Agenda Item C.6
Attachment 2
September 2021

Status of lingcod (*Ophiodon elongatus*) along the southern U.S. west coast in 2021

by
Kelli F. Johnson[1]
Ian G. Taylor[1]
Brian J. Langseth[1]
Andi Stephens[2]
Laurel S. Lam[3]
Melissa H. Monk[4]
John E. Budrick[5]
Melissa A. Haltuch[1]

[1]Northwest Fisheries Science Center, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, 2725 Montlake Boulevard East, Seattle, Washington 98112
[2]Northwest Fisheries Science Center, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, 2032 Southeast OSU Drive, Newport, Oregon 97365
[3]Pacific States Marine Fisheries Commission, Northwest Fisheries Science Center, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, 2725 Montlake Boulevard East, Seattle, Washington 98112
[4]Southwest Fisheries Science Center, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, 110 McAllister Way, Santa Cruz, California 95060
[5]California Department of Fish and Wildlife, 1123 Industrial Rd., Suite 300, San Carlos, California 94070

August 2021

© Pacific Fishery Management Council, 2021

Correct citation for this publication:

Taylor, I.G., K.F. Johnson, B.J. Langseth, A. Stephens, L.S. Lam, M.H. Monk, J.E. Budrick, M.A. Haltuch. 2021. Status of lingcod (*Ophiodon elongatus*) along the southern U.S. west coast in 2021. Pacific Fishery Management Council, Portland, Oregon. xvi p.

Contents

Disclaimer **i**

Executive summary **ii**

Stock ii

Catches ii

Data and assessment iii

Stock biomass and dynamics iv

Recruitment vi

Exploitation status viii

Ecosystem considerations x

Reference points x

Management performance xii

Unresolved problems and major uncertainties xii

Decision table xiii

Scientific uncertainty xv

Regional management considerations xv

Research and data needs xv

Disclaimer

These materials do not constitute a formal publication and are for information only. They are in a pre-review, pre-decisional state and should not be formally cited (or reproduced). They are to be considered provisional and do not represent any determination or policy of NOAA or the Department of Commerce.

Executive summary

Stock

This assessment reports the status of lingcod (*Ophiodon elongatus*) off the southern U.S. west coast using data through 2020. Lingcod were modeled as two stocks and this document contains summary information about the species as a whole and detailed information for the southern stock. Stocks were split at 40°10'N based on the results of a genetic analysis. This boundary also happens to be the boundary used for the management of commercial catches. Models for lingcod do not include catches from the Alaskan, Canadian, or Mexican populations and assume that these flanking populations do not contribute to the stock being assessed here.

Catches

The first known records of lingcod landings date back to the late 1800s (Figure i). Catch reconstructions for these early landings were informed by state resources and recent landings (Table i) were available from PacFIN and RecFIN. Commercial discards were modeled using discard rates and length compositions, which facilitated the estimation of retention curves. Recreational catches included estimates of dead discards in the catch data (Table i). Discard mortality was assumed to be 50% for commercial trawl and 7% for commercial fixed-gear and recreational fleets.

The fleet structure for commercial landings included two fleets, trawl (TW) and fixed gear (FG). Trawl landings included information from bottom trawls, shrimp trawls, net gear, and dredging activities. Landings from all other gear types, mainly hook and line, were assigned to FG. This fleet structure matches the fleet structure used in the previous assessment.

Table i: Recent commercial landings and recreational catches by fleet (mt), total summed across fleets, and the total mortality including discards which were estimated internal to the model for the commercial fleets.

Year	Comm. trawl	Comm. fixed	Rec. WA	Rec. OR	Rec. CA	Total landings	Total dead
2011	6.02	20.47	0	0	186.70	213.19	215.17
2012	11.36	26.77	0	0	235.43	273.56	276.85
2013	10.93	37.07	0	0	380.67	428.67	431.79
2014	13.67	63.40	0	0	425.99	503.06	506.73
2015	25.94	88.77	0	0	596.99	711.70	717.46
2016	19.13	63.19	0	0	593.33	675.65	679.53
2017	23.18	69.95	0	0	453.05	546.18	549.83
2018	46.76	56.48	0	0	346.21	449.46	454.40
2019	76.49	43.42	0	0	269.32	389.23	396.61
2020	55.39	32.83	0	0	198.28	286.50	291.91

