# Report of the Pre-Assessment Workshop for 2023 Groundfish Stock Assessments of Copper Rockfish, Canary Rockfish and Black Rockfish

Pacific Fishery Management Council
Online Meeting

January 31 and February 1, 2023

The pre-assessment workshop for 2023 groundfish stock assessments of copper, canary, and black rockfish convened via webinar on January 31 and February 1, 2023. The purpose of this workshop was to review proposed data inputs, modeling approaches, and any other pertinent information to inform the upcoming stock assessment with a goal of promoting dialogue between the stock assessment team (STAT) and data providers. The Pacific Fishery Management Council's Scientific and Statistical Committee (SSC) Groundfish Subcommittee members serving as stock assessment and review (STAR) Panel Chairs were Dr. Jason Schaffler for copper rockfish (STAR Panel 1), Dr. John Field for canary rockfish (STAR Panel 3), and Dr. John Budrick for black rockfish (STAR Panel 2). Appendix 1 notes SSC Groundfish Subcommittee members and STAT team members who participated.

## Copper Rockfish

Drs. Chantel Wetzel (Northwest Fisheries Science Center; NWFSC), Melissa Monk (Southwest Fisheries Science Center; SWFSC), and Julia Coates (California Department of Fish and Wildlife; CDFW) provided a document (https://pfmc-assessments.github.io/copper_rockfish_2023/data_workshop/) that is linked through the meeting notice and titled "Pre-assessment data-workshop for copper rockfish off California in 2023". This document provides a preliminary overview of the data inputs, modeling approaches, and other pertinent information to be used in the upcoming copper rockfish stock assessment.

Copper rockfish was last assessed in 2021 using a data-moderate approach. Several concerns arose from that approach that included fixed growth based on length-at-age samples from Oregon and Washington due to limited information from California sources. For 2023, additional samples from California will be included and growth will be estimated within the model. Assessed areas within California will continue to use Point Conception (34°27′ N. lat.) as a stock boundary resulting in northern and southern California models. Fleet structure will differ in 2023 such that four removal fleets will be modeled that include a recreational fleet of commercial passenger fishing vessels (CPFV), a recreational fleet that includes private and rental boats (and shore-based catch where it occurs), a commercial fleet landing dead fish, and a commercial fleet landing live fish. This structure will be identical across both northern and southern areas.

The majority of commercial landings arises from hook and line gear in both regions of California. Landings of live copper rockfish began in the 1990s and have increased in recent years. There was a large amount of trawl catch in the 1980s that was concentrated around San Francisco ports which raised a question of whether this was real or an artifact of composition sampling. It was suggested to look at catch associated with these copper rockfish landings to determine their validity. Discard rates are needed to expand landed catch into total catch. The 2021 assessment assumed a constant discard mortality rate of 4.4% and was informed by the

West Coast Groundfish Observer Program. This raises the question as to whether the rate is reasonable or if discarding has been variable across time?

Recreational landings of copper rockfish come from across California. Historical landings were higher in the northern region but since the 1990s, recreational landings are similar between regions. In the northern region, the private fleet dominates the landings whereas the CPFV fleet dominates landings in the southern region. There are three years (1990-1992) of missing data that will have to be estimated and another year that has gone missing (2004) but was available during the 2021 assessment. There is a spike in landings from the northern region during 1981 that CDFW staff may provide a revised estimate for. To expand recreational landings to catch, the Recreational Fisheries Information Network (RecFIN) derived estimates (WGT_AB1) which account for discard mortality by depth from PFMC adopted surface mortality rates or mortality with the use of a descending device (adopted by the PFMC in 2022 and will only apply to that year).

Multiple indices of abundance are available for copper rockfish. The California Collaborative Fisheries Research Program (CCFRP) survey began in 2007 and was expanded across California in 2017. These data may support the development of abundance indices for both north and south regions. Some concern about these data were expressed due to gear and weather impacts on the survey. However, these factors can be accounted for in construction of the index. The Northwest Fisheries Science Center Hook and Line survey data will also be available for the model south of Point Conception. This survey was initiated during 2004 and added sites within the Cowcod Conservation Area beginning in 2014. Data through 2022 will be analyzed to produce an index. A third survey, the Northwest Fisheries Science West Coast Groundfish Bottom Trawl Survey, observes copper rockfish in California. This survey operated between 2003-2021. The majority of copper rockfish observations occur in the southern region from this survey. This survey will likely not contribute an index of abundance due to the sampling method (trawl) which results in a very limited number of positive tows (i.e. tows with catch of copper rockfish) per year. However, the biological samples from this survey (length and ages) will be used to inform estimates of growth. There are several other data sources that will be considered to produce a fishery independent index. Fishery dependent indices similar to other recent assessments will be constructed as well. These indices will only run through 2019 due to COVID-19 related sampling impacts beginning during 2020.

