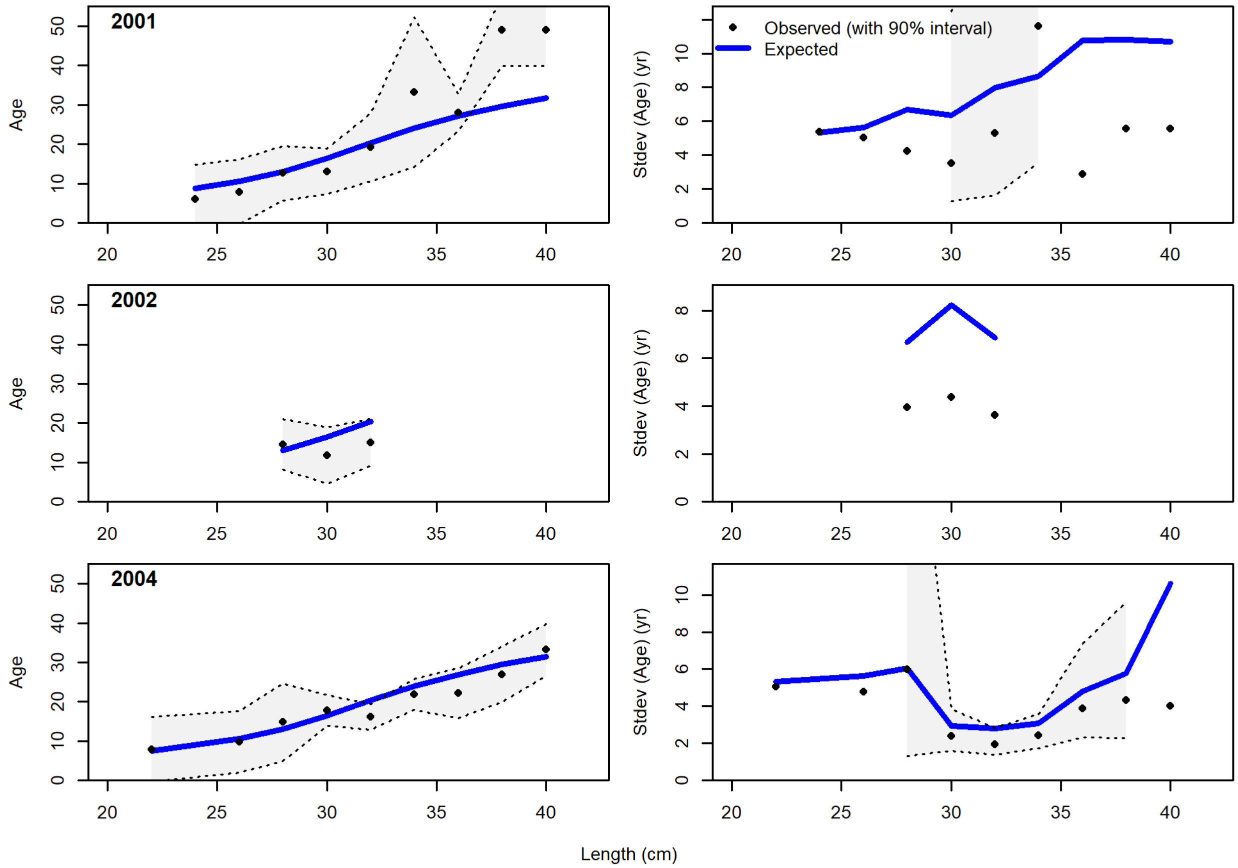


Figure 6: Estimated recruitment (red circles) and the assumed stock-recruit relationship (black line) for China rockfish. The green line shows the effect of the bias correction for the lognormal distribution. fig:SR_curve2



