Status of the Yellowtail rockfish stock off the U.S. West Coast north of 40°10′ in 2025

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Table of contents

List of Figures

List of Tables


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0.1 Executive Summary

0.1.1 Stock

0.1.2 Catches

Table 1: Recent catches (mt) by fleet and total catch (mt) summed across fleets for the model area.

Year	Commercial (mt)	At-Sea-Hake (mt)	Recreational (mt)	PLACEHOLDER (mt)	Total Catch (mt)
2015	1844.84	86.39	49.00	0	1980.23
2016	1410.12	62.32	44.59	0	1517.04
2017	2712.98	278.14	61.92	0	3053.04
2018	3210.10	229.87	74.86	0	3514.83
2019	3295.03	316.90	80.22	0	3692.15
2020	3410.77	166.85	99.10	0	3676.72
2021	2760.88	82.36	90.90	0	2934.14
2022	2968.01	27.43	121.78	0	3117.22
2023	2917.57	267.57	174.88	0	3360.02
2024	2663.91	14.53	123.16	0	2801.60

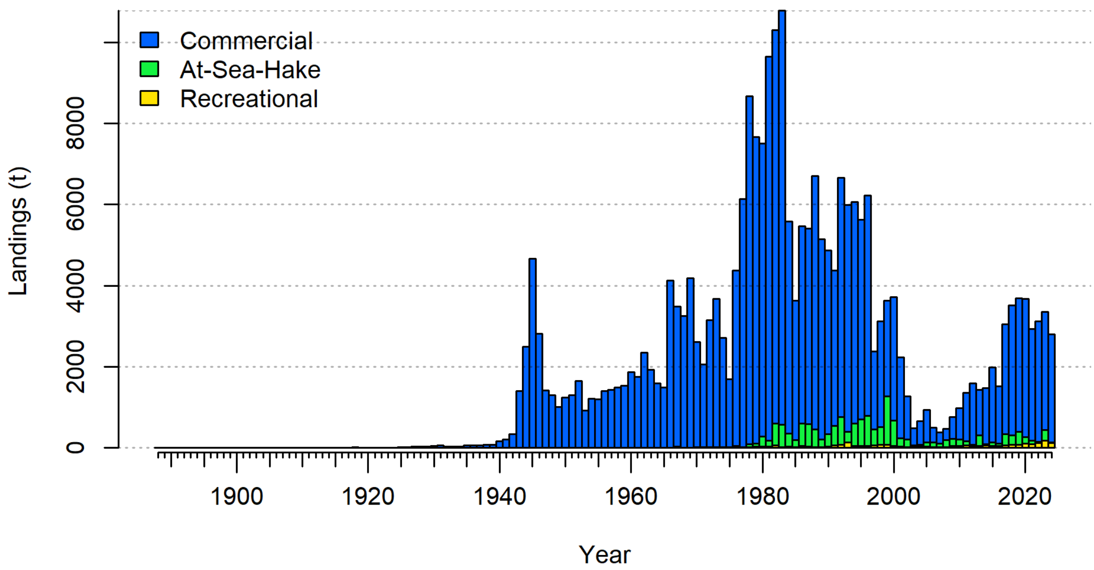

Figure 1: Landings by fleet used in the base model where catches in metric tons by fleet are stacked

0.1.3 Data and assessment

0.1.4 Stock biomass and dynamics

Table 2: Estimated recent trend in spawning output (trillions of eggs) and the fraction unfished and the 95 percent intervals for the model area.

Year	Spawning output (trillions of eggs)	Lower Interval	Upper Interval	Fraction Unfished	Lower Interval	Upper Interval
2015	10.67	7.44	13.91	0.71	0.54	0.88
2016	10.74	7.49	13.99	0.71	0.54	0.88
2017	10.97	7.68	14.27	0.73	0.56	0.89
2018	11.04	7.68	14.41	0.73	0.56	0.90
2019	11.07	7.62	14.51	0.73	0.56	0.90
2020	11.02	7.50	14.54	0.73	0.56	0.90
2021	10.93	7.35	14.51	0.72	0.55	0.90
2022	10.89	7.27	14.50	0.72	0.55	0.90
2023	10.76	7.12	14.40	0.71	0.54	0.89
2024	10.51	6.87	14.15	0.70	0.52	0.87
2025	10.27	6.65	13.89	0.68	0.51	0.85

