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)

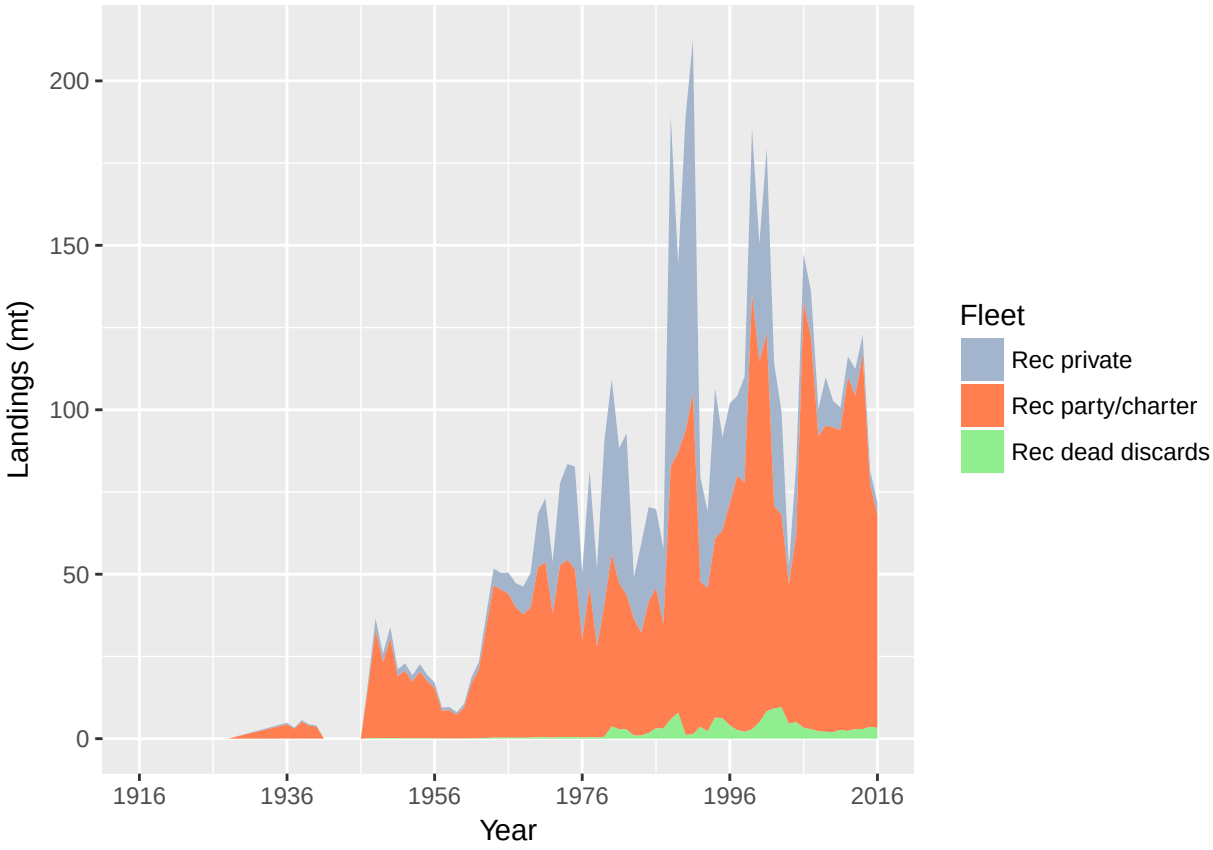

Figure a: California scorpionfish landings history for the recreational fleets. fig:Exec_catch1

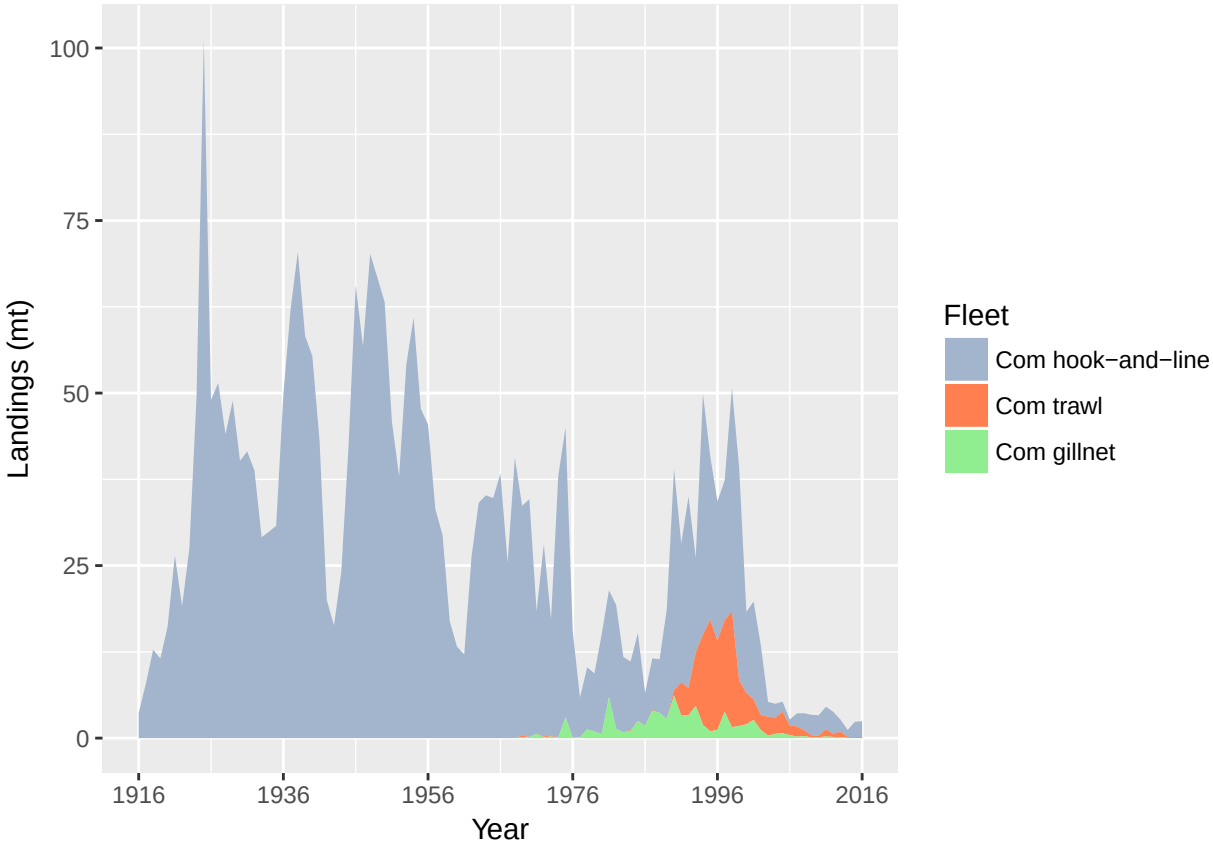

Figure b: Stacked line plot of California scorpionfish landings history for the commercial fleets. `fig:Exec_catch2`

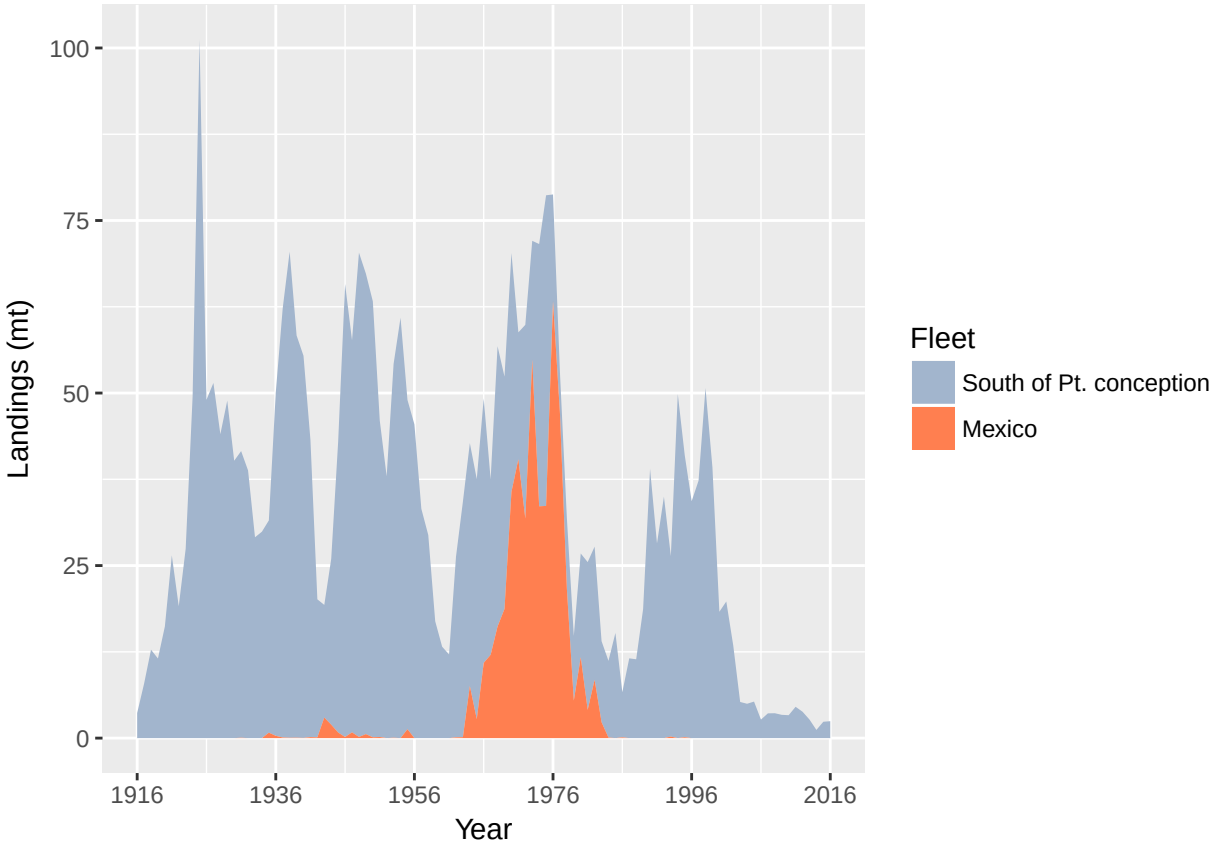

Figure c: Stacked line plot of California scorpionfish landings history by region, north of Pt. Conception, between Pt. Conception and the U.S.-Mexico border, and Mexican waters. `fig:Exec_catch3`