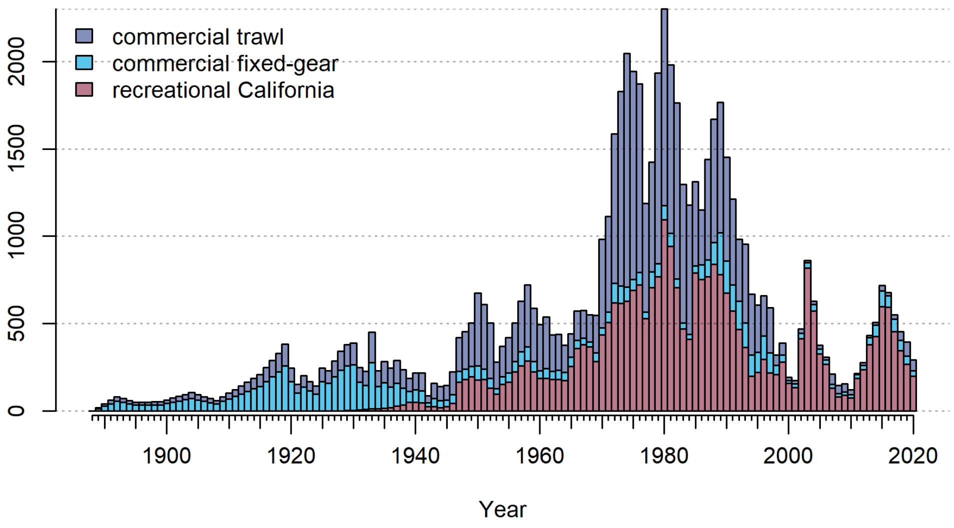

Figure i: Landings plus dead discards (mt) by fleet as input and estimated in the base model.

Data and assessment

This assessment uses the Stock Synthesis fisheries stock assessment model version 3.30.17.01. Lingcod has been modeled using various age-structured forward-projection models since the mid 1990s and was most recently assessed in 2017 (Haltuch et al. 2018). Data included in the base model provided information on landings for each commercial and recreational fleet, commercial discards, available from the West Coast Groundfish Observer Program; relative abundance as informed by the Triennial Survey, West Coast Groundfish Bottom Trawl Survey, commercial trawl fishery, and each recreational fishery; length and age compositions, available from the previous sources as well as research done by L. Lam.

For this southern stock, information on abundance, length, and age was also available from the Hook and Line Survey. The final model included ages from just the West Coast Groundfish Bottom Trawl Survey because of conflicts between age- and length-composition data.

Age data were explored using conditional-age-at-length rather than marginal ages and length data were modeled as sex-specific compositions for fish that were sexed and as combined-sex compositions for fish that were measured but not sexed. Unsexed fish that were aged were not included in the conditional age-at-length data.

Key parameters related to productivity were estimated and parameters related to growth and mortality were sex specific and time invariant. Main annual recruitment deviations started in 1972, just prior to the availability of reliable length- and age-composition data. Selectivity for each fleet was modeled using a double-normal function of length that allowed for dome or asymptotic shapes that were supported by the data. Time blocks were used for selectivity and retention to account for management changes.

A wide range of sensitivity runs were conducted to explore various model structures related to biology and recruitment, changes to the data that were included in the model, ways in which selectivity was parameterized, etc. Results were sensitive to the addition and subtraction of age data, which typically changed the scale of the population and estimates of key productivity parameters.

Stock biomass and dynamics

The stock biomass is currently trending upwards, though the rate of the increase is highly uncertain (Table ii; Figure ii). Uncertainty in the initial stock size is vast and this uncertainty is carried forward until approximately the early 1980s when more informative data are available. The current estimated biomass is below, but close to, the management target with the uncertainty in this estimate spanning well above and below the management target and the minimum stock size threshold (Figure iii).

Table ii: Estimated recent trend in spawning biomass and the fraction unfished and the 95 percent intervals.

Year	Spawning biomass (mt)	Lower interval	Upper interval	Fraction unfished	Lower interval	Upper interval
2011	5362	1468	9256	0.203	0.053	0.353
2012	5847	1807	9886	0.221	0.055	0.387
2013	6516	2242	10790	0.246	0.057	0.435
2014	7247	2648	11846	0.274	0.060	0.489
2015	7951	2971	12932	0.301	0.062	0.540
2016	8554	3143	13966	0.323	0.062	0.585
2017	9159	3286	15032	0.346	0.063	0.630
2018	9639	3337	15940	0.364	0.067	0.662
2019	9968	3296	16640	0.377	0.071	0.683
2020	10208	3215	17200	0.386	0.076	0.696
2021	10415	3145	17685	0.394	0.082	0.706

