Status of California Scorpionfish (*Scorpaena guttata*) Off Southern California in 2017

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Executive Summary

executive-summary

Stock

stock

This assessment reports the status of the California scorpionfish (*Scorpaena guttata*) resource in U.S. waters off the coast of the California, Oregon, and Washington using data through 2016. Etc...

Catches

catches

Catch figure(s) with fleets: (Figures a-c)
Catch table: (Table a)

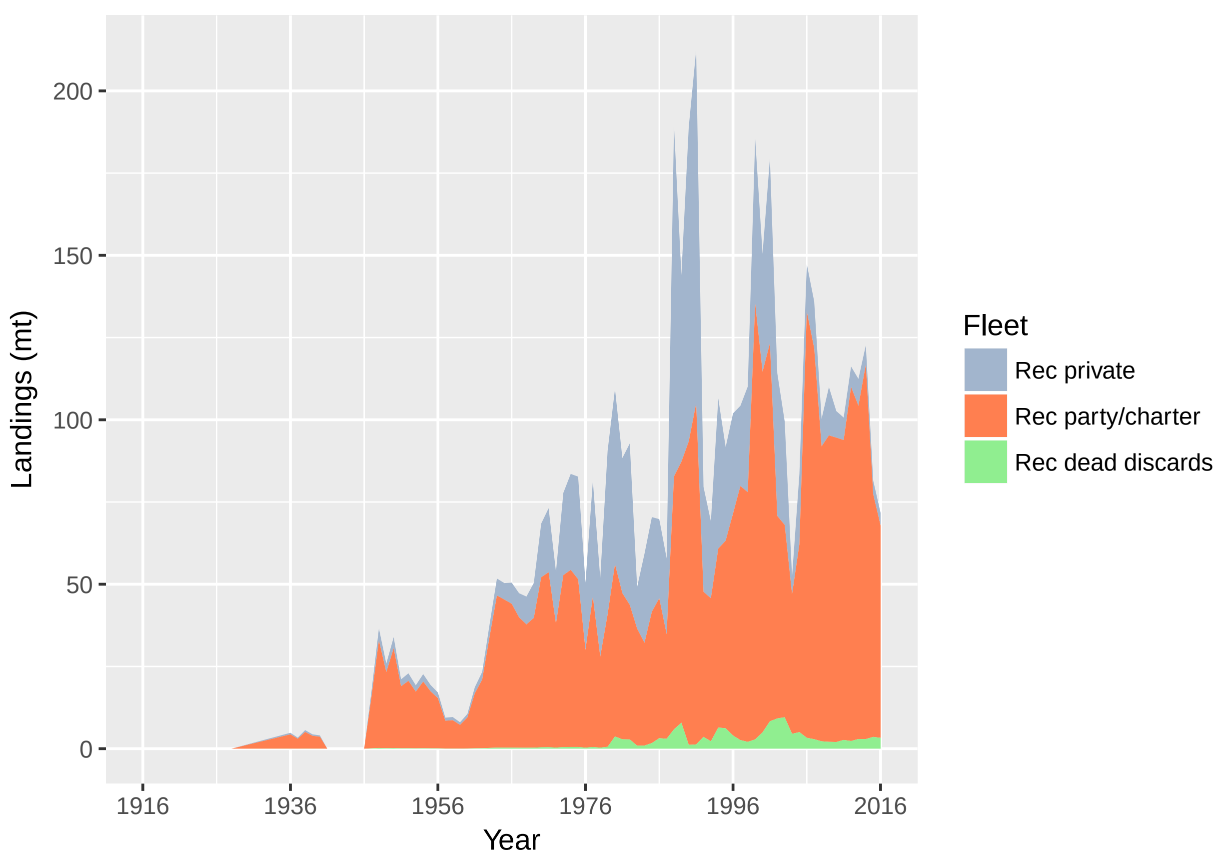

Figure a: California scorpionfish landings history for the recreational fleets. fig:Exec_catch1

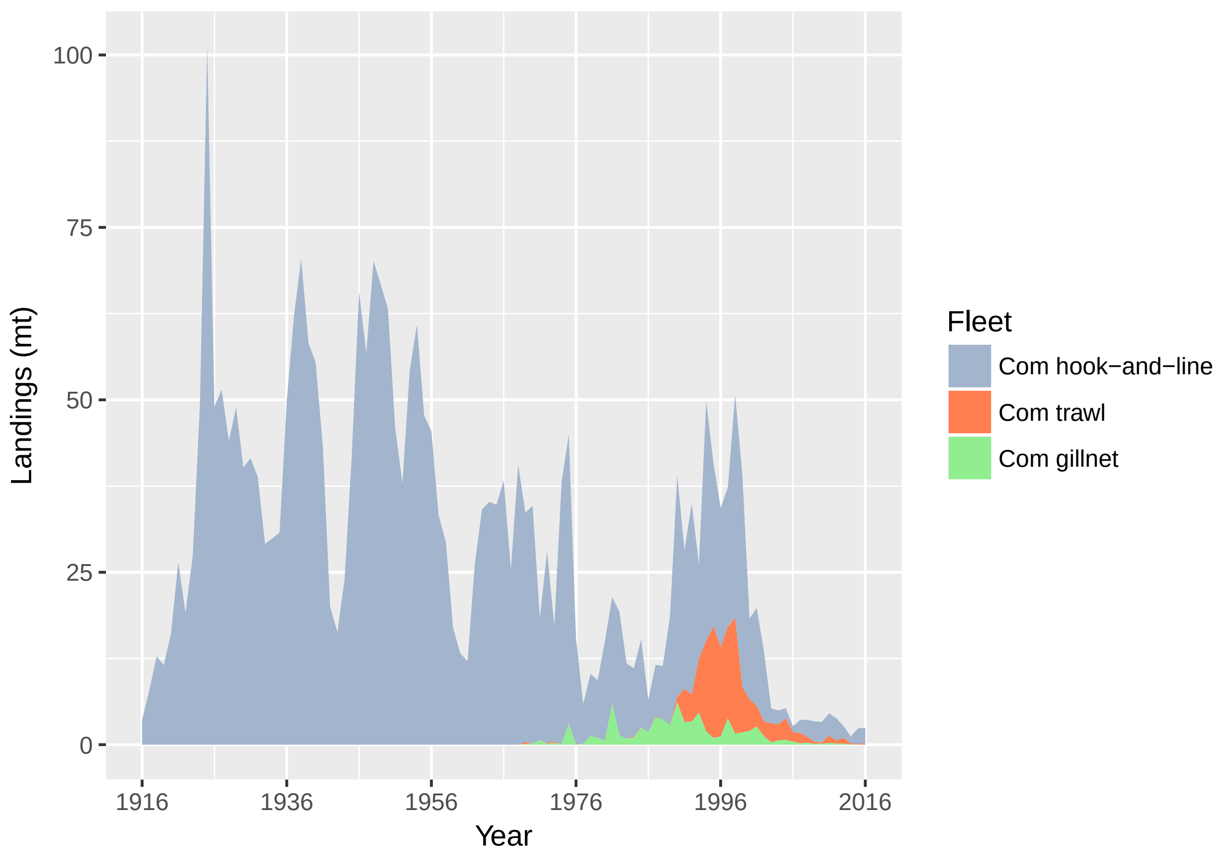

Figure b: Stacked line plot of California scorpionfish landings history for the commercial fleets. fig:Exec_catch2

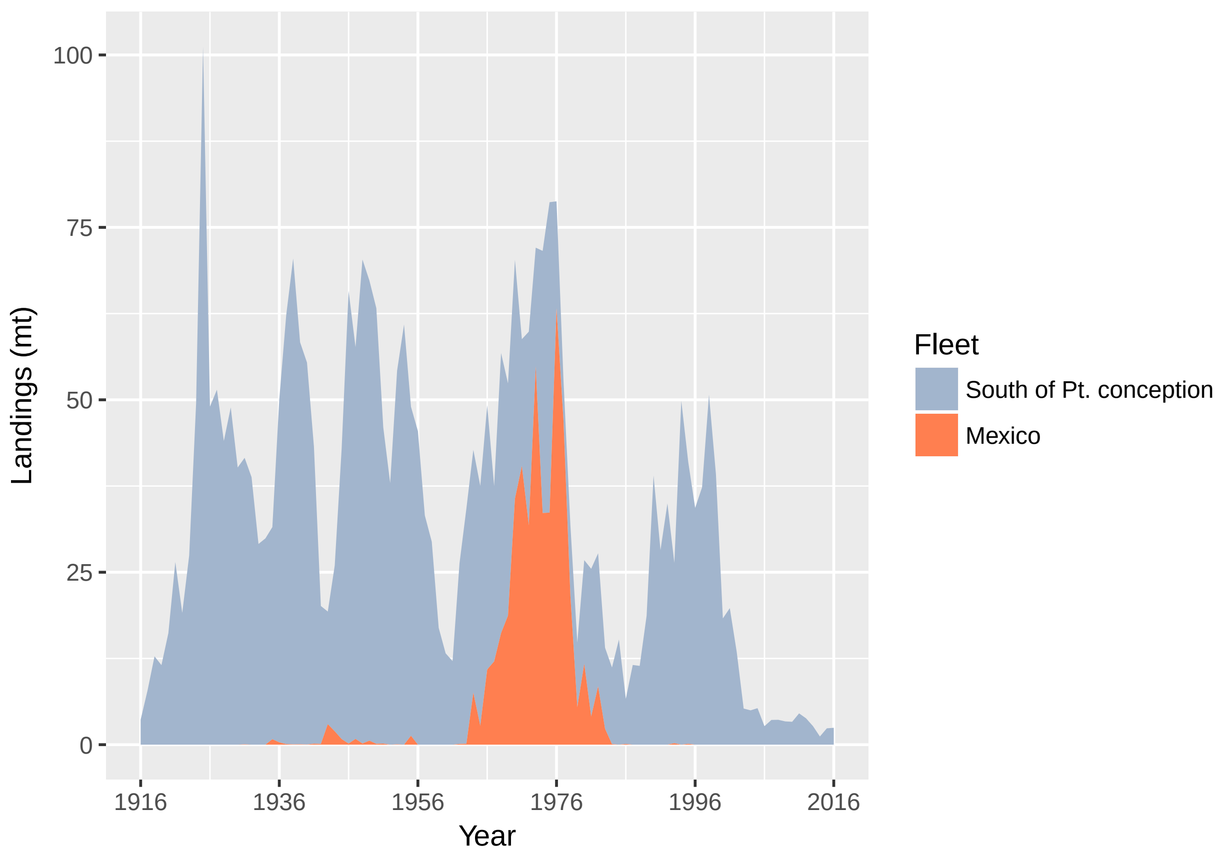

Figure c: Stacked line plot of California scorpionfish landings history by region, north of Pt. Conception, between Pt. Conception and the U.S.-Mexico border, and Mexican waters. fig:Exec_catch3

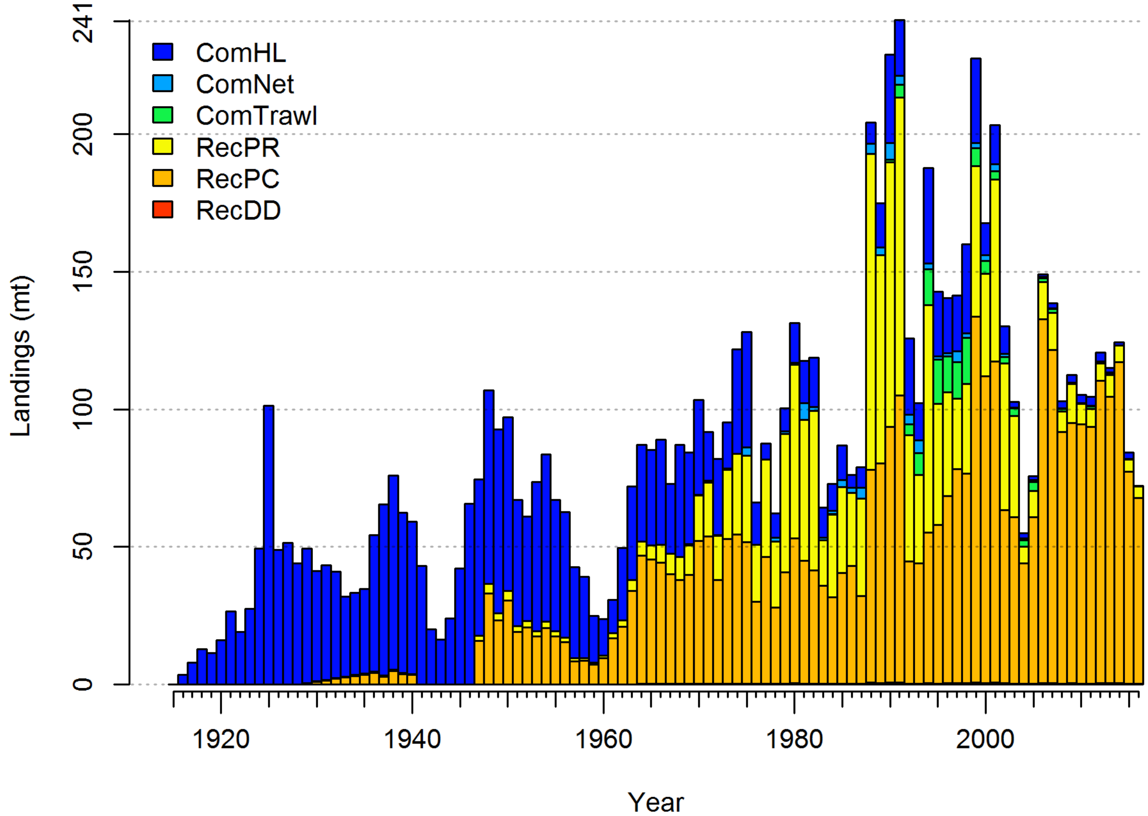

Figure d: Landings history of California scorpionfish in the base model. fig:r4ss_catches

Table a: Recent California scorpionfish landings (mt) by recreational (Rec.) and commercial (Com.) fleets.

tab:Exec_catch

Year	Rec. Private	Rec. Party/Charter	Rec. Dead Discards	Com. Hook-and-line	Com. Trawl	Com. Gillnet	Total
2007	14.24	118.87	2.89	1.90	1.48	0.21	139.58
2008	8.38	89.65	2.25	2.46	0.86	0.28	103.89
2009	14.68	93.16	2.09	2.97	0.27	0.13	113.31
2010	8.07	92.55	2.03	2.99	0.18	0.14	105.97
2011	6.84	91.18	2.66	3.24	1.05	0.24	105.21
2012	6.22	107.63	2.34	3.22	0.43	0.18	120.00
2013	8.18	101.31	2.94	1.73	0.83	0.14	115.14
2014	5.88	113.83	2.93	1.03	0.13	0.04	123.82
2015	4.15	73.78	3.59	2.21	0.13	0.03	83.89
2016	3.86	64.56	3.29	2.32	0.13	0.00	74.16

Data and Assessment

data-and-assessment

California scorpionfish was assessed in 2005 (Maunder et al. 2005) using Stock Synthesis II version 1.18. This assessment uses the newest version of Stock Synthesis (3.30.0.4). The model begins in 1916, and assumes the stock was at an unfished equilibrium that year.