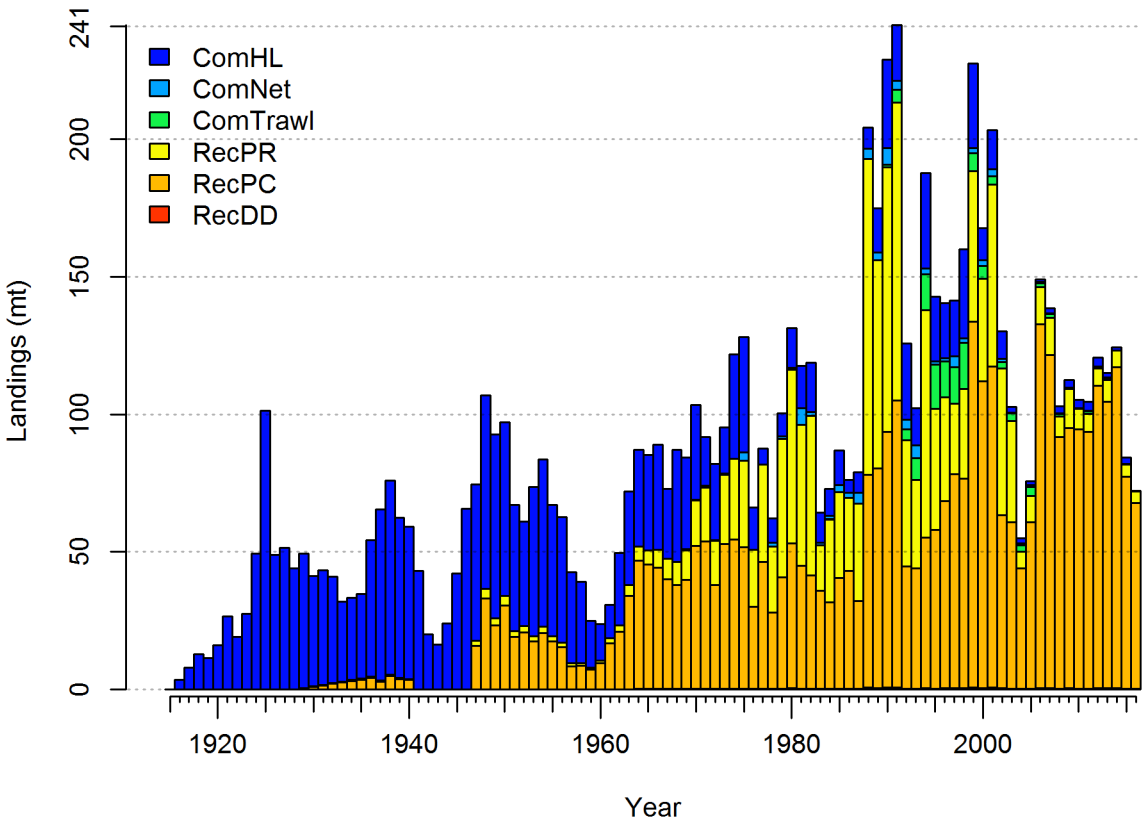

Figure d: Landings history of California scorpionfish in the base model. `fig:r4ss_catches`

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).

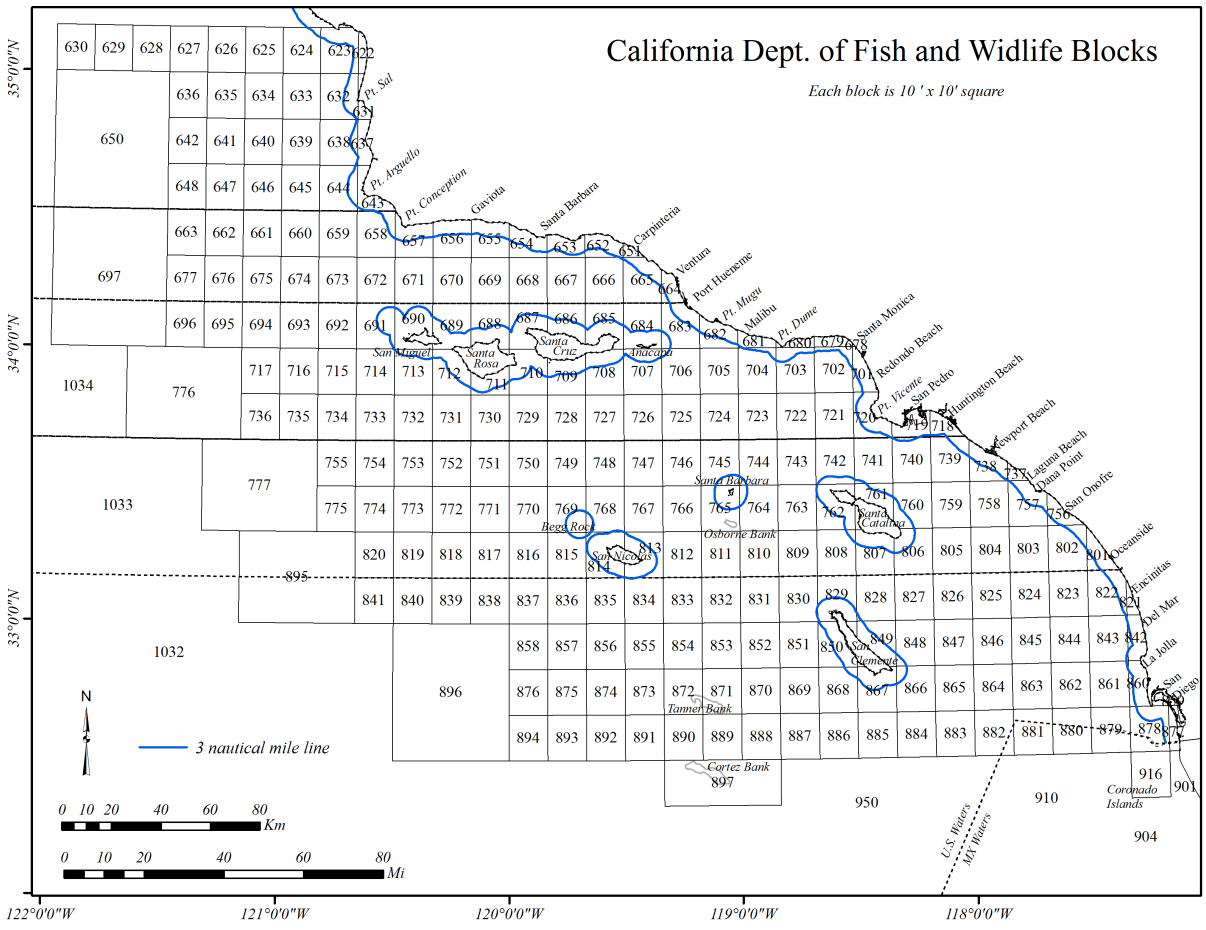

Figure e: Map depicting the boundaries for the base-case model. fig:assess_region_map

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)

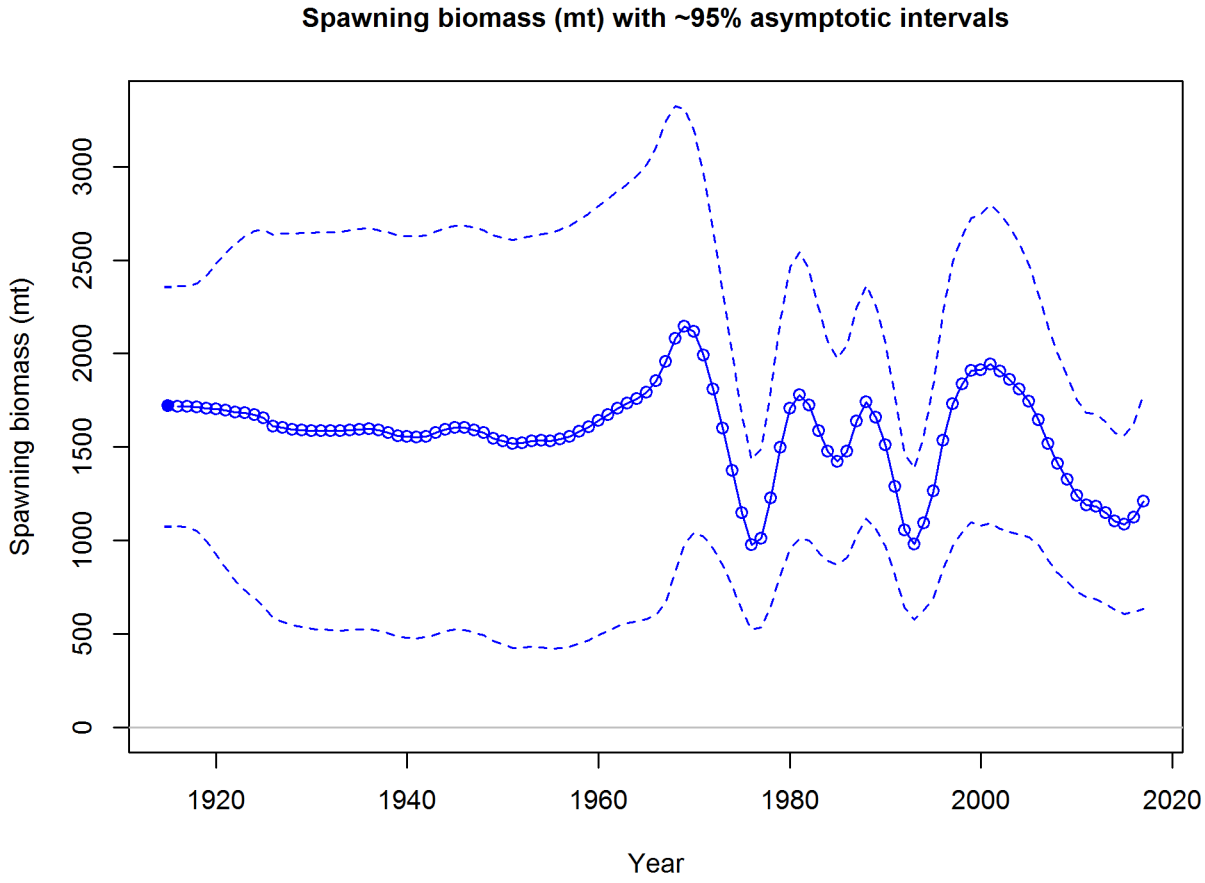

Figure f: Time series of spawning output trajectory (circles and line: median; light broken lines: 95% credibility intervals) for the base case assessment model. `fig:Spawnbio_all`

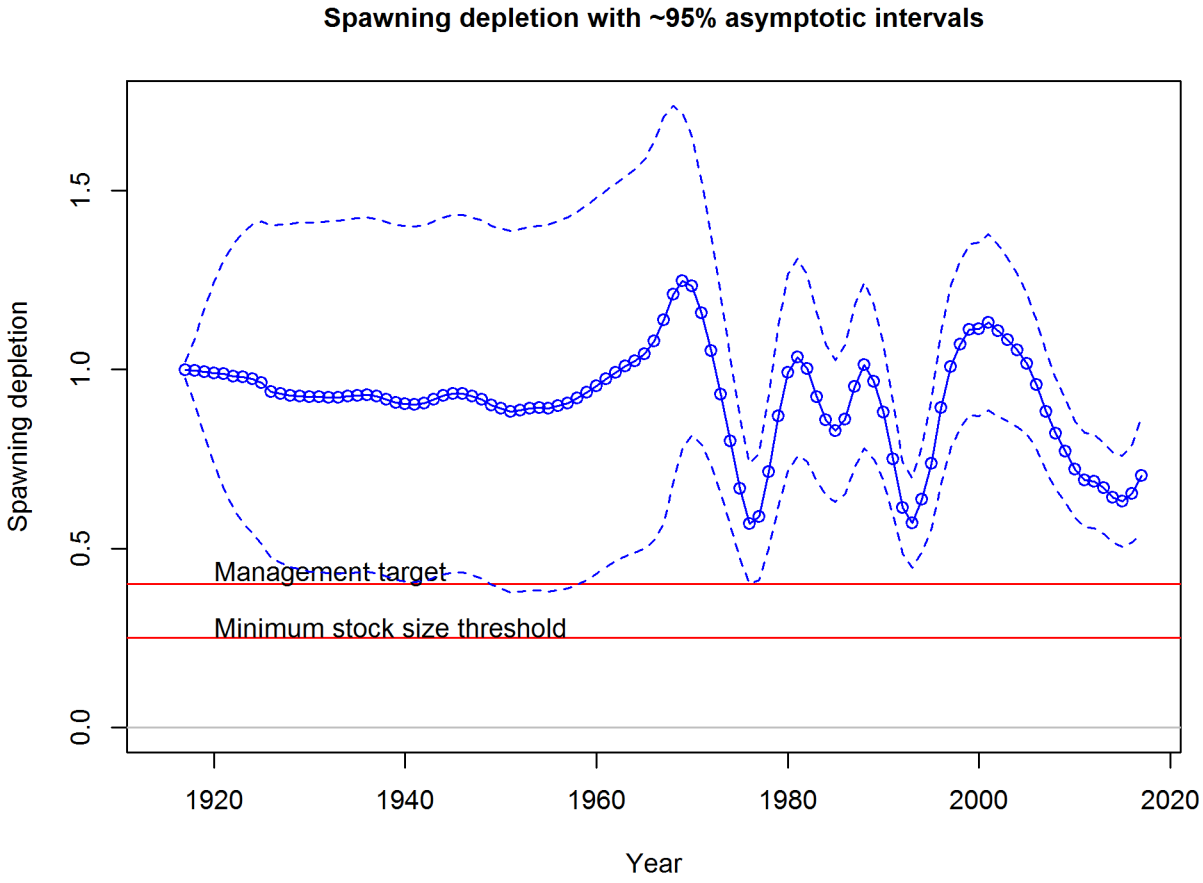

Figure g: Estimated relative depletion with approximate 95% asymptotic confidnce intervals (dashed lines) for the base case assessment model. `fig:RelDeplete_all`

