The Combined Status of Gopher (*Sebastes carnatus*) and Black-and-Yellow Rockfishes (*Sebastes chrysomelas*) in U.S. Waters Off California in 2019

Gopher rockfish (left) and black-and-yellow rockfish (right). Photos by Steve Lonhart.

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The Combined Status of Gopher (*Sebastes carnatus*) and Black-and-Yellow Rockfishes (*Sebastes chrysomelas*) in U.S. Waters Off California in 2019

Contents

Executive Summary

executive-summary

Stock

stock

This assessment reports the status of the GBY rockfish (*Sebastes carnatus/Sebastes chrysomelas*) resource in U.S. waters off the coast of ... using data through 2018.

Catches

catches

Information on historical landings of GBY rockfish are available back to xxxx... (Table a). Commercial landings were small during the years of World War II, ranging between 4 to 27 metric tons (mt) per year.

(Figures a-b)
(Figure c)

Since 2000, annual total landings of GBY rockfish have ranged between 69-159 mt, with landings in 2018 totaling 93 mt.

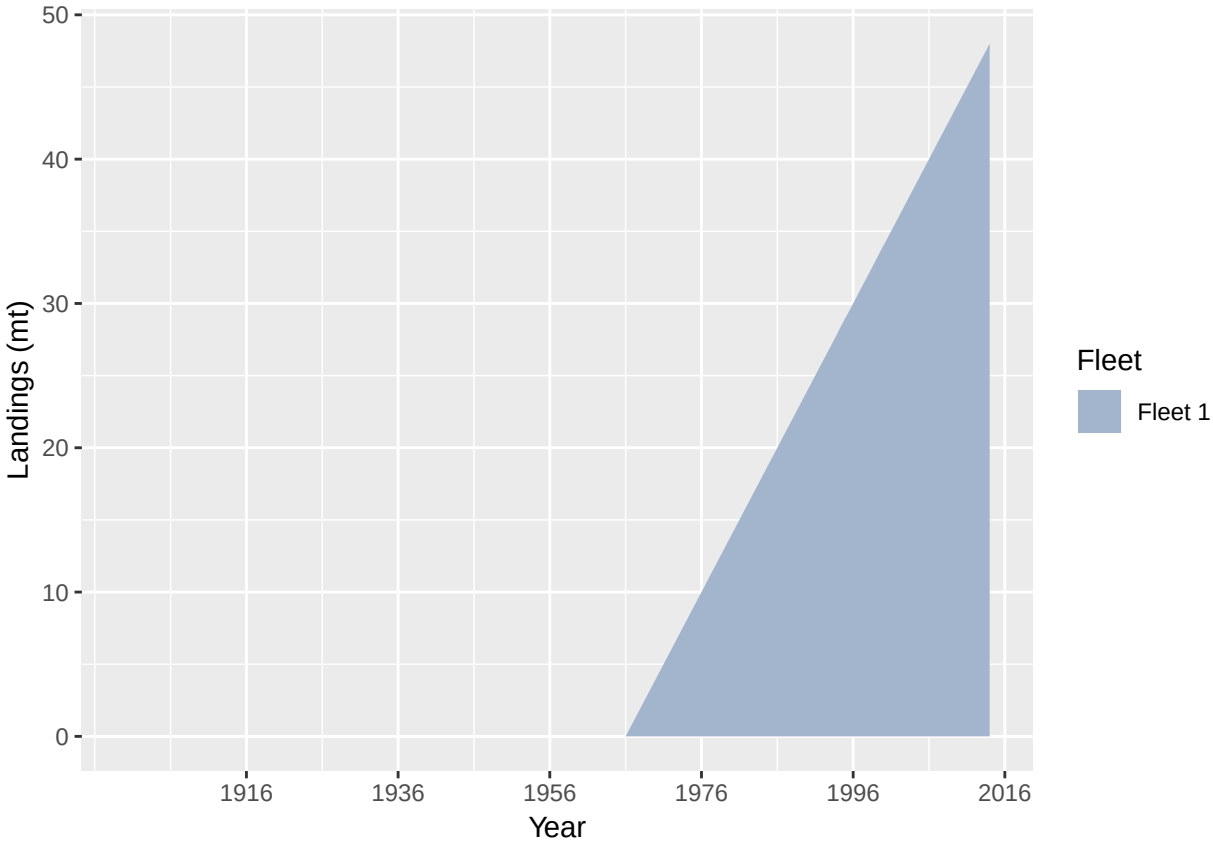

Figure a: GBY rockfish catch history for the recreational fleets. `fig:Exec_catch1`

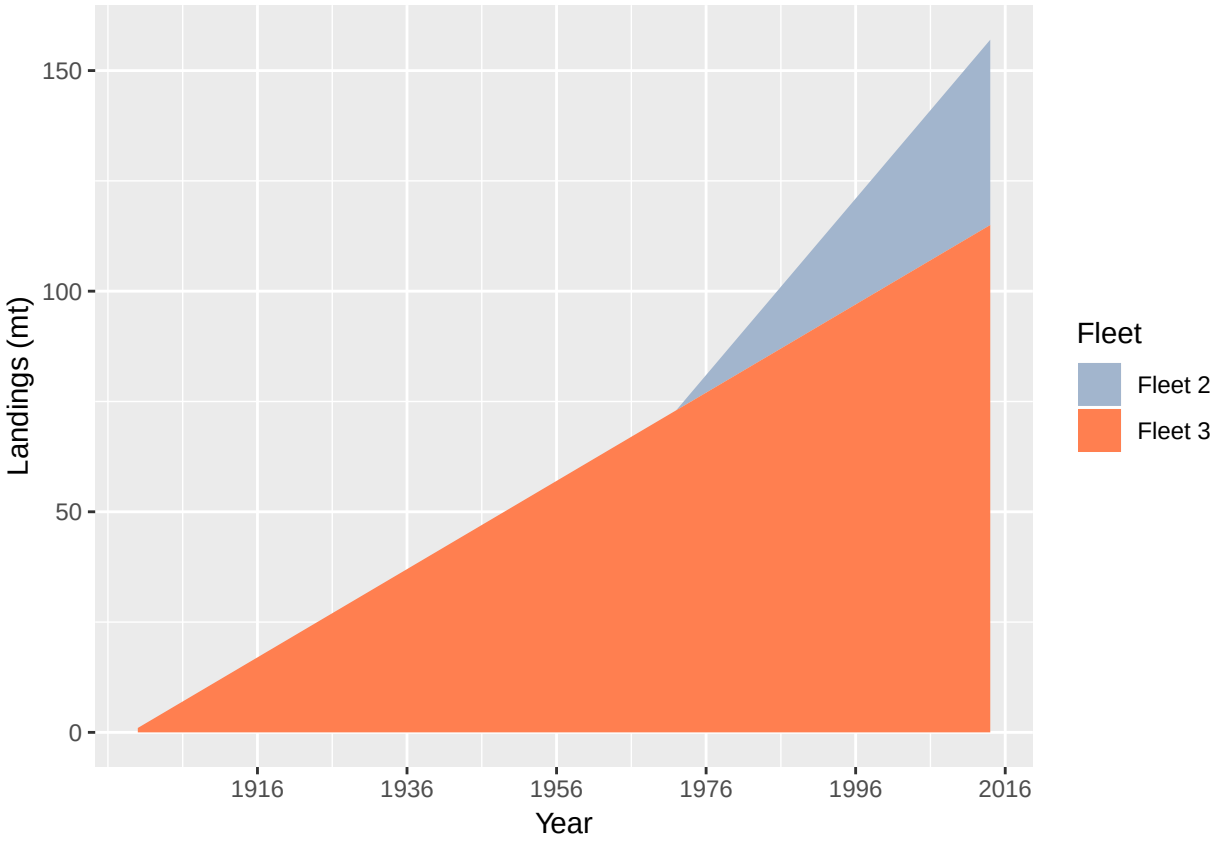

Figure b: Stacked line plot of GBY rockfish catch history for the commercial fleets. `fig:Exec_catch2`

Table a: Recent GBY 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	-	-	-	-	-	-