Map of assessment region: (Figure e).

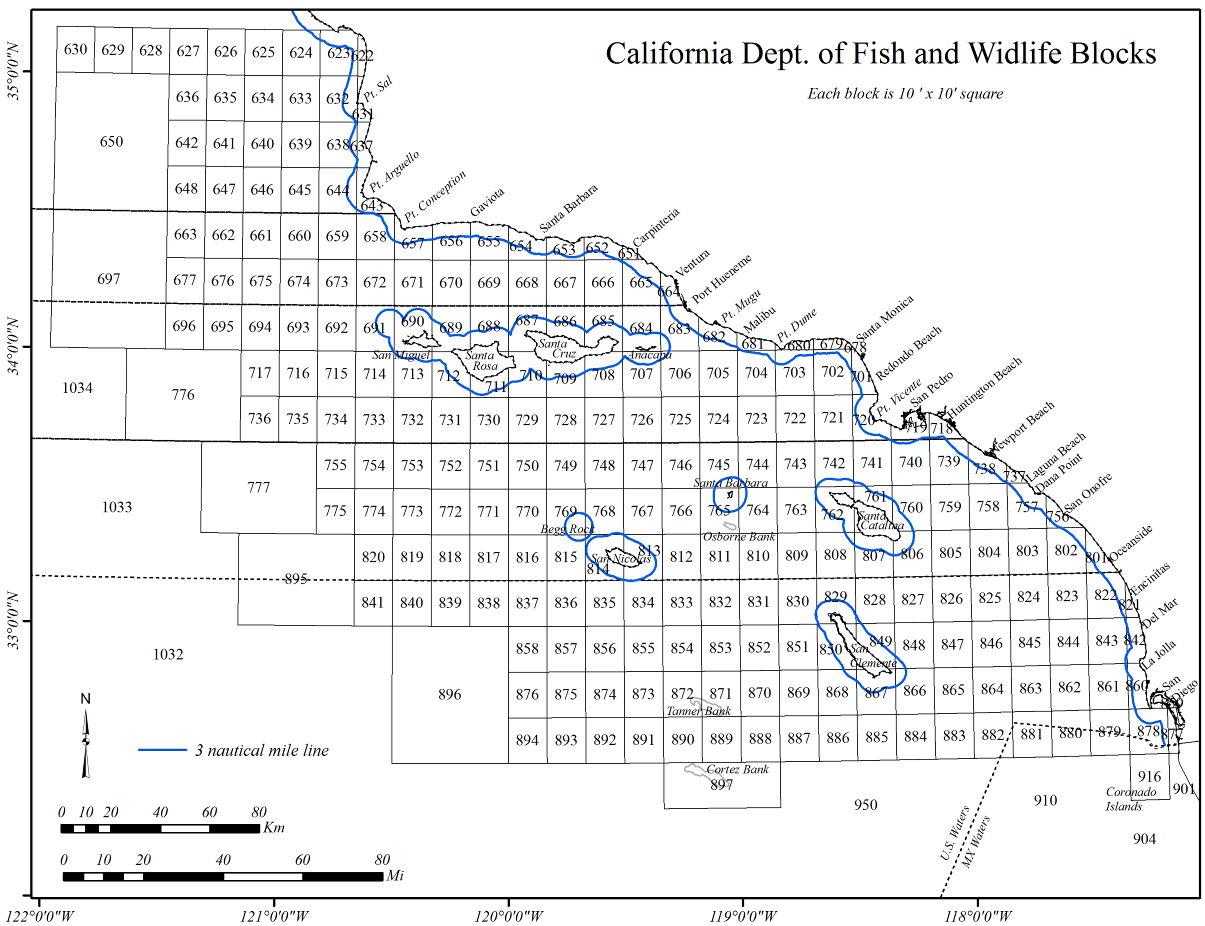

Figure e: Map depicting the boundaries for the base-case model. fig:assess_region_map

Stock Biomass

stock-biomass

Spawning output Figure: Figure f
Spawning output Table(s): Table b
Relative depletion Figure: Figure g

The estimated relative depletion level (spawning output relative to unfished spawning output) of the the base-case model in 2016 is 70.4% (˜95% asymptotic interval: ± 53.8%-87%) (Figure g).

Table b: Recent trend in beginning of the year spawning output and depletion for the base model for California scorpionfish.

tab:SpawningDeplete_mod1

Year	Spawning Output (mt)	˜ 95% confidence interval	Estimated depletion	˜ 95% confidence interval
2008	1411.880	(826-1997.76)	0.821	(0.667-0.976)
2009	1327.280	(779.49-1875.07)	0.772	(0.628-0.916)
2010	1240.230	(727.54-1752.92)	0.722	(0.587-0.856)
2011	1188.880	(694.44-1683.32)	0.692	(0.561-0.823)
2012	1180.620	(686.04-1675.2)	0.687	(0.556-0.818)
2013	1149.250	(662.71-1635.79)	0.669	(0.541-0.796)
2014	1103.550	(630.12-1576.98)	0.642	(0.517-0.767)
2015	1085.150	(607.15-1563.15)	0.631	(0.504-0.759)
2016	1122.560	(616.11-1629.01)	0.653	(0.516-0.79)
2017	1209.890	(634.69-1785.09)	0.704	(0.538-0.87)

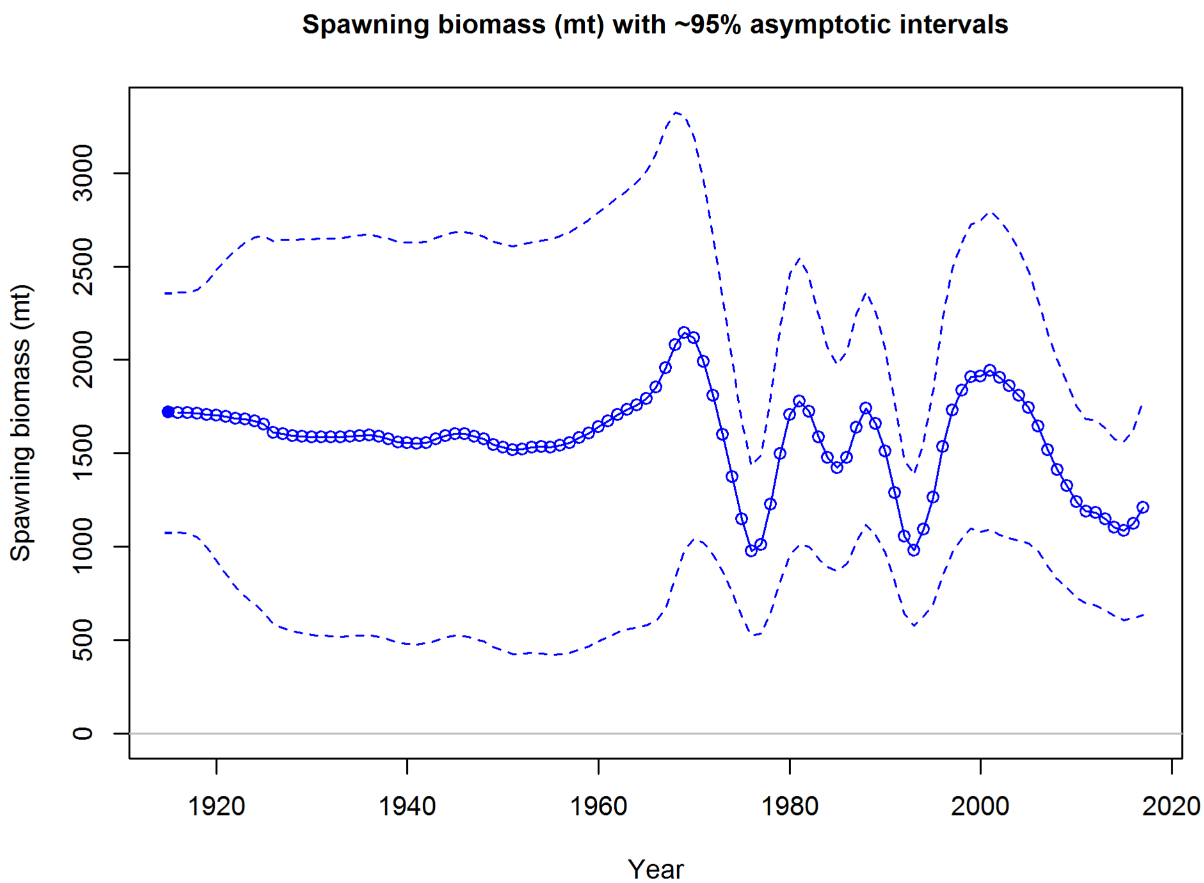

Figure f: Time series of spawning output trajectory (circles and line: median; light broken lines: 95% credibility intervals) for the base case assessment model. fig:Spawnbio_all

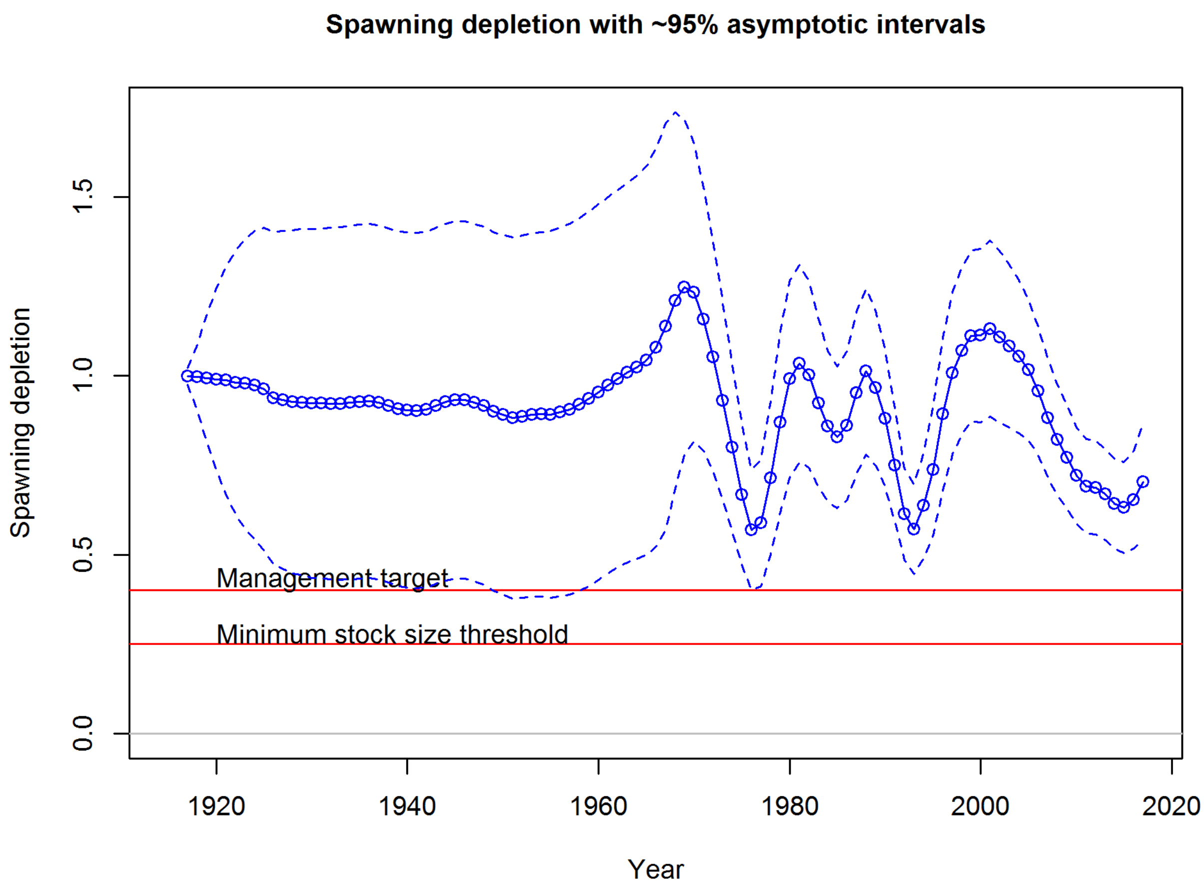

Figure g: Estimated relative depletion with approximate 95% asymptotic confidnce intervals (dashed lines) for the base case assessment model. fig:RelDeplete_all

Recruitment

recruitment

Recruitment Figure: (Figure h)
Recruitment Tables: (Tables c, ?? and ??)