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)

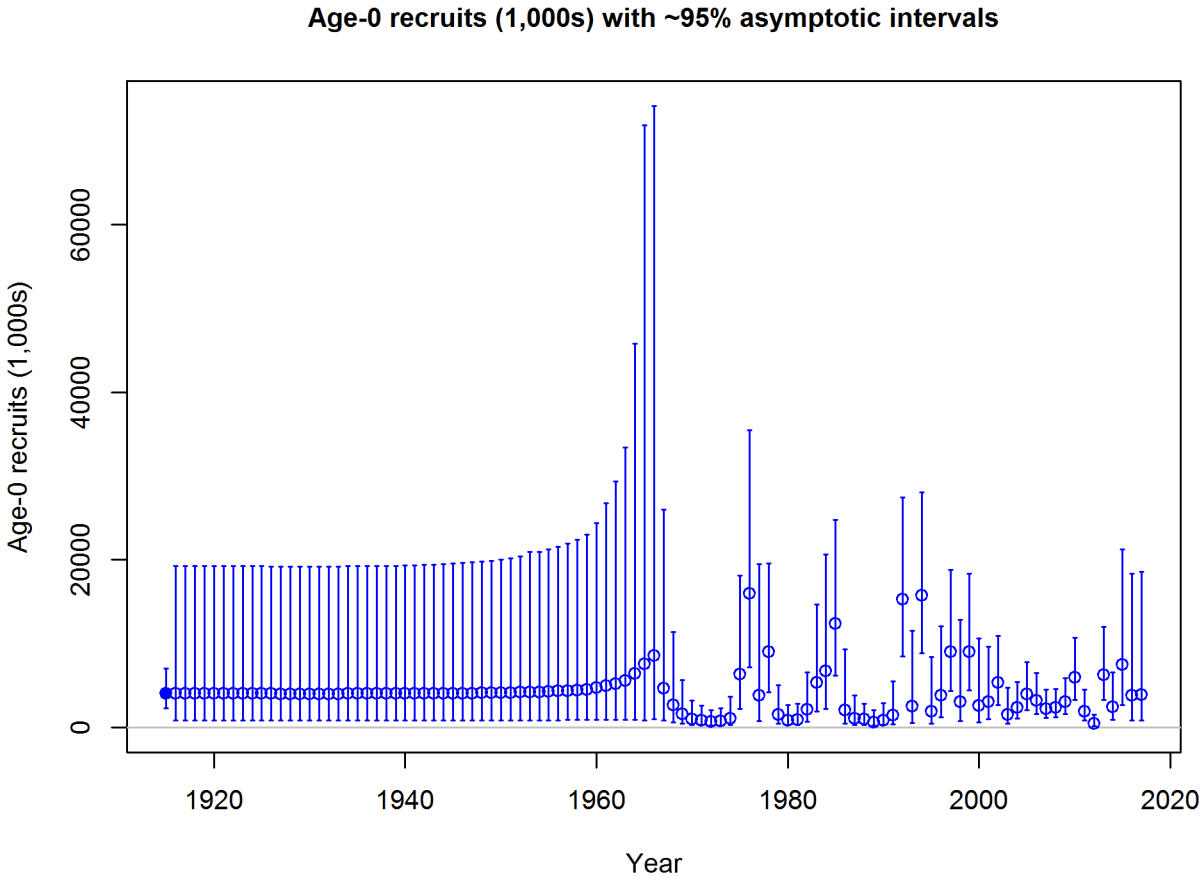

Figure h: Time series of estimated California scorpionfish recruitments for the base-case model with 95% confidence or credibility intervals. `fig:Recruits_all`

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)

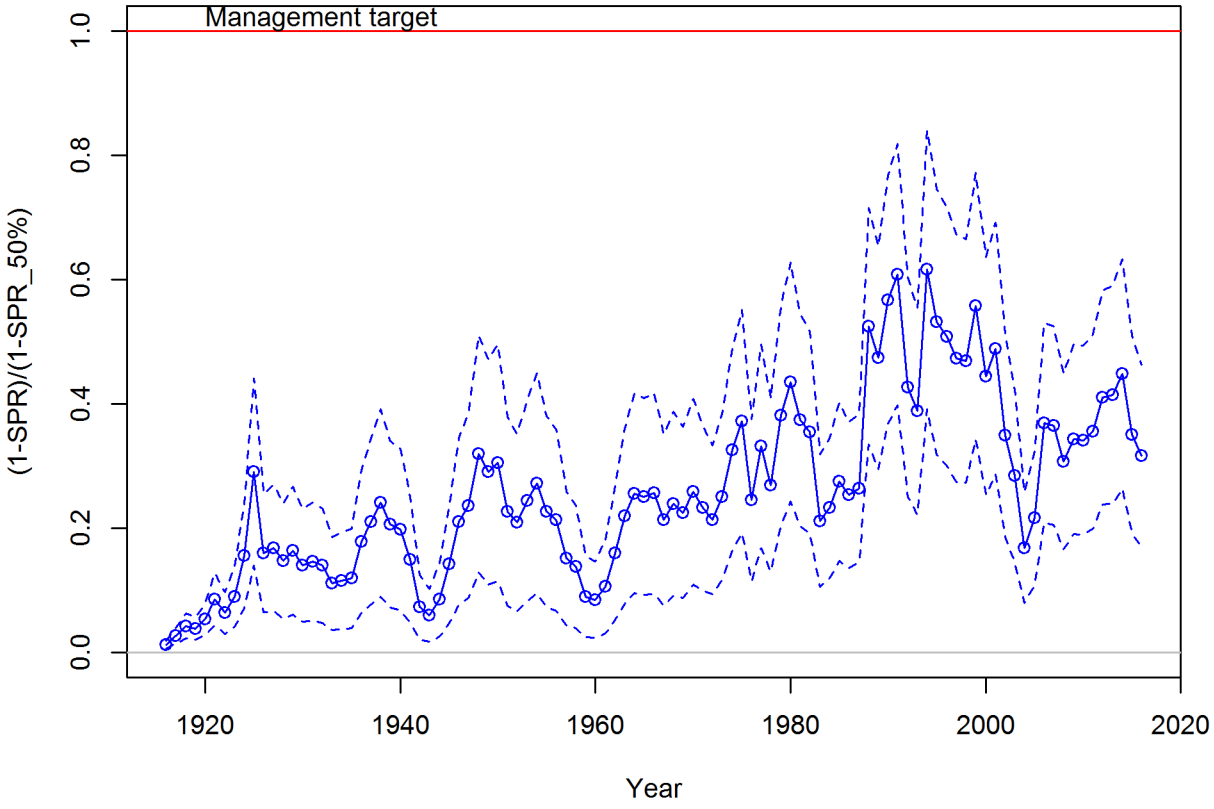

Figure i: Estimated spawning potential ratio (SPR) for the base-case model. One minus SPR is plotted so that higher exploitation rates occur on the upper portion of the y-axis. The management target is plotted as a red horizontal line and values above this reflect harvests in excess of the overfishing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

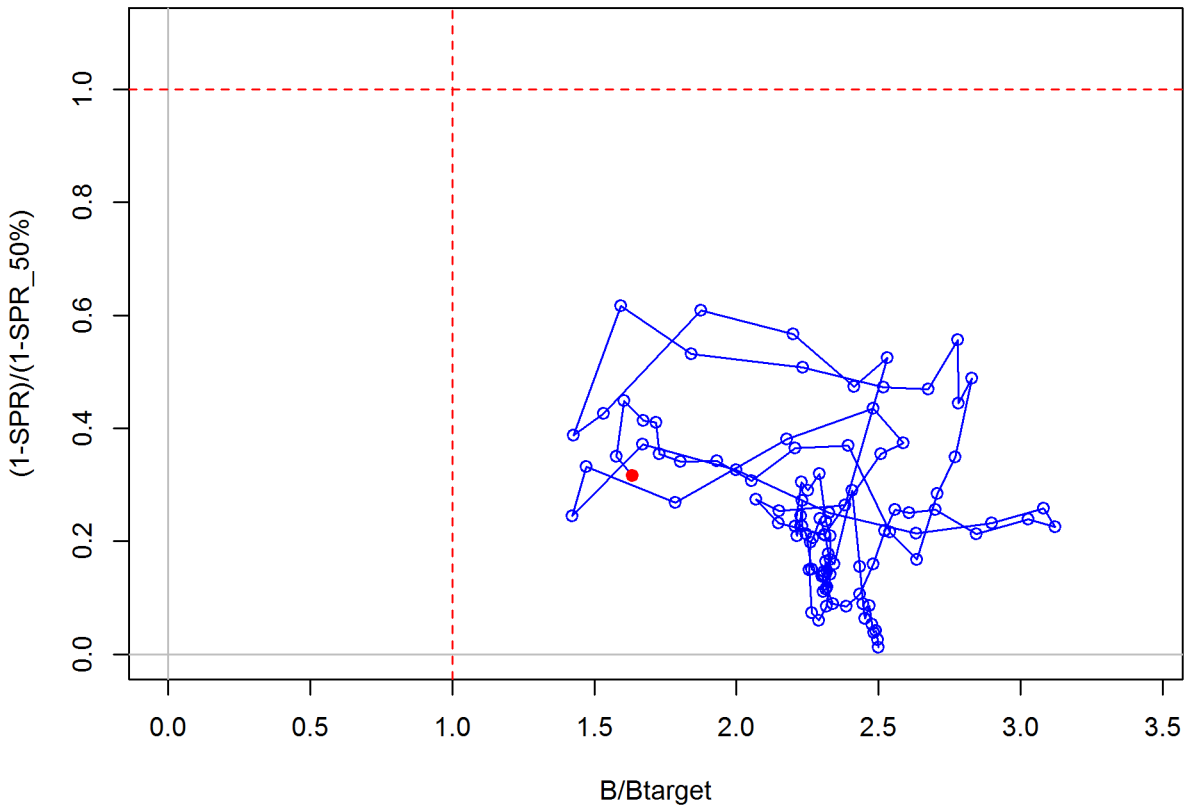

Figure j: Phase plot of estimated relative (1-SPR) vs. relative spawning biomass for the base case model. The relative (1-SPR) is (1-SPR) divided by 50% (the SPR target). Relative depletion is the annual spawning biomass divided by the unfished spawning biomass. 「fig:Phase_all