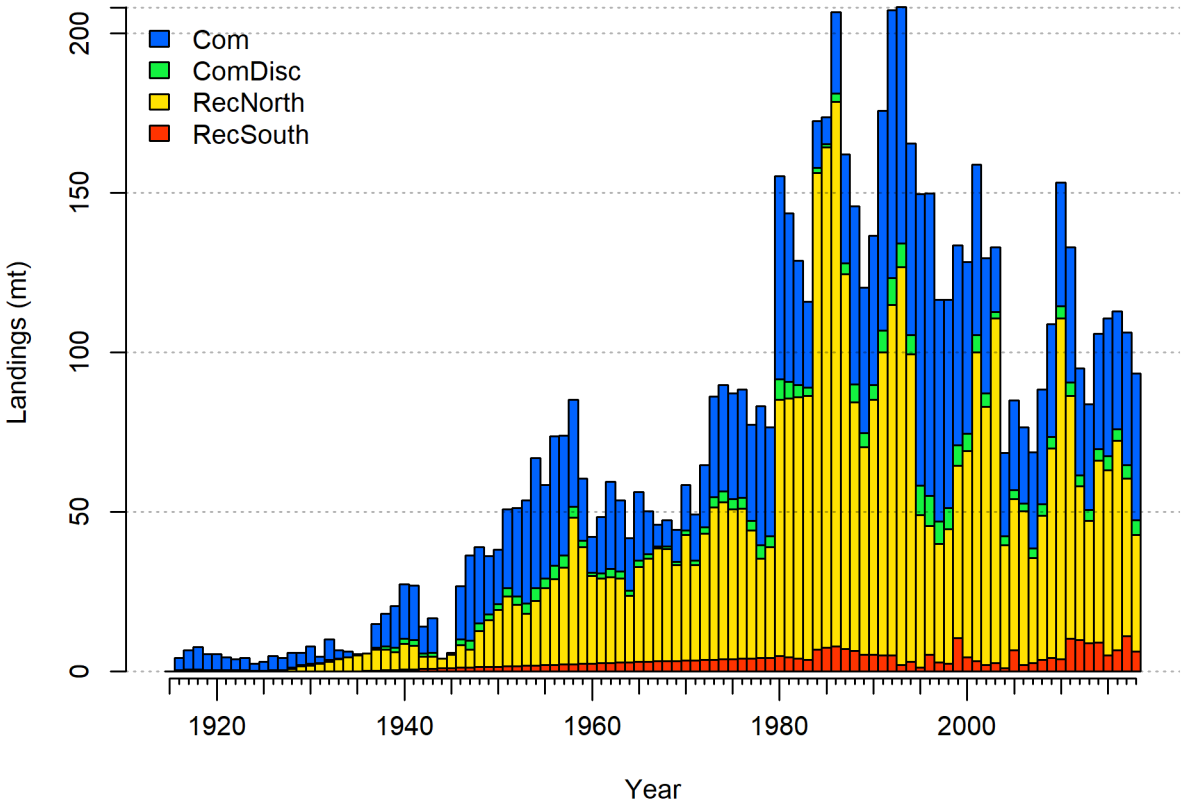

Figure c: Catch history of GBY rockfish in the model. ⌈fig:r4ss_catches

Data and Assessment

data-and-assessment

This a new full assessment for GBY 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 1916, and assumes the stock was at an unfished equilibrium that year.

(Figure d).

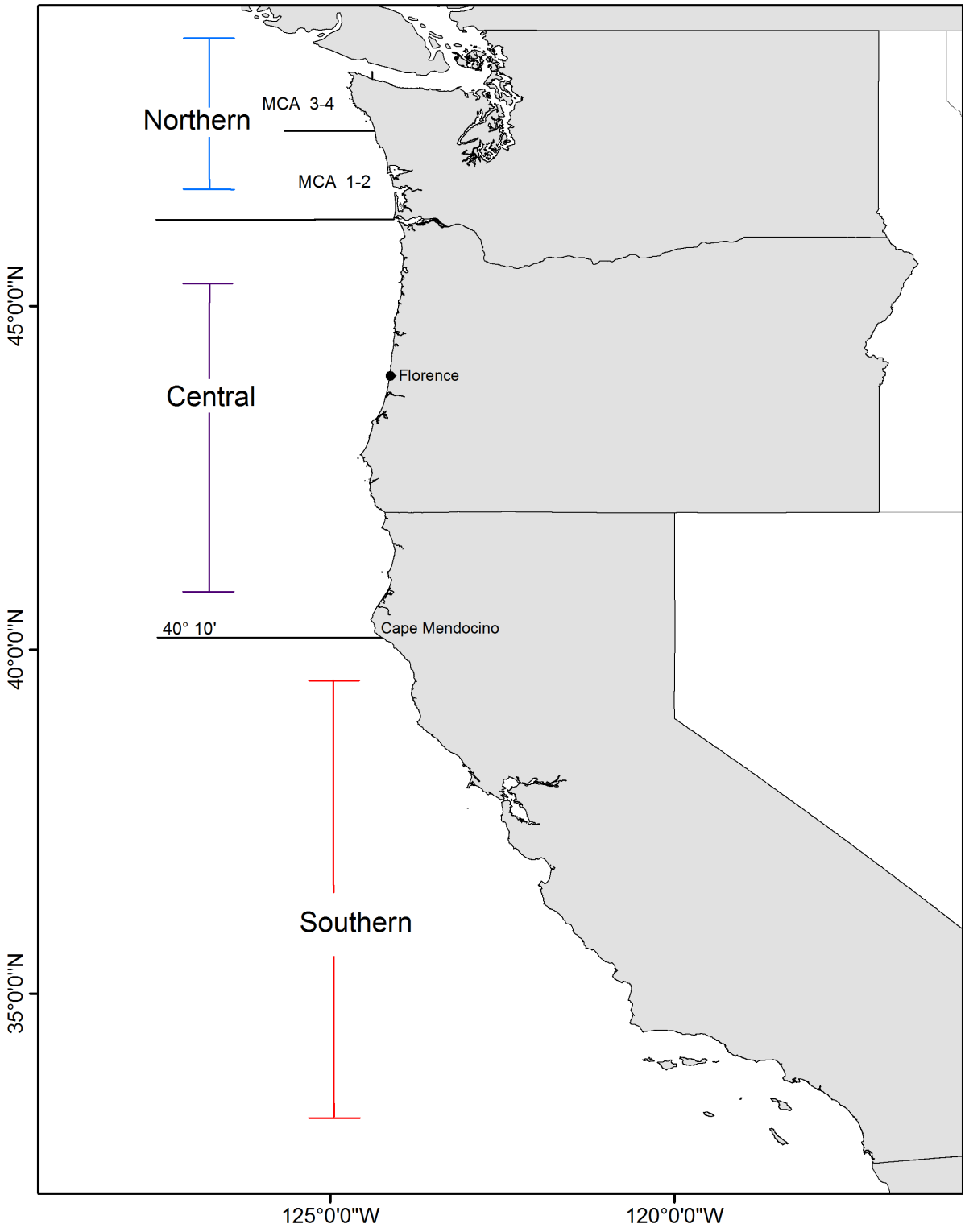

Figure d: Map depicting the distribution of California scorpionfish out to 600 ft. The stock assessment is bounded at Pt. Conception in the north to the U.S./Mexico border in the south. `fig:assess_region_map`

Stock Biomass

stock-biomass

(Figure e and Table b).

The 2018 estimated spawning biomass relative to unfished equilibrium spawning biomass is above the target of 40% of unfished spawning biomass at 45.1% (95% asymptotic interval: ± 28.9%-61.3%) (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 model for GBY rockfish.

tab:SpawningDeplete_mod1

Year	Spawning Output (million eggs)	~ 95% confidence interval	Estimated depletion	~ 95% confidence interval
2010	864.575	(604.3-1124.85)	0.650	(0.515-0.786)
2011	795.859	(549.68-1042.04)	0.599	(0.471-0.726)
2012	741.221	(507.57-974.88)	0.558	(0.437-0.678)
2013	711.779	(487.79-935.76)	0.535	(0.421-0.65)
2014	691.107	(474.44-907.77)	0.520	(0.41-0.63)
2015	661.019	(449.78-872.25)	0.497	(0.39-0.604)
2016	634.707	(425.9-843.51)	0.477	(0.371-0.584)
2017	612.729	(404.15-821.3)	0.461	(0.353-0.569)
2018	599.056	(389.03-809.08)	0.451	(0.34-0.561)
2019	599.431	(397.31-801.55)	0.451	(0.289-0.613)

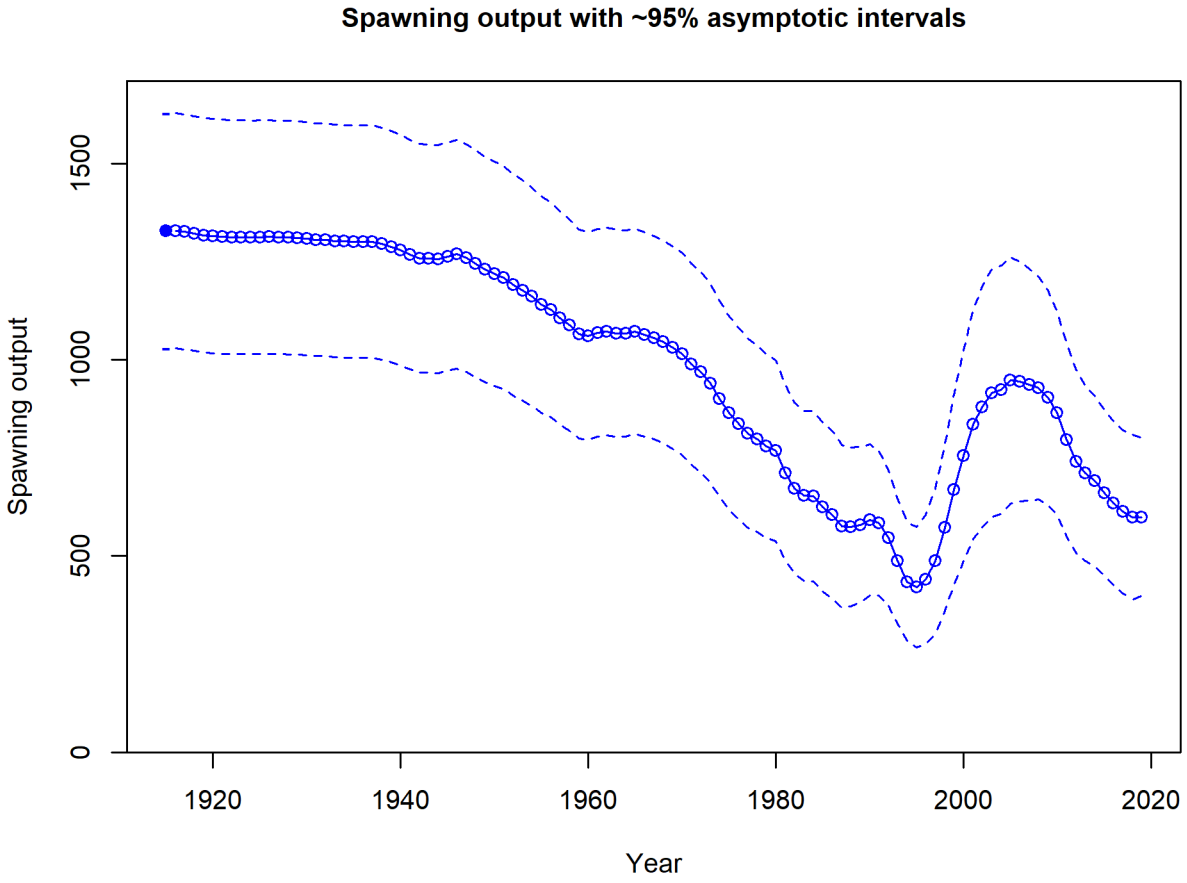

Figure e: Time series of spawning biomass trajectory (circles and line: median; light broken lines: 95% credibility intervals) for the base case assessment model. ⌜fig:Spawnbio_all