Table c: Recent recruitment for the base model.

tab:Recruit_mod1

Year	Estimated Recruitment (1,000s)	˜ 95% confidence interval
2008	2334.67	(1188.11 - 4587.71)
2009	3043.29	(1586.6 - 5837.4)
2010	5924.02	(3274.03 - 10718.9)
2011	1919.20	(814.17 - 4524.02)
2012	466.56	(145.49 - 1496.19)
2013	6221.57	(3237.03 - 11957.84)
2014	2427.69	(894.39 - 6589.64)
2015	7513.87	(2659.09 - 21232.2)
2016	3822.13	(796 - 18352.62)
2017	3861.95	(804.12 - 18547.73)

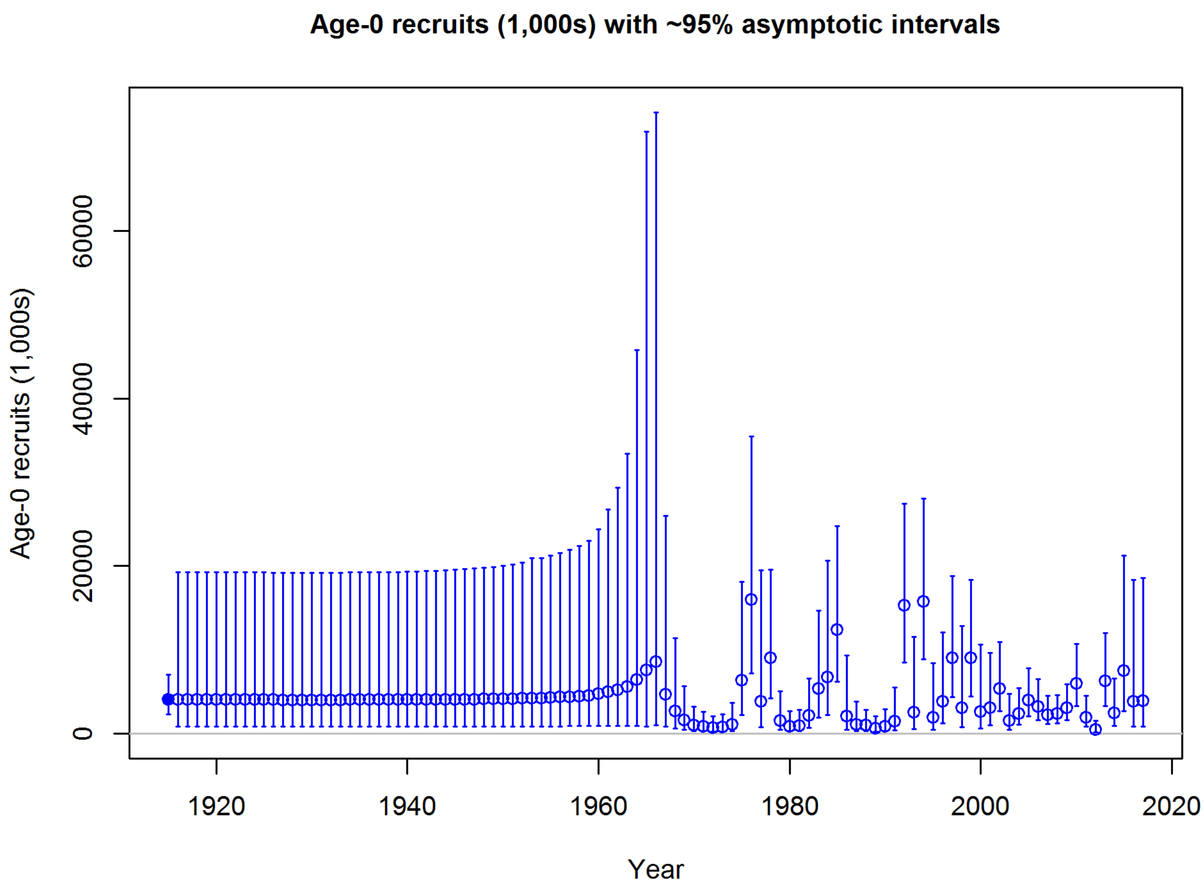

Figure h: Time series of estimated California scorpionfish recruitments for the base-case model with 95% confidence or credibility intervals. fig:Recruits_all

Exploitation status

exploitation-status

Exploitation Tables: Table d, Table ??, Table ?? Exploitation Figure: Figure i).

A summary of California scorpionfish exploitation histories for base model is provided as Figure j.

Table d: Recent trend in spawning potential ratio and exploitation for California scorpionfish in the base 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
2007	0.36	(0.21-0.52)	0.04	(0.02-0.06)
2008	0.31	(0.17-0.45)	0.03	(0.02-0.04)
2009	0.34	(0.19-0.5)	0.04	(0.02-0.05)
2010	0.34	(0.19-0.49)	0.04	(0.02-0.05)
2011	0.36	(0.2-0.51)	0.03	(0.02-0.05)
2012	0.41	(0.24-0.58)	0.04	(0.02-0.06)
2013	0.41	(0.24-0.59)	0.04	(0.02-0.06)
2014	0.45	(0.26-0.63)	0.05	(0.02-0.07)
2015	0.35	(0.19-0.51)	0.03	(0.02-0.05)
2016	0.32	(0.17-0.46)	0.02	(0.01-0.04)

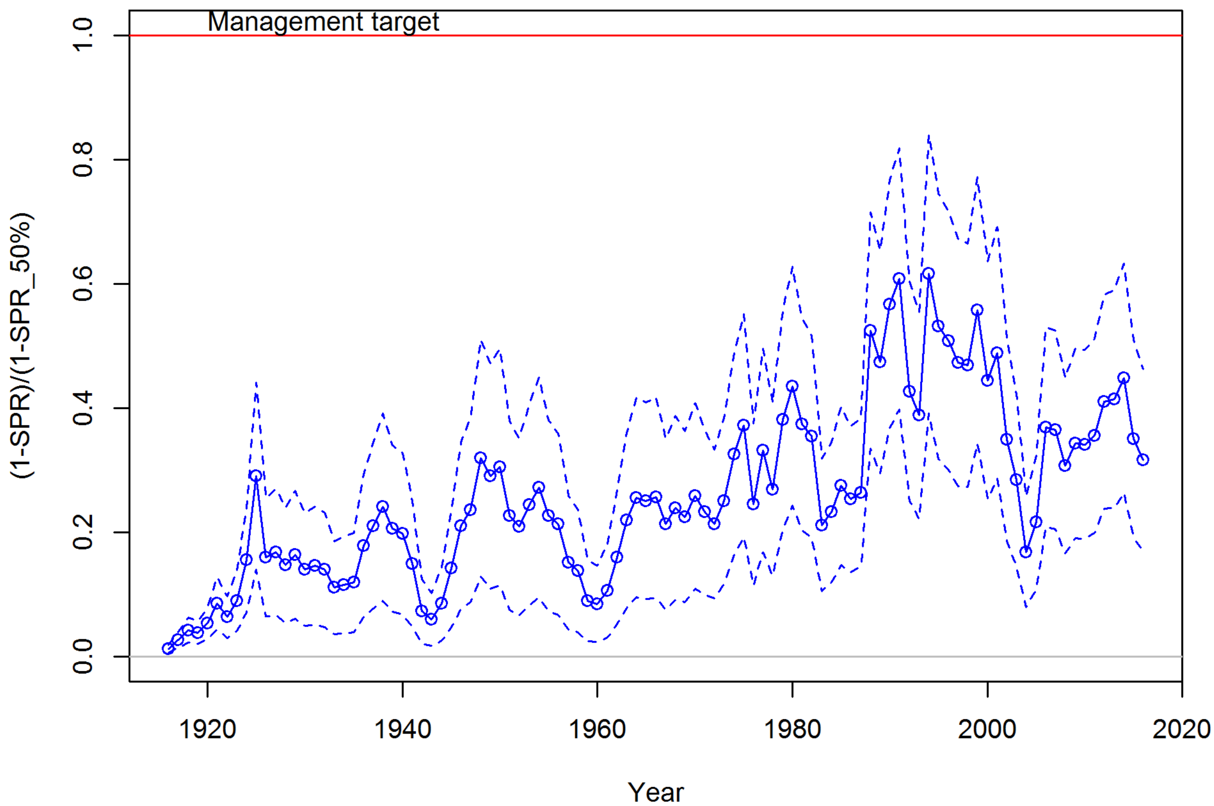

Figure i: Estimated spawning potential ratio (SPR) for the base-case model. One minus SPR is plotted so that higher exploitation rates occur on the upper portion of the y-axis. The management target is plotted as a red horizontal line and values above this reflect harvests in excess of the overfishing proxy based on the $\mathrm{SPR}_{50\%}$ harvest rate. The last year in the time series is 2016. fig:SPR_all

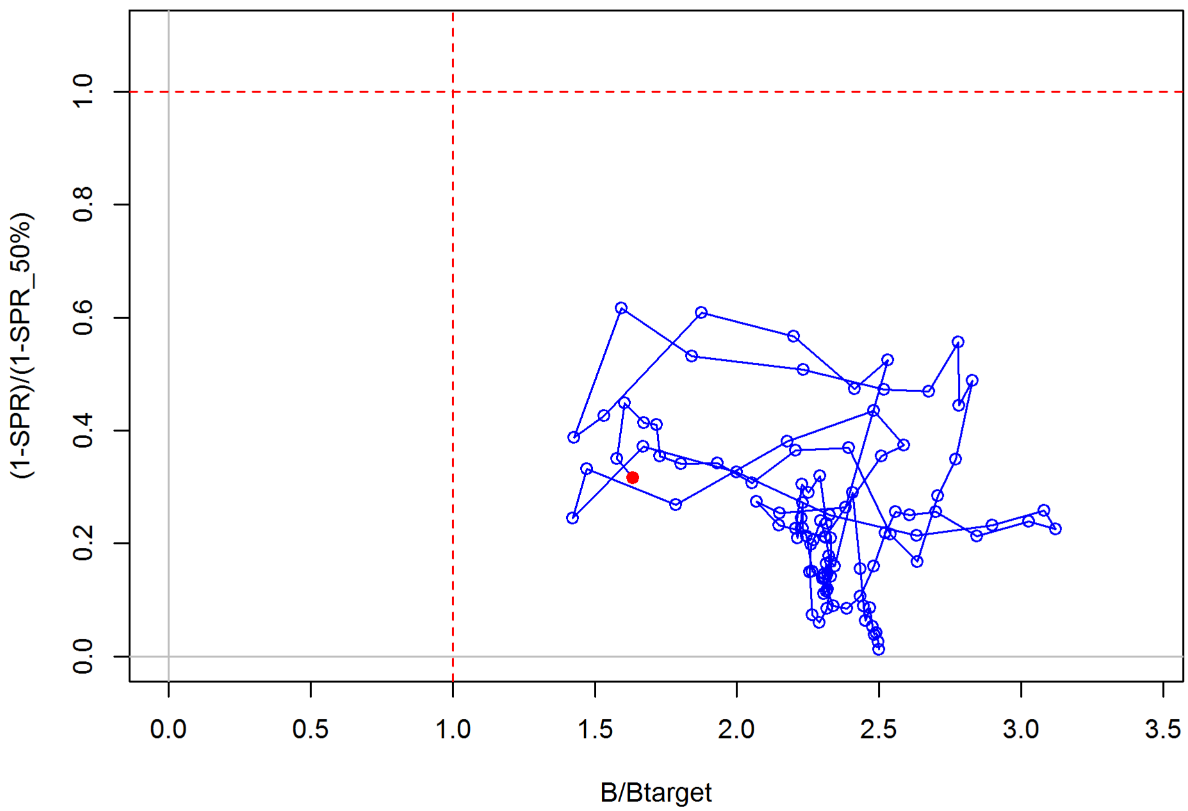

Figure j: Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model. The relative (1-SPR) is (1-SPR) divided by 50% (the SPR target). Relative depletion is the annual spawning biomass divided by the unfished spawning biomass. fig:Phase_all

Ecosystem Considerations

`ecosystem-considerations`

In this assessment, ecosystem considerations were.....

Reference Points

`reference-points`

This stock assessment estimates that California scorpionfish in the base model are above the biomass target, but above the minimum stock size threshold. Add sentence about spawning output trend. The estimated relative depletion level for Model 1 in 2016 is 70.4% (~95% asymptotic interval: ± 53.8%-87%, corresponding to an unfished spawning output of 1209.89 mt (~95% asymptotic interval: 634.69-1785.09 mt) of spawning output in the base model (Table e). Unfished age 1+ biomass was estimated to be 3780.4 mt in the base case model. The target spawning output based on the biomass target ($SB_{40\%}$) is 687.5 mt, which gives a catch of 295.1 mt. Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is 276.8 mt.