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 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

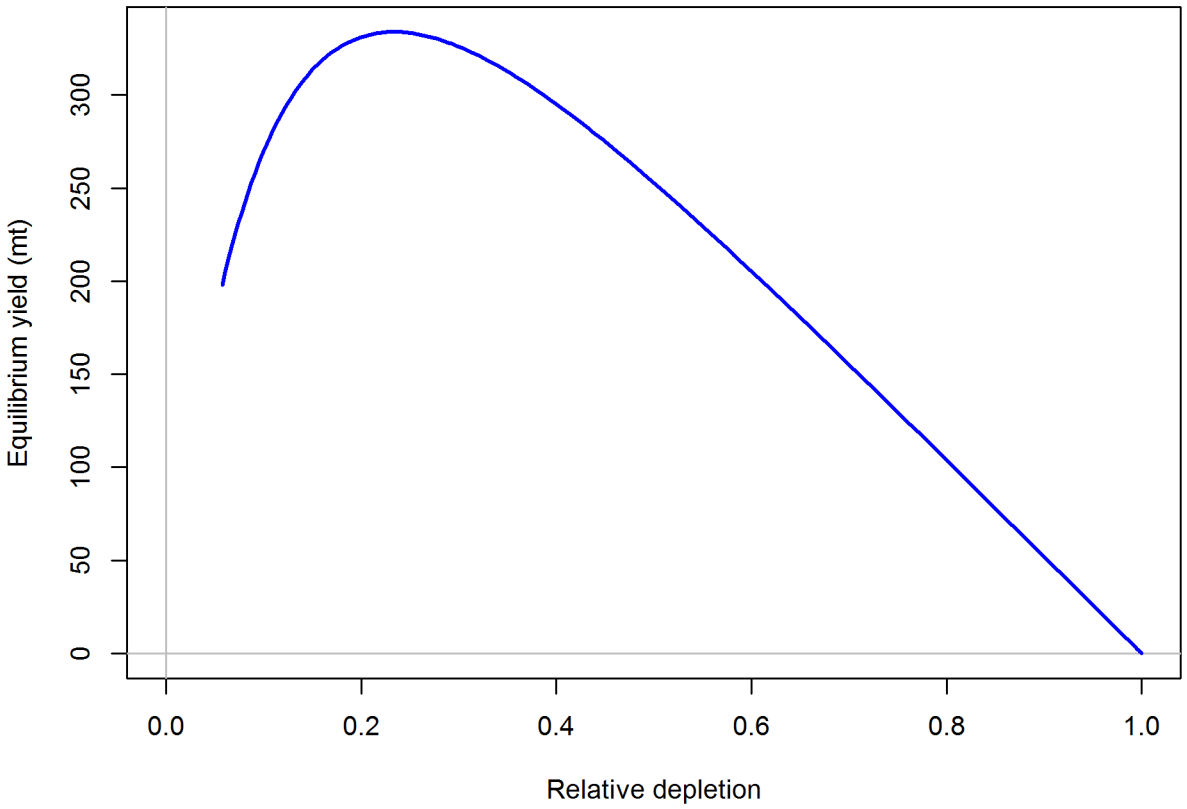

Figure k: Equilibrium yield curve for the base case model. Values are based on the 2016 fishery selectivity and with steepness fixed at... `fig:Yield_all`

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 and Life History

basic-information-and-life-history

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.).

1.2 Early Life History

early-life-history

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.).

1.3 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`

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).

California scorpionfish comprise a minor part of the Californian sport and commercial fisheries (Love et al. 1987). Historically, California scorpionfish were taken commercially by hook and line and, occasionally, by round haul nets (Daugherty 1949). Scorpionfish were commonly caught around Santa Catalina Island during the late 19th Century with gillnets (**???**). The 1937 Bureau of Commercial Fisheries report noted that California scorpionfish had been a fairly important commercial species for a long time. The species was targeted by a few fishermen during the summer months, and was also taken as a bycatch in the rockfish fisheries. By 1949, Bureau of Marine Fisheries reported "[Scorpionfish] will even come to the surface to lights at night" and were also taken in round haul nets. At that time, scorpionfish were rarely targeted by fishermen except by a few specialists.

More recently, commercial bottom longlines have been used to target spawning aggregations offshore of Long Beach (Love et al. 1987). Since the early 1990s, trawl catch has been a substantial component of the commercial catch. Commercial landings have fluctuated

substantially over time, which could, in part, be due to changes in targeting and El Nio events (Love et al. 1987). A high proportion of the catch landed in California during the 1960s and 1970s was taken from Mexican waters. In recent years, most of the catch has come from around the Los Angeles region. In general, the majority of the commercial catch has come from the Los Angeles region, except in the 1960s and 1970s when the majority of the catch came from the San Diego region and Mexican waters.

They are most often taken by boat fishermen, but fairly large numbers are caught from piers, jettys, and rocky shorelines. The CPFV effort has remained relatively constant over a long period (1959-1998) (Dotson and Charter 2003). However, there appears to be a shift in effort towards less utilized species, such as California scorpionfish, over the past decade (Dotson and Charter 2003). Especially as catch limits for rockfish have become more restricted commercial passenger fishing vessels (CPFV) operators target California scorpionfish spawning aggregations during spring and summer (Love et al. 1987), and also target California scorpionfish in the winter when other fisheries are closed. California scorpionfish become a target species for day boats during the spawning months when spawning aggregations can be located. There are a small number of boats that specialize in targeting these aggregations. The spawning aggregations occur in deeper waters, often times outside of the three nautical mile state jurisdiction. It is also unknown what fraction of the population aggregates during the spawning season, e.g., all mature fish.

Aggregate mortality has been far below the Annual Catch Limits (ACL) established by the 2005 stock assessment. The ACL projections from the 2005 assessment assumed that the entire ACL was being taken each year and as a result, the ACL for each subsequent year declined despite under-attainment in reality. In addition, in 2014, recreational catch was higher than expected. As a result, in 2014, the combined recreational and commercial catch exceeded the OFL by 2mt (1%) resulting from assumption that the ACL had been attained. Subsequently, action was taken to decrease the recreational season by four months (Sept 1-Dec 31). A catch only update of the stock was undertaken in 2015 (**???**) that imputed the actual catch values since the last assessment, resulting in significant increase in the OFL and ACL. Retrospectively, the catch in 2014 was well below the OFL as well as the ACL that would have been in place had the ACL values from the actual attainment been in place in 2014. Thus the stock has not been subject to overfishing since the original assessment or been in an overfished condition historically and is considered healthy. The season restriction in the recreational fishery remained in place as a precautionary measure until the full assessment is completed to better inform the current status of the stock, catch limits and regulations given the perspective provided.

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 onboard observer study (*recreational charter discards*, 1984-1989)
- California recreational sources combined (*recreational charter retained catch*)
  - CDFW and Ally onboard observer surveys (1984-1989)
  - Collins and Crooke onboard observer surveys (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 28 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 29

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 30).

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 31

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: Commercial removals (mt) from the commercial fisheries. Data sources are the the CDFG Fishery Bulletins (availabl from California Explores the Ocean) and the California Fisheries Information System (CFIS)

Year	Hook-and-line	Trawl	Gillnet	Mexico	Total U.S. Removals	Source
1916	3.64	0.00	0.00	0.00	3.64	CDFG Bulletins
1917	7.90	0.00	0.00	0.00	7.90	CDFG Bulletins
1918	12.81	0.00	0.00	0.00	12.81	CDFG Bulletins
1919	11.54	0.00	0.00	0.00	11.54	CDFG Bulletins
1920	16.18	0.00	0.00	0.00	16.18	CDFG Bulletins
1921	26.48	0.00	0.00	0.00	26.48	CDFG Bulletins
1922	19.11	0.00	0.00	0.00	19.11	CDFG Bulletins
1923	27.43	0.00	0.00	0.00	27.43	CDFG Bulletins
1924	49.47	0.00	0.00	0.00	49.47	CDFG Bulletins
1925	101.20	0.00	0.00	0.00	101.20	CDFG Bulletins
1926	49.02	0.00	0.00	0.00	49.02	CDFG Bulletins
1927	51.46	0.00	0.00	0.00	51.46	CDFG Bulletins
1928	44.04	0.00	0.00	0.00	44.04	CDFG Bulletins
1929	48.90	0.00	0.00	0.00	48.90	CDFG Bulletins
1930	40.19	0.00	0.00	0.00	40.19	CDFG Bulletins
1931	41.54	0.00	0.00	0.05	41.54	CDFG Bulletins
1932	38.78	0.00	0.00	0.00	38.78	CDFG Bulletins
1933	29.10	0.00	0.00	0.00	29.10	CDFG Bulletins
1934	29.91	0.00	0.00	0.00	29.91	CDFG Bulletins
1935	30.76	0.00	0.00	0.79	30.76	CDFG Bulletins
1936	49.75	0.00	0.00	0.34	49.75	CDFG Bulletins
1937	62.19	0.00	0.00	0.09	62.19	CDFG Bulletins
1938	70.44	0.00	0.00	0.05	70.44	CDFG Bulletins
1939	58.29	0.00	0.00	0.06	58.29	CDFG Bulletins
1940	55.37	0.00	0.00	0.03	55.37	CDFG Bulletins
1941	43.07	0.00	0.00	0.14	43.07	CDFG Bulletins
1942	20.00	0.00	0.00	0.11	20.00	CDFG Bulletins
1943	16.32	0.00	0.00	2.98	16.32	CDFG Bulletins
1944	24.03	0.00	0.00	1.95	24.03	CDFG Bulletins
1945	42.13	0.00	0.00	0.81	42.13	CDFG Bulletins
1946	65.63	0.00	0.00	0.16	65.63	CDFG Bulletins
1947	56.79	0.00	0.00	0.84	56.79	CDFG Bulletins
1948	70.17	0.00	0.00	0.18	70.17	CDFG Bulletins
1949	66.72	0.00	0.00	0.58	66.72	CDFG Bulletins
1950	63.16	0.00	0.00	0.12	63.16	CDFG Bulletins
1951	45.85	0.00	0.00	0.16	45.85	CDFG Bulletins
1952	37.93	0.00	0.00	0.00	37.93	CDFG Bulletins

Table 1: Commercial removals (mt) from the commercial fisheries. Data sources are the the CDFG Fishery Bulletins (availabl from California Explores the Ocean) and the California Fisheries Information System (CFIS)