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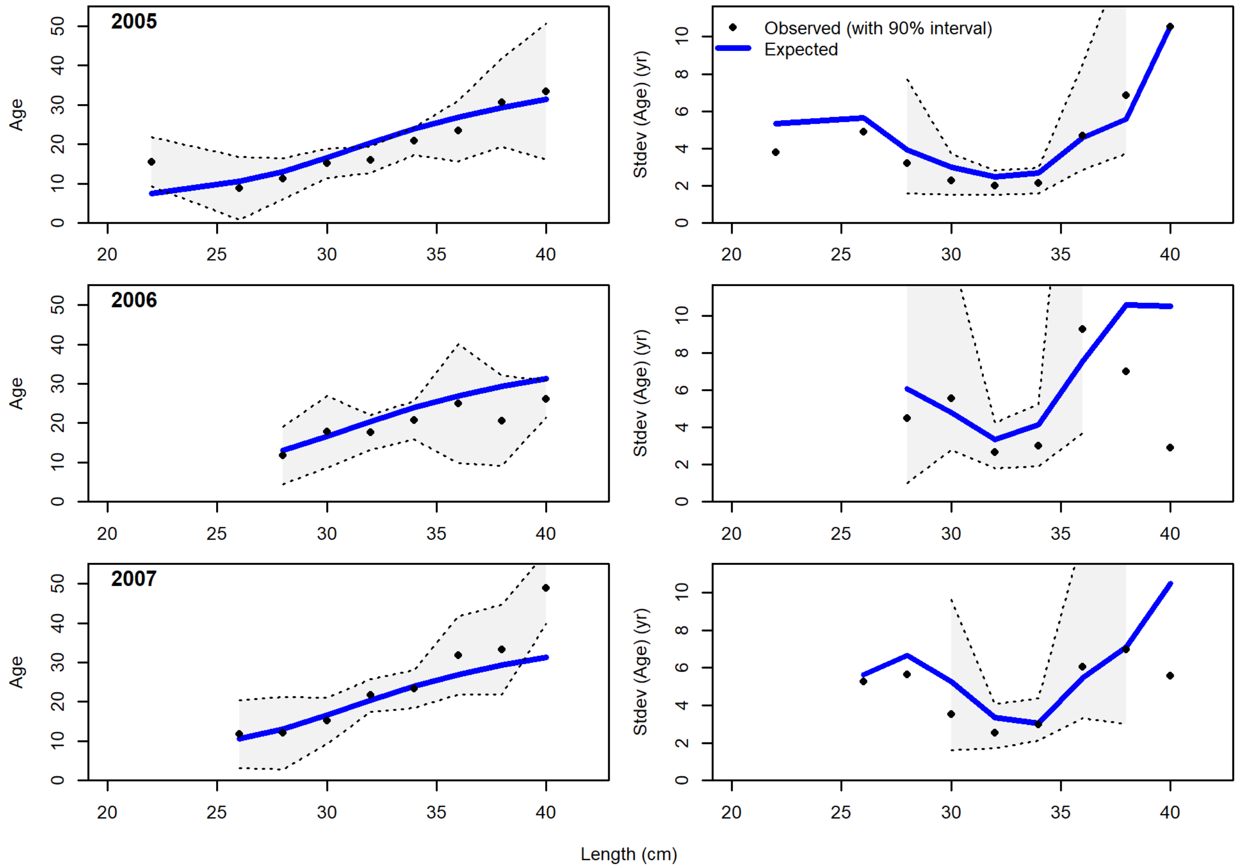