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

`tab:Ref_pts_mod1`

Quantity	**Estimate**	**~95% Confidence Interval**
Unfished spawning output (mt)	1718.8	(1076.9-2360.7)
Unfished age 1+ biomass (mt)	3780.4	(2208.7-5352.1)
Unfished recruitment (R0, thousands)	4021.4	(1722.4-6320.4)
Spawning output(2016 mt)	1122.6	(616.1-1629)
Depletion (2016)	0.6531	(0.5164-0.7898)
Reference points based on $\mathbf{SB_{40\%}}$		
Proxy spawning output ($B_{40\%}$)	687.5	(430.8-944.3)
SPR resulting in $B_{40\%}$ ($SPR_{B40\%}$)	0.4589	(0.4589-0.4589)
Exploitation rate resulting in $B_{40\%}$	0.1461	(0.1305-0.1618)
Yield with $SPR_{B40\%}$ at $B_{40\%}$ (mt)	295.1	(150.3-440)
Reference points based on SPR proxy for MSY		
Spawning output	765.8	(479.8-1051.8)
SPR_{proxy}	0.5	
Exploitation rate corresponding to SPR_{proxy}	0.1267	(0.1134-0.1401)
Yield with SPR_{proxy} at SB_{SPR} (mt)	276.8	(141.3-412.3)
Reference points based on estimated MSY values		
Spawning output at MSY (SB_{MSY})	433.4	(262.4-604.3)
SPR_{MSY}	0.3256	(0.3157-0.3354)
Exploitation rate at MSY	0.2346	(0.2124-0.2568)
MSY (mt)	333.2	(169.2-497.2)

Management Performance

management-performance

Management performance table: Table f

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	-	-	-	-

Unresolved Problems And Major Uncertainties

unresolved-problems-and-major-uncertainties

TBD after STAR panel

Decision Table(s) (groundfish only)

decision-tables-groundfish-only

OFL projection table: Table g

Decision table(s) Table h, Table **??**, Table **??**

`Yield curve: Figure \ref{fig:Yield_all}`

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

tab:OFL_projection

Year	OFL
2017	507.83

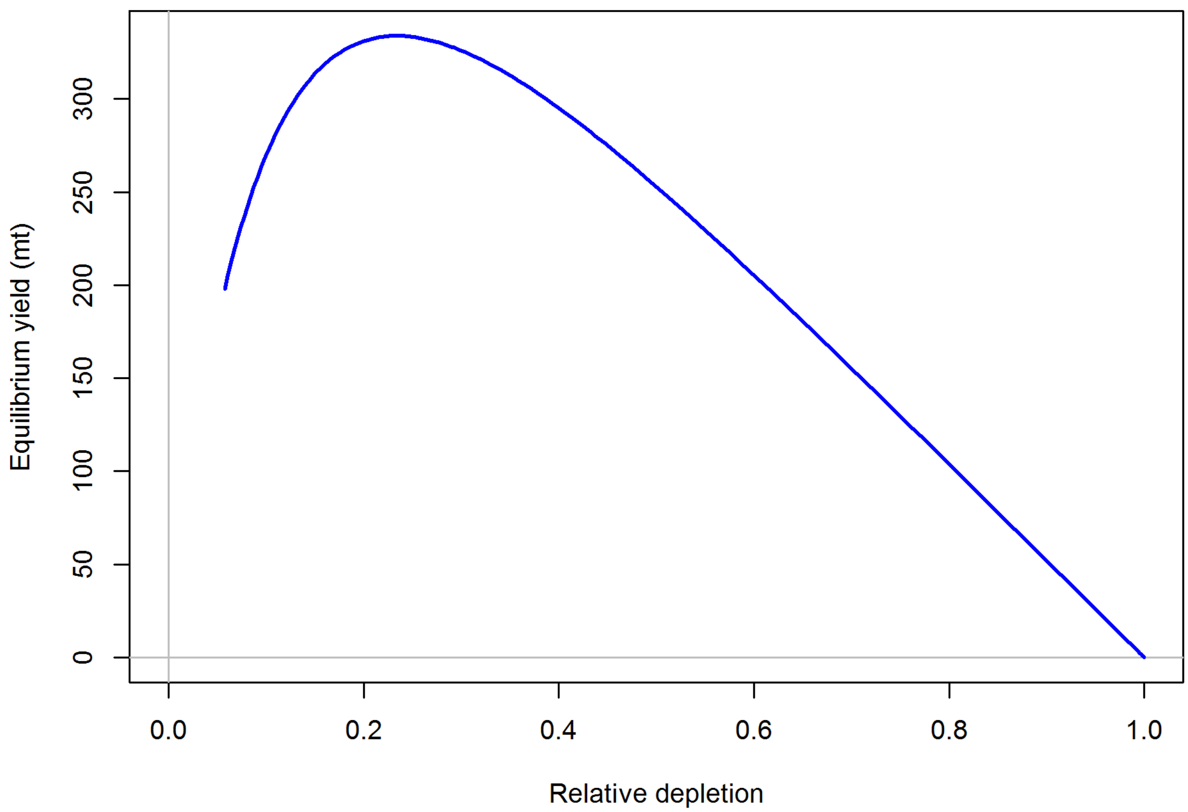

Figure k: Equilibrium yield curve for the base case model. Values are based on the 2016 fishery selectivity and with steepness fixed at. . . fig:Yield_all

Table h: Summary of 10-year projections beginning in 2018 for alternate states of nature based on an axis of uncertainty for the base 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	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Landings (mt)										
Total Est. Catch (mt)										
OFL (mt)										
ACL (mt)										
(1-SPR)(1-$SPR_{50\%}$)	0.31	0.34	0.34	0.36	0.41	0.41	0.45	0.35	0.32	
Exploitation rate	0.03	0.04	0.04	0.03	0.04	0.04	0.05	0.03	0.02	
Age 1+ biomass (mt)	3512.93	3280.86	3090.02	2944.76	3006.93	2893.02	2665.74	2758.96	2684.49	2943.31
Spawning Output	1411.9	1327.3	1240.2	1188.9	1180.6	1149.2	1103.5	1085.2	1122.6	1209.9
95% CI	(826-1997.76)	(779.49-1875.07)	(727.54-1752.92)	(694.44-1683.32)	(686.04-1675.2)	(662.71-1635.79)	(630.12-1576.98)	(607.15-1563.15)	(616.11-1629.01)	(634.69-1785.09)
Depletion	0.8	0.8	0.7	0.7	0.7	0.7	0.6	0.6	0.7	0.7
95% CI	(0.667-0.976)	(0.628-0.916)	(0.587-0.856)	(0.561-0.823)	(0.556-0.818)	(0.541-0.796)	(0.517-0.767)	(0.504-0.759)	(0.516-0.79)	(0.538-0.87)
Recruits	2334.67	3043.29	5924.02	1919.20	466.56	6221.57	2427.69	7513.87	3822.13	3861.95
95% CI	(1188.11 - 4587.71)	(1586.6 - 5837.4)	(3274.03 - 10718.9)	(814.17 - 4524.02)	(145.49 - 1496.19)	(3237.03 - 11957.84)	(894.39 - 6589.64)	(2659.09 - 21232.2)	(796 - 18352.62)	(804.12 - 18547.73)

Research And Data Needs

research-and-data-needs

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

1. List item No. 1 in the list
2. List item No. 2 in the list, etc.

Rebuilding Projections

rebuilding-projections

1 Introduction

introduction

1.1 Basic Information

basic-information

California scorpionfish (*Scorpaena guttata*), also known locally as sculpin or spotted scorpionfish, originates from the Greek word for scorpionfishes and *guttata* is Latin for speckled. California scorpionfish is a medium-bodied fish and like other species in the genus Scorpaena, it produces a toxin in its dorsal, anal, and pectoral fin spines, which produces intense, painful wounds (Love et al. 1987). Scorpionfish are very resistant to hooking mortality and have shown survival under extreme conditions.

Its range extends from central California (Santa Cruz) to the Gulf of California, although within U.S. waters they are most common in the Southern California Bight (Eschmeyer et al. 1983, Love et al. 1987). The species generally inhabits rocky reefs, caves and crevices, but in certain areas and seasons it aggregates over sandy or muddy substrate (Love et al. 1987, Frey n.d.). California scorpionfish have been observed from the intertidal to 600 ft with a preferred depth range from 20-450 ft.

Males and females show different growth rates, with females growing to a larger size than males, and the sexes exhibit different length-weight relationships (Love et al. 1987). Few California scorpionfish are mature at one year old (14 cm TL). Fifty-percent of fish mature at 17-18 cm (2 years old) and all by 22 cm (4 years old) (Love et al. 1987).

California scorpionfish feed on a wide variety of mobile prey, including crabs, fishes (e.g., include northern anchovy, spotted cusk-eel), octopi, isopods and shrimp, (Taylor 1963, Quast 1968, Love et al. 1987, TuRNER et al. n.d.). The species is nocturnal, but have been observed feeding during the day. Predation on scorpionfish is believed to be low, but one individual was found in the gut of a leopard shark (Love pers comm.).

California scorpionfish utilize the "explosive breeding assemblage" reproductive mode in which fish migrate to, and aggregate at traditional spawning sites for brief periods (Love et al. 1987). California scorpionfish migrate to deeper waters (120-360 ft) to spawn during May-August, with peak spawning occurring July. The species is oviparous, producing floating, gelatinous egg masses in which the eggs are embedded in a single layer (Orton 1955). and it is believed that spawning takes place just before, and perhaps after dawn, in the water column (Love et al. 1987). Tagging data suggest California scorpionfish return to the same spawning site, but information is not available on non-spawning season site fidelity.

Little is known about California scorpionfish larvae. The CalCOFI survey observed 463 California scorpionfish larvae from 1977-2000, with the majority at station close to Oxnard (east of the Channel Islands) (Moser, H. G., R. L. Charter, P. E. Smith, D. A. Ambrose, W. Watson et al. 2002). Higher densities of larvae have been observed in the CalCOFI stations throughout Baja, peaking south of Punta Eugenia from July to September. The hatching length is reported as 1.9-2.0 mm (Washington et al. n.d.) and transformation length of greater than 1.3 cm (Washington et al. n.d.) less than 2.1 cm (Moser n.d.).

1.2 Map

`map`

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

1.3 Life History

`life-history`

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`

Rockfish example: The rockfish fishery off the U.S. Pacific coast first developed off California in the late 19th century as a hook-and-line fishery (Love et al. 2002).
The rockfish trawl fishery was established in the early 1940s, when the United States became involved in World War II and wartime shortage of red meat created an increased demand for other sources of protein (Harry and Morgan 1961, Alverson et al. 1964). Etc....

1.6 Summary of Management History

`summary-of-management-history`

Prior to the adoption of the Pacific Coast Groundfish Fishery Management Plan (FMP) in 1982, California scorpionfish (*Scorpaena guttata*) was managed through a regulatory process that included the California Department of Fish and Wildlife (CDFW) along with either the California State Legislature or the Fish and Game Commission (FGC) depending on the sector (recreation or commercial) and fishery. With implementation of the Pacific Coast Groundfish FMP, California scorpionfish came under the management authority of the Pacific Fishery Management Council (PFMC), being incorporated, along with all genera and species of the family Scorpaenidae, into a federal rockfish classification and managed as part of "Remaining Rockfish" under the larger heading of "Other Rockfish" ((Pacific Fishery Management Council (Institution/Organization) 2002, 2004), Tables 31-39).

The ABCs provided by the PFMC's Groundfish Management Team (GMT) in the 1980's were based on an analysis of commercial landings from the 1960's and 1970's. For this analysis, most of the rockfishes were lumped into one large group. This analysis indicated that the landings for rockfish in the Monterey-Conception area were at or near ABC levels (Pacific Fishery Management Council (Institution/Organization) 1993). To keep landings within these adopted harvest targets, the Pacific Coast Groundfish FMP provided the Council with a variety of management tools including area closures, season closures, gear restrictions, and, for the commercial sector, cumulative limits (generally for two-month periods). With the implementation of a federal groundfish restricted access program in 1994, allocations of total catch and cumulative limits began to be specifically set for open access (including most of California's commercial fisheries that target California scorpionfish in Southern California) and limited entry fisheries (Pacific Fishery Management Council (Institution/Organization) 2002, 2004). As a result, in the later 1990'ss as commercial landings decreased and recreational harvest became a greater proportion of the available harvest.

Beginning in 1997, California scorpionfish was managed as part of the Sebastes complex-south, Other Rockfish category. (*Sebastes* complex-south included the Eureka, Monterey, and Conception areas while Sebastes complex-north included the Vancouver and Columbia areas.) The PFMC's rockfish management structure changed significantly in 2000 with the replacement of the *Sebastes* complex -north and -south areas with Minor Rockfish North (now covering the Vancouver, Columbia, and Eureka areas) and Minor Rockfish South (now Monterey and Conception areas only). The OY for these two groups (which continued to be calculated as 0.50 of the ABC) was further divided (between north and south of 40°10′ N. latitude) into nearshore, shelf, and slope rockfish categories with allocations set for Limited Entry and Open Access fisheries within each of these three categories (January 4, 2000, 65 FR 221; (Pacific Fishery Management Council (Institution/Organization) 2002), Tables 54-55). Because of its depth range and southern distribution, California scorpionfish was included within the Minor Rockfish South, Other Rockfish ABC and managed under the south of 40°10′ N. latitude nearshore rockfish OY and trip limits ((Pacific Fishery Management Council (Institution/Organization) 2002), Table 29).

Along with the above changes, in 2000 the southern area divided into two separate management areas at Point Lopez, 36°00′ N. latitude. This was followed in 2001 with the implementation of the northern rockfish and lingcod management area between (40°10′ N. latitude) and Point Conception (34°27′ N. latitude); and the southern rockfish and lingcod management area between Point Conception and the U.S.- Mexico border. These were later revised starting in 2004 with the northern rockfish and lingcod management area redefined as ocean waters from the Oregon-California border (42°00′ N. latitude) to 40°10′ N. latitude, the central rockfish and lingcod management area defined as ocean waters from 40°10′ N. latitude to Point Conception, and the southern rockfish and management area continuing to be defined as ocean waters from Point Conception to the U.S.-Mexico border.

Cowcod Conservation Areas (CCAs) also were established in 2001 to reduce fishing effort for cowcod rockfish ((Pacific Fishery Management Council (Institution/Organization) 2002), Table 29). These areas were closed to all recreational and commercial fishing for groundfish except for minor nearshore rockfish1 (including California scorpionfish) within waters less than 20 fathoms. In addition, Rockfish Conservation Areas (RCAs) were established in 2003 to allow for the closure of specific area and depth ranges along the West Coast for the purpose of reducing fishing effort for shelf and slope rockfish. The California Rockfish Conservation Area (CRCA) was defined as those ocean waters south 40°10′ N. latitude to the U.S.-Mexico border with different depth zones specified for the areas north and south of Pt. Reyes (37°59.73′ N. latitude).