Year	Hook-and-line	Trawl	Gillnet	Mexico	Total U.S. Removals	Source
1953	54.17	0.00	0.00	0.05	54.17	CDFG Bulletins
1954	60.92	0.00	0.00	0.00	60.92	CDFG Bulletins
1955	47.71	0.00	0.00	1.29	47.71	CDFG Bulletins
1956	45.47	0.00	0.00	0.00	45.47	CDFG Bulletins
1957	33.23	0.00	0.00	0.00	33.23	CDFG Bulletins
1958	29.43	0.00	0.00	0.00	29.43	CDFG Bulletins
1959	16.94	0.00	0.00	0.00	16.94	CDFG Bulletins
1960	13.25	0.00	0.00	0.00	13.25	CDFG Bulletins
1961	12.12	0.00	0.00	0.00	12.12	CDFG Bulletins
1962	26.18	0.00	0.00	0.11	26.18	CDFG Bulletins
1963	34.11	0.00	0.00	0.14	34.11	CDFG Bulletins
1964	35.19	0.00	0.00	7.55	35.19	CDFG Bulletins
1965	34.78	0.00	0.00	2.75	34.78	CDFG Bulletins
1966	38.31	0.00	0.00	10.90	38.31	CDFG Bulletins
1967	25.42	0.00	0.00	12.07	25.42	CDFG Bulletins
1968	40.60	0.00	0.00	16.18	40.60	CDFG Bulletins
1969	33.28	0.28	0.10	18.72	33.66	CFIS
1970	34.45	0.00	0.16	35.67	34.62	CFIS
1971	17.76	0.00	0.63	40.41	18.38	CFIS
1972	27.84	0.11	0.13	31.81	28.08	CFIS
1973	16.80	0.17	0.24	54.85	17.21	CFIS
1974	37.94	0.00	0.06	33.59	38.00	CFIS
1975	41.95	0.02	3.03	33.64	45.01	CFIS
1976	15.41	0.06	0.01	63.29	15.49	CFIS
1977	5.75	0.00	0.13	47.07	5.88	CFIS
1978	8.99	0.00	1.26	21.62	10.25	CFIS
1979	8.40	0.00	0.97	5.43	9.37	CFIS
1980	14.47	0.00	0.56	11.72	15.03	CFIS
1981	15.48	0.01	5.93	4.09	21.41	CFIS
1982	17.95	0.00	1.34	8.46	19.29	CFIS
1983	10.91	0.00	0.83	2.31	11.74	CFIS
1984	9.89	0.15	1.07	0.08	11.11	CFIS
1985	12.73	0.02	2.48	0.00	15.24	CFIS
1986	4.76	0.02	1.76	0.11	6.54	CFIS
1987	7.46	0.11	3.99	0.00	11.56	CFIS
1988	7.77	0.00	3.65	0.00	11.42	CFIS
1989	15.87	0.02	2.80	0.00	18.69	CFIS
1990	32.07	0.78	6.17	0.00	39.01	CFIS
1991	20.12	4.80	3.29	0.00	28.20	CFIS

Table 1: Commercial removals (mt) from the commercial fisheries. Data sources are the the CDFG Fishery Bulletins (availabl from California Explores the Ocean) and the California Fisheries Information System (CFIS)

Year	Hook-and-line	Trawl	Gillnet	Mexico	Total U.S. Removals	Source
1992	27.71	3.94	3.33	0.00	34.98	CFIS
1993	13.72	7.76	4.66	0.22	26.14	CFIS
1994	34.85	13.08	1.92	0.00	49.86	CFIS
1995	23.69	16.20	0.98	0.13	40.87	CFIS
1996	20.17	12.97	1.19	0.00	34.33	CFIS
1997	20.22	13.28	3.82	0.00	37.31	CFIS
1998	32.34	16.80	1.59	0.00	50.72	CFIS
1999	30.88	6.56	1.78	0.00	39.22	CFIS
2000	11.74	4.57	2.00	0.00	18.30	CFIS
2001	14.18	2.98	2.64	0.00	19.80	CFIS
2002	10.09	2.16	1.18	0.00	13.43	CFIS
2003	2.13	2.75	0.35	0.00	5.24	CFIS
2004	2.00	2.36	0.62	0.00	4.98	CFIS
2005	1.47	3.12	0.70	0.00	5.29	CFIS
2006	0.86	1.38	0.44	0.00	2.68	CFIS
2007	1.90	1.48	0.21	0.00	3.59	CFIS
2008	2.46	0.86	0.28	0.00	3.61	CFIS
2009	2.97	0.27	0.13	0.00	3.38	CFIS
2010	2.99	0.18	0.14	0.00	3.32	CFIS
2011	3.24	1.05	0.24	0.00	4.54	CFIS
2012	3.22	0.43	0.18	0.00	3.82	CFIS
2013	1.73	0.83	0.14	0.00	2.70	CFIS
2014	1.03	0.13	0.04	0.00	1.19	CFIS
2015	2.21	0.13	0.03	0.00	2.37	CFIS
2016	2.32	0.13	0.00	0.00	2.45	CFIS

tab:Comm_catches

Table 2: Recreational removals (mt) from the party/charter and private vessels. Removals from man-made and beach/bank modes were included in the private mode removals. Dead discards include all modes. CDFW provided all data. Note: A discard mortality rate of 7to the dead discard removals.

Year	Private	Party/charter	Dead Discard (all modes)	Total Removals
1929	0.06	0.54	0.00	0.61
1930	0.12	1.08	0.01	1.21
1931	0.18	1.62	0.01	1.81
1932	0.24	2.16	0.01	2.42
1933	0.30	2.70	0.02	3.02
1934	0.36	3.24	0.02	3.63
1935	0.42	3.78	0.03	4.23
1936	0.48	4.33	0.03	4.84
1937	0.34	3.01	0.02	3.37
1938	0.56	5.06	0.04	5.66
1939	0.44	3.90	0.03	4.36
1940	0.40	3.61	0.02	4.04
1941	0.00	0.00	0.00	0.00
1942	0.00	0.00	0.00	0.00
1943	0.00	0.00	0.00	0.00
1944	0.00	0.00	0.00	0.00
1945	0.00	0.00	0.00	0.00
1946	0.00	0.00	0.00	0.00
1947	1.76	15.73	0.11	17.60
1948	3.65	32.67	0.23	36.55
1949	2.58	23.12	0.16	25.86
1950	3.38	30.29	0.21	33.89
1951	2.11	18.84	0.13	21.08
1952	2.29	20.48	0.14	22.91
1953	1.93	17.24	0.12	19.28
1954	2.26	20.27	0.14	22.67
1955	1.93	17.33	0.12	19.38
1956	1.70	15.26	0.11	17.07
1957	0.94	8.44	0.06	9.44
1958	0.96	8.60	0.06	9.62
1959	0.80	7.19	0.05	8.04
1960	1.06	9.47	0.07	10.59
1961	1.86	16.71	0.12	18.69
1962	2.33	20.87	0.14	23.34
1963	3.77	33.75	0.23	37.75
1964	5.16	46.25	0.32	51.73
1965	5.02	45.03	0.31	50.36
1966	6.44	43.74	0.31	50.48
1967	7.34	39.64	0.29	47.27

Table 2: Recreational removals (mt) from the party/charter and private vessels. Removals from man-made and beach/bank modes were included in the private mode removals. Dead discards include all modes. CDFW provided all data. Note: A discard mortality rate of 7to the dead discard removals.

Year	Private	Party/charter	Dead Discard (all modes)	Total Removals
1968	8.46	37.50	0.29	46.25
1969	10.62	39.47	0.32	50.41
1970	16.32	51.69	0.43	68.44
1971	19.46	53.19	0.46	73.10
1972	15.80	37.62	0.34	53.76
1973	25.01	52.28	0.49	77.78
1974	29.18	53.84	0.52	83.55
1975	31.19	51.01	0.52	82.72
1976	20.44	29.75	0.32	50.50
1977	35.19	45.69	0.51	81.39
1978	23.82	27.63	0.33	51.77
1979	49.76	40.23	0.58	90.57
1980	53.27	52.35	3.72	109.35
1981	41.08	44.42	2.85	88.36
1982	49.04	40.92	2.81	92.77
1983	12.65	35.56	0.93	49.14
1984	27.06	31.25	0.96	59.27
1985	28.77	39.93	1.71	70.41
1986	24.07	42.53	3.19	69.79
1987	23.05	31.78	3.02	57.85
1988	106.56	76.88	5.89	189.34
1989	56.79	79.32	7.90	144.00
1990	95.63	92.27	1.16	189.06
1991	107.40	103.63	1.30	212.34
1992	31.91	44.10	3.60	79.60
1993	23.31	43.49	2.26	69.07
1994	45.62	54.40	6.42	106.45
1995	28.44	57.03	6.21	91.68
1996	30.46	67.48	4.00	101.93
1997	24.39	77.23	2.62	104.24
1998	32.12	75.91	2.08	110.11
1999	50.11	132.50	2.83	185.43
2000	35.86	109.64	4.97	150.47
2001	56.20	114.90	8.33	179.43
2002	43.39	61.57	9.20	114.15
2003	31.49	58.46	9.56	99.52
2004	5.29	42.42	4.53	52.24
2005	21.34	57.15	5.04	83.53
2006	14.44	129.58	3.31	147.33

Table 2: Recreational removals (mt) from the party/charter and private vessels. Removals from man-made and beach/bank modes were included in the private mode removals. Dead discards include all modes. CDFW provided all data. Note: A discard mortality rate of 7to the dead discard removals.

Year	Private	Party/charter	Dead Discard (all modes)	Total Removals
2007	14.24	118.87	2.89	135.99
2008	8.38	89.65	2.25	100.28
2009	14.68	93.16	2.09	109.93
2010	8.07	92.55	2.03	102.65
2011	6.84	91.18	2.66	100.68
2012	6.22	107.63	2.34	116.18
2013	8.18	101.31	2.94	112.44
2014	5.88	113.83	2.93	122.63
2015	4.15	73.78	3.59	81.52
2016	3.86	64.56	3.29	71.71

tab:Rec_removal

Table 3: Recreational private mode dockside data sample sizes at each data filtering step. The bold value indicates the final sample size used for delta-GLM analysis.

tab:Fleet4_RecPR_dockside_filter

Filter	Criteria	Sample size (no. positive trips)	Sample size (no. of trips)
Entire dataset			108,171
General data filters	CRFS-PR1 survey only, Southern California only (sub_reg = 1), Hook and line gear only (geara = 'H'), Ocean only (Area_X = 1 or 2)	3,802	43,956
Region	Remove trips from Santa Barbara	3,757	42,956
Year	Remove 2004-2005; fishery closed majority of year	3,094	33,770
Closed fishery	Remove remaining trips when fishery closed	3,056	32,236
Rare and co-occurring species	Remove trips with yellowfin tuna and dolphinfish and species present in ¡1% of all trips and in at least 5 years of data	3,056	30,033
Stephens-MacCall	Retain all positive trips, plus "False Positives" (trips predicted to be in California scorpionfish habitat, but with no California scorpionfish retained)	3,056	4,873

Table 4: AIC values for each model in the recreational private mode dockside sample index.

tab:Fleet4_RecPR_dockside_aic

Model	Binomial	Lognormal
Year	6182.366	8103.204
Year + County	5862.9	8003.9
Year + Wave	6091	8092.2
Year + County + Wave	**5792.29**	**8000.45**

Table 5: The recreational private mode dockside sample index.

tab:Fleet4_RecPR_dockside_index

Year	Index	Log-scale SE
2006	1.1154	0.0533
2007	0.9353	0.0500
2008	0.8052	0.0481
2009	0.7645	0.0516
2010	0.6716	0.0657
2011	0.7660	0.0734
2012	0.6651	0.0807
2013	0.6143	0.0708
2014	0.6076	0.0826
2015	0.6465	0.0901
2016	0.6530	0.1275

Table 6: Recreational CPFV logbook sample sizes at each data filtering step. The bold value indicates the final sample size used for delta-GLM analysis.