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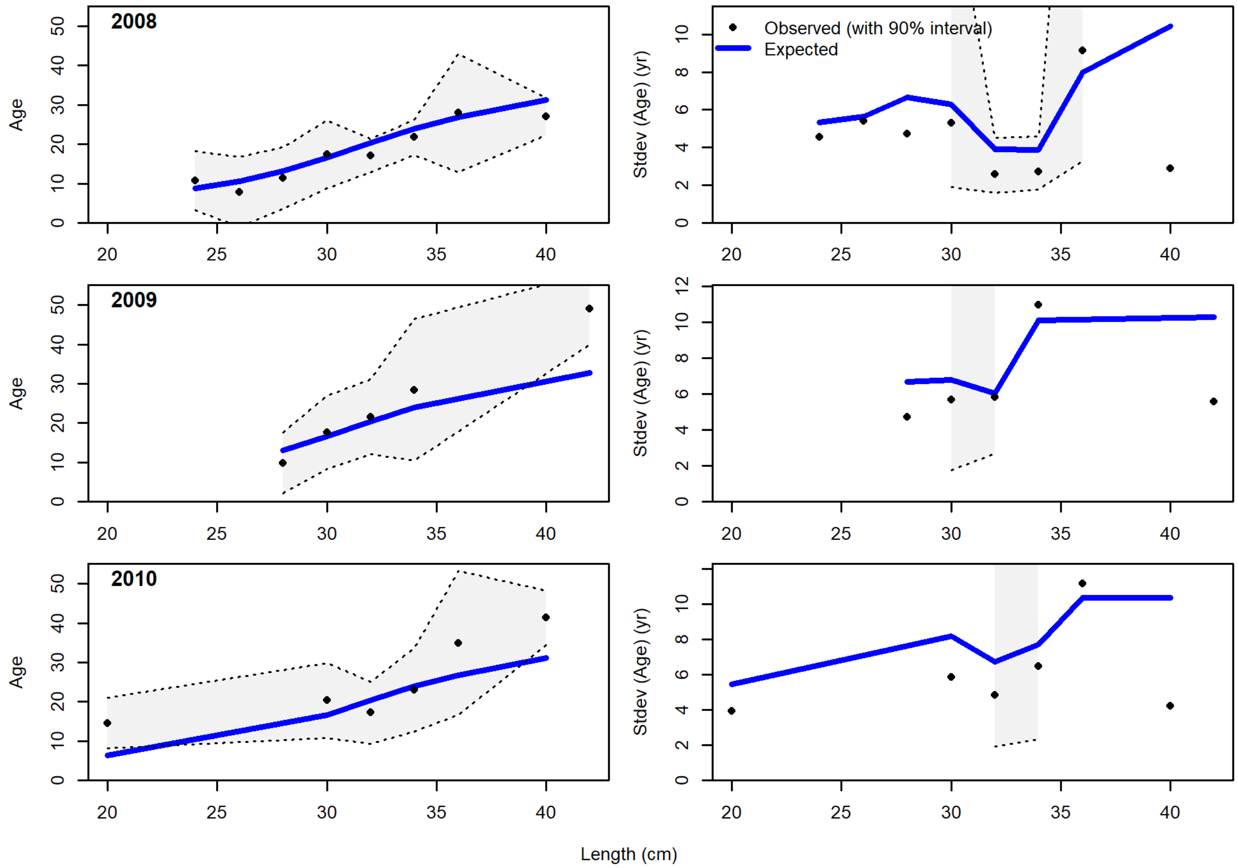