During the late 1990's and early 2000's, major changes also occurred in the way that California managed its nearshore fishery. The Marine Life Management Act (MLMA), which was passed in 1998 by the California Legislature and enacted in 1999, required that the FGC adopt an FMP for nearshore finfish. It also gave authority to the FGC to regulate commercial and recreational nearshore fisheries through FMPs and provided broad authority to adopt regulations for the nearshore fishery during the time prior to adoption of the nearshore finfish FMP. Within this legislation, the Legislature also included commercial size limits for nine nearshore species including California scorpionfish (10-inch minimum size) and a requirement that commercial fishermen landing these nine nearshore species possess a nearshore permit.

Following adoption of the Nearshore FMP and accompanying regulations by the FGC in fall of 2002, the FGC adopted regulations in November 2002 which established a set of marine reserves around the Channel Islands in Southern California (which became effective April 2003) and adopted a nearshore restricted access program in December 2002 (which included the establishment of a Deeper Nearshore Permit) to be effective starting in the 2003 fishing year.

Although the Nearshore FMP provided for the management of the nearshore rockfish and California scorpionfish, management authority for these species continued to reside with the Council. Even so, for the 2003 and subsequent fishery seasons, the State provided recommendations to the Council specific to the nearshore species that followed the directives set out in the Nearshore FMP. These recommendations, which the Council incorporated into the 2003 management specifications, included a recalculated OY for Minor Rockfish South - Nearshore, division of the Minor Rockfish South - Nearshore into three groups (shallow nearshore rockfish; deeper nearshore rockfish; and California scorpionfish), and specific harvest targets and recreational and commercial allocations for each of these groups.

Also, since the enactment of the MLMA, the Council and State in a coordinated effort developed and adopted various management specifications to keep harvest within the harvest targets, including seasonal and area closures (e.g. the CCAs; a closure of Cordell Banks to specific fishing), depth restrictions, minimum size limits, and bag limits to regulate the recreational fishery and license and permit regulations, finfish trap permits, gear restrictions, seasonal and area closures (e.g. the RCAs and CCAs; a closure of Cordell Banks to specific fishing), depth restrictions, trip limits, and minimum size imits to regulate the commercial fishery.

1.7 Management Performance

management-performance-1

Management performance table: (Table f)
A summary of these values as well as other base case summary results can be found in Table i.

1.8 Fisheries off Mexico

fisheries-off-mexico

Include if necessary.

2 Assessment

assessment

2.1 Data

data

Data used in the California scorpionfish assessment are summarized in Figure 2.
A description of each data source is below.

2.1.1 Commercial Fishery Landings

commercial-fishery-landings

Sub-heading 1

Sub-heading 2

Sub-heading 3

2.1.2 Sport Fishery Removals

sport-fishery-removals

Sub-heading 1

Sub-heading 2

Sub-heading 3

2.1.3 Estimated Discards

estimated-discards

Sub-heading 1

Sub-heading 2

Sub-heading 3

2.1.4 Abundance Indices

abundance-indices

Sub-heading 1

Sub-heading 2

2.1.5 Fishery-Independent Data: possible sources

fishery-independent-data-possible-sources

Northwest Fisheries Science Center (NWFSC) slope survey
The NWFSC slope survey was conducted annually from 1999 to 2002.
The depth range of this survey is 100-700 fm.

Northwest Fisheries Science Center (NWFSC) shelf-slope survey
This survey is referred to as the "combo," conducted annually since 2003.
The survey consistently covered depths between 30 and 700 fm.

Alaska Fisheries Science Center (AFSC) shelf survey
The survey, often referred to as the "triennial" survey was conducted every third year between 1977 and (and conducted in 2004 by the NWFSC using the same protocols). The triennial survey trawls in depths of 30 to 275 fm.

Partnership For Interdisciplinary Studies of Coastal Oceans (PISCO)
Blurb on species presence in PISCO surveys

2.1.6 Biological Parameters and Data

biological-parameters-and-data

Length And Age Compositions

Include: Sample size information for length and age composition data by area, year, gear, market category, etc., including both the number of trips and fish sampled.

Length compositions were provided from the following sources, with brief descriptions below:

- CDFW market category study (*commercial dead fish*,1996-2003)
- CALCOM (*commercial dead fish*, 2013-2016)
- CDFW onboard observer (*recreational charter discards*, 2003-2016)
- Ally et al. [-@Ally1991] onboard observer study (*recreational charter discards*, 1984-1989)
- California recreational sources combined (*recreational charter retained catch*)
  - CDFW and Ally et al. (1991) onboard observer surveys (1984-1989)
  - Collins and Crooke onboard observer survey (1975-1978)
  - MRFSS (1980-2003)
  - CRFS (2004-2014)
- California recreational sources combined (*private mode retained catch*)
  - MRFSS (1980-2003)
  - CRFS (2004-2016)
- Sanitation district trawl surveys (*research*, 1970-2016)
- CSUN/VRG gillnet survey (*research*, 1995-2008)
- Power plant impingement surveys (*research*, 1974-2016)
- Southern California Bight trawl survey (*research*, 1994,1998,2003,2008,2013)

Recreational: California MRFSS And CRFS Length Composition Data Individual fish lengths recorded by MRFSS (1980-2003) and CRFS (2004-2011) samplers were downloaded from the RecFIN website (www.recfin.org). CRFS data from 2012-2014 were obtained directly from CDFW.

Commercial: PacFIN

Research: NWFSC shelf-slope survey

Research: NWFSC slope survey

Age Structures Age data were provided from the NWFSC trawl survey from 2005-2016.

Length-at-age was initially estimated external to the population dynamics models using the 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

The weight-length relationship is based on the standard power function: $W = \alpha(L^\beta)$ where W is individual weight (kg), L is length (cm), and α and β are coefficients used as constants.

Maturity And Fecundity

Natural Mortality Hamel (2015) developed a method for combining meta-analytic approaches to relating the natural mortality rate M to other life-history parameters such as longevity, size, growth rate and reproductive effort, to provide a prior on M. In that same issue of ICESJMS, Then et al. (2015), provided an updated data set of estimates of M and related life history parameters across a large number of fish species, from which to develop an M estimator for fish species in general. They concluded by recommending M estimates be based on maximum age alone, based on an updated Hoenig non-linear least squares (nls) estimator $M = 4.899 * {A_{max}}^{-.916}$. The approach of basing M priors on maximum age alone was one that was already being used for west coast rockfish assessments. However, in fitting the alternative model forms relating $-.916M$ to A_{max}, Then et al. (2015) did not consistently apply their transformation. In particular, in real space, one would expect substantial heteroscedasticity in both the observation and process error associated with the observed relationship of M to A_{max}. Therefore, it would be reasonable to fit all models under a log transformation. This was not done. Revaluating the data used in Then et al. (2015) by fitting the one-parameter A_{max} model under a log-log transformation (such that the slope is forced to be -1 in the transformed space (as in Hamel (2015)), the point estimate for M is:

$$M = \frac{5.4}{A_{max}} \tag{1}$$

The above is also the median of the prior. The prior is defined as a lognormal with mean $ln\frac{5.4}{A_{max}}$ and SE = 0.4384343. Using a maximum age of 21 the point estimate and median of the prior is 0.2545, which is used as a prior for females in the assessment model.

Sex ratios

2.1.7 Environmental Or Ecosystem Data Included In The Assessment

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

2.2 History Of Modeling Approaches Used For This Stock

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

2.2.1 Previous Assessments

`previous-assessments`

2.2.2 2005 Assessment Recommendations

`assessment-recommendations`

Include: Response to STAR panel recommendations from the most recent previous assessment.

Recommendation 1: The sanitation surveys conducted to track the impact of sewage outfall provided a fishery independent index of abundance for scorpionfish. This data source should be more fully explored for other near-shore species of recreational or commercial interest. Methods should be developed to produce a more statistically rigorous index from the separate surveys.

STAT response: Data from all sanitation districts in southern California were obtained for this assessment. All of the data were pooled across surveys to develop one index of abundance using the delta-GLM method

Recommendation 2: An age, growth and maturity study for scorpionfish is needed. Although there has been previous research on scorpionfish age and growth, the available information is not appropriate for stock assessment modeling.

STAT response: Age data are available from the NWFSC trawl survey from 2005-2016. THere have been no additional studies on growth or maturity for California scorpionfish since the 2005 assessment.

Recommendation 3: Location information for the historic groundfish data of all species is currently available, in hard copy form only, from the California Department of Fish and Game. Putting this information into electronic format would greatly improve the ability to assign catches of all species to specific stocks on a trip-by-trip basis.

STAT response: The location-sepciic catches referred to above have been key-punched and are available in electornic form from the SWFSC, Santa Cruz.

Recommendation 4: The SS2 model should be modified to allow for projections of user-specified recruitment at user defined values. It would be most helpful if the default harvest policies were then recalculated automatically for these user-specified recruitments.

STAT response: The status of this within Stock Synthesis is unknown.

2.3 Model Description

model-description

2.3.1 Transition To The Current Stock Assessment

transition-to-the-current-stock-assessment

Include: Complete description of any new modeling approaches

Below, we describe the most important changes made since the last full assessment and explain rationale for each change.:

1. Change No. 1. *Rationale*: blah blah blah.
2. Change No. 2. *Rationale*: blah blah blah.
3. Change No. 3. *Rationale*: Continue list as needed.

2.3.2 Definition of Fleets and Areas

`definition-of-fleets-and-areas`

We generated data sources for each of the models. Fleets by model include:

Model Region 1 or remove this line if only one model

Commercial: The commercial fleets include…

Recreational: The recreational fleets include…

Research: Research derived-data include…

2.3.3 Summary of Data for Fleets and Areas

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

2.3.4 Modeling Software

`modeling-software`

The STAT team used Stock Synthesis 3 version 3.30.0.4 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`

Citation for Francis method (Francis 2011)
Citation for Ianelli-McAllister harmonic mean method (McAllister and Ianelli 1997)

2.3.6 Priors

`priors`

Citation for Hamel prior on natural mortality (Hamel 2015)

2.3.7 General Model Specifications

general-model-specifications

Model data, control, starter, and forecast files can be found in Appendices A-D.

2.3.8 Estimated And Fixed Parameters

estimated-and-fixed-parameters

A full list of all estimated and fixed parameters is provided in Tables.... Estimated and fixed parameters tables currently read in from .csv file, EXAMPLE: Table **??**

2.4 Model Selection and Evaluation

model-selection-and-evaluation

2.4.1 Key Assumptions and Structural Choices

key-assumptions-and-structural-choices

Include: Evidence of search for balance between model realism and parsimony. Comparison of key model assumptions, include comparisons based on nested models (e.g., asymptotic vs. domed selectivities, constant vs. time-varying selectivities).

2.4.2 Alternate Models Considered

alternate-models-considered

Include: Summary of alternate model configurations that were tried but rejected.

2.4.3 Convergence

convergence

Include: Randomization run results or other evidence of search for global best estimates.

Convergence testing through use of dispersed starting values often requires extreme values to actually explore new areas of the multivariate likelihood surface. Jitter is a SS option that generates random starting values from a normal distribution logistically transformed into each parameter's range (Methot 2015). Table 3 shows the results of running 100 jitters for each pre-STAR base model....

2.5 Response To The Current STAR Panel Requests

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

Request No. 1: Add after STAR panel.

Rationale: Add after STAR panel.

STAT Response: Add after STAR panel.

Request No. 2: Add after STAR panel.

Rationale: Add after STAR panel.

STAT Response: Add after STAR panel.

Request No. 3: Add after STAR panel.

Rationale: Add after STAR panel.

STAT Response: Add after STAR panel.

Request No. 4: Example of a request that may have a list:

- **Item No. 1**
- **Item No. 2**
- **Item No. 3, etc.**

Rationale: Add after STAR panel.

STAT Response: Continue requests as needed.

2.6 Model 1

`model-1`

2.6.1 Model 1 Base Case Results

`model-1-base-case-results`

Table **??**

2.6.2 Model 1 Uncertainty and Sensitivity Analyses

`model-1-uncertainty-and-sensitivity-analyses`

Table 4

2.6.3 Model 1 Retrospective Analysis

model-1-retrospective-analysis

2.6.4 Model 1 Likelihood Profiles

model-1-likelihood-profiles

2.6.5 Model 1 Harvest Control Rules (CPS only)

model-1-harvest-control-rules-cps-only

2.6.6 Model 1 Reference Points (groundfish only)

model-1-reference-points-groundfish-only

Intro sentence or two....(Table 5).

Equilibrium yield at the proxy F_{MSY} harvest rate corresponding to $SPR_{50\%}$ is 276.8 mt. Table e shows the full suite of estimated reference points for the northern area model and Figure k shows the equilibrium yield curve.

3 Harvest Projections and Decision Tables

harvest-projections-and-decision-tables

Table f

Model 1 Projections and Decision Table (groundfish only) (Table 6

Table h

Model 2 Projections and Decision Table (groundfish only)

Model 3 Projections and Decision Table (groundfish only)

4 Regional Management Considerations

regional-management-considerations

1. For stocks where current practice is to allocate harvests by management area, a recommended method of allocating harvests based on the distribution of biomass should be provided. The MT advisor should be consulted on the appropriate management areas for each stock.
2. Discuss whether a regional management approach makes sense for the species from a biological perspective.
3. If there are insufficient data to analyze a regional management approach, what are the research and data needs to answer this question?

5 Research Needs

`research-needs`

1. Research need No. 1
2. Research need No. 2
3. Research need No. 3
4. etc.

6 Acknowledgments

`acknowledgments`

Include: STAR panel members and affiliations as well as names and affiliations of persons who contributed data, advice or information but were not part of the assessment team. Not required in draft assessment undergoing review.