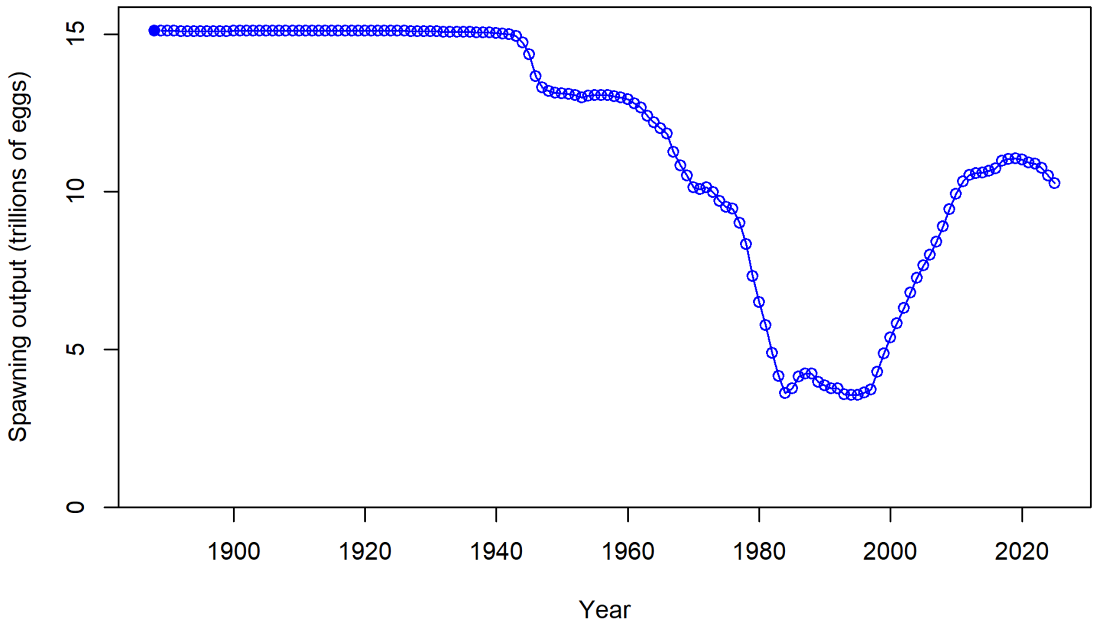

Figure 2: Estimated time series of spawning output for the base model

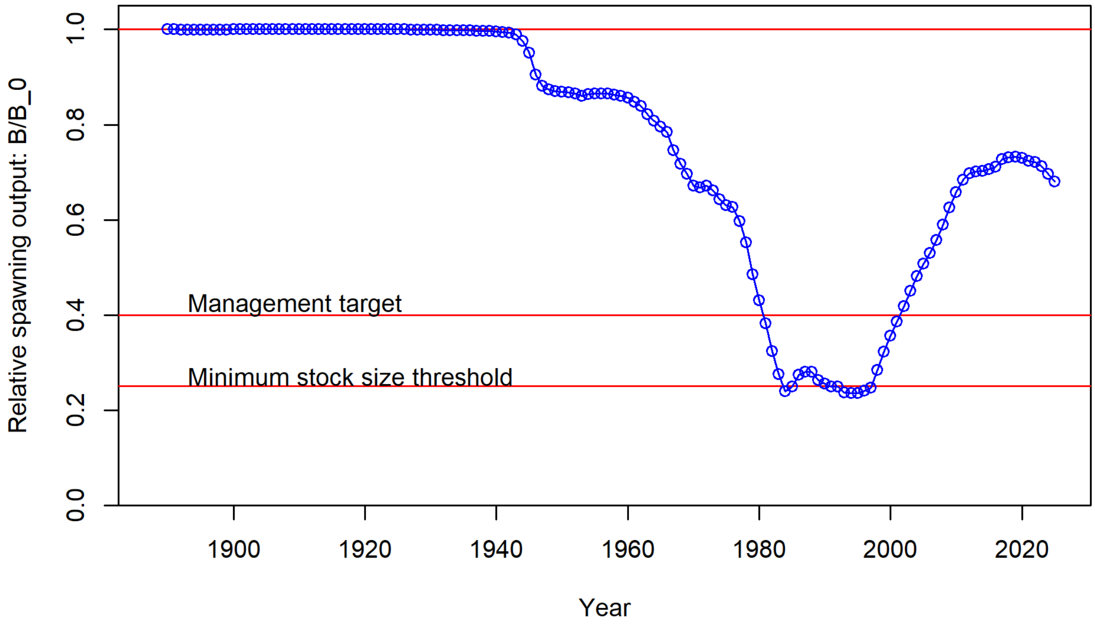

Figure 3: Estimated time series of fraction of unfished spawning output for the base model

0.1.5 Recruitment

Table 3: Estimated recent trend in recruitment (1,000s) and recruitment deviations and the 95 percent intervals for the model area.