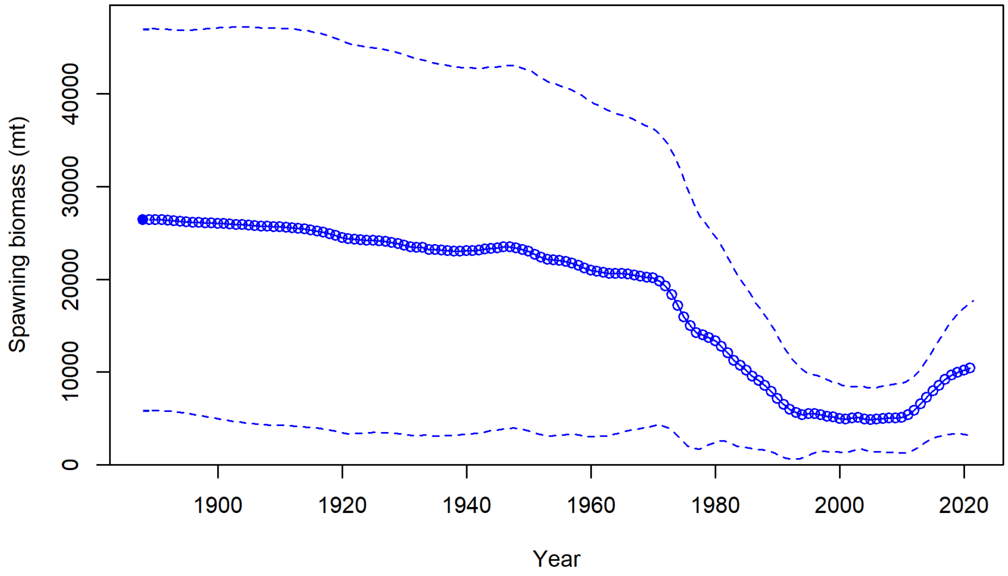

Figure ii: Estimated time series of spawning output (circles and line are maximum likelihood estimates; light broken lines are 95% intervals) for the base model.

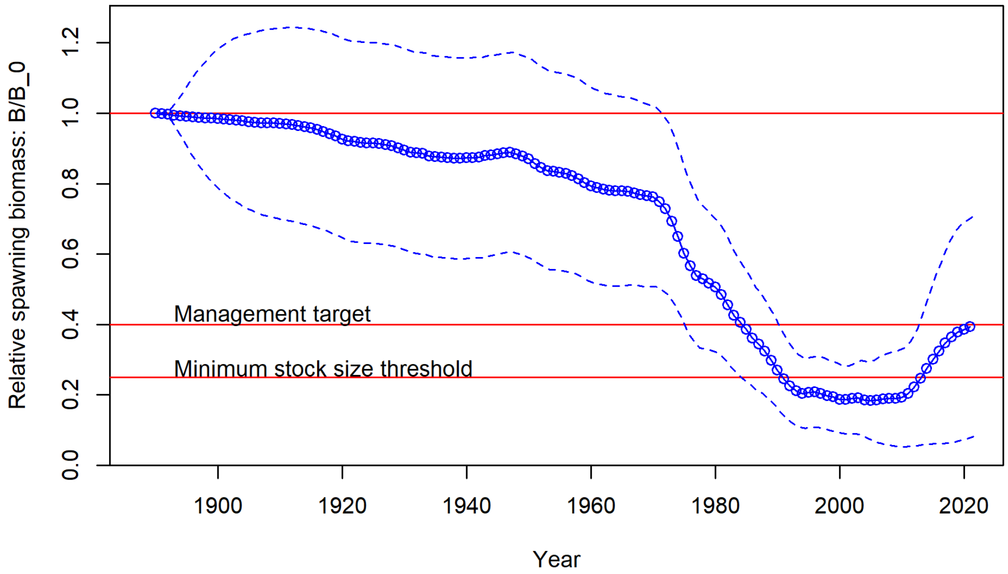

Figure iii: Estimated time series of fraction of unfished spawning output (circles and line are maximum likelihood estimates; light broken lines are 95% intervals) for the base model.

Recruitment

Lingcod appear to have moderate variability in estimates of recruitment with recruitment variability (σ_R) fixed at 0.6 (Figures iv and v). Given the pandemic and the lack of recent survey information, there was little information in the data to estimate recruitment in 2019. Thus, 2019 and 2020 were not included in the main recruitment deviations and are instead termed late recruitment deviations that are not constrained to sum to zero (Table iii). If the survey in 2019 would have been conducted, then 2019 recruitment perhaps would have been less uncertain. Lingcod are not seen as age-0 fish in any data set in appreciable quantities, and thus, the terminal year of recruitment is never estimated. The last large recruitment event for this stock occurred in 2013 and a smaller event may have also occurred within the last half-decade though its magnitude is more uncertain.

Table iii: Estimated recent trend in recruitment and recruitment deviations and the 95 percent intervals.

Year	Recruitment	Lower interval	Upper interval	Recruitment deviations	Lower interval	Upper interval
2011	1509	772	2948	0.439	0.157	0.721
2012	1657	850	3231	0.480	0.207	0.753
2013	2622	1341	5126	0.875	0.645	1.105
2014	1134	560	2296	-0.022	-0.313	0.269
2015	943	460	1929	-0.257	-0.573	0.059
2016	1028	498	2120	-0.208	-0.553	0.137
2017	1370	657	2854	0.045	-0.338	0.428
2018	755	334	1707	-0.588	-1.136	-0.039
2019	820	308	2186	-0.590	-1.390	0.211
2020	1603	474	5424	0.000	-1.176	1.176
2021	1630	484	5490	0.000	-1.176	1.176