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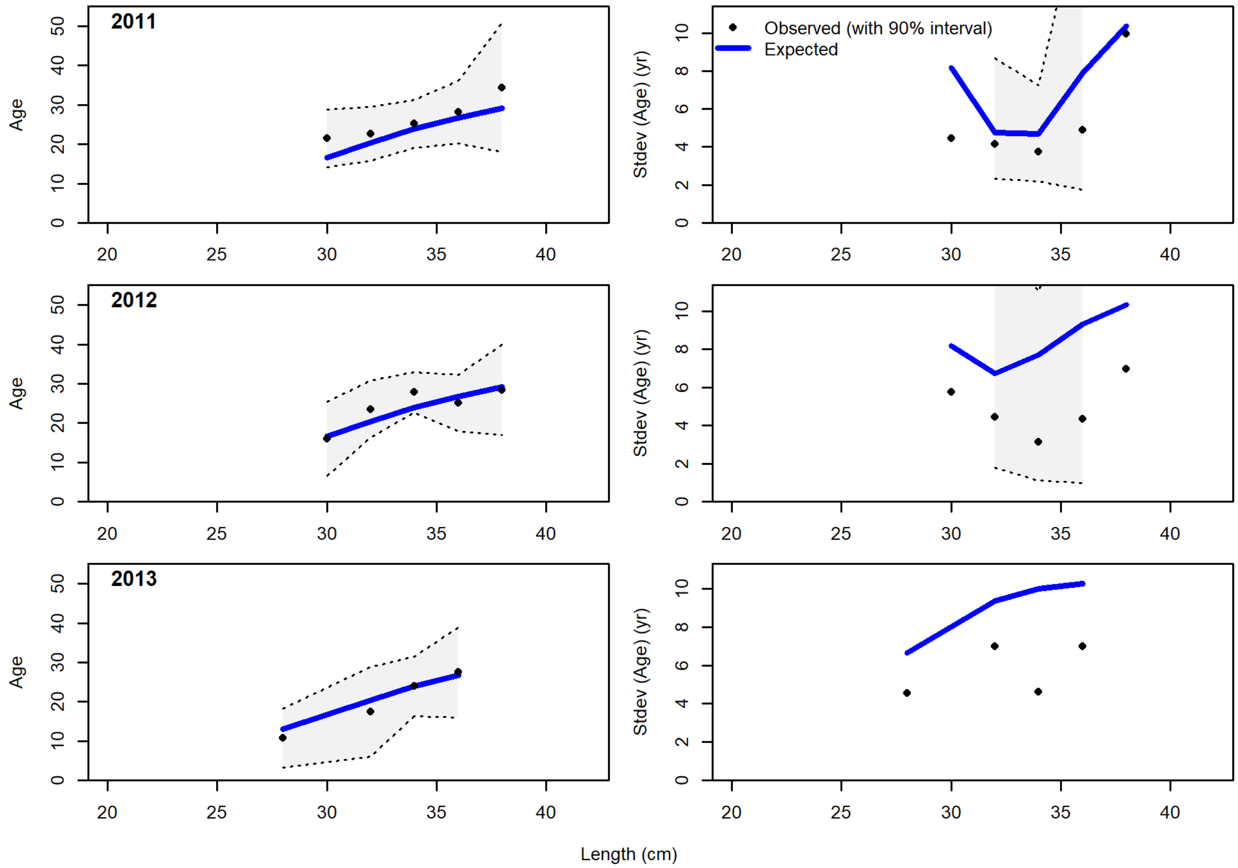

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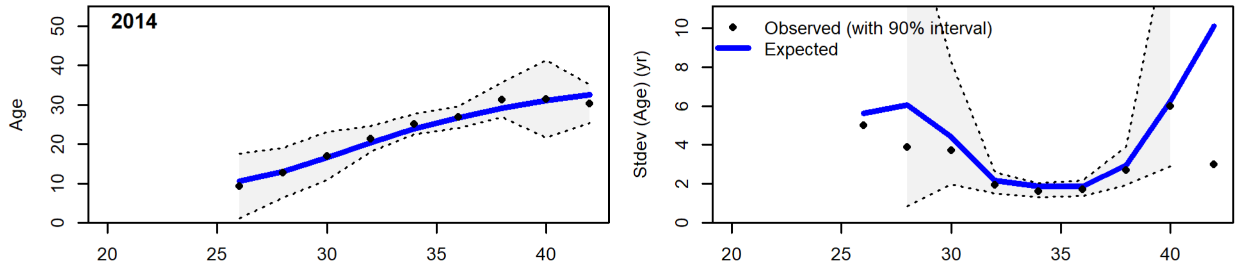

Length (cm)

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¡!– ***********h Likelihood profile FIGURES****************************** –¿