Year	Recruitment (1,000s)	Lower Interval	Upper Interval	Recruitment Deviations	Lower Interval	Upper Interval
2015	24620.3	12409.03	48848.25	-0.22	-0.75	0.32
2016	25269.7	12948.93	49313.56	-0.19	-0.70	0.32
2017	16355.8	7873.69	33975.45	-0.64	-1.24	-0.04
2018	14272.3	6763.40	30117.78	-0.79	-1.42	-0.17
2019	17825.7	8275.36	38397.80	-0.59	-1.26	0.08
2020	22391.3	9531.89	52599.27	-0.38	-1.17	0.41
2021	29880.7	11410.55	78248.33	-0.11	-1.05	0.82
2022	33758.7	12473.12	91368.48	0.00	-0.98	0.98
2023	33718.7	12454.87	91285.63	0.00	-0.98	0.98
2024	33617.6	12414.68	91032.83	0.00	-0.98	0.98
2025	33514.6	12375.79	90760.14	0.00	-0.98	0.98

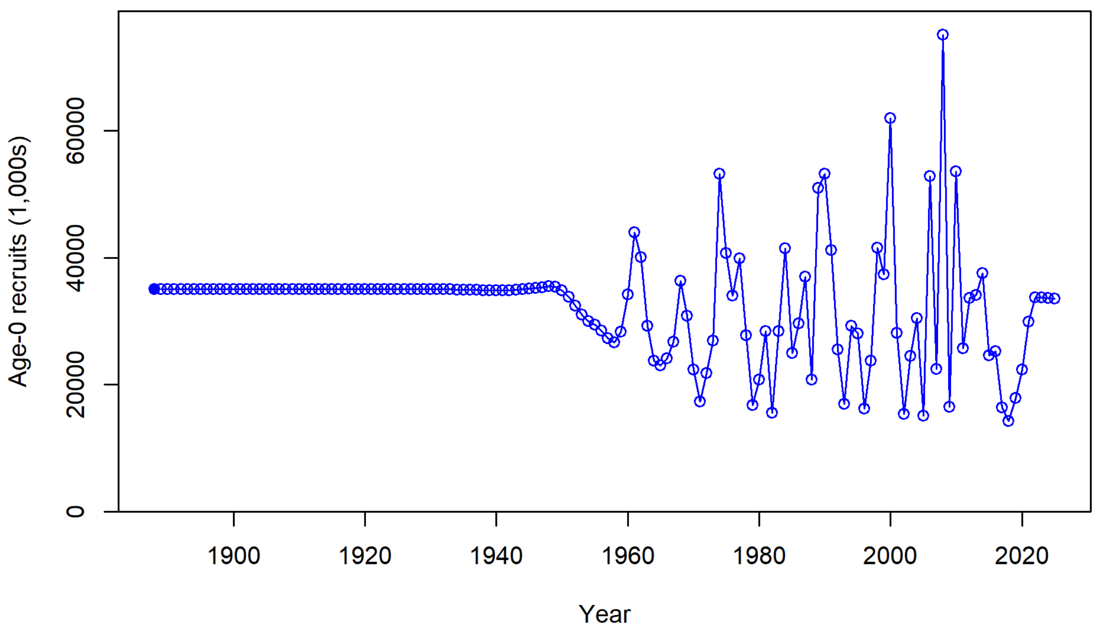

Figure 4: Estimated time series of age-0 recruits (1000s) for the base model