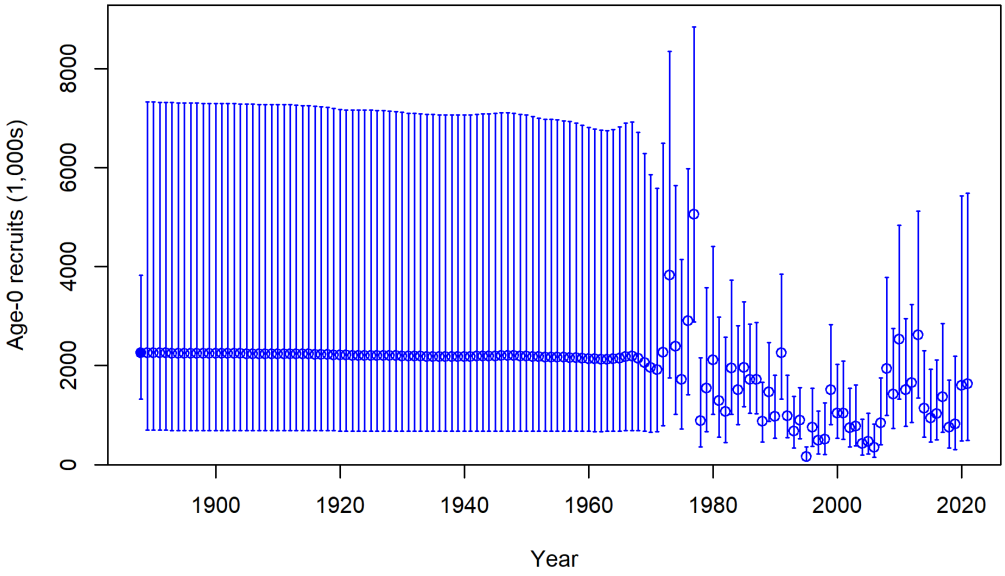

Figure iv: Estimated time series of age-0 recruits (1000s) for the base model with 95 percent intervals.

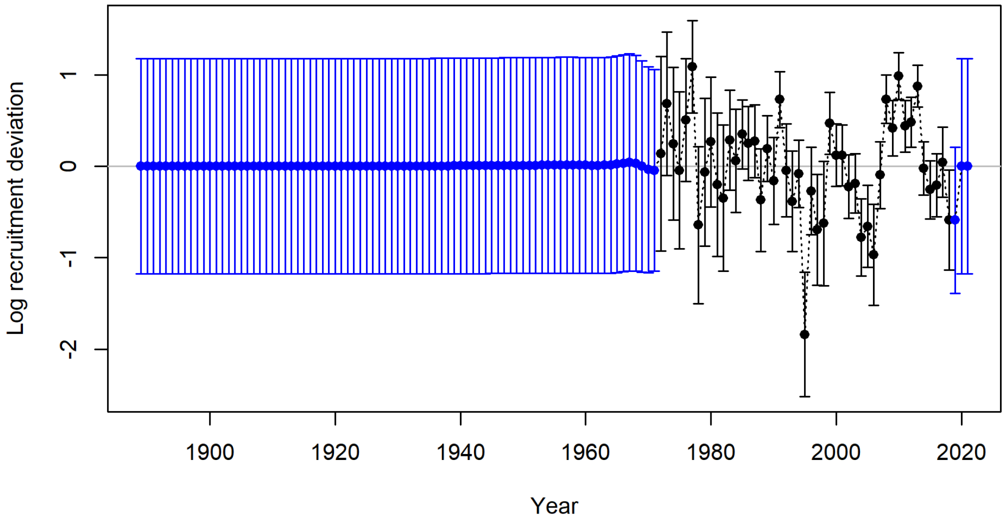

Figure v: Estimated time series of recruitment deviations.

Exploitation status

The stock was estimated to have been harvested above the target proxy harvest rate from the 1970s to approximately the late 1990s and again in the early 2000s (Figure vi). The relative fishing intensity is estimated to have peaked in 1989 at a value of (1 - SPR)/(1-SPR45%) = 1.52. Recent estimates of harvest have all been below the target proxy harvest rate and the estimate of fishing intensity for the terminal year was the lowest estimated since 2011 (Table iv).

Table iv: Estimated recent trend in relative fishing intensity and exploitation rate with associated 95% intervals. Fishing intensity is (1-SPR)/(1-SPR45%), where SPR is the spawning potential and SPR45% = 0.45 is the SPR target. Exploitation rate is annual total dead catch divided by age 3+ biomass.

Year	Relative fishing intensity	Lower interval	Upper interval	Exploitation rate	Lower interval	Upper interval
2011	0.457	0.225	0.688	0.030	0.012	0.048
2012	0.462	0.235	0.689	0.035	0.014	0.055
2013	0.552	0.296	0.807	0.046	0.021	0.072
2014	0.554	0.298	0.809	0.050	0.022	0.077
2015	0.691	0.389	0.994	0.065	0.029	0.101
2016	0.630	0.339	0.921	0.056	0.025	0.087
2017	0.515	0.262	0.769	0.044	0.019	0.069
2018	0.456	0.224	0.687	0.036	0.015	0.057
2019	0.435	0.210	0.660	0.031	0.012	0.049
2020	0.350	0.163	0.537	0.022	0.009	0.036