7 Tables

tables

Table 1: 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	0.246	3	(0.01, 1)	OK	0.018	None
2	L_at_Amin_Fem_GP_1	13.874	2	(10, 30)	OK	0.563	None
3	L_at_Amax_Fem_GP_1	33.203	2	(30, 50)	OK	0.535	None
4	VonBert_K_Fem_GP_1	0.223	2	(0.05, 0.5)	OK	0.022	None
5	CV_young_Fem_GP_1	0.145	3	(0.02, 0.5)	OK	0.015	None
6	CV_old_Fem_GP_1	0.111	3	(0.02, 0.75)	OK	0.006	None
7	Wtlen_1_Fem	0.000	-3	(-3, 3)			None
8	Wtlen_2_Fem	3.058	-3	(2, 4)			None
9	Mat50%_Fem	17.188	-3	(10, 30)			None
10	Mat_slope_Fem	-0.466	-3	(-3, 3)			None
11	Eggs/kg_inter_Fem	1.000	-3	(-3, 3)			None
12	Eggs/kg_slope_wt_Fem	0.000	-3	(-3, 3)			None
13	NatM_p_1_Mal_GP_1	-0.216	3	(-3, 3)	OK	0.037	Normal (-0.22, 99)
14	L_at_Amin_Mal_GP_1	0.230	2	(-3, 3)	OK	0.042	None
15	L_at_Amax_Mal_GP_1	-0.136	2	(-3, 3)	OK	0.018	None
16	VonBert_K_Mal_GP_1	-0.588	2	(-3, 3)	OK	0.159	None
17	CV_young_Mal_GP_1	-0.327	3	(-1, 1)	OK	0.114	None
18	CV_old_Mal_GP_1	-0.325	3	(-3, 3)	OK	0.085	None
19	Wtlen_1_Mal	0.000	-5	(0, 1)			None
20	Wtlen_2_Mal	2.981	-5	(2, 4)			None
24	CohortGrowDev	1.000	-1	(1, 1)			None
25	FracFemale_GP_1	0.500	-4	(0.000001, 0.999999)			None
26	SR_LN(R0)	8.299	2	(0, 31)	OK	0.292	None
27	SR_BH_steep	0.718	-2	(0.21, 0.99)			Full_Beta (0.718, 0.158)
28	SR_sigmaR	0.900	-2	(0, 2)			None
29	SR_regime	0.000	-4	(-5, 5)			None

Continued on next page

Table 1: 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	-3	(0, 0.5)			None
134	InitF_seas_1_flt_1ComHL	0.000	-1	(0, 1)			Normal (0.01, 1000)
135	LnQ_base_RecPR(4)	-8.721	-1	(-15, 15)			None
136	Q_extraSD_RecPR(4)	0.006	4	(0.0001, 1)	LO	0.014	None
137	LnQ_base_RecPC(5)	-10.639	-1	(-15, 15)			None
138	Q_extraSD_RecPC(5)	0.386	4	(0.0001, 1)	OK	0.057	None
139	LnQ_base_Sanitation(7)	-10.885	-1	(-15, 15)			None
140	Q_extraSD_Sanitation(7)	0.218	4	(0.0001, 1)	OK	0.047	None
141	LnQ_base_NWFSCTrawl(8)	-1.480	-1	(-15, 15)			None
142	Q_extraSD_NWFSCTrawl(8)	0.250	4	(0.0001, 1)	OK	0.145	None
143	LnQ_base_SCBSurvey(11)	-12.854	-1	(-15, 15)			None
144	Q_extraSD_SCBSurvey(11)	0.177	4	(0.0001, 1)	OK	0.143	None
145	LnQ_base_RecPCOBR(12)	-8.945	-1	(-15, 15)			None
146	Q_extraSD_RecPCOBR(12)	0.093	2	(0.0001, 1)	OK	0.032	None
147	SizeSel_P1_ComHL(1)	39.749	4	(13, 44)	OK	2.095	None
148	SizeSel_P2_ComHL(1)	15.000	-3	(-10, 16)			None
149	SizeSel_P3_ComHL(1)	4.713	4	(-1, 10)	OK	0.191	None
150	SizeSel_P4_ComHL(1)	15.000	-3	(-1, 16)			None
151	SizeSel_P5_ComHL(1)	-17.448	5	(-25, -1)	OK	103.065	None
152	SizeSel_P6_ComHL(1)	10.000	-3	(-5, 11)			None
153	SizeSel_P1_ComNet(2)	1.000	-2	(1, 45)			None
154	SizeSel_P2_ComNet(2)	45.000	-3	(1, 45)			None
155	SizeSel_P1_ComTrawl(3)	1.000	-2	(1, 45)			None
156	SizeSel_P2_ComTrawl(3)	45.000	-3	(1, 45)			None
157	SizeSel_P1_RecPR(4)	35.320	4	(13, 44)	OK	0.736	None
158	SizeSel_P2_RecPR(4)	15.000	-3	(-10, 16)			None
159	SizeSel_P3_RecPR(4)	4.105	4	(-1, 10)	OK	0.101	None

Continued on next page

Table 1: 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)
160	SizeSel_P4_RecPR(4)	15.000	-3	(-1, 16)			None
161	SizeSel_P5_RecPR(4)	-6.188	5	(-25, -1)	OK	0.343	None
162	SizeSel_P6_RecPR(4)	10.000	-3	(-5, 11)			None
163	SizeSel_P1_RecPC(5)	39.414	4	(13, 44)	OK	1.052	None
164	SizeSel_P2_RecPC(5)	15.000	-3	(-10, 16)			None
165	SizeSel_P3_RecPC(5)	4.264	4	(-1, 10)	OK	0.114	None
166	SizeSel_P4_RecPC(5)	15.000	-3	(-1, 16)			None
167	SizeSel_P5_RecPC(5)	-7.030	5	(-25, -1)	OK	0.362	None
168	SizeSel_P6_RecPC(5)	10.000	-3	(-5, 11)			None
169	SizeSel_P1_RecDD(6)	24.506	4	(13, 44)	OK	0.020	None
170	SizeSel_P2_RecDD(6)	-12.531	3	(-15, 16)	OK	43.212	None
171	SizeSel_P3_RecDD(6)	1.508	4	(-1, 10)	OK	0.235	None
172	SizeSel_P4_RecDD(6)	-12.601	3	(-20, 5)	OK	35.327	None
173	SizeSel_P5_RecDD(6)	-1.723	5	(-25, 3)	OK	0.187	None
174	SizeSel_P6_RecDD(6)	-1.932	3	(-5, 11)	OK	0.181	None
175	SizeSel_P1_Sanitation(7)	26.150	4	(13, 44)	OK	0.499	None
176	SizeSel_P2_Sanitation(7)	15.000	-3	(-10, 16)			None
177	SizeSel_P3_Sanitation(7)	3.462	4	(-1, 10)	OK	0.128	None
178	SizeSel_P4_Sanitation(7)	15.000	-3	(-1, 16)			None
179	SizeSel_P5_Sanitation(7)	-3.595	4	(-25, 5)	OK	0.497	None
180	SizeSel_P6_Sanitation(7)	10.000	-3	(-5, 11)			None
181	SizeSel_P1_NWFSCTrawl(8)	26.815	4	(13, 44)	OK	2.433	None
182	SizeSel_P2_NWFSCTrawl(8)	15.000	-3	(-10, 16)			None
183	SizeSel_P3_NWFSCTrawl(8)	4.173	4	(-1, 10)	OK	1.047	None
184	SizeSel_P4_NWFSCTrawl(8)	15.000	-3	(-1, 16)			None
185	SizeSel_P5_NWFSCTrawl(8)	-2.000	4	(-25, 5)	OK	2.252	None
186	SizeSel_P6_NWFSCTrawl(8)	10.000	-3	(-5, 11)			None

Continued on next page

Table 1: 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)
187	SizeSel_P1_GillnetSurvey(9)	1.000	-2	(1, 45)			None
188	SizeSel_P2_GillnetSurvey(9)	45.000	-3	(1, 45)			None
189	SizeSel_P1_Impingement(10)	1.000	-2	(1, 45)			None
190	SizeSel_P2_Impingement(10)	45.000	-3	(1, 45)			None
191	SizeSel_P1_SCBSurvey(11)	21.519	4	(13, 44)	OK	2.011	None
192	SizeSel_P2_SCBSurvey(11)	15.000	-3	(-10, 16)			None
193	SizeSel_P3_SCBSurvey(11)	2.216	4	(-1, 10)	OK	1.182	None
194	SizeSel_P4_SCBSurvey(11)	15.000	-3	(-1, 16)			None
195	SizeSel_P5_SCBSurvey(11)	-2.987	5	(-25, -1)	OK	1.329	None
196	SizeSel_P6_SCBSurvey(11)	10.000	-3	(-5, 11)			None
197	SizeSel_P1_RecPCOBR(12)	1.000	-2	(1, 45)			None
198	SizeSel_P2_RecPCOBR(12)	45.000	-3	(1, 45)			None
199	SizeSel_P1_ComHL(1)_BLK1repl_1999	28.986	4	(13, 44)	OK	0.284	None
200	SizeSel_P3_ComHL(1)_BLK1repl_1999	2.099	4	(-1, 10)	OK	0.124	None
201	SizeSel_P1_RecPR(4)_BLK1repl_1999	28.199	4	(13, 44)	OK	0.220	None
202	SizeSel_P3_RecPR(4)_BLK1repl_1999	1.870	4	(-1, 10)	OK	0.120	None
203	SizeSel_P1_RecPC(5)_BLK1repl_1999	35.289	4	(13, 44)	OK	0.369	None
204	SizeSel_P3_RecPC(5)_BLK1repl_1999	3.355	4	(-1, 10)	OK	0.074	None

tab:model_params

Table 2: Summary of the biomass/abundance time series used in the stock assessment.
tab:Index_summary

Region	ID	Fleet	Years	Name	Fishery ind.	Filtering	Method	Endorsed
WA	1	4	1981-2014	Dockside CPUE	No	trip, area, month, Stephens-MacCall	delta-GLM (bin-gamma)	SSC
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-

Table 3: Results from 100 jitters from each of the three models.

tab:jitter

Status	Model.1	Model.2	Model.3
Returned to base case	-	-	-
Found local minimum	-	-	-
Found better solution	-	-	-
Error in likelihood	-	-	-
Total	100	100	100

Table 5: Time-series of population estimates from the base-case model.

Yr	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative exploitation rate	SPR
1916	3764	1719	1.00	4022	4	0.00	0.99
1917	3745	1717	1.00	4022	8	0.00	0.99
1918	3723	1713	1.00	4021	13	0.00	0.98
1919	3728	1707	0.99	4020	12	0.00	0.98
1920	3708	1703	0.99	4019	16	0.00	0.97
1921	3663	1697	0.99	4018	26	0.01	0.96
1922	3694	1686	0.98	4015	19	0.01	0.97
1923	3658	1681	0.98	4014	27	0.01	0.96
1924	3567	1673	0.97	4013	49	0.01	0.92
1925	3376	1654	0.96	4008	101	0.03	0.85
1926	3561	1611	0.94	3998	49	0.01	0.92
1927	3549	1603	0.93	3996	51	0.01	0.92
1928	3578	1594	0.93	3995	44	0.01	0.93
1929	3555	1592	0.93	3995	49	0.01	0.92
1930	3589	1586	0.92	3994	41	0.01	0.93
1931	3581	1586	0.92	3995	43	0.01	0.93
1932	3590	1585	0.92	3996	41	0.01	0.93
1933	3630	1586	0.92	3997	32	0.01	0.94
1934	3624	1591	0.93	4000	33	0.01	0.94
1935	3619	1595	0.93	4003	35	0.01	0.94
1936	3537	1597	0.93	4006	54	0.02	0.91
1937	3491	1589	0.92	4006	65	0.02	0.89
1938	3449	1577	0.92	4005	76	0.02	0.88
1939	3498	1561	0.91	4005	62	0.02	0.90
1940	3509	1554	0.90	4007	59	0.02	0.90
1941	3575	1551	0.90	4010	43	0.01	0.93
1942	3681	1557	0.91	4017	20	0.01	0.96
1943	3700	1575	0.92	4029	16	0.00	0.97
1944	3665	1592	0.93	4041	24	0.01	0.96
1945	3586	1603	0.93	4052	42	0.01	0.93
1946	3490	1603	0.93	4062	66	0.02	0.89
1947	3461	1591	0.93	4070	74	0.02	0.88
1948	3348	1576	0.92	4080	107	0.03	0.84
1949	3386	1547	0.90	4087	93	0.03	0.85
1950	3368	1532	0.89	4100	97	0.03	0.85
1951	3475	1517	0.88	4115	67	0.02	0.89
1952	3501	1522	0.89	4156	61	0.02	0.90
1953	3450	1531	0.89	4218	74	0.02	0.88
1954	3412	1534	0.89	4226	84	0.02	0.86
1955	3475	1533	0.89	4263	67	0.02	0.89

Table 5: Time-series of population estimates from the base-case model.