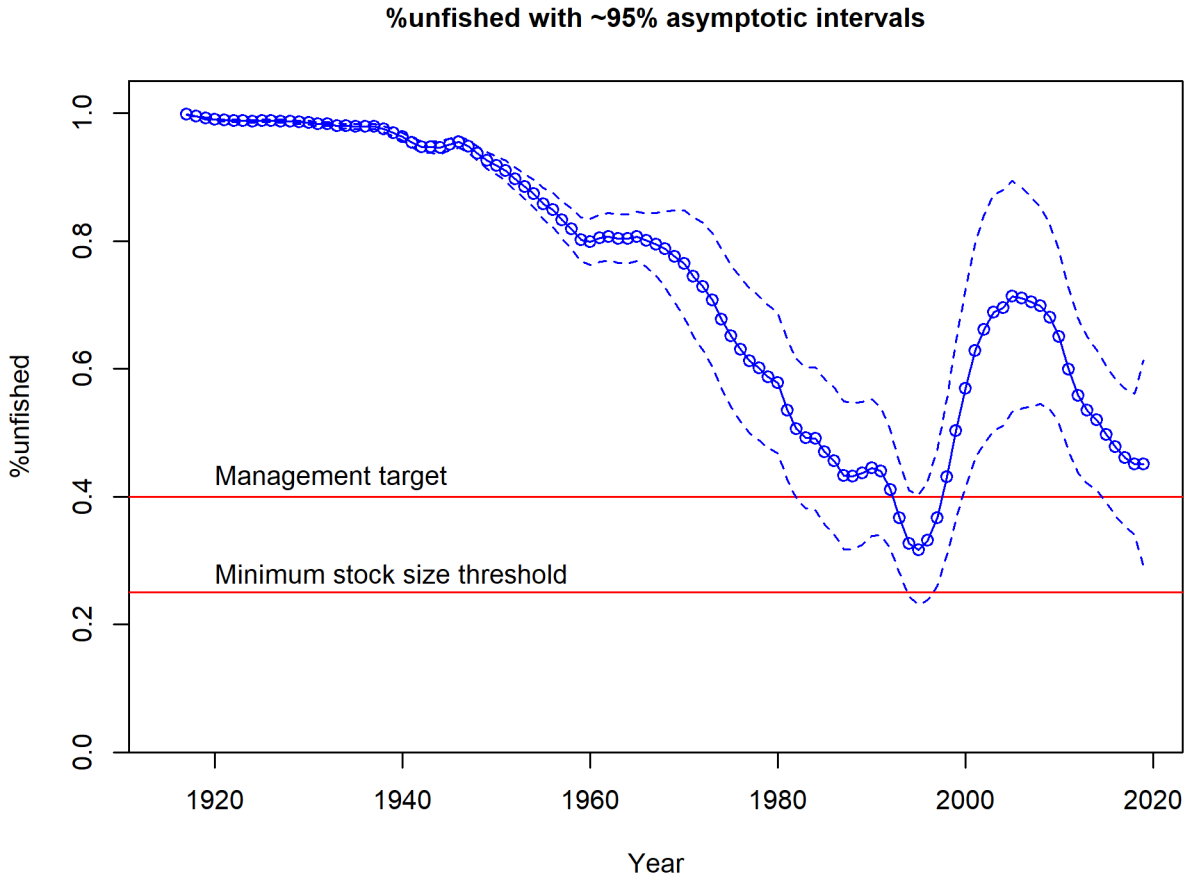

Figure f: Estimated percent depletion with approximate 95% asymptotic confidence intervals (dashed lines) for the base case assessment model. ⌜fig:RelDeplete_all

Recruitment

recruitment

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

Table c: Recent recruitment for the model.

tab:Recruit_mod1

Year	Estimated Recruitment (1,000s)	~ 95% confidence interval
2010	3218.83	(1410.42 - 7345.97)
2011	2746.99	(1180.57 - 6391.77)
2012	2631.66	(1126.64 - 6147.16)
2013	2767.28	(1179.6 - 6491.88)
2014	3916.77	(1632.26 - 9398.66)
2015	5510.34	(2305.44 - 13170.55)
2016	4079.14	(1645.01 - 10115.07)
2017	3360.32	(1372 - 8230.16)
2018	2968.86	(1262.36 - 6982.25)
2019	3352.25	(1373.02 - 8184.58)

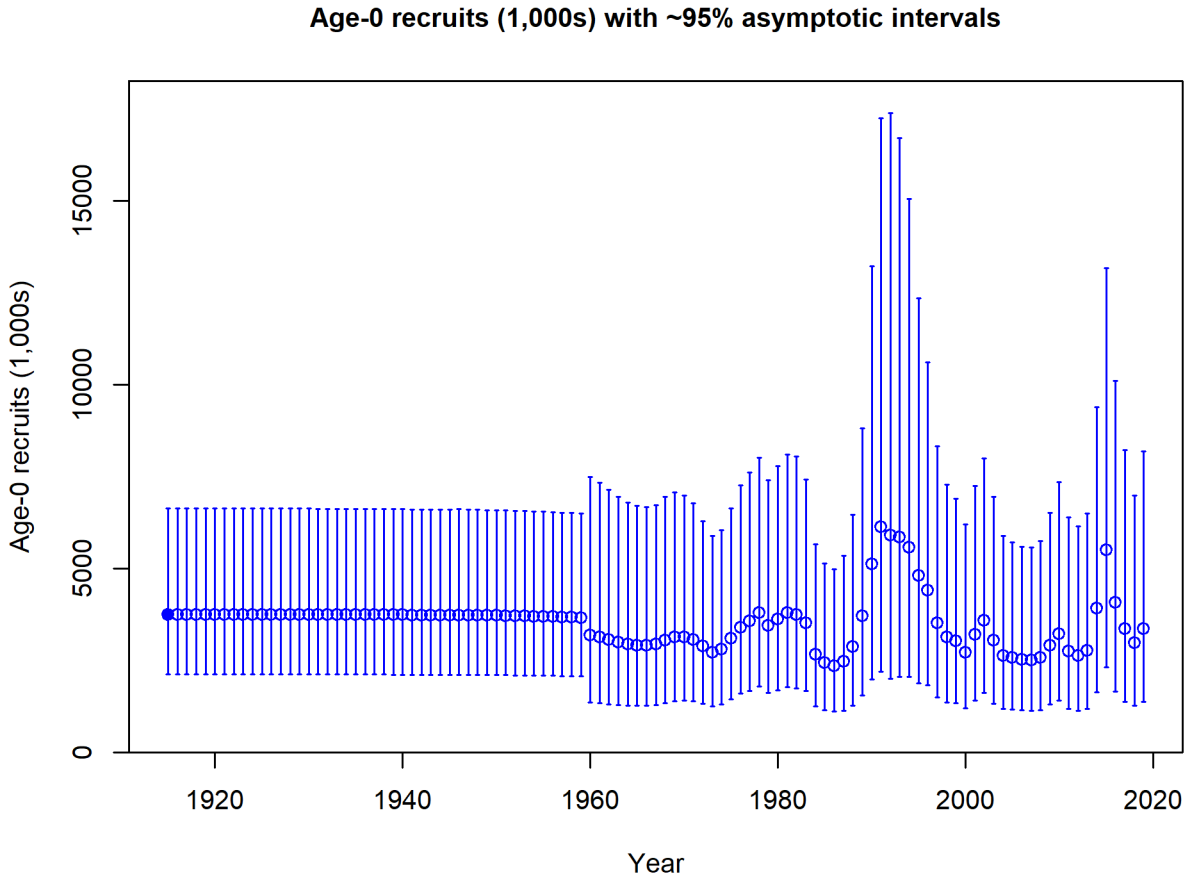

Figure g: Time series of estimated GBY rockfish recruitments for the base-case model with 95% confidence or credibility intervals. ⌜fig:Recruits_all