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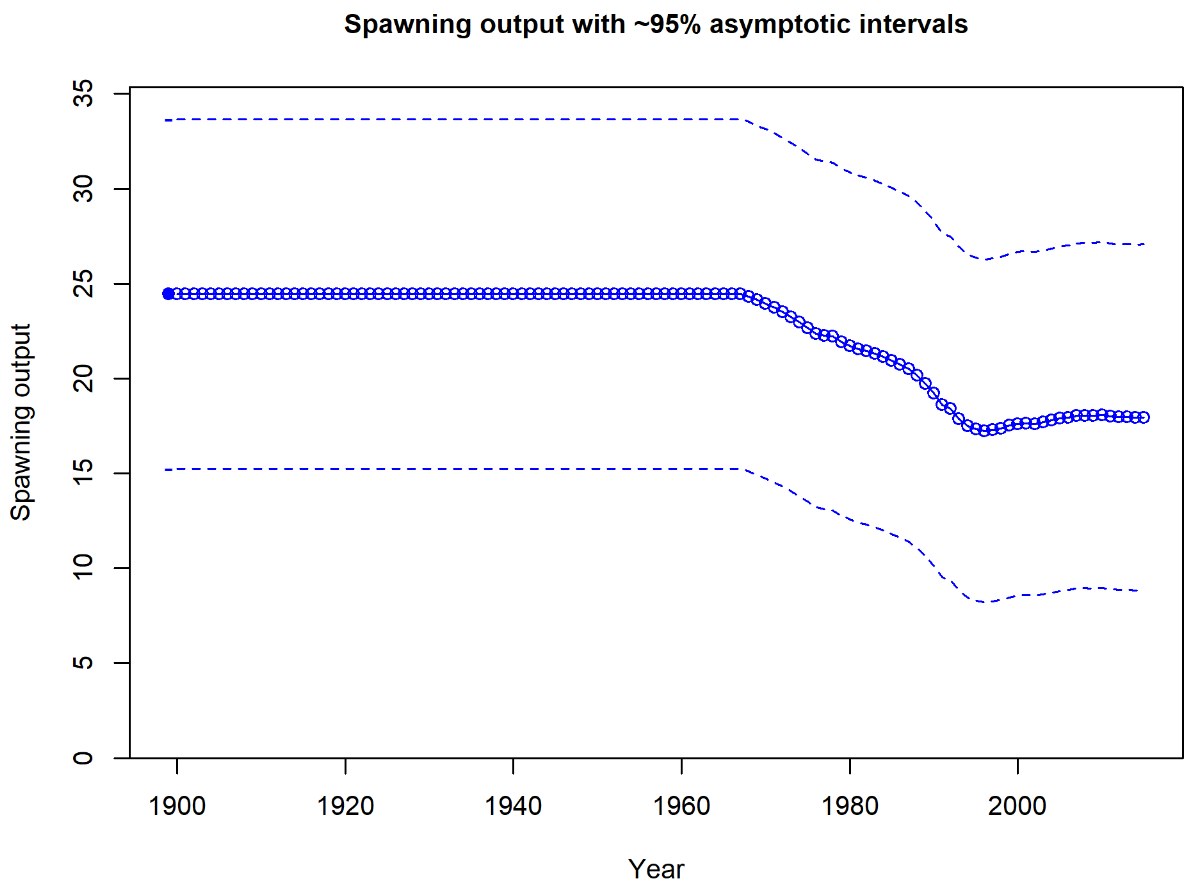

Figure 7: Estimated spawning biomass (mt) with approximate 95% asymptotic intervals. fig:ts7_Spawn