Yr	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative exploitation rate	SPR
1956	3494	1544	0.90	4313	63	0.02	0.89
1957	3577	1557	0.91	4367	43	0.01	0.92
1958	3596	1582	0.92	4431	39	0.01	0.93
1959	3661	1608	0.94	4524	25	0.01	0.96
1960	3670	1641	0.95	4698	24	0.01	0.96
1961	3644	1674	0.97	4990	31	0.01	0.95
1962	3570	1706	0.99	5212	50	0.01	0.92
1963	3492	1734	1.01	5535	72	0.02	0.89
1964	3445	1759	1.02	6391	87	0.02	0.87
1965	3452	1793	1.04	7533	85	0.02	0.87
1966	3443	1856	1.08	8524	89	0.02	0.87
1967	3503	1956	1.14	4618	73	0.02	0.89
1968	3465	2081	1.21	2678	87	0.02	0.88
1969	3485	2146	1.25	1552	84	0.02	0.89
1970	3440	2119	1.23	974	103	0.02	0.87
1971	3478	1992	1.16	849	92	0.02	0.88
1972	3499	1809	1.05	648	82	0.02	0.89
1973	3453	1600	0.93	728	95	0.03	0.87
1974	3344	1374	0.80	1064	122	0.04	0.84
1975	3278	1148	0.67	6362	128	0.05	0.81
1976	3456	978	0.57	15965	66	0.03	0.88
1977	3341	1012	0.59	3790	88	0.03	0.83
1978	3425	1228	0.71	9023	62	0.02	0.87
1979	3269	1496	0.87	1534	100	0.03	0.81
1980	3193	1706	0.99	856	131	0.03	0.78
1981	3278	1778	1.03	891	118	0.03	0.81
1982	3304	1724	1.00	2100	119	0.03	0.82
1983	3506	1588	0.92	5316	64	0.02	0.89
1984	3474	1476	0.86	6742	73	0.02	0.88
1985	3417	1423	0.83	12359	87	0.03	0.86
1986	3449	1478	0.86	2011	76	0.02	0.87
1987	3430	1637	0.95	1038	79	0.02	0.87
1988	3063	1740	1.01	959	204	0.05	0.74
1989	3140	1660	0.97	618	175	0.05	0.76
1990	3001	1512	0.88	858	229	0.07	0.72
1991	2942	1289	0.75	1433	241	0.09	0.70
1992	3200	1054	0.61	15257	126	0.05	0.79
1993	3258	980	0.57	2527	102	0.03	0.81
1994	2920	1095	0.64	15750	188	0.06	0.69
1995	3053	1266	0.74	1927	143	0.04	0.73

Table 5: Time-series of population estimates from the base-case model.

Yr	Total biomass (mt)	Spawning biomass (mt)	Depletion	Age-0 recruits	Total catch (mt)	Relative exploitation rate	SPR
1996	3092	1535	0.89	3795	140	0.04	0.75
1997	3146	1731	1.01	9011	141	0.03	0.76
1998	3147	1839	1.07	3079	160	0.04	0.77
1999	3060	1910	1.11	9011	228	0.05	0.72
2000	3218	1913	1.11	2555	168	0.04	0.78
2001	3150	1945	1.13	3020	203	0.05	0.76
2002	3328	1905	1.11	5369	130	0.03	0.83
2003	3420	1861	1.08	1486	103	0.02	0.86
2004	3578	1811	1.05	2377	55	0.01	0.92
2005	3519	1746	1.02	3973	76	0.02	0.89
2006	3332	1646	0.96	3186	149	0.04	0.82
2007	3337	1517	0.88	2231	139	0.04	0.82
2008	3411	1412	0.82	2335	103	0.03	0.85
2009	3362	1327	0.77	3043	113	0.04	0.83
2010	3368	1240	0.72	5924	105	0.04	0.83
2011	3351	1189	0.69	1919	105	0.03	0.82
2012	3283	1181	0.69	467	121	0.04	0.79
2013	3277	1149	0.67	6222	115	0.04	0.79
2014	3236	1104	0.64	2428	124	0.05	0.78
2015	3359	1085	0.63	7514	84	0.03	0.82
2016	3403	1123	0.65	3822			

tab:Timeseries_mod1

Table 4: Sensitivity of the base model to dropping or down-weighting data sources and alternative assumptions about growth.

`tab:Sensitivity_model1`

Label	Base (Francis weights)	Harmonic mean weights	Drop index	Drop ages	Down-weight lengths	Free size Age0	Free CV Amin	External growth
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: Projection of potential OFL, spawning biomass, and depletion for the base case model.

tab:Forecast_mod1

Yr	OFL contriubtion (mt)	ACL landings (mt)	Age 5+ biomass (mt)	Spawning Biomass (mt)	Depletion
2017	507.83	507.83	3053.30	1209.89	0.70

8 Figures

figures

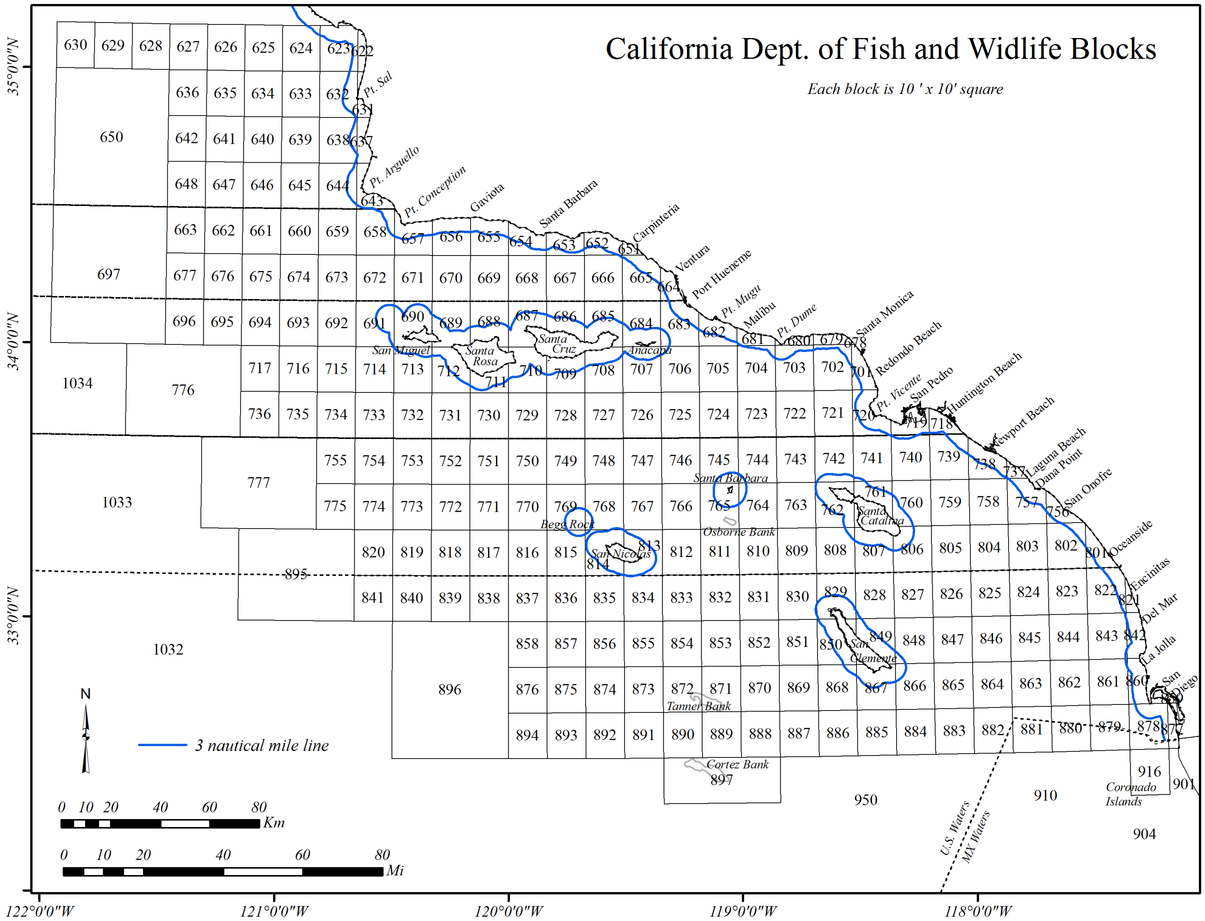

Figure 1: Map showing the state boundary lines for management of the recreational fishing fleets. CRFS Districts 1-6 in California are presented as well as the WDFW Recreational Management Areas in Washington. Florence, OR is shown as a potential location of model stratification. fig:boundary_map