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 GBY rockfish in the 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
2009	0.67	(0.49-0.85)	0.08	(0.06-0.1)
2010	0.82	(0.63-1.02)	0.11	(0.08-0.15)
2011	0.81	(0.61-1.01)	0.11	(0.08-0.14)
2012	0.71	(0.52-0.9)	0.08	(0.06-0.1)
2013	0.67	(0.49-0.86)	0.07	(0.05-0.09)
2014	0.78	(0.58-0.97)	0.09	(0.07-0.12)
2015	0.81	(0.61-1.01)	0.10	(0.07-0.13)
2016	0.85	(0.64-1.05)	0.10	(0.07-0.13)
2017	0.85	(0.64-1.06)	0.10	(0.06-0.13)
2018	0.81	(0.6-1.02)	0.08	(0.05-0.11)

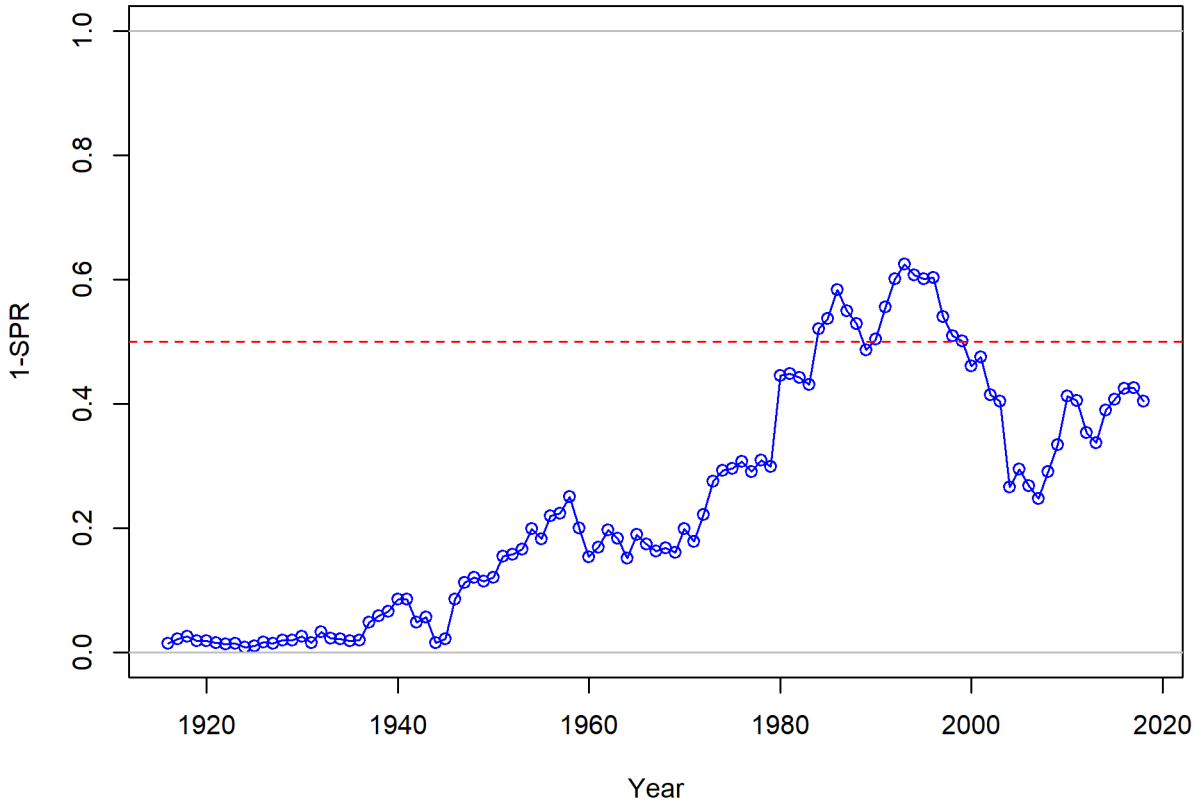

Figure h: Estimated spawning potential ratio (SPR) for the base-case model. One minus SPR is plotted so that higher exploitation rates occur on the upper portion of the y-axis. The management target is plotted as a red horizontal line and values above this reflect harvests in excess of the overfishing proxy based on the $SPR_{50\%}$ harvest rate. The last year in the time series is 2018. 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 GBY rockfish in the 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 2019 is 45.1% (95% asymptotic interval: ± 28.9%-61.3%, corresponding to an unfished spawning biomass of 599.431 million eggs (95% asymptotic interval: 397.31-801.55 million eggs) of spawning biomass in the base model (Table e). Unfished age 1+ biomass was estimated to be 1,969 mt in the base case model. The target spawning biomass ($SB_{40\%}$) is 532 million eggs, which corresponds with an equilibrium yield of 145 mt. Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is 136 mt (Figure i).

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

tab:Ref_pts_mod1

Quantity	Estimate	Low 2.5% limit	High 2.5% limit
Unfished spawning output (million eggs)	1,329	1,030	1,629
Unfished age 1+ biomass (mt)	1,969	1,642	2,296
Unfished recruitment (R_0)	3,749	1,561	5,937
Spawning output(2018 million eggs)	599	389	809
Depletion (2018)	0.451	0.34	0.561
Reference points based on SB$_{40\%}$			
Proxy spawning output ($B_{40\%}$)	532	456	607
SPR resulting in $B_{40\%}$ ($SPR_{B40\%}$)	0.458	0.458	0.458
Exploitation rate resulting in $B_{40\%}$	0.139	0.107	0.171
Yield with $SPR_{B40\%}$ at $B_{40\%}$ (mt)	145	105	184
Reference points based on SPR proxy for MSY			
Spawning output	593	509	677
SPR_{proxy}	0.5		
Exploitation rate corresponding to SPR_{proxy}	0.121	0.093	0.15
Yield with SPR_{proxy} at SB_{SPR} (mt)	136	99	173
Reference points based on estimated MSY values			
Spawning output at MSY (SB_{MSY})	297	248	346
SPR_{MSY}	0.299	0.288	0.31
Exploitation rate at MSY	0.234	0.171	0.296
Dead Catch MSY (mt)	165	117	212
Retained Catch MSY (mt)	165	117	212

130 # Management Performance

management-performance

131 Table f

132 # 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	-	-	-	-

Decision Table

decision-table

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

tab:OFL_projection

Year	OFL
2019	145.83

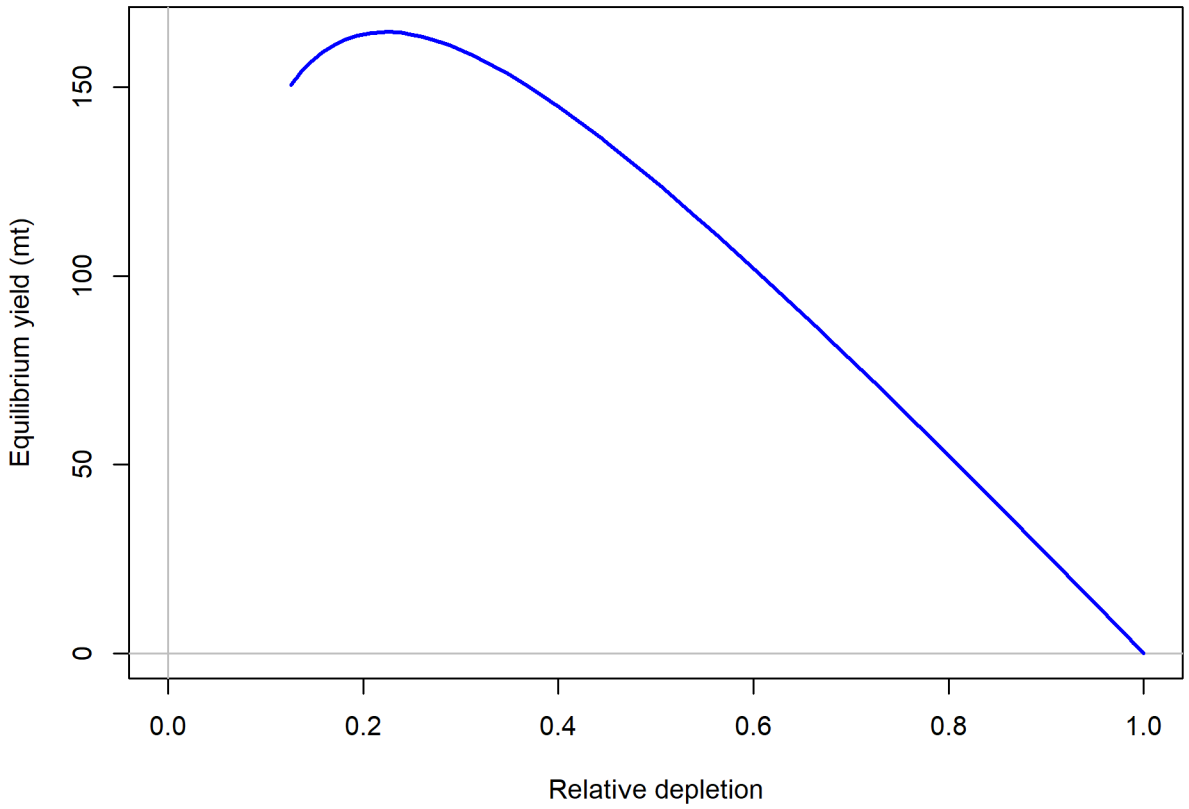

Figure i: Equilibrium yield curve for the base case model. Values are based on the 2018 fishery selectivity and with steepness fixed at 0.718. ⌜fig:Yield_all