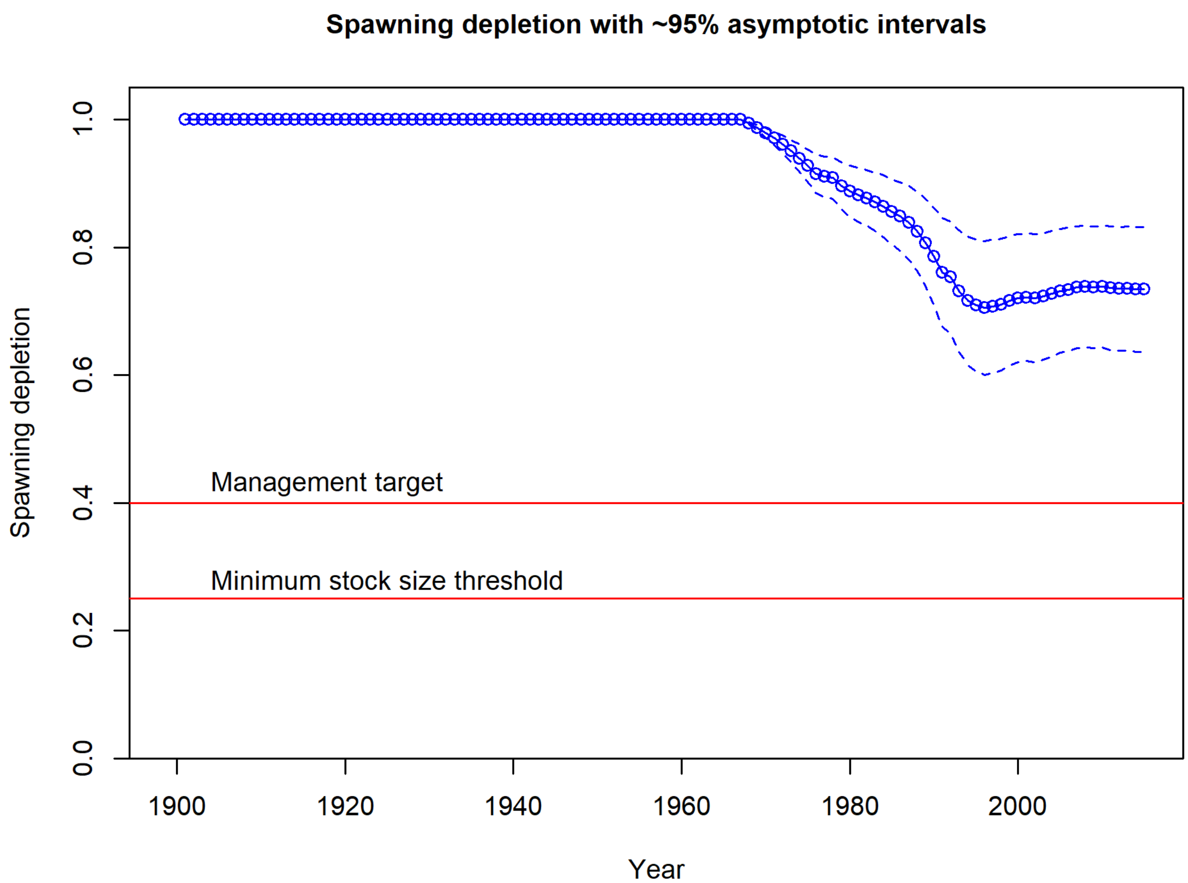

Figure 8: Estimated spawning depletion with approximate 95% asymptotic intervals. fig:ts9_Spawnin