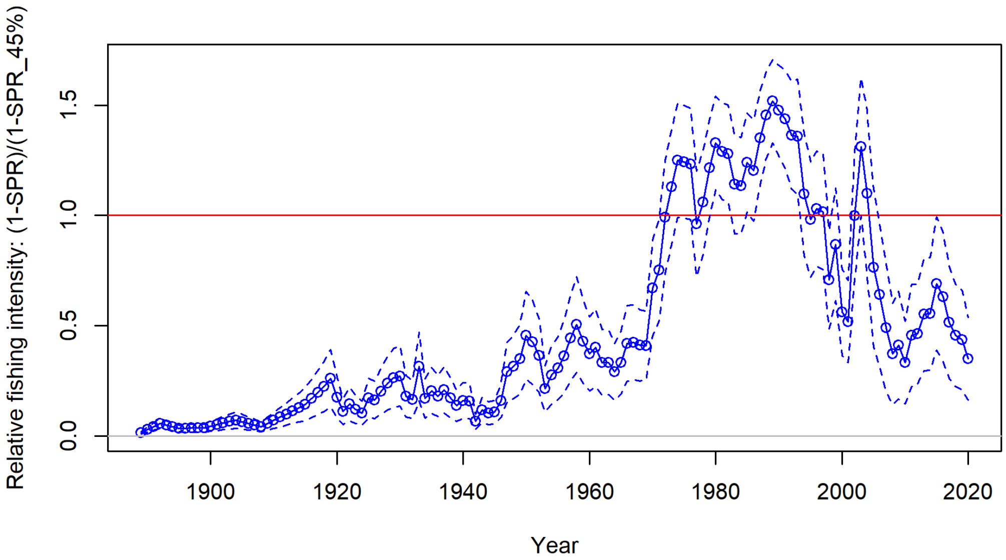

Figure vi: Estimated relative fishing intensity = (1-SPR)/(1-SPR45%) with 95% intervals, where SPR is the spawning potential and SPR45% = 0.45 is the SPR target. The red horizontal line at 1.0 indicates fishing intensity equal to the target and values above this reflect harvest in excess of the proxy harvest rate.

Ecosystem considerations

Ecosystem considerations were not explicitly included in this analysis. However, habitat variables were included in some of the models used to standardize commercial and recreational catch per unit effort (CPUE) data prior to including that information as an index in the stock assessment model. Future work could expand upon that done by Bassett et al. (2018), which found that ontogenetic habitat shifts could be an age restriction on the lingcod able to benefit from the placement of Rockfish Conservation Areas (RCAs) and Marine Protected Areas (MPAs).

Given the predatory nature of lingcod, they more than likely influence the natural mortality of rockfish species that are highly targeted by recreational fishers (e.g., Beaudreau and Essington 2007). When diet data are collected at a sufficient spatial resolution to inform predatory relationships, the estimated abundance of lingcod could be used to inform estimates of time-varying natural mortality for these longer-lived rockfish species.

Reference points

The 2021 spawning biomass relative to unfished equilibrium biomass (fraction unfished) was estimated to be close to the management target at 0.3939 (Table vi; Figures vii and viii). The uncertainty in this estimate spans above and well below the target, suggesting the current status of the stock is uncertain (Figure vii).

Table v: Summary of reference points and management quantities, including estimates of the 95 percent intervals.

Reference point	Estimate	Lower interval	Upper interval
Unfished Spawning Biomass (mt)	26443.6	9955.9126	42931.2874
Unfished Age 3+ Biomass (mt)	32617.3	10983.4135	54251.1865
Unfished Recruitment (R0)	2253.21	1036.5996	3469.8204
Spawning Biomass (mt) (2021)	10415	3145.2388	17684.7612
Fraction Unfished (2021)	0.3939	0.0818	0.7059
Reference Points Based SB40%	-	-	-
Proxy Spawning Biomass (mt) SB40%	10577.4	3982.3172	17172.4828
SPR Resulting in SB40%	0.549	0.4448	0.6532
Exploitation Rate Resulting in SB40%	0.0616	0.0209	0.1022
Yield with SPR Based On SB40% (mt)	832.098	675.5033	988.6927
Reference Points Based on SPR Proxy for MSY	-	-	-
Proxy Spawning Biomass (mt) (SPR45)	7093.73	2578.6982	11608.7618
SPR45	0.45	NA	NA
Exploitation Rate Corresponding to SPR45	0.0874	0.0401	0.1348
Yield with SPR45 at SB SPR (mt)	810.758	528.925	1092.591
Reference Points Based on Estimated MSY Values	-	-	-
Spawning Biomass (mt) at MSY (SB MSY)	9353.58	2160.9042	16546.2558
SPR MSY	0.5142	0.3449	0.6836
Exploitation Rate Corresponding to SPR MSY	0.0697	0.0126	0.1269
MSY (mt)	839.056	671.5202	1006.5918