Commercial length sampling is primarily from hook and line gear and shows that the length of fish from the live fish landings are generally smaller than dead fish landings. This data also shows that the northern area lengths are somewhat larger than southern area fish. The same pattern of size shows up in recreational length samples. The CPFV fleet tends to land slightly larger fish than the private fleet, particularly in the northern region. Bias was shown to exist in the CPFV fleet landings lengths due to underrepresentation of lengths from overnight trips. However, this bias was insignificant compared to the 2-cm length bins and should not present a problem during the assessment. A request was made to perform a similar analysis of potential bias and its effect on half-day versus full day trips from the CPFV data. Could there be a different pattern of discarding due to trip length and differential selectivity due to availability and distribution of larger fish and angler preference affecting the smallest fish retained? Trip duration

has a large effect on fishing locations and may be impacting lengths observed in unknown ways. What else can be done to assess these effects?

Within the CCFRP survey data, there is evidence that larger fish reside in Marine Protected Areas (MPAs). Otolith ages will be included from the Northwest Fisheries Science Center Hook and Line, the West Coast Groundfish Bottom Trawl surveys, CCFRP, commercial fisheries, recreational fisheries, and research collections. Most of these otoliths are from outside MPAs. The SWFSC Santa Cruz is collecting samples for maturity and fecundity and that data will be ready for the assessment. The new estimate of fecundity at length will be compared to the estimate from a meta-analysis conducted by Dr. E.J. Dick which was used in the 2021 assessment. Natural mortality was fixed at 0.108 in the previous assessment and will be reevaluated in this assessment based on newly obtained age data. Oregon Department of Fish and Wildlife recently published an age validation paper that included copper rockfish that is available.

Copper rockfish extend into Mexican waters but little is known about their abundance or life history. Catch landed from Mexican waters and landed in the U.S. should be partitioned out. Additional genetic analyses are being conducted by the SWFSC Santa Cruz but are unlikely to be available for this assessment.

**Canary Rockfish**

Drs. Kiva Oken and Brian Langseth briefed the meeting on data availability and model structure plans for the upcoming canary rockfish stock assessment (see (https://www.pcouncil.org/documents/2023/01/canary-rockfish-workshop-presentation.pdf/). They began by noting that canary rockfish have been intensively assessed along the U.S. West Coast, having first been assessed in 1984, and with 9 full assessments since that time (along with several updates and catch-only projections), with the most recent benchmark in 2015. Their plan for the 2023 benchmark assessment is to have a coastwide model, conduct a full exploration of model assumptions and data, and they anticipate that the data used will be highly comparable to data used in past models with respect to catch, length and age, abundance indices and biological data.

The greatest difference anticipated between the 2015 assessment and the upcoming 2023 assessment, is that the 2015 model was spatially structured (with separate fleets, recruitment apportionment and recruitment deviations by state), with an assumption of no adult movement among areas. The STAT plans to explore simplifying population structure while maintaining fleet structure, as sensitivities from the 2015 model indicated limited differences in model results across the range of spatial structure assumptions, such that the additional complexity did not appear to contribute to an improved understanding of stock dynamics or productivity. The extensive run times associated with the complexity of the 2015 model, are also contributing factors to the STAT's plan. There was some discussion regarding the merits and shortcomings of moving away from the spatially structured model used in 2015, given the interest in potential differences in relative abundance over space. The STAT also noted that in addition to the concerns regarding model complexity, the absence of robust tagging and movement data for this species were contributing factors in their decision to move towards a non-spatially explicit

model. It was also noted that the 2015 model did not suggest any localized depletion within the resolution of that model.

The STAT plans for the upcoming model to have between 5-15 fleets (5 fleets by 1-3 areas per fleet), with a range of abundance indices (mostly including those used in the past but also exploring additional state-based surveys). Sex-specific life history information will be explored. Commercial landings will be separated by trawl and non-trawl gears, with recreational catches combined across private/charter and private/rental modes. Most removals are known to be from commercial trawl fisheries, for which total landings were minimal relative to historical landings between approximately 2000 and 2017, but have increased modestly over the past 5-6 years. The STAT posed the question of whether historical (pre-1980 or 1986 for OR) landings will change. It was noted that California historical landings estimates have not changed, although Alison Whitman (ODFW) indicated that modest changes in the shrimp trawl fleet catch estimates off of Oregon may have changed. The STAT intends to pool targeted bottom trawl, midwater trawl and shrimp trawl landings.

The STAT posed the question of