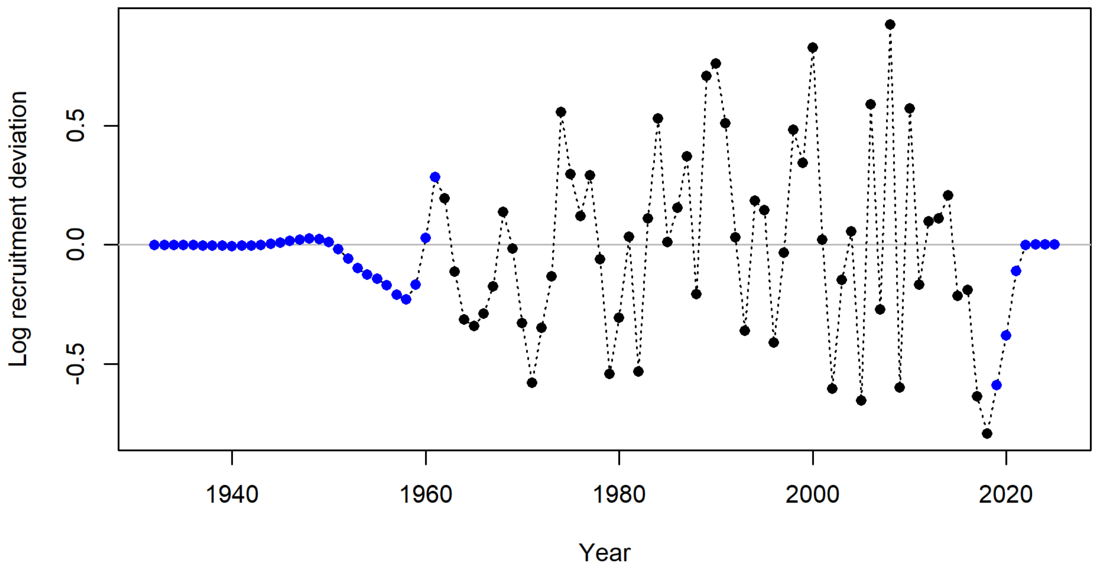

Figure 5: Estimated time series of recruitment deviations for the base model

0.1.6 Exploitation status

Table 4: Estimated recent trend in the (1-SPR)/(1-SPR 50%) where SPR is the spawning potential ratio, the exploitation rate, and the 95 percent intervals for the model area.

Year	(1-SPR)/(1-SPR 50\%)	Lower Interval	Upper Interval	Exploitation Rate	Lower Interval	Upper Interval
2015	0.46	0.31	0.60	0.02	0.01	0.02
2016	0.36	0.24	0.48	0.01	0.01	0.02
2017	0.62	0.44	0.80	0.03	0.02	0.03
2018	0.68	0.49	0.87	0.03	0.02	0.04
2019	0.71	0.51	0.91	0.03	0.02	0.04
2020	0.71	0.50	0.91	0.03	0.02	0.04
2021	0.60	0.42	0.79	0.03	0.02	0.04
2022	0.63	0.44	0.83	0.03	0.02	0.04
2023	0.69	0.48	0.89	0.03	0.02	0.05
2024	0.61	0.42	0.80	0.03	0.02	0.04