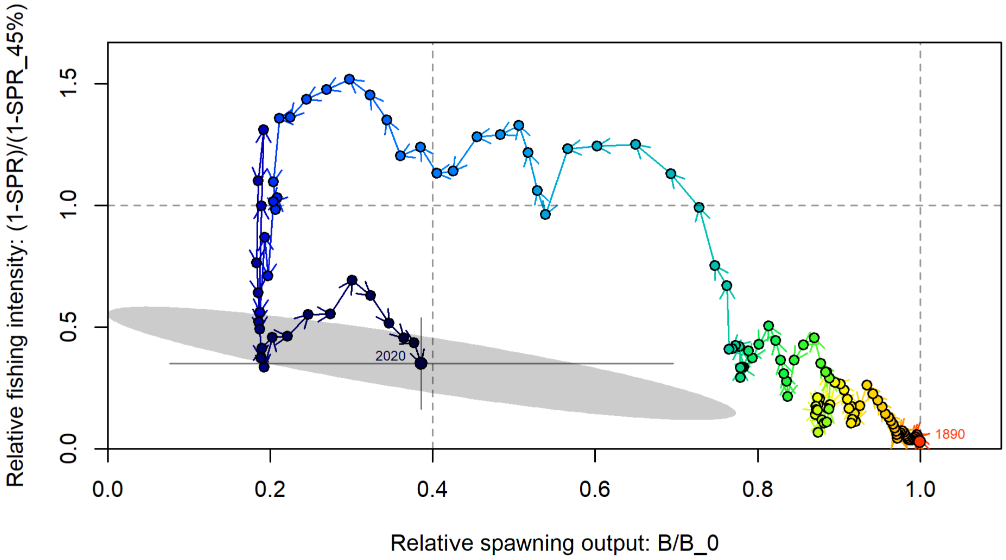

Figure vii: Phase plot of biomass ratio vs. spawning potential ratio (SPR) ratio. Each point represents the biomass ratio at the start of the year and the relative fishing intensity in that same year. Lines through the final point show 95% intervals based on the asymptotic uncertainty for each dimension. The shaded ellipse is a 95% region which accounts for the estimated correlation between the two quantities.

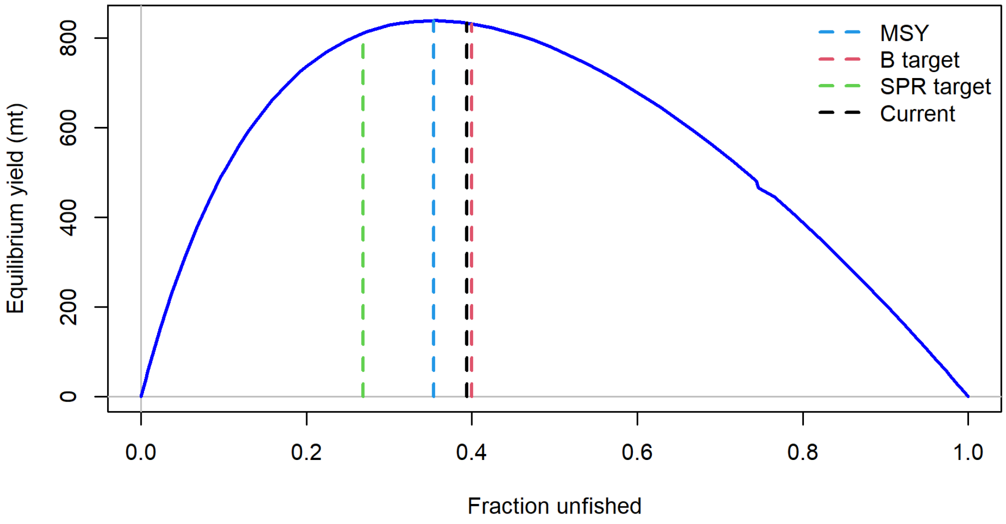

Figure viii: Equilibrium yield curve for the base case model. Values are based on the 2020 fishery selectivities.

Management performance

In the last ten years, the annual catch limit has been below the overfishing limit and acceptable biological catch (Table vi). Furthermore, landings and total dead catches (including estimated dead discards) have been well below the annual catch limit.

Table vi: Recent trend in the overfishing limits (OFL), the acceptable biological catches (ABCs), the annual catch limits (ACLs), the total landings, and total mortality (mt).

Year	OFL	ABC	ACL	Landings	Total mortality
2011	2523	2102	2102	213	215
2012	2597	2164	2164	274	277
2013	1334	1111	1111	429	432
2014	1276	1063	1063	503	507
2015	1205	1004	1004	712	717
2016	1136	946	946	676	680
2017	1502	1251	1251	546	550
2018	1373	1144	1144	449	454
2019	1143	1093	1039	389	397
2020	977	934	869	286	292

Unresolved problems and major uncertainties

The base-model configuration was developed with the goal of balancing parsimony with realism and fitting the data. To achieve parsimony, some simplification of the model structure was assumed relative to known processes, which may impact the interpretation and fit to specific data sets. For example, a clear break between the northern and southern stock at Cape Mendocino is unrealistic but we do not currently have the resources necessary to add spatial dynamics to the stock assessment or estimate the level of overlap between the stocks.

Patterns of sex-specific selectivity were apparent in the data, particularly for the fishing fleets. Unfortunately, we were unable to configure the model in such a way that the model fit all data sources equally as well as the base-model configuration when attempting to account for these patterns.