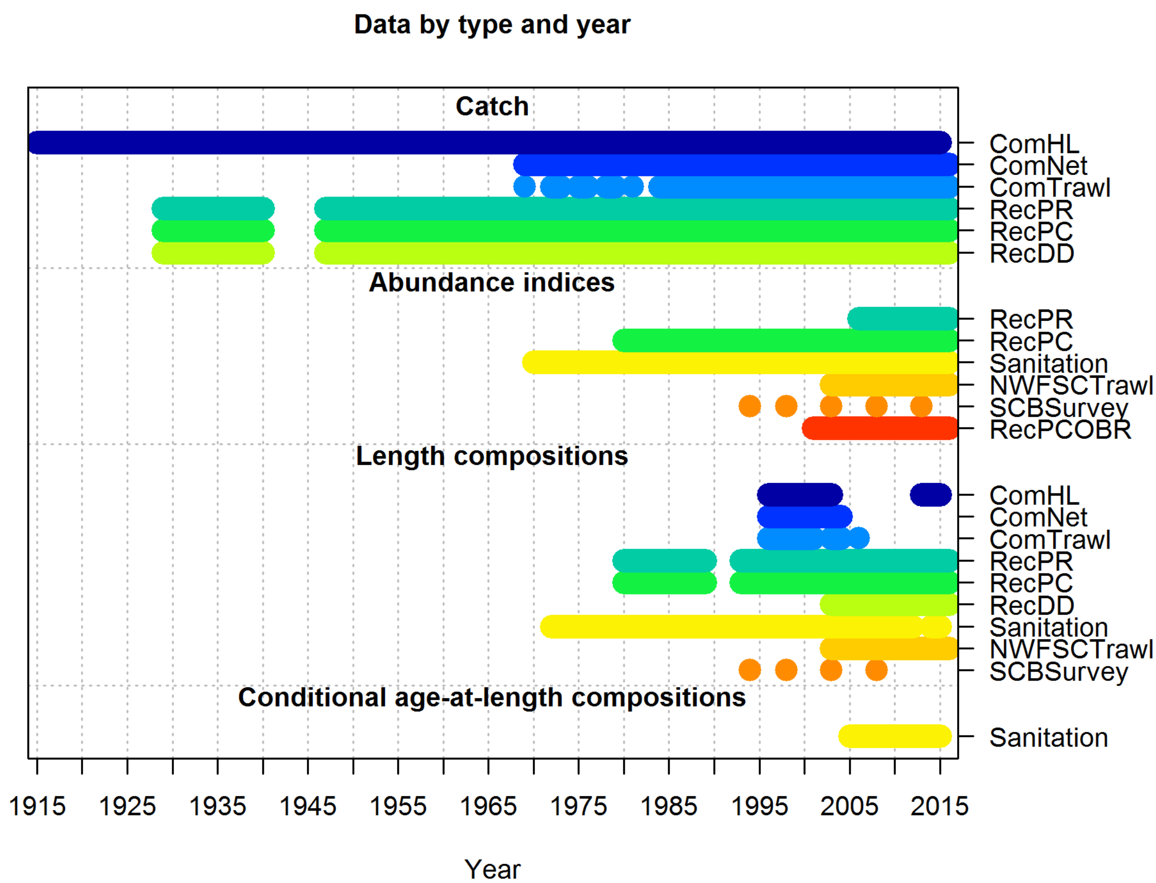

Figure 2: Summary of data sources used in the base model. fig:data_plot

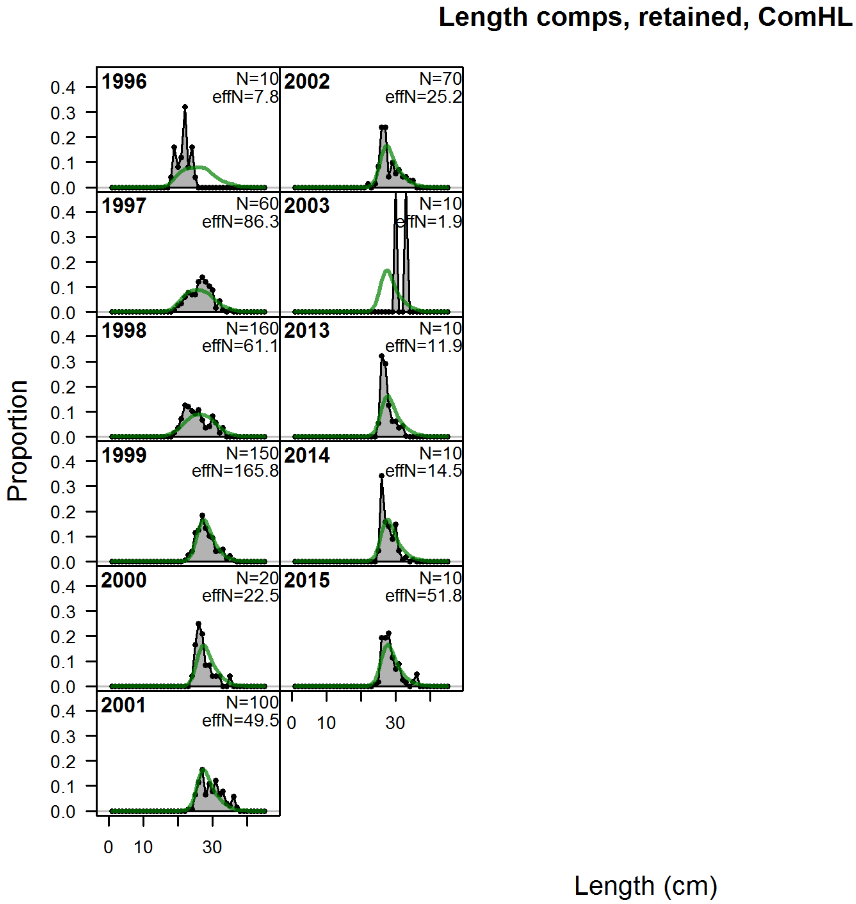

Figure 3: Length comps, retained, ComHL fig:mod1_1_comp_lenfit_flt1mkt2

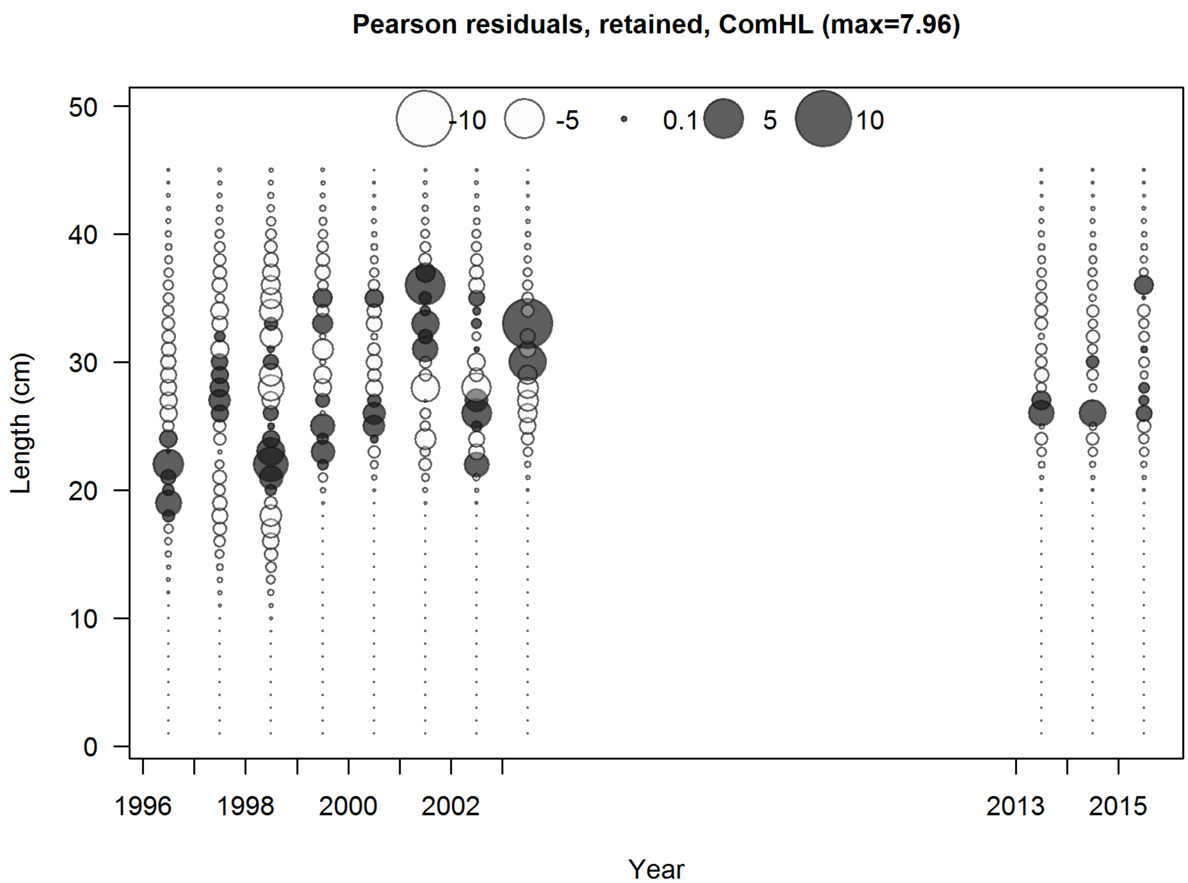

Figure 4: Pearson residuals, retained, ComHL (max=7.96)
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). fig:mod1_2_comp_lenfit_residsflt1mkt2

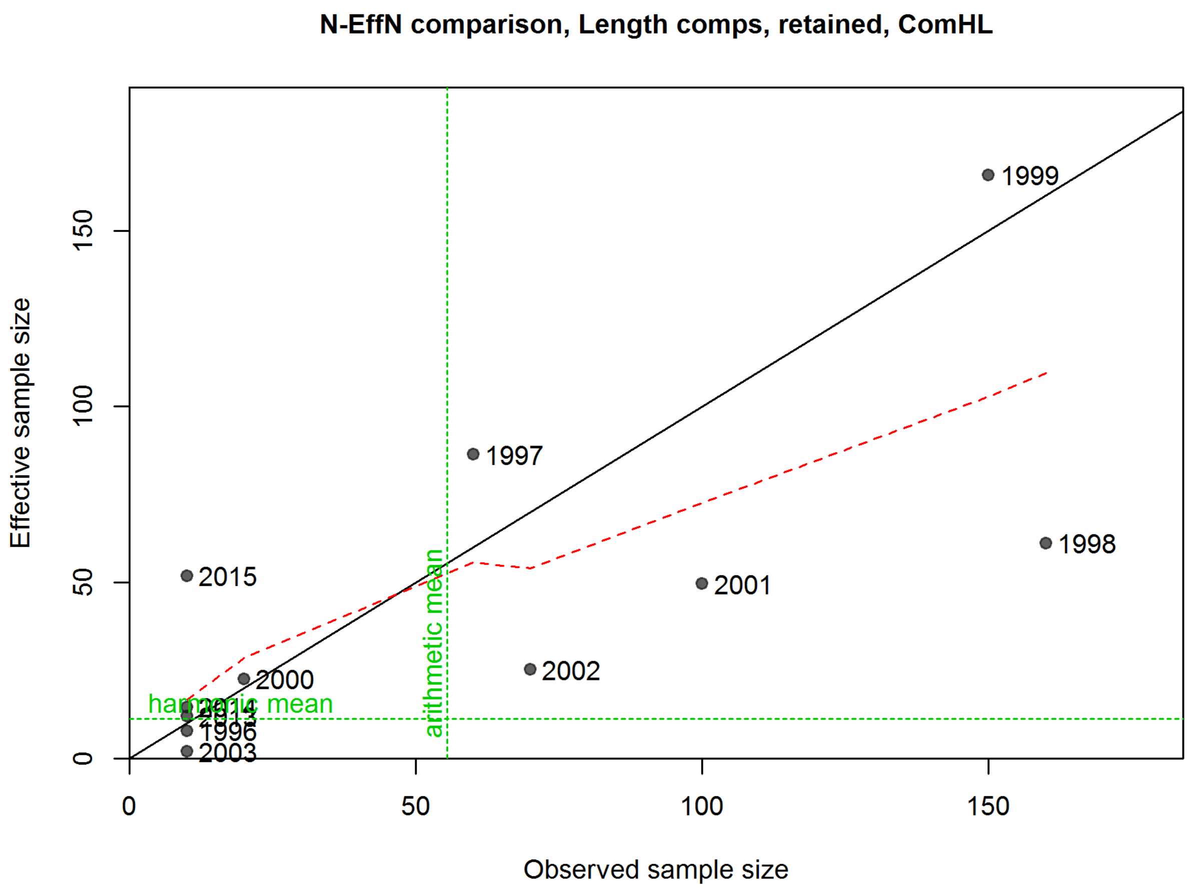

Figure 5: N_EffN comparison, Length comps, retained, ComHL fig:mod1_3_comp_lenfit_sa

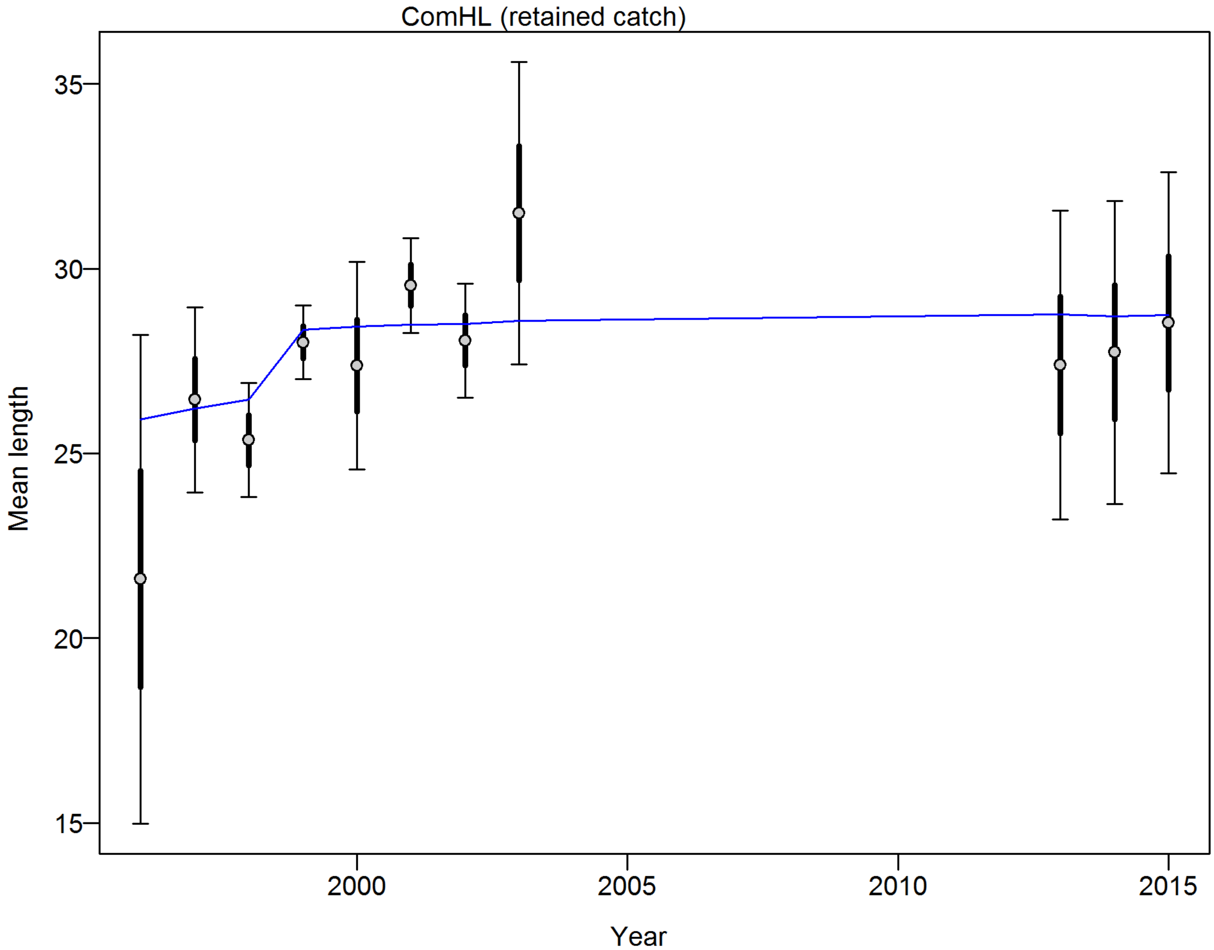

Figure 6: Francis data weighting method TA1.8: ComHL Suggested sample size adjustment (with 95% interval) for len data from ComHL: 0.197 (0.1179_1.1745) For more info, see Francis, R.I.C.C. (2011). Data weighting in statistical fisheries stock assessment models. Can. J. Fish. Aquat. Sci. 68: 1124_1138. fig:mod1_4_comp_lenfit_data_weighting_TA1.8_ComHL

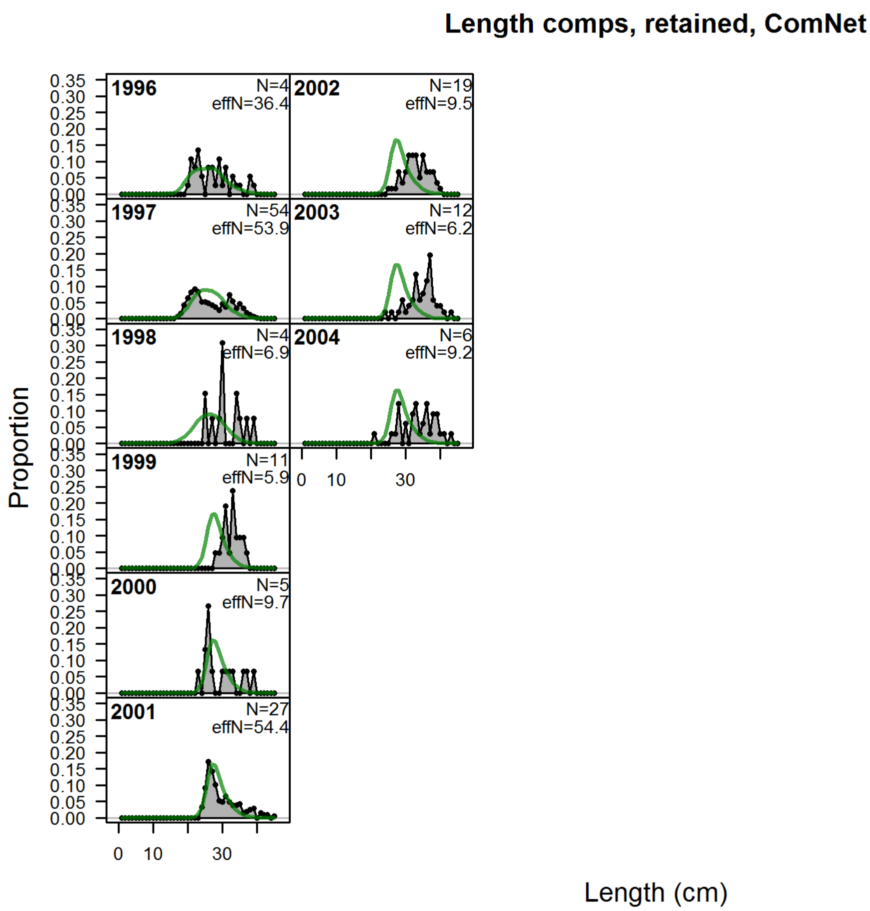

Figure 7: Length comps, retained, ComNet fig:mod1_5_comp_lenfit_flt2mkt2

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