tab:Fleet5_RecPC_CPFVlogbook_filter

Filter	Criteria	Sample size (no. of trips)
All CA data	No filter	1,164,662
Gear	Remove trips reported as diving, mooching or trolling	959,740
Effort or missing data	Remove trips with missing effort or species information	930,233
Year	Remove 2017, remaining years 1980-2016	929,781
Region	Remove trips north of Pt. Conception and in Mexico	568,222
Fish encountered	Remove trips reporting number of retained fish greater than in the 99% quantile (>325 fish)	564,433
Target species	Remove trips targeting sharkes, striped bass, sturgeon, tun, misc. bay, and potluck	558,872
Single-species trips	Filter trips reporting catches of only species and that one species in <100 trips	558,833
Offshore trips	Remove trips catching yellowtail, tunas, and dolphinfish that were not designated as offshore trips	475,492
Vessel	Remove trips by vessels that had fewer than 10 trips catching scorpionfish	466,023
Anglers	Remove trips with number of anglers < the 1% and > the 99% quantile (retain 5-75 anglers)	452,938
Depth	Remove trips in blocks with a minimum depth of >140m	443,929
Scorpionfish targets	Blocks with at least 100 scorpionfish trips	433,248
Sample size	Blocks with at least 500 trips	**432,868**

Table 7: AIC values for each model in the recreational CPFV logbook sample index.

tab:Fleet5_RecPC_CPFVlogbook_aic

Model	Negative Binomial
Year	1918470
Year+ Month	1901592
Year + Block	1872224
Year+ Month + Block	**1854652**

Table 8: The recreational CPFV logbook sample index.

tab:Fleet5_RecPC_CPFVlogbook_index

Year	Index	Log-scale SE	NA	NA
1980	0.0159	0.0579		
1981	0.0128	0.0580		
1982	0.0143	0.0583		
1983	0.0134	0.0610		
1984	0.0111	0.0605		
1985	0.0188	0.0588		
1986	0.0165	0.0579		
1987	0.0168	0.0593		
1988	0.0291	0.0584		
1989	0.0296	0.0581		
1990	0.0293	0.0585		
1991	0.0348	0.0579		
1992	0.0172	0.0587		
1993	0.0166	0.0590		
1994	0.0226	0.0588		
1995	0.0291	0.0587		
1996	0.0316	0.0583		
1997	0.0498	0.0592		
1998	0.0289	0.0595		
1999	0.0482	0.0583		
2000	0.0338	0.0587		
2001	0.0345	0.0586		
2002	0.0203	0.0588		
2003	0.0193	0.0593		
2004	0.0168	0.0595		
2005	0.0146	0.0592		
2006	0.0457	0.0592		
2007	0.0489	0.0589		
2008	0.0355	0.0593		
2009	0.0399	0.0595		
2010	0.0400	0.0597		
2011	0.0304	0.0593		
2012	0.0296	0.0591		
2013	0.0330	0.0592		
2014	0.0311	0.0602		
2015	0.0252	0.0622		
2016	0.0253	0.0615		

Table 9: Recreational onboard observer data sample sizes at each data filtering step. The bold value indicates the final sample size used for delta-GLM analysis. The same sample data were used for the discard-only index and the retained-only catch indices

tab:Fleet6_RecDD_onboard_filter

Filter	Criteria	Sample size (no. positive trips)	Sample size (no. of trips)
Initial SQL filtering		6,475	59,192
Habitat filter	Remove drifts >1000 m of alpha hull buffer, remove "reefs" with <0 drifts or 5% positives, or in CCA	6,365	30,987
Exclude 1999 and 2000	Management changes (depth and gear restrictions)	5,986	29,577
Depth	Remove upper and lower 1% of data (retain 26-330ft)	5,921	29,002
Minutes Fished	Remove upper and lower 1% of data (retain 4 - 155 minutes)	5,780	28,460
Observed Anglers	Remove upper and lower 1% of data (retain 4 - 15 anglers)	5,679	27,946
Boats	Include boats encountering scorpionfish in at least 3 years; at least 30 drifts and 10 with scorpionfish	5,509	26,805
Second depth filter	Remove anything >100 m after looking at 20 m depth bins	5,507	**26,733**

Table 10: AIC values for each model in the The recreational CPFV onboard observer discard-only catch index.

tab:Fleet6_RecDD_onboard_aic

Model	Binomial	Lognormal
Year	19619.56	9177.115
Year + Reef	18677.11	9177.115
Year + Depth	19374.02	8860.893
Year + Depth + Reef	18392.13	8778.47
Year + Month + Reef + Depth	**18318.92**	**8769.844**

Table 11: The recreational CPFV onboard observer discard-only catch sample index.

tab:Fleet6_RecDD_onboard_index

Year	Index	Log-scale SE
2001	0.0373	0.0373
2002	0.0836	0.0834
2003	0.0670	0.0670
2004	0.0736	0.0735
2005	0.0842	0.0840
2006	0.0766	0.0765
2007	0.0691	0.0690
2008	0.0611	0.0610
2009	0.0596	0.0596
2010	0.0640	0.0640
2011	0.0506	0.0506
2012	0.0400	0.0400
2013	0.0392	0.0392
2014	0.0387	0.0386
2015	0.0349	0.0349
2016	0.0535	0.0535

Table 12: AIC values for each model in the The recreational CPFV onboard observer retained-only catch index.

tab:Fleet12_RecPC_onboard_aic

Model	Binomial	Lognormal
Year	21826.47	11507.73
Year + Reef	21192.97	11325.43
Year + Depth	21265.79	10704.15
Year + Depth + Reef	20691.44	10619.25
Year + Month + Reef + Depth	**20453.43**	**10599.42**

Table 13: The recreational CPFV onboard observer retained-only catch sample index.

tab:Fleet12_RecPC_onboard_index

Year	Index	Log-scale SE
2001	0.1134	0.1611
2002	0.0759	0.1566
2003	0.0374	0.1600
2004	0.0880	0.1410
2005	0.0615	0.1444
2006	0.0898	0.1025
2007	0.1360	0.0760
2008	0.1048	0.0722
2009	0.1027	0.0723
2010	0.1121	0.0701
2011	0.0905	0.0775
2012	0.0807	0.0736
2013	0.0654	0.0763
2014	0.0663	0.0895
2015	0.0403	0.1088
2016	0.0720	0.1026

Table 14: The trawl sample sizes for each sanitation district at each data filtering step. The bold value indicates the final sample size used for delta-GLM analysis.

tab:Fleet7_Sanitation_filter

Filter	Criteria	City of LA	LA County	Orange County	City of San Diego	Total trawls
General	Erroneous and missing data, harbors or Mexican waters	1,496	2,321	1,671	1,180	6,668
District-specific filters	Stations sampled >29 years or <305 ft		1,848			
	Stations sampled >9 years	930			998	
	Stations sampled >13 years			1,558		
	Stations sampled >11 years					
Station	Stations encountering scorpionfish >4% of trawls	930	1,848	1,500	998	
Tow time and depth	Stations with tow times >4 minutes and <24 ft	921				
	Tow distance 100-599 m (target tow distance 400 m)			1,490		
Final data		921	1,848	1,490	998	**5,257**

Table 15: AIC values for each model in the sanitation districts trawl sample index.

tab:Fleet7_Sanitation_aic

Model	Binomial	Lognormal
Year	7330.73	6748.7
Year + Quarter	7179.5	6642.7
Year + Station	6321.6	6372.8
Year + Station + Quarter	**6130.94**	**6252.71**

Table 16: The sanitation districts trawl sample index. tab:Fleet7_Sanitation_index

Year	Index	Log-scale SE
1970	0.0548	0.5975
1971	0.0703	0.4554
1972	0.1261	0.3709
1973	0.1047	0.3344
1974	0.0841	0.2973
1975	0.0719	0.3571
1976	0.0737	0.2780
1977	0.1408	0.2035
1978	0.1426	0.2135
1979	0.3617	0.1598
1980	0.4085	0.1645
1981	0.4360	0.1543
1982	0.3841	0.2056
1983	0.1343	0.2110
1984	0.0627	0.2817
1985	0.1087	0.1745
1986	0.1624	0.2172
1987	0.2377	0.1644
1988	0.2382	0.1471
1989	0.1605	0.1513
1990	0.1691	0.1551
1991	0.1037	0.1801
1992	0.1126	0.1595
1993	0.1147	0.1055
1994	0.1120	0.1267
1995	0.1970	0.1083
1996	0.2276	0.1006
1997	0.2407	0.1036
1998	0.1795	0.1148
1999	0.2343	0.1001
2000	0.1281	0.1439
2001	0.2433	0.0947
2002	0.1329	0.1411
2003	0.1632	0.1688
2004	0.1873	0.1320
2005	0.2435	0.1673
2006	0.2497	0.1368
2007	0.1347	0.1615
2008	0.1126	0.1643
2009	0.1246	0.1717
2010	0.0791	0.1772
2011	0.1081	0.1851
2012	0.0462	0.2760
2013	0.0190	0.4105
2014	0.0674	0.2917
2015	0.1290	0.2641
2016	0.1167	0.2660

Table 17: NWFSC trawl survey sample sizes at each data filtering step. The bold value indicates the final sample size used for delta-GLM analysis.

tab:Fleet8_NWFSCTrawl_filter

Filter	Criteria	Sample size (no. positive trips)	Sample size (no. of trips)

Table 18: AIC values for each model in the NWFSC trawl survey sample index.

tab:Fleet8_NWFSCTrawl_aic

Model	Binomial	Lognormal

Table 19: The NWFSC trawl survey index.

tab:Fleet8_NWFSCTrawl_index

Year	Index	Log-scale SE
2003	615.6453	0.5708
2004	1000.1240	0.4503
2005	936.2185	0.5943
2006	245.5559	0.5092
2007	1001.1330	0.5099
2008	195.6025	0.4484
2009	1940.3440	0.5137
2010	277.3953	0.5338
2011	710.0569	0.3744
2012	561.1833	0.5361
2013	3243.2760	0.5728
2014	370.3868	0.7000
2015	409.8495	0.4045
2016	366.7447	0.4809

Table 20: Recreational private mode dockside data sample sizes at each data filtering step. The bold value indicates the final sample size used for delta-GLM analysis.

tab:Fleet9_GillnetSurvey_filter

Filter	Criteria	Sample size (no. positive trips)	Sample size (no. of trips)
Entire dataset		325	3,558
General data filters	Samples with no net failures	269	3,515
Net type	Samples using a net type 1", 1.5" and 2" mesh	269	2,815
Sites	Sites frequently sampled	266	2,170
Month	Months sampled consistently (April, June, August, October)	259	2,019

Table 21: AIC values for each model in the recreational private mode dockside sample index.

tab:Fleet9_GillnetSurvey_aic

Model	Binomial	Lognormal
Year + month + site + perp_para + floats	1983.12	1008.62
Year + site + perp_para + floats	2000.281	1004.4
Year + month + perp_para + floats	2349.989	1264.8
Year + site + perp_para	**2010.078**	**1004.1**

Table 22: The recreational private mode dockside sample index.

tab:Fleet9_GillnetSurvey_index

Year	Index	Log-scale SE
1995	0.0537	0.0536
1996	0.0401	0.0401
1997	0.0478	0.0477
1998	0.0275	0.0275
1999	0.0360	0.0360
2000	0.0299	0.0299
2001	0.0331	0.0331
2002	0.0348	0.0348
2003	0.0304	0.0304
2004	0.0541	0.0541
2005	0.0324	0.0324
2006	0.0572	0.0572
2007	0.0508	0.0508
2008	0.0618	0.0618