Uncertainty in parameter estimates are quite large relative to recent assessments because of the choice to estimate both natural mortality and steepness. Recent work has shown the utility of estimating both parameters with respect to management reference points, and although estimates provided in this document are imprecise, we predict that they are less biased than if the model would have been configured with one or more of these parameters as fixed inputs rather than estimated. Estimating both parameters led to counter-intuitive differences in estimates of natural mortality between the southern and northern areas. Hopefully, future work on parameterizing selectivity will lead to more precise estimates of male and female natural mortality given the life history of this species, specifically the nest-guarding behavior of males.

Decision table

The forecast of stock abundance and yield was developed using the base model (Table vii). The total catches for the first two years of the forecast period were based on values provided by the Groundfish Management Team. These assumed removals are likely higher than what the true removals will be for this year and next year but their influence on the assessment of stock status and future removals are limited.

The projections, including the first two years, also assume a 40:60 split between the trawl and fixed-gear commercial fleets based on guidance from the Groundfish Management Team.

The axes of uncertainty in the decision table (Table viii) are based on the uncertainty in female natural mortality of the base model. Three alternative catch streams were created for the decision table (Table viii). The first option uses recent average catch as provided by the Groundfish Management Team, the second option uses a P^* of 0.40, and the third option uses a P^* of 0.45. These P^* values are combined with the category 2 default $\sigma = 1.0$ in calculating the buffer between OFL and ABC.

Table vii: Projections of potential overfishing limits (OFLs; mt), allowable biological catches (ABCs; mt), annual catch limits (ACLs; mt), estimated summary biomass (mt), spawning biomass (mt), and fraction unfished. Values are based on removals for the first two years. ABCs include a buffer for scientific uncertainty based on a Pstar of 0.45 and the category 2 default sigma = 1.0. ACLs additionally include the 40:10 adjustment for projections which fall below the B40 reference point.

Year	Assumed Removal (mt)	Predicted OFL (mt)	ABC Catch (mt)	ACL Catch (mt)	Age 3+ Biomass (mt)	Spawning Biomass (mt)	Fraction Unfished
2021	1,024.97	-	-	-	13,145.00	10,415.00	0.39
2022	907.85	-	-	-	12,602.00	10,224.30	0.39
2023	-	845.56	739.02	725.57	12,407.40	9,994.59	0.38
2024	-	855.31	739.84	722.34	12,315.20	9,831.95	0.37
2025	-	896.54	768.33	748.30	12,312.70	9,760.15	0.37
2026	-	936.59	795.16	773.36	12,330.50	9,720.59	0.37
2027	-	965.62	812.09	788.97	12,344.40	9,690.31	0.37
2028	-	984.37	819.98	795.95	12,354.40	9,666.70	0.37
2029	-	996.22	822.88	798.29	12,363.50	9,650.48	0.36
2030	-	1,003.92	821.21	796.47	12,375.70	9,643.62	0.36
2031	-	1,009.40	817.61	793.07	12,393.40	9,646.52	0.36
2032	-	1,013.68	813.99	789.92	12,418.50	9,659.43	0.37

Table viii: Decision table summary of 10-year projections based on recent average catch for the first two years of the projection, alternative states of nature (columns), and management assumptions (asm.; rows) based on recent average catch and annual catch limits (ACLs) defined using an estimate of uncertainty (i.e., P^*) of 0.40 and 0.45. Catch and resulting fraction unfished are colored relatively with lighter colors representing lower values.

			Low M (M = 0.11)		Base (M ~ 0.17)		High M (M = 0.22)	
Asm.	Year	Catch	SSB (mt)	Frac. unfished	SSB (mt)	Frac. unfished	SSB (mt)	Frac. unfished
Recent avg. catch	2021	700	15066	0.296	10415	0.394	6475	0.419
	2022	700	15200	0.299	10224	0.387	6138	0.397
	2023	700	15221	0.299	9995	0.378	5849	0.378
	2024	700	15234	0.299	9858	0.373	5722	0.370
	2025	700	15252	0.300	9810	0.371	5715	0.369
	2026	700	15263	0.300	9813	0.371	5762	0.372
	2027	700	15265	0.300	9846	0.372	5831	0.377
	2028	700	15262	0.300	9901	0.374	5908	0.382
	2029	700	15256	0.300	9972	0.377	5991	0.387
	2030	700	15257	0.300	10057	0.380	6075	0.393
	2031	700	15264	0.300	10152	0.384	6162	0.398
	2032	700	15284	0.300	10254	0.388	6249	0.404
ACL P^*=0.40	2021	700	15066	0.296	10415	0.394	6475	0.419
	2022	700	15200	0.299	10224	0.387	6138	0.397
	2023	633	15221	0.299	9995	0.378	5849	0.378
	2024	634	15277	0.300	9897	0.374	5758	0.372
	2025	658	15347	0.302	9892	0.374	5787	0.374
	2026	681	15398	0.303	9924	0.375	5856	0.379
	2027	696	15424	0.303	9969	0.377	5929	0.383
	2028	702	15432	0.303	10024	0.379	6001	0.388
	2029	703	15429	0.303	10089	0.382	6074	0.393
	2030	700	15427	0.303	10164	0.384	6149	0.397
	2031	696	15431	0.303	10250	0.388	6228	0.403
	2032	692	15448	0.304	10346	0.391	6310	0.408
ACL P^*=0.45	2021	700	15066	0.296	10415	0.394	6475	0.419
	2022	700	15200	0.299	10224	0.387	6138	0.397
	2023	726	15221	0.299	9995	0.378	5849	0.378
	2024	722	15205	0.299	9832	0.372	5699	0.368
	2025	748	15194	0.299	9760	0.369	5672	0.367
	2026	773	15154	0.298	9721	0.368	5684	0.367
	2027	789	15076	0.296	9690	0.366	5701	0.369
	2028	796	14972	0.294	9667	0.366	5717	0.370
	2029	798	14848	0.292	9650	0.365	5733	0.371
	2030	796	14718	0.289	9644	0.365	5752	0.372
	2031	793	14586	0.287	9647	0.365	5775	0.373
	2032	790	14462	0.284	9659	0.365	5801	0.375