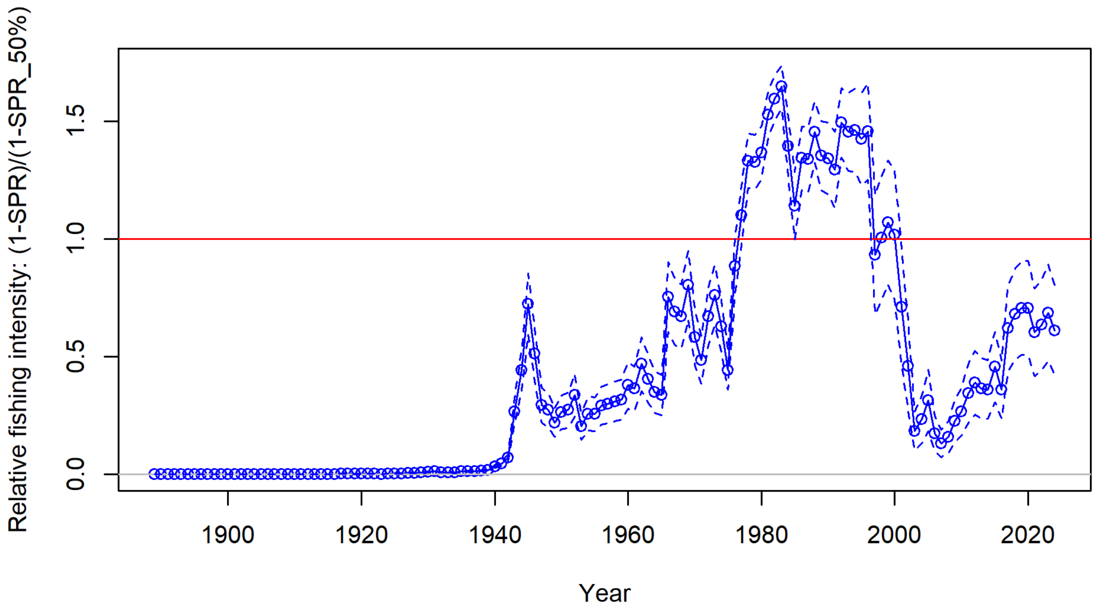

Figure 6: Estimated time series of the fishing intensity (1 - SPR), where SPR is the spawning potential ratio, with approximate 95% asymptotic intervals. The horizontal line at 0.6 corresponds to SPR = 0.4, the management reference point for yellowtail rockfish. The horizontal line at 1.0 corresponds to SPR = 0 (all spawning fish removed from the population).

0.1.7 Ecosystem considerations

0.1.8 Reference points

Table 5: Summary of reference points and management quantities, including estimates of the 95 percent intervals for the model area.

Reference Points	Estimate	Lower Interval	Upper Interval
Unfished Spawning output (trillions of eggs)	15.10	13.01	17.19
Unfished Age 4+ Biomass (mt)	134833.00	112503.13	157162.87
Unfished Recruitment (R0)	35014.50	21427.32	48601.68
2025 Spawning output (trillions of eggs)	10.27	6.65	13.89
2025 Fraction Unfished	0.68	0.51	0.85
Reference Points Based SO40\%	NA	NA	NA
Proxy Spawning output (trillions of eggs) SO40\%	6.04	5.20	6.88
SPR Resulting in SO40\%	0.46	0.46	0.46
Exploitation Rate Resulting in SO40\%	0.06	0.05	0.06
Yield with SPR Based On SO40\% (mt)	4487.15	3533.09	5441.21
Reference Points Based on SPR Proxy for MSY	NA	NA	NA
Proxy Spawning output (trillions of eggs) (SPR50)	6.73	5.80	7.66
SPR50	0.50	NA	NA
Exploitation Rate Corresponding to SPR50	0.05	0.05	0.05
Yield with SPR50 at SO SPR (mt)	4235.93	3340.87	5130.99
Reference Points Based on Estimated MSY Values	NA	NA	NA
Spawning output (trillions of eggs) at MSY (SO MSY)	3.56	3.04	4.07
SPR MSY	0.31	0.31	0.32
Exploitation Rate Corresponding to SPR MSY	0.09	0.08	0.09
MSY (mt)	4994.84	3902.57	6087.11

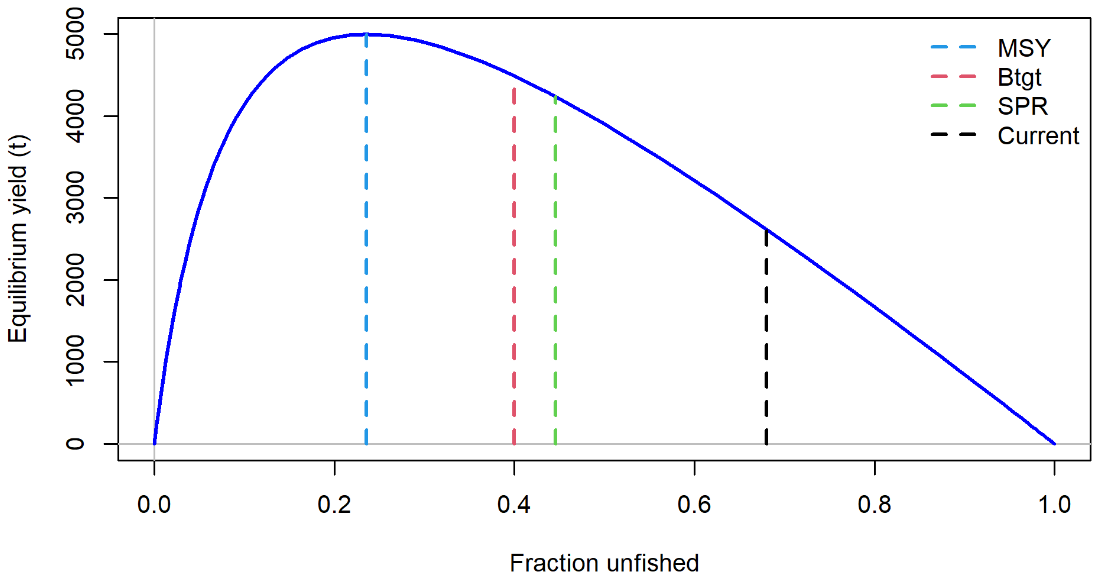

Figure 7: Equilibrium yield curve for the base case model.