Table 23: Recreational private mode dockside data sample sizes at each data filtering step. The bold value indicates the final sample size used for delta-GLM analysis.

tab:Fleet11_SCBSurvey_filter

Filter	Criteria	Sample size (no. positive trips)	Sample size (no. of trips)
All trawls	No filter	158	944
Depth	Trawls < 98 m (retains 95% of all data)	149	662
Region	Exclude trawls in harbors, south of Ventura and islands (few scorpionfish)	129	398

Table 24: AIC values for each model in the recreational private mode dockside sample index.

tab:Fleet11_SCBSurvey_aic

Model	Binomial	Lognormal
Year	494.73	339.56
Year + Region	490.24	343.16
Year + Month	493.02	336.68
Year + Month + Region	**486.55**	**337.87**

Table 25: The recreational private mode dockside sample index.

tab:Fleet11_SCBSurvey_index

Year	Index	Log-scale SE	NA	NA
1994	0.0475	0.3042		
1998	0.0223	0.2499		
2003	0.0514	0.2356		
2008	0.0156	0.3187		
2013	0.0214	0.3021		

Table 26: 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 26: 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 26: 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 26: 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 27: Summary of the biomass/abundance time series used in the stock assessment.

tab:Index_summary

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

Table 28: 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 30: 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 30: 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 30: 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 29: 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 31: 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

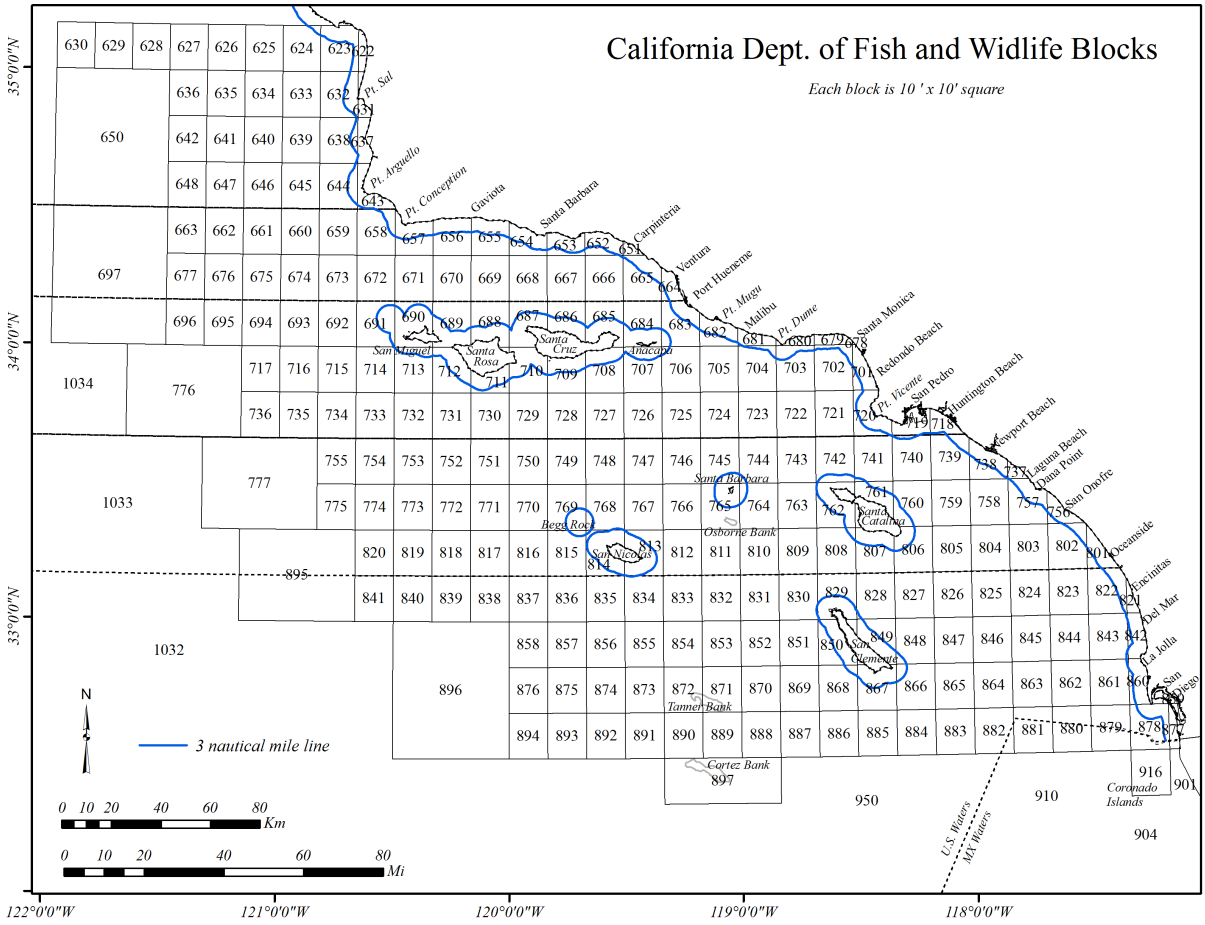

Figure 1: Map showing the state boundary lines for management of the recreational fishing fleets. CRFS Districts 1-6 in California are presented as well as the WDFW Recreational Management Areas in Washington. Florence, OR is shown as a potential location of model stratification. ⌈