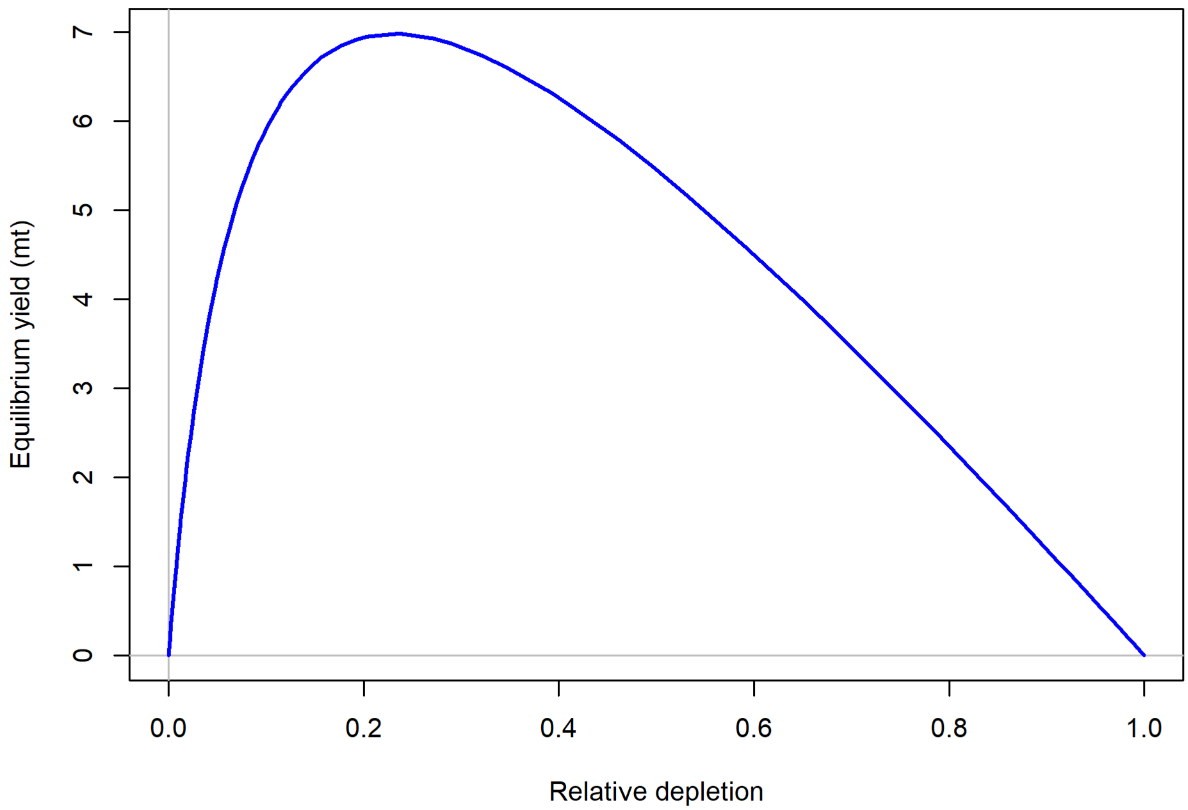

Figure 9: Equilibrium yield curve for the base case model. Values are based on the 2014 fishery selectivity and with steepness fixed at 0.718. fig:yield1_yield_curve

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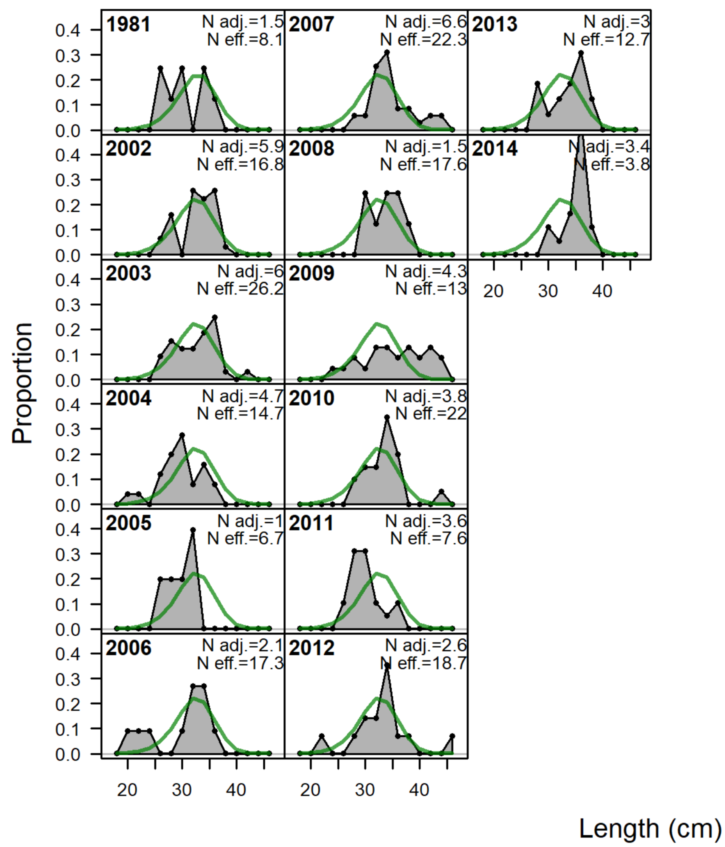