0.1.9 Management performance

0.1.10 Unresolved problems and major uncertainties

0.1.11 Decision table and projections

0.1.12 Scientific uncertainty

0.1.13 Research and data needs

1 Introduction

Yellowtail Rockfish, *Sebastes flavidus*, occur off the West Coast of the United States from Baja California to the Aleutian Islands. Yellowtail is a major commercial species, captured mostly in trawls from Central California to British Columbia (Love 2011). Because it is an aggregating, midwater species it is usually caught in the commercial midwater trawl fishery. In California there is a large recreational fishery as well. The center of Yellowtail Rockfish abundance is from southern Oregon through British Columbia (Fraidenburg 1980). Yellowtail Rockfish are colloquially known as "greenies", although *flavidus* is Latin for "yellow" (Love 2011). We briefly summarize Yellowtail Rockfish life history, fisheries, assessment and management here, but in-depth, extensive background information on Yellowtail Rockfish and other managed species is available at (Council 2016).

A number of studies correlate environmental conditions to pelagic juvenile abundance and juvenile recruitment of rockfishes, including Yellowtail Rockfish. Year-class strength is particularly impacted during the early larval phase, and annual pelagic juvenile abundance is correlated with physical conditions, especially upwelling strength along the coast (e.g., (Field and Ralston 2005), (Laidig, Chess, and Howard 2007), (Laidig 2010), (Ralston and Stewart 2013)).

A recent genetic study (Hess, Vetter, and Moran 2011) indicates that there are in fact two stocks of Yellowtail Rockfish, with a genetic cline at Cape Mendocino, California, roughly $40^{\circ}10'$ North Latitude. This study of 1013 fish from 21 sites along the West Coast from Mexico through Alaska examined two datasets, one of mitochondrial DNA, and one of nuclear DNA microsattelite loci. Findings in both datasets agreed, and also concur with the findings of Field and Ralston (Field and Ralston 2005) who looked at differences in recruitment trends related to physical forcing and coherence along the coast, and found the greatest differences among the U.S. and Canadian stocks to be defined by Cape Mendocino. Neither the genetic study nor the oceanographic studies definitively identify mechanisms of stock isolation, however they suggest that a combination of physical forcing due to offshore advection and differences in available habitat across Cape Mendocino may together account for the differences observed.

The species has never had a full length and age integrated assessment south of Cape Mendocino, mainly due to a lack of fishery-independent data; this assessment represents an initial attempt to do so.

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

1.1 Life History

1.2 Ecosystem considerations

1.3 Fishery description

1.4 Management History

1.5 Management performance

1.6 Fisheries off Canada and Alaska

2 Data

2.1 Fishery-dependent data

2.1.1 Landings

2.1.2 Discards

2.1.3 Biological data

2.1.4 Abundance indices

2.1.4.1 Oregon ORBS Dockside Index (2001 - 2024)

Trip-level catch-per-unit-effort data from ORBS dockside sampling was obtained from ODFW. To mitigate the confounding of hourly effort associated with these trips with travel, the travel time was subtracted from the hours fished. Travel time was stratified by boat type (charter and private) and was calculated as boat type-specific speeds (13 mph for charter boat trips and 18 mph for private boat trips) multiplied by twice the distance between the port of origin and the reef that was fished. CPUE, expressed in terms of fish per angler-hour, was calculated by multiplying the number of anglers and the adjusted travel time. The database contains information on catch by species (number of retained fish), effort (angler hours), sample location (port where data were collected), date, bag limits and other relevant regulations, boat type (charter or private), and trip type (e.g., bottom associated fish).

The unfiltered data set contained 456,172 trips from 2001 - 2024. Multiple standardized filters are applied to ORBS trip-level data to remove outliers and data unsuitable for an index. These filters include trips with incorrect interview times, which impact calculation of effort, unreasonably long or short trips, and retaining only bottomfish target trips. Further filters were utilized for fishing closures (i.e. temporal or spatial closures) and catches exceeding bag limits, which would presumably impact catch rates. Trips from several ports with extremely small sample sizes (<1% of total trips) were also excluded and finally, trips that met criteria for irrational effort reporting (i.e., implausible values) or extreme catch rates were excluded as well. The final dataset included 137,502 trips (TABLE “percent_pos.csv”).