Table h: Summary of 10-year projections beginning in 2020 for alternate states of nature based on an axis of uncertainty for the 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	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Landings (mt)										
Total Est. Catch (mt)										
OFL (mt)										
ACL (mt)										
(1-SPR)(1-$SPR_{50\%}$)	0.82	0.81	0.71	0.67	0.78	0.81	0.85	0.85	0.81	
Exploitation rate	0.11	0.11	0.08	0.07	0.09	0.10	0.10	0.10	0.08	
Age 1+ biomass (mt)	1391.63	1332.20	1246.97	1184.00	1156.13	1140.65	1116.13	1101.05	1097.89	1118.10
Spawning Output	864.6	795.9	741.2	711.8	691.1	661.0	634.7	612.7	599.1	599.4
95% CI	(604.3-1124.85)	(549.68-1042.04)	(507.57-974.88)	(487.79-935.76)	(474.44-907.77)	(449.78-872.25)	(425.9-843.51)	(404.15-821.3)	(389.03-809.08)	(397.31-801.55)
Depletion	0.7	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5
95% CI	(0.515-0.786)	(0.471-0.726)	(0.437-0.678)	(0.421-0.65)	(0.41-0.63)	(0.39-0.604)	(0.371-0.584)	(0.353-0.569)	(0.34-0.561)	(0.289-0.613)
Recruits	3218.83	2746.99	2631.66	2767.28	3916.77	5510.34	4079.14	3360.32	2968.86	3352.25
95% CI	(1410.42 - 7345.97)	(1180.57 - 6391.77)	(1126.64 - 6147.16)	(1179.6 - 6491.88)	(1632.26 - 9398.66)	(2305.44 - 13170.55)	(1645.01 - 10115.07)	(1372 - 8230.16)	(1262.36 - 6982.25)	(1373.02 - 8184.58)

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 GBY 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

Commercial landings in California are based on two primary data sources: a cooperative port sampling program (California Cooperative Groundfish Survey, CALCOM) that collects information including species composition data (i.e. the proportion of species landed in a sampling stratum), and landing receipts (sometimes called "fish tickets") that are a record of pounds landed in a given stratum. Strata in California are defined by market category, year, quarter, gear group, port complex, and disposition (live or dead). Although many market categories are named after actual species, catch in a given market category can consist of several species. All landings used in this assessment are "expanded" landings, i.e., species composition data collected by port samplers were used to allocate pounds recorded on landing receipts to species. Use of the "Gopher Rockfish" or the "Black-and-Yellow Rockfish" categories alone to represent actual landings of GBY would not be accurate. See Pearson et al. Appendix C (2008) for a simple example of the expansion calculations. Data from the California Cooperative Groundfish Survey, species compositions, and expanded landings estimates are stored in the CALCOM database at the Pacific States Marine Fisheries Commission, a central repository of commercial landings data for the U.S. West Coast.

Commercial catches of black-and-yellow rockfish from 1916-1968 and for gopher rockfish from 1937-1968 were queried (4 April 2019) from the California Catch Reconstruction (Ralston et al. 2010). Landings in this database are divided into trawl and 'non-trawl.' Since the majority of GBYR are caught in the commercial fixed gear fisheries, only estimated catch in the 'non-trawl' was used. A total of 0.154 mt (3.18%) were removed from Eureka commercial landings (based on current proportions of commercial catch from north of Cape Mencodino in Eureka) since the assessment represents the GBYR stock south of Cape Mendocino.

Commercial landings from 1969-2018 were queried for a final time from the CALCOM database on 4 April 2019 (Table **??**. Commercial landings were also queried from PacFIN (Pacific Fisheries Inforamtion Network) for a final time on 3 June 2019 for comparison to CALCOM landings. There are very small differences in commercial landings between CALCOM and PacFIN from 1981-2018 (Figure **??**fig:Calcom_vs_Pacfin}). Landings estiamtes from CALCOM were used in the assessment. Landings were stratified by year, quarter, live/dead, market category, gear group, port complex, and source of species composition data (actual port samples, borrowed samples, or assumed nominal market category). Data from individual quarters were aggregated at the year level. Fish landed live or dead were combined, due to changes over time in the reliability of condition information (D. Pearson, pers. comm.). From 1916-1968, on average, 74% of GBYR were landed north of Point Conception, which rose to 97% from 1978-2018. Given the smaller landings south of Point Conception and the similar length composition of GBYR north and south of Pt. Conception, no spatial separation was considered for the commercial fleet.

2.1.2 Commercial Discards

commercial-discards

The West Coast Groundfish Observer Program (WCGOP) provides observer data on discarding practices across sectors back to 2003. Gopher and black-and-yellow rockfishes have different depth-stratified commercial fishery discard mortality rates (Pacific Fishery Management Council 2018). In consultation with WCGOP staff, the STAT used estimates of total discard mortality from WCGOP's Groundfish Expanded Mortality Multiyear (GEMM) report. WCGOP observes between 1-5% of nearshore fixed gear landings annually south of 40°10′ N. latitude (coverage rates available here). The expanded estimates of total discard by species is calculated as the ratio of the discard of the individual species observed by WCGOP divided by the observed landings from PacFIN landing receipts. WCGOP discard estimates for the nearshore fixed gear fishery take into account the depth distribution of landings in order to appropriately apply the depth-stratified discard mortality rates by species (Somers, K.A., J. Jannot, V. Tuttle, K. Richerson and McVeigh 2018). The discard mortality for 2018 was estimated as an average of the discard mortality from 20213-2017. Discard mortality was estimated from the period prior to WCGOP discard estimates (1916-2002) based on the average discard mortality rate from 2003-2016 (2017 was excluded because 2017 discard mortality was disproportionately higher than all other years) (Table 1).

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

Three data sources were used to estimate retained and discard mortality for the recreational fishing fleet; the California Catch Reconstruction (Ralston et al. 2010) and the California Department of Fish and Wildlife MRFSS (1980-2003) and CRFS (2004-2018) databases.

Historical recreational landings and discard, 1928-1980 Ralston et al. (2010) reconstructed estimates of recreational rockfish catch and discard in California, 1928-1980. Reported landings of total rockfish were allocated to species based on several sources of species composition data. Estimates of GBYR landings and discard (combined) from 1928-1979 are available from the SWFSC. For this assessment, historical recreational catch was stratified by year and area (north and south of Point Conception). The catches of GBYR reported in Ralston et al. (2010) are higher than expected given the more recent catches of GBYR south of Pt.

Conception and the species' ranges (Figure 4). The California Catch Reconstruction used a linear from from 1928-1936 that was not altered. From 1937-1979 linear ramp to the average recreational landing from 1980 and 1983 (1981-1982 catches interpolated as described in the next section) of 4.3 mt. The recreational catches north of Pt. Conception were not altered from the original catch reconstruction. The resulting alternate recreational catch streams are in (Table 2 and Figure 5).

Marine Recreational Fisheries Statistics Survey (MRFSS), 1980-2003

California Recreational Fisheries Survey (CRFS), 2004-2016

Recreational Discard

There was a lapse in MRFSS sampling from 1990 through 1992, for which retained catch and discard mortality were estimated using the average of values three years before and three years after the lapse for all modes other than the party/charter mode. For the party/charter mode, estimates of numbers of fish were available from logbook data and average weight from the three years before and after this period were applied to provide estimates for the party/charter mode.

Estimates of retained catch and discards were not available from the non-party/charter modes prior to 1980, thus the ratio of catch in the party/charter mode to the other modes for 1980 through 1985 was used to provide an estimate of catch in the other modes in the years 1932-1979. In the case of the private/rental mode, a linear ramp in the ratio adjustment between party/charter and private/rental modes was applied between 1966 and 1979 from 0.55 in 1980 to 0.10 in 1965, reflecting the increase in the relative proportion of catch contributed by the private/rental mode with time as more individuals anglers purchased vessels, as recommended in the California Catch Reconstruction (Ralston et al. 2010), and the ratio of 0.10 was assumed for all years prior. The ratio of party/charter estimates to the man-made structure (MM) and beach/bank (BB) modes was assumed constant and the average between 1980 and 1989 was applied from 1932 to 1979. Catch estimates from CPFV logbooks were not available during the World War II era from 1941 until 1946 and catch was assumed to be zero for all modes during this period. Estimates for retained catch and discarded mortality for 1928 to 3528 were estimated using a linear ramp from the value for 1936 to zero in 1928 for the party/charter mode and ratios party/charter compared to other modes were used to proxy estimates for other modes based on the resulting ramped values for the party/charter mode. The final time series of landings and discard mortality are in Table 2.

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`

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 **??**. 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 **??**.

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 **??**.

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 **??** and the likelihood components are in Table **??**. 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 **??**.

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 **??**).

The stock-recruit curve ... Figure **??** 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, (2017). Sustainable total yield (landings plus discards) were 136 mt when using an $SPR_{50\%}$ reference harvest rate and with a 95% confidence interval of 99 mt based on estimates of uncertainty. The spawning biomass equivalent to 40% of the unfished level ($SB_{40\%}$) was 532 mt.

(Figure **??**

The 2018 spawning biomass relative to unfished equilibrium spawning biomass is above/below the target of 40% of unfished levels (Figure **??**). 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 **??** 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 GBY 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

Table 1: Commercial landings and discards (mt) from the commercial fisheries. Data sources are the California Catch Reconstruction, CALCOM, and WCGOP GEMM report.