Scientific uncertainty

The model estimated uncertainty around the 2021 spawning biomass was $\sigma = 0.35$ and the uncertainty around the OFL was $\sigma = 0.03$.

This is likely an underestimate of overall uncertainty because there is no explicit incorporation of model structural uncertainty. The category 2 default $\sigma = 1.0$ is used to apply scientific uncertainty in the projections.

Regional management considerations

Commercial quotas for lingcod are set separately for the areas north and south of 40°10'N. This management boundary, which is based on the boundary between International North Pacific Fishery Commission (INPFC) areas, happens to align with the stock boundary used for this assessment.

Recreational quotas for lingcod are set separately for each state, which aligns with the fleet structure used in this model. The catch associated with the California recreational fleet was split at 40°10'N based on location of landing, and thus, at least some California recreational catches are assigned to each stock. Projections for this fleet should be a combination of those given in this report as well as those reported in the output for the north model.

The average proportions of the total dead catch, including estimated dead discards, associated with each fleet over the period 2011-2020 are:

- commercial trawl: 0.071,
- commercial fixed-gear: 0.114, and
- recreational California: 0.815.

However, for purposes of the projections, the split between commercial trawl and fixed-gear in the south was assumed to be 40:60, based on input from the Groundfish Management Team (GMT), leading to the following proportions among fleets:

- commercial trawl: 0.074,
- commercial fixed-gear: 0.111, and
- recreational California: 0.815.

Estimation of finer-scale differences in lingcod abundance or status within California, such as north and south of Point Conception (34°27'N), was not possible within this assessment. However, the state of California could apply finer-scale spatial management to account for any regional management considerations indicated by other sources of information about the lingcod in those waters.

Research and data needs

Investigating and or addressing the following items could improve future assessments of lingcod:

- Sex-specific selectivity is likely given the life history of lingcod, but knowledge of the fine-scale spatial distribution of ages and sexes relative to the distribution of fishing effort and survey sampling locations is lacking to inform these patterns. Some relationships may be dome-shaped while others may be asympototic and these relationships could depend on whether the process is governed by length or age. Care should be taken during explorations of selectivity to ensure that the model does not become overparameterized given that selectivity and mortality are correlated.
- Some data sources that were provided by state representatives were not fully explored, e.g., information from video landers and remote operated vehicles (ROVs). Currently, there is not a method to include multiple indices for a given fishery, and thus, the best-case scenario would be to provide comparisons of model results given fits to these alternative data sources rather than those that were used to fit the model. Additional work would be needed to formulate a method to combine them or allow for the inclusion of multiple CPUE indices for a given fleet.
- It is likely that natural mortality is not constant across age as it was parameterized. Exploration of the Lorenzen natural mortality function prior to the review of this assessment suggested that information on natural mortality at age was lacking for the southern stock. Additional approaches are available to model age-specific natural mortality that could also be explored.
- Data-weighting approaches that separate tuning of sample sizes for discarded and retained fish from the same fleet should be explored such that data on discard rates and mean body weight can be weighted appropriately. These changes will hopefully bring the estimates of total mortality for years with high discard rates closer to the values reported in the Groundfish Expanded Mortality Multi-Year (GEMM) data product based on data collected by West Coast Groundfish Observer Program (WCGOP).
- Conflicts were present in the information provided by the age and length data.

Bassett, M., Lindholm, J., Garza, C., Kvitek, R., and Wilson-Vandenberg, D. 2018. Lingcod (*Ophiodon elongatus*) habitat associations in California: Implications for conservation and management. Environmental biology of fishes 101(1): 203–213.

Beaudreau, A.H., and Essington, T.E. 2007. Spatial, temporal, and ontogenetic patterns of predation on rockfishes by lingcod. Transactions of the American Fisheries Society 136(5): 1438–1452.

Haltuch, M.A., Wallace, J., Akselrud, C.A., Nowlis, J., Barnett, L.A.K., Valero, J.L., Tsou, T., and Lam, L. 2018. 2017 lingcod stock assessment. Pacific Fishery Management Council, 7700 Ambassador Place NE, Suite 200, Portland, OR 97220.