Covariates evaluated included year, month, port, the open depths to fishing (all depths or inside 20/30/40fm), boat type and the daily bag limit for Yellowtail Rockfish. Preliminary model explorations indicated that the daily bag limit covariate could not be combined with the open depth of the fishery due to changes in recreational fishing regulations over time. Prior to 2017, Yellowtail Rockfish were included in the general marine bag limit. However, in 2017, Yellowtail Rockfish were also included in a specialized longleader recreational bag limit where participants were required to be outside of 40fm.

As a result, the bag limits were binned into a binary covariate for low (5 – 8 fish) and high (10 – 15fish) bag limits during the 2001 – 2024 time period. Negative binomial models were fit in sdmTMB (Version 0.6.0) to the trip-level data (catch with a log offset for adjusted angler hours). Tweedie distributions were also explored for selected models but generally did not improve model diagnostics. The final model selected includes year, month, port, open fishery depths, longleader trip and binned target bag limit covariates, which was the best fit model by AIC in this series (TABLE "model_selection.csv"). Acceptable diagnostics for the model were achieved (FIGURE – qqplot) and the negative binomial distribution was preferred over the tweedie. The index of abundance are shown in Figure/Table XXXX.

2.2 Fishery-independent data

2.2.1 Abundance Indices

2.2.1.1 SMURF YOY Index

ODFW and Oregon State University (OSU) have collaborated on young of the year (YOY) fish and environmental monitoring in and around Oregon Marine Reserves (MR) using SMURF devices, standardized sampling units that collect newly-settled juvenile fishes. Data were provided for two regions on the Oregon coast, near the Otter Rock MR (central) and the Redfish Rocks MR (southern) with a site inside of the reserve and a comparison site outside of the reserve from 2011 to the present. These are monitored regularly (approximately every 2 weeks) during the settlement season (April - September) and YOY are collected for genetic identification and measured. Settlement rate of YOY Yellowtail Rockfish was provided by OSU for each site within each region. Paired temperature at depth data was provided by ODFW MR Ecological Monitoring team for this assessment. Daily mean temperature data was provided for three depth strata (1m, 7.5m, and 15m) for each site within each region.

Oceanographic sampling by the ODFW MR Ecological Monitoring team has not been able to be done simultaneously in both reserves at each mooring site at all depths due to a lack of equipment. However, for time periods when there was matched data, temperature was highly correlated across depths (Pearson's correlation coefficient > 0.90) and between sites within each region (Pearson's correlation coefficients >0.98). In order to calculate an index of daily water column temperature that was continuous enough to be combined with settlement rate data, temperature data was standardized within year and depth. For periods with multiple observations, the mean was taken in order to generate a single continuous temperature time series. Mean SMURF deployment lasted 15.5 days. In order to summarize temperature in an ecologically meaningful way relative to the SMURF sampling design, a 16-day rolling mean of temperature and cumulative degree days over 16-day periods were calculated. These data were matched with settlement rate data such that the mean temperature or the cumulative degree days during the 16-day period that the SMURF was deployed was used.

Covariates evaluated for were year, month, region (Redfish Rocks or Otter Rock), temperature, and site (within marine reserve or nearby comparison site). Preliminary model runs indicated a consistent lack of convergence and additional filters were applied to address this, including limiting the data to 2014 - 2024 and to the peak months of settlement for yellowtail (May - July). Month was not included in models that included temperature as both covariates were used to describe seasonal variation in settlement rate. Site was not a significant covariate in this model but this was not unexpected, as the presence of a reserve would not be anticipated to impact juvenile settlement rates. Models were fit to the settlement rate data (YOY fish per day) using sdmTMB R package (Version 0.6.0). Both negative binomial and tweedie distributions were evaluated. The model that was selected based on fit (TABLE X) and expert opinion from OSU and ODFW staff. The final model contained year, region, and temperature summarized as cumulative degree days 16-days prior to SMURF recovery using a negative binomial distribution. Acceptable model convergence and other diagnostic criteria for the final index were achieved (FIGURE - qqplot). The index of YOY abundance and associated standard errors are shown in Figure/Table Y.