Year	Landings	Discards	Total Commercial Removals	Source
1916	3.88	0.38	4.27	Catch Reconstruction
1917	6.03	0.59	6.63	Catch Reconstruction
1918	7.06	0.69	7.75	Catch Reconstruction
1919	4.91	0.48	5.39	Catch Reconstruction
1920	5.01	0.49	5.50	Catch Reconstruction
1921	4.13	0.41	4.54	Catch Reconstruction
1922	3.56	0.35	3.90	Catch Reconstruction
1923	3.84	0.38	4.22	Catch Reconstruction
1924	2.22	0.22	2.44	Catch Reconstruction
1925	2.78	0.27	3.05	Catch Reconstruction
1926	4.48	0.44	4.92	Catch Reconstruction
1927	3.81	0.37	4.18	Catch Reconstruction
1928	4.60	0.45	5.06	Catch Reconstruction
1929	3.81	0.37	4.18	Catch Reconstruction
1930	5.40	0.53	5.93	Catch Reconstruction
1931	1.93	0.19	2.11	Catch Reconstruction
1932	6.24	0.61	6.85	Catch Reconstruction
1933	2.58	0.25	2.84	Catch Reconstruction
1934	1.75	0.17	1.92	Catch Reconstruction
1935	0.43	0.04	0.47	Catch Reconstruction
1936	0.01	0.00	0.01	Catch Reconstruction
1937	7.27	0.71	7.98	Catch Reconstruction
1938	10.29	1.01	11.30	Catch Reconstruction
1939	13.13	1.29	14.42	Catch Reconstruction
1940	16.90	1.66	18.56	Catch Reconstruction
1941	17.06	1.67	18.73	Catch Reconstruction
1942	8.55	0.84	9.38	Catch Reconstruction
1943	11.00	1.08	12.08	Catch Reconstruction
1944	0.05	0.00	0.05	Catch Reconstruction
1945	0.59	0.06	0.65	Catch Reconstruction
1946	16.71	1.64	18.35	Catch Reconstruction
1947	26.71	2.62	29.33	Catch Reconstruction
1948	23.95	2.35	26.30	Catch Reconstruction
1949	18.29	1.79	20.09	Catch Reconstruction
1950	17.15	1.68	18.83	Catch Reconstruction
1951	24.83	2.44	27.26	Catch Reconstruction

Continues next page

tab:CommCatches

Table 1: Commercial landings and discards (mt) from the commercial fisheries. Data sources are the California Catch Reconstruction, CALCOM, and WCGOP GEMM report.

Year	Landings	Discards	Total Commercial Removals	Source
1952	27.59	2.71	30.29	Catch Reconstruction
1953	32.30	3.17	35.47	Catch Reconstruction
1954	40.75	4.00	44.74	Catch Reconstruction
1955	29.49	2.89	32.38	Catch Reconstruction
1956	40.66	3.99	44.65	Catch Reconstruction
1957	37.52	3.68	41.20	Catch Reconstruction
1958	33.56	3.29	36.86	Catch Reconstruction
1959	19.62	1.92	21.54	Catch Reconstruction
1960	11.30	1.11	12.41	Catch Reconstruction
1961	17.49	1.72	19.20	Catch Reconstruction
1962	27.18	2.67	29.85	Catch Reconstruction
1963	22.29	2.19	24.48	Catch Reconstruction
1964	16.55	1.62	18.17	Catch Reconstruction
1965	21.50	2.11	23.61	Catch Reconstruction
1966	13.44	1.32	14.76	Catch Reconstruction
1967	6.70	0.66	7.36	Catch Reconstruction
1968	8.29	0.81	9.10	Catch Reconstruction
1969	9.99	0.98	10.97	CALCOM
1970	14.21	1.39	15.60	CALCOM
1971	14.41	1.41	15.83	CALCOM
1972	19.42	1.91	21.33	CALCOM
1973	31.43	3.08	34.51	CALCOM
1974	33.41	3.28	36.69	CALCOM
1975	33.08	3.25	36.33	CALCOM
1976	33.90	3.33	37.23	CALCOM
1977	30.13	2.96	33.09	CALCOM
1978	43.41	4.26	47.67	CALCOM
1979	34.24	3.36	37.60	CALCOM
1980	63.65	6.24	69.89	CALCOM
1981	52.67	5.17	57.84	CALCOM
1982	38.96	3.82	42.78	CALCOM
1983	26.89	2.64	29.52	CALCOM
1984	14.82	1.45	16.27	CALCOM
1985	8.42	0.83	9.25	CALCOM
1986	25.49	2.50	27.99	CALCOM
1987	34.21	3.36	37.57	CALCOM
1988	55.73	5.47	61.20	CALCOM
1989	45.48	4.46	49.94	CALCOM

Continues next page

tab:CommCatches

Table 1: Commercial landings and discards (mt) from the commercial fisheries. Data sources are the California Catch Reconstruction, CALCOM, and WCGOP GEMM report.

Year	Landings	Discards	Total Commercial Removals	Source
1990	46.77	4.59	51.36	CALCOM
1991	68.85	6.75	75.60	CALCOM
1992	83.99	8.24	92.23	CALCOM
1993	74.09	7.27	81.35	CALCOM
1994	60.06	5.89	65.95	CALCOM
1995	91.42	8.97	100.39	CALCOM
1996	94.71	9.29	104.00	CALCOM
1997	69.37	6.81	76.18	CALCOM
1998	65.28	6.40	71.68	CALCOM
1999	62.70	6.15	68.85	CALCOM
2000	53.91	5.29	59.20	CALCOM
2001	53.41	5.24	58.65	CALCOM
2002	42.28	4.15	46.42	CALCOM
2003	20.18	13.04	33.22	CALCOM & WCGOP
2004	26.27	2.66	28.93	CALCOM & WCGOP
2005	28.09	3.33	31.42	CALCOM & WCGOP
2006	23.87	4.10	27.96	CALCOM & WCGOP
2007	30.14	4.50	34.64	CALCOM & WCGOP
2008	36.06	1.63	37.69	CALCOM & WCGOP
2009	35.42	5.38	40.80	CALCOM & WCGOP
2010	38.65	3.92	42.57	CALCOM & WCGOP
2011	42.28	5.72	48.01	CALCOM & WCGOP
2012	33.46	1.93	35.39	CALCOM & WCGOP
2013	33.17	2.85	36.02	CALCOM & WCGOP
2014	36.15	2.85	39.00	CALCOM & WCGOP
2015	43.18	2.93	46.11	CALCOM & WCGOP
2016	36.84	2.42	39.26	CALCOM & WCGOP
2017	41.51	1.65	43.15	CALCOM & WCGOP
2018	46.08	2.54	48.62	CALCOM & WCGOP

Table 2: Recreational removals (mt) of GBYR. Data sources are the California Catch Reconstruction (modified for south of Pt. Conception), MRFSS (modified for 1981-1982), and CRFS.

Year	North of Pt. Conception	South of Pt. Conception	Total Recreational Removals	Source
1928	0.80	0.01	0.81	Catch Reconstruction
1929	1.60	0.03	1.63	Catch Reconstruction
1930	1.83	0.04	1.88	Catch Reconstruction
1931	2.44	0.06	2.50	Catch Reconstruction
1932	3.06	0.07	3.13	Catch Reconstruction
1933	3.67	0.09	3.76	Catch Reconstruction
1934	4.28	0.10	4.38	Catch Reconstruction
1935	4.89	0.12	5.01	Catch Reconstruction
1936	5.50	0.21	5.71	Catch Reconstruction
1937	6.52	0.31	6.83	Catch Reconstruction
1938	6.41	0.40	6.82	Catch Reconstruction
1939	5.61	0.50	6.11	Catch Reconstruction
1940	8.08	0.59	8.67	Catch Reconstruction
1941	7.46	0.69	8.15	Catch Reconstruction
1942	3.96	0.78	4.75	Catch Reconstruction
1943	3.79	0.88	4.67	Catch Reconstruction
1944	3.11	0.97	4.09	Catch Reconstruction
1945	4.15	1.07	5.22	Catch Reconstruction
1946	7.14	1.16	8.31	Catch Reconstruction
1947	5.65	1.26	6.91	Catch Reconstruction
1948	11.28	1.35	12.63	Catch Reconstruction
1949	14.62	1.45	16.07	Catch Reconstruction
1950	17.82	1.54	19.36	Catch Reconstruction
1951	21.94	1.64	23.58	Catch Reconstruction
1952	19.09	1.73	20.83	Catch Reconstruction
1953	16.26	1.83	18.09	Catch Reconstruction
1954	20.21	1.92	22.14	Catch Reconstruction
1955	24.10	2.02	26.12	Catch Reconstruction
1956	26.91	2.11	29.02	Catch Reconstruction
1957	30.38	2.21	32.58	Catch Reconstruction
1958	46.00	2.30	48.30	Catch Reconstruction
1959	36.54	2.40	38.94	Catch Reconstruction
1960	27.37	2.49	29.87	Catch Reconstruction
1961	26.50	2.59	29.09	Catch Reconstruction
1962	26.78	2.68	29.47	Catch Reconstruction
1963	26.30	2.78	29.08	Catch Reconstruction
1964	20.76	2.87	23.63	Catch Reconstruction

Continues next page

tab:Rec_removal

Table 2: Recreational removals (mt) of GBYR. Data sources are the California Catch Reconstruction (modified for south of Pt. Conception), MRFSS (modified for 1981-1982), and CRFS.