Figure A10: Length comps, retained, 1_WA_SouthernWA_Rec_PCPR. 'N adj.' is the input sample size after data_weighting adjustment. N eff. is the calculated effective sample size used in the McAllister_Iannelli tuning method. fig:mod1_1_comp_lenfit_flt1mkt2

351 # Appendix A. Detailed fits to length composition data

appendix-a.-detailed-fits-to-length-composition-data

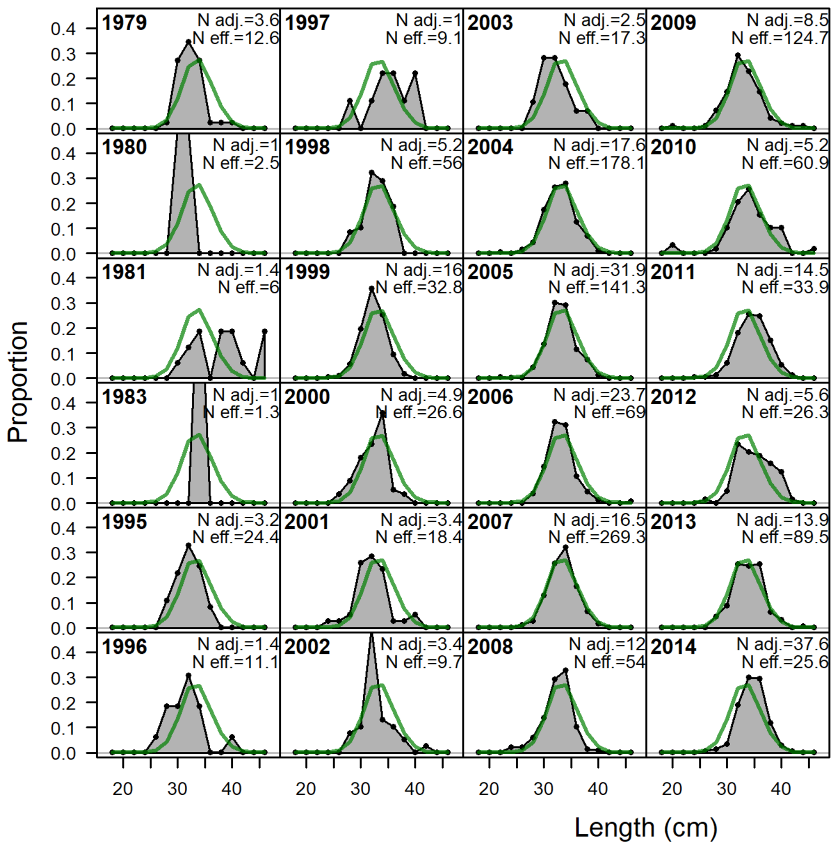

Figure A11: Length comps, retained, 3_WA_NorthernWA_Rec_PR. 'N adj.' is the input sample size after data_weighting adjustment. N eff. is the calculated effective sample size used in the McAllister_Iannelli tuning method. fig:mod1_2_comp_lenfit_flt3mkt2

References

references

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Hamel, O. 2015. A method for calculating a meta-analytical prior for the natural mortality rate using multiple life history correlates. ICES Journal of Marine Science **72**: 62–69.

Love, M.S., Axell, B., Morris, P., Collins, R., and Brooks, A. 1987. Life history and fishery of the California scorpionfish, *Scorpaena guttata*, within the Southern California Bight. Fishery Bulletin **85**: 99–116.