2.3 Biological Parameters

2.3.1 Natural Mortality

2.3.2 Weight-at-length

2.3.3 Maturity

We used a total of 292 individual histological samples of aged female yellowtail rockfish to estimate maturity for the assessment. These samples were all collected north of 40.167; this latitude filter excluded 5 additional samples collected in the south, but the inclusion or exclusion of these samples did not change our results. The 292 samples were collected over the period 2016—2023, though more samples were collected earlier in these years (n = 111 in 2016, 52 in 2017, 31 in 2018, 17 in 2021, 9 in 2022, 13 in 2023). Previous assessments of yellowtail estimated length-based maturity (L50 = 42.49cm in 2017 assessment); however, we switched to an age based model for the current assessment. For many species, energy is reallocated toward maturation from growth, and as a result growth rates slow during the juvenile to adult transition period. Thus, length at 50% maturity will represent a range of ages, providing a less accurate understanding of the spawning population. We treated maturity as a binomial response, and considered a variety of models with temporal and spatial covariates, using a logit link and generalized linear mixed model framework, implemented the R package sdmTMB (Anderson et al. 2024). Briefly, we considered models that included (1) temporal year effects (either estimated as a random walk intercept, or smooth term), (2) spatial random fields (using a mesh cutoff distance of 50km), and (3) spatially varying coefficients of age, following the model adopted by Grandin et al. (2024). Models that converged were compared by examining QQ plots, AUC metrics, and AIC scores. Likely because of the uneven temporal distribution of sampling, and general sparsity, we did not find support for including temporal or spatial effects, and decided on the simpler null model (equivalent to a logistic regression). For the age-based model, we estimated an intercept of -6.70 (SE = 0.99) and slope of 0.67 (SE = 0.10), equivalent to an A50 of 10.0 years. For a more direct comparison to the previous assessment, we used these same 292 samples to fit an equivalent length – based model, which resulted in an estimated L50 = 42.5 cm.

2.3.4 Fecundity

2.4 Environmental and ecosystem data

2.4.1 Oceanographic Index

Over the past several years, progress has been made in understanding how oceanographic conditions drive recruitment of groundfish species in the California Current Ecosystem across lifestages including petrale sole, sablefish and hake. Recent increases in capacity supported by the Climate, Ecosystem, and Fisheries Initiative provided the ability to build on these previous lines of research and examine the relationship between northern Yellowtail rockfish recruitment and oceanographic drivers based on model output from Global Ocean Physics Reanalysis (GLORYS) from Copernicus Marine Environment Monitoring Service (CMEMS) and Regional Ocean Modeling System (ROMS) model for the California Current Ecosystem (Neveu et al. 2016). The results suggest that GLORYS and ROMS output may allow for better model precision and near-term forecasting. This approach builds on previous research (Tolimieri et al. 2020, Haltuch et al. 2020, Vestfals et al. 2023) and assessments (Taylor et al. 2023, Johnson et al. 2023) by applying similar techniques to establish oceanographic relationships and develop an oceanographic index based on a conceptual life history model for yellowtail rockfish (Darby et al. in prep). GLORYS also provides a temporally robust time series and is not susceptible to discontinuities identified in the 2023 petrale sole assessment. Appendix A of this report describes the most recent efforts in developing a new environmental index of northern Yellowtail recruitment based on GLORYS products. The final selected model included the date of spring transition from the Coastal Upwelling Transport Index, degree days (represent temperature exposure) during egg fertilization and development, long-shore transport during the pelagic juvenile lifestage, and El Nino conditions during the pelagic juvenile lifestage. The oceanographic model was fit using the recruitment deviations (1994 - 2019) from the base model and used to predict log recruitment deviations 5 years ahead, 2020 - 2024, using oceanographic conditions.

3 Assessment model

3.1 History of modeling approaches

3.2 Response to most recent STAR panel and SSC recommendations

3.3 Model Structure and Assumptions

3.3.1 Model Changes from the Last Assessment

3.3.2 Modeling Platform and Structure

3.3.3 Model Parameters

3.3.4 Key Assumptions and Structural Choices

3.4 Base Model Results

3.4.1 Parameter Estimates

3.4.2 Fits to the Data

3.4.3 Population Trajectory

3.5 Model Diagnostics

3.5.1 Convergence

3.5.2 Sensitivity Analyses

3.5.3 Retrospective Analysis

3.5.4 Likelihood Profiles

3.6 Unresolved Problems and Major Uncertainties

4 Management

4.1 Reference Points

4.2 Harvest Projections and Decision Tables

4.3 Evaluation of Scientific Uncertainty

4.4 Regional management considerations

4.5 Research and Data Needs

4.6 Acknowledgements

4.7 References

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4.8 Tables

4.9 Figures

4.10 Notes

4.11 Appendices