Year	North of Pt. Conception	South of Pt. Conception	Total Recreational Removals	Source
1965	29.71	2.97	32.68	Catch Reconstruction
1966	32.33	3.06	35.40	Catch Reconstruction
1967	35.43	3.16	38.59	Catch Reconstruction
1968	35.13	3.25	38.39	Catch Reconstruction
1969	30.05	3.35	33.40	Catch Reconstruction
1970	39.41	3.44	42.85	Catch Reconstruction
1971	29.78	3.54	33.32	Catch Reconstruction
1972	39.64	3.63	43.27	Catch Reconstruction
1973	47.79	3.73	51.52	Catch Reconstruction
1974	49.30	3.82	53.12	Catch Reconstruction
1975	46.82	3.92	50.74	Catch Reconstruction
1976	47.10	4.01	51.11	Catch Reconstruction
1977	40.11	4.11	44.22	Catch Reconstruction
1978	31.11	4.20	35.32	Catch Reconstruction
1979	34.61	4.30	38.91	Catch Reconstruction
1980	80.33	4.91	85.25	MRFSS
1981	81.08	4.51	85.59	Estimated
1982	81.83	4.10	85.93	Estimated
1983	82.58	3.70	86.28	MRFSS
1984	149.49	6.79	156.28	MRFSS
1985	156.91	7.44	164.35	MRFSS
1986	170.66	7.94	178.60	MRFSS
1987	117.36	7.12	124.48	MRFSS
1988	78.02	6.43	84.45	MRFSS
1989	64.98	5.26	70.24	MRFSS
1990	79.91	5.19	85.10	MRFSS
1991	94.84	5.12	99.96	MRFSS
1992	109.77	5.04	114.82	MRFSS
1993	124.71	1.97	126.68	MRFSS
1994	96.44	3.03	99.48	MRFSS
1995	47.85	1.19	49.04	MRFSS
1996	40.30	5.23	45.53	MRFSS
1997	37.23	2.84	40.07	MRFSS
1998	42.13	2.52	44.66	MRFSS
1999	54.11	10.45	64.56	MRFSS
2000	64.70	4.39	69.10	MRFSS
2001	96.79	3.29	100.08	MRFSS

Continues next page

tab:Rec_removal

Table 2: Recreational removals (mt) of GBYR. Data sources are the California Catch Reconstruction (modified for south of Pt. Conception), MRFSS (modified for 1981-1982), and CRFS.

Year	North of Pt. Conception	South of Pt. Conception	Total Recreational Removals	Source
2002	80.83	2.15	82.98	MRFSS
2003	107.98	2.70	110.68	MRFSS
2004	38.70	0.98	39.68	CRFS
2005	47.51	6.59	54.10	CRFS
2006	48.10	2.13	50.22	CRFS
2007	32.88	2.70	35.58	CRFS
2008	45.14	3.61	48.74	CRFS
2009	65.64	4.30	69.94	CRFS
2010	106.76	3.90	110.67	CRFS
2011	76.16	10.24	86.40	CRFS
2012	48.25	9.89	58.14	CRFS
2013	38.43	8.86	47.28	CRFS
2014	56.96	9.06	66.02	CRFS
2015	58.09	5.00	63.09	CRFS
2016	65.72	6.57	72.29	CRFS
2017	49.36	11.15	60.51	CRFS
2018	36.48	6.30	42.78	CRFS

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8 Figures

figures

9 Figures

figures-1

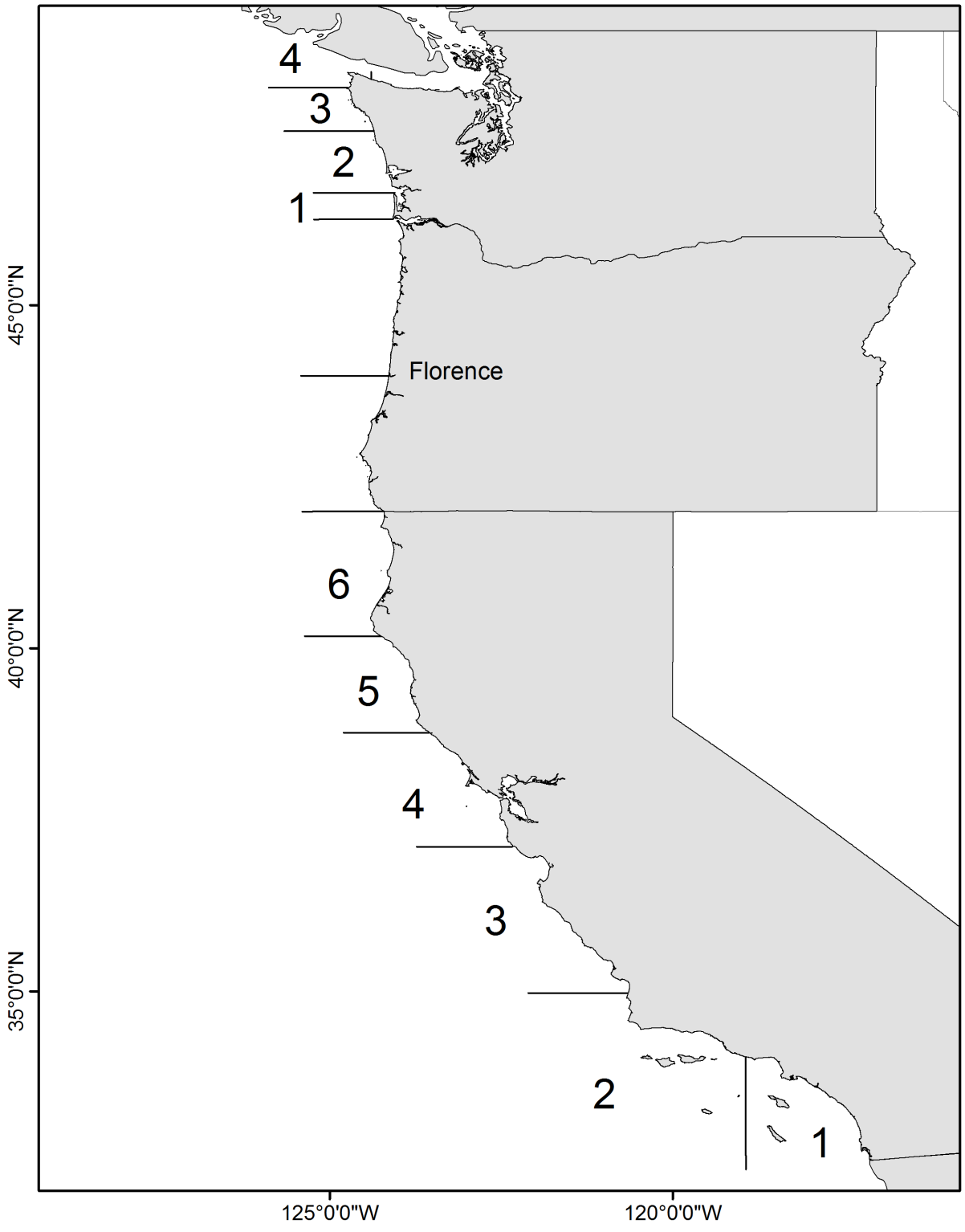

Figure 1: Map showing the state boundary lines for management of the recreational fishing fleets `fig:boundary_map`