fig:boundary_map

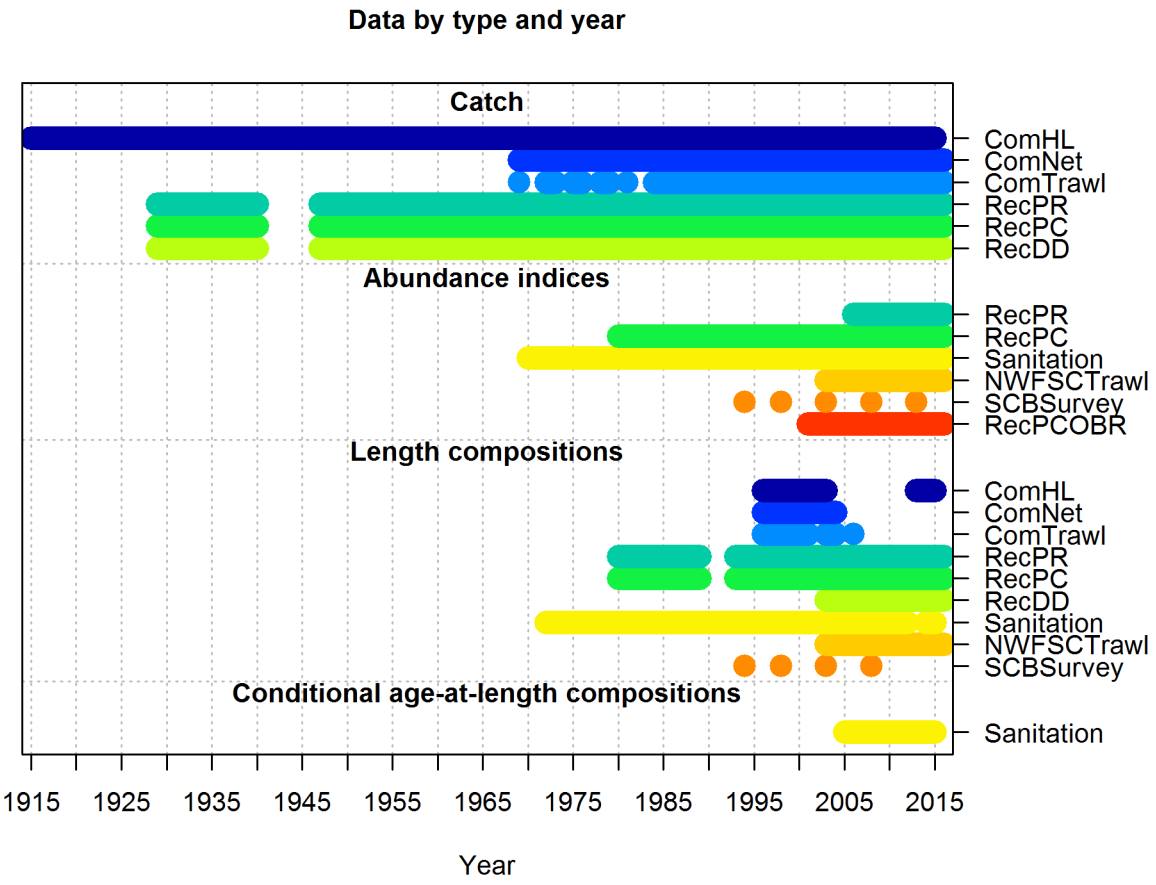

Figure 2: Summary of data sources used in the base model. `fig:data_plot`

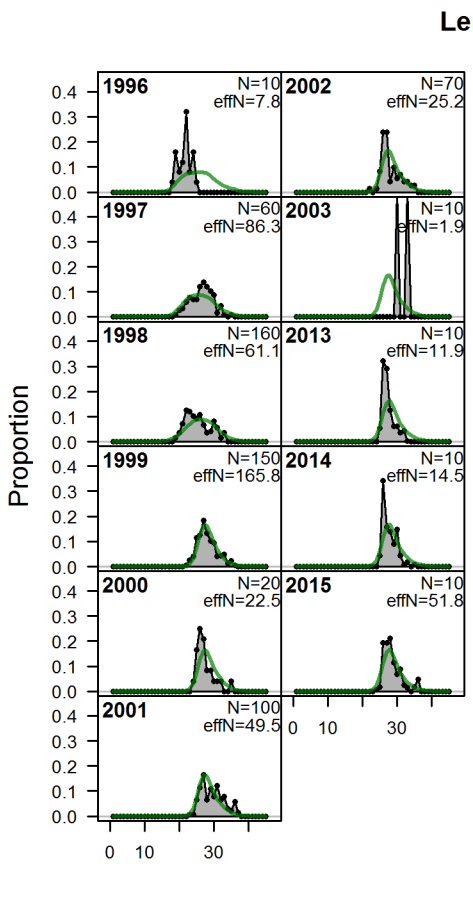

Figure 3: Length comps, retained, ComHL [fig:mod1_1_comp_lenfit_flt1mkt2

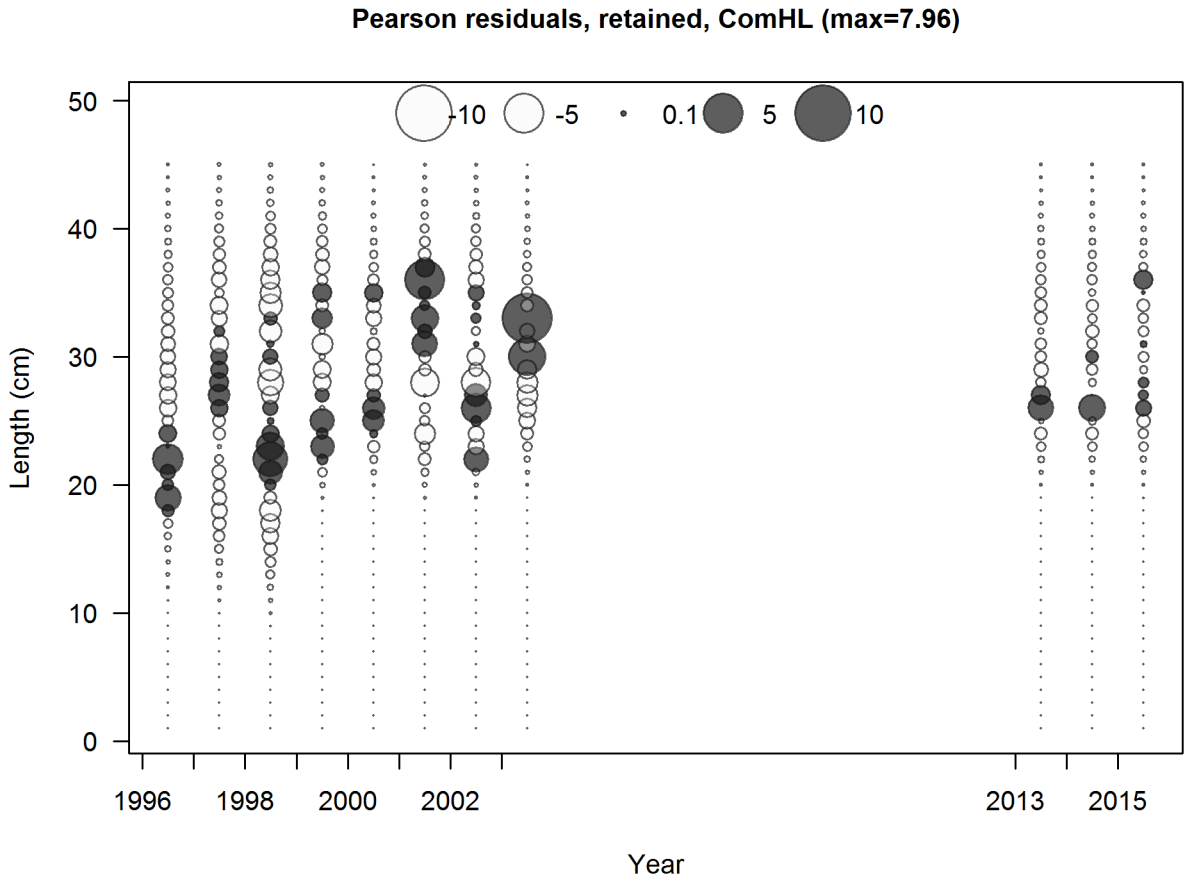

Figure 4: Pearson residuals, retained, ComHL (max=7.96)
Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected). [fig:mod1_2_comp_lenfit_residsflt1mkt2]

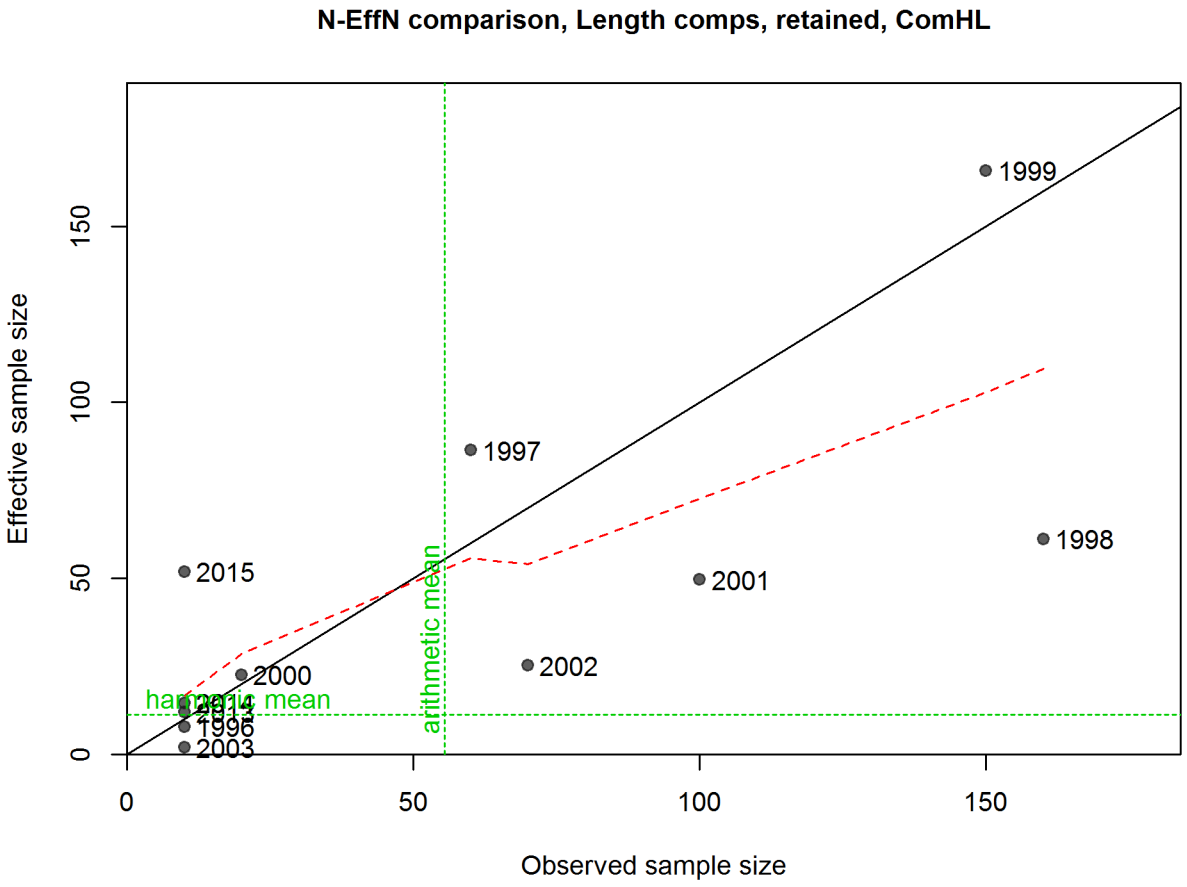

Figure 5: N_EffN comparison, Length comps, retained, ComHL [fig:mod1_3_comp_lenfit_sa

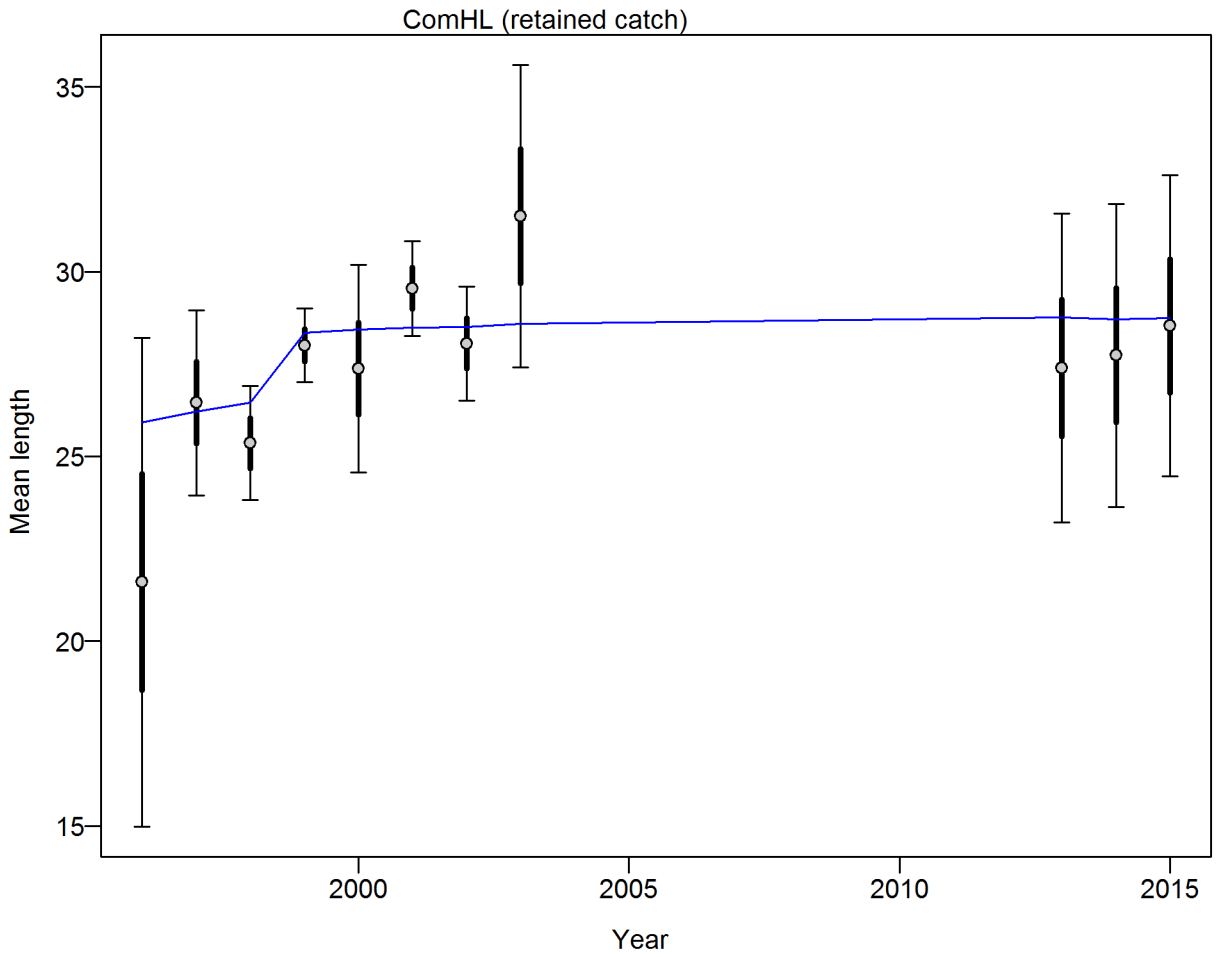

Figure 6: Francis data weighting method TA1.8: ComHL Suggested sample size adjustment (with 95% interval) for len data from ComHL: 0.197 (0.1179_1.1745) For more info, see Francis, R.I.C.C. (2011). Data weighting in statistical fisheries stock assessment models. Can. J. Fish. Aquat. Sci. 68: 1124_1138.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

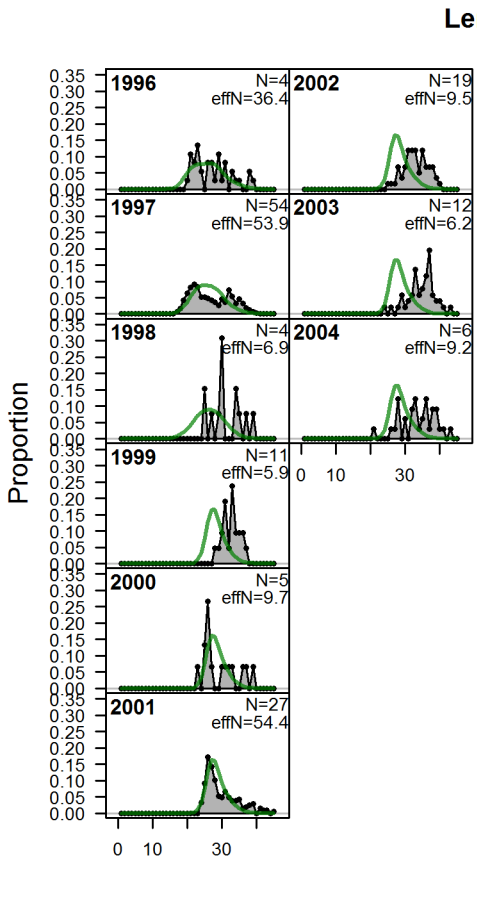

Figure 7: Length comps, retained, ComNet [fig:mod1_5_comp_lenfit_flt2mkt2

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