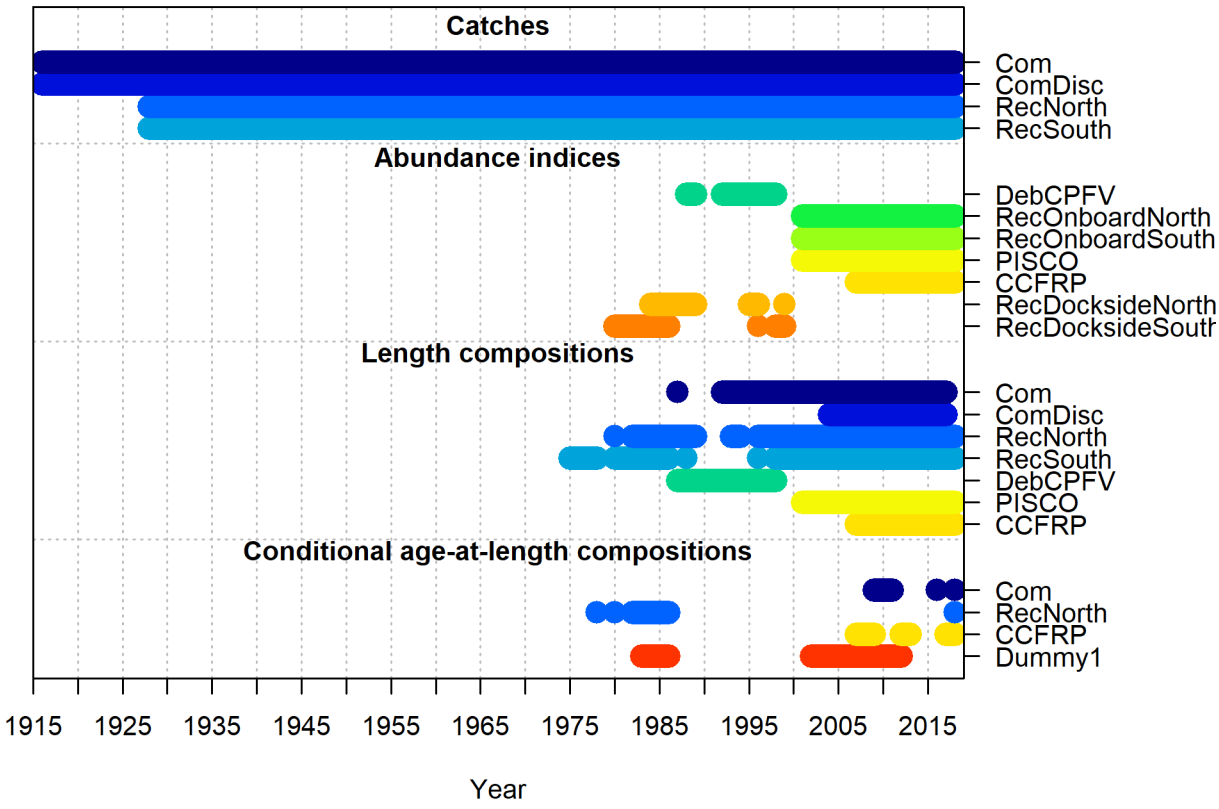

Figure 2: Summary of data sources used in the model. `fig:data_plot`

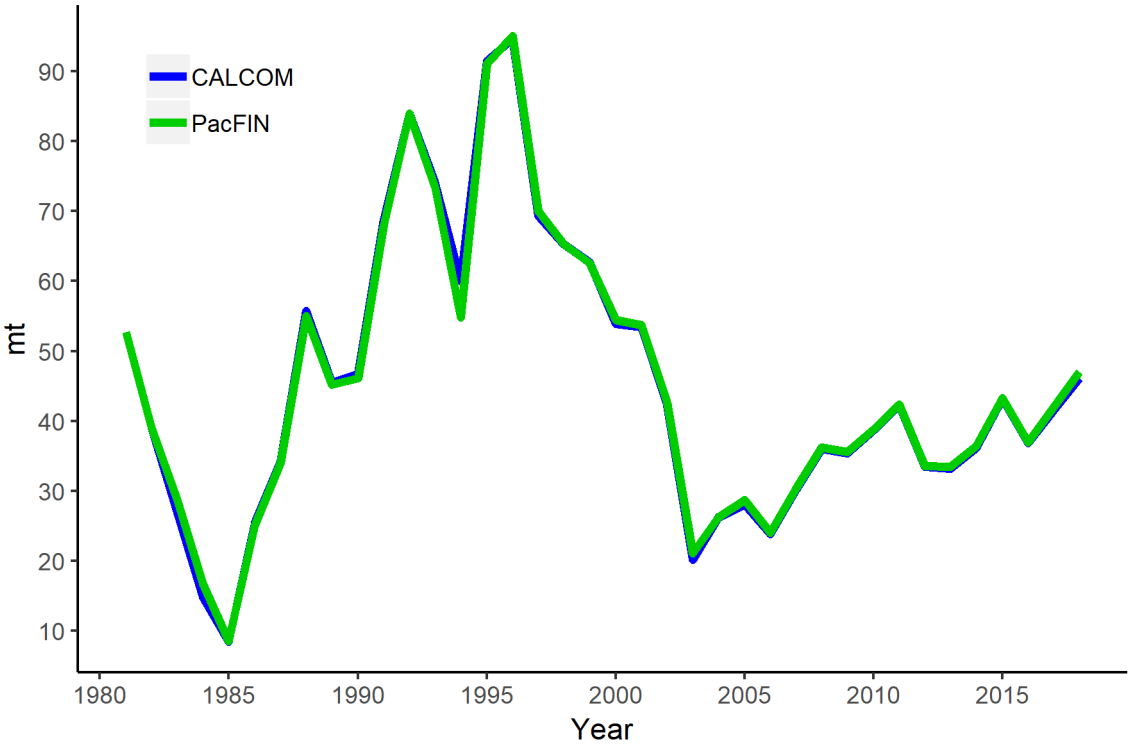

Figure 3: Commercial landings estimates from CALCOM add PacFIN. `fig:Calcom_vs_Pacfin`

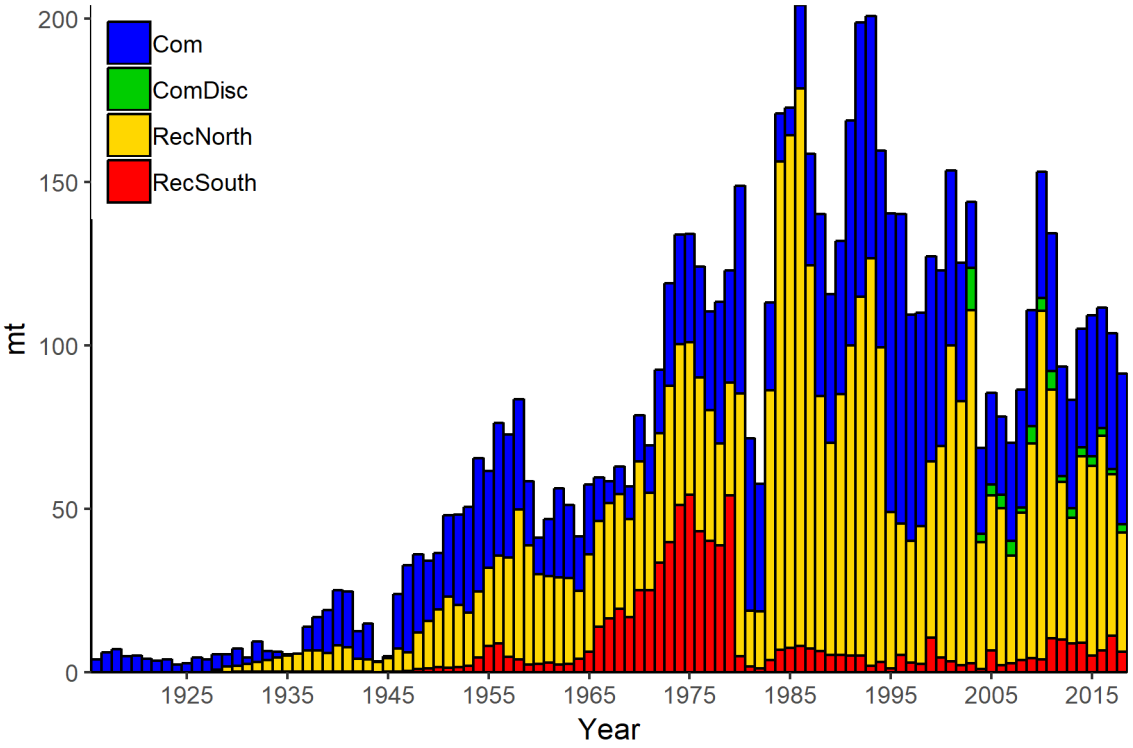

Figure 4: Commercial and recreational landings estimates prior to any data modification or interpolation to the recreational catches or hindcasting of commercial discards. `fig:Catches_original`

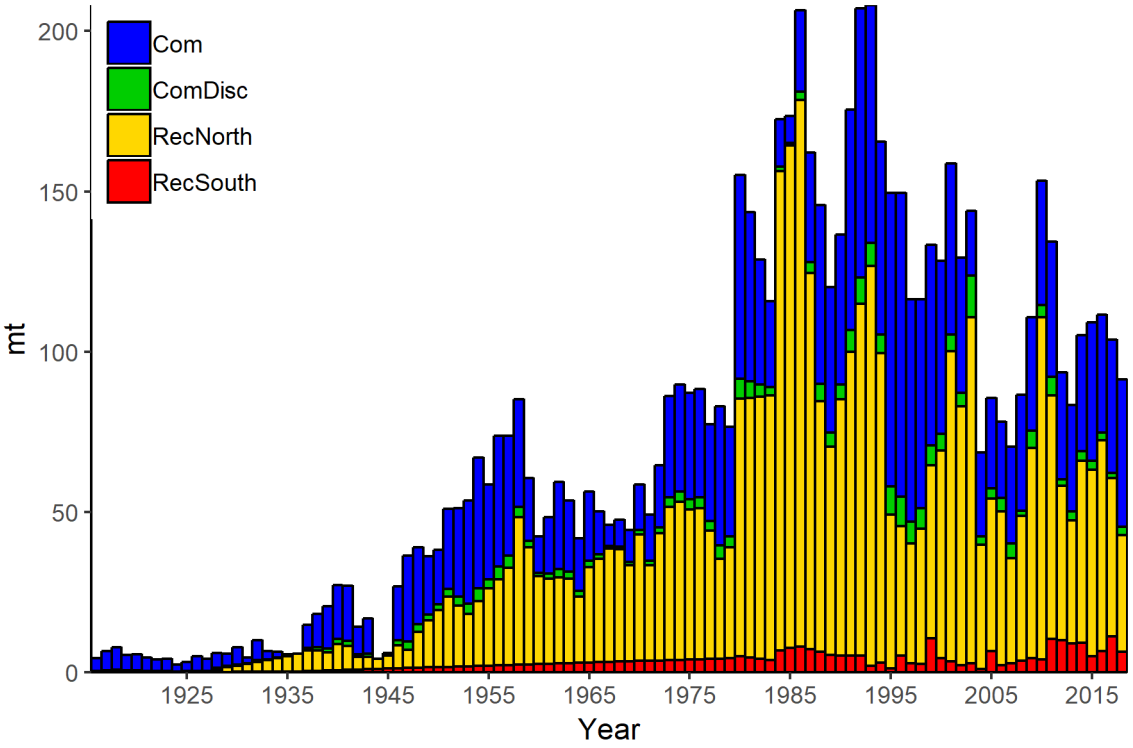

Figure 5: Commercial and recreational landings estimates after data modification and interpolations were made to the recreational catches and commercial discards. ⌜fig:Catches_alternate

¡!– ********** –¿

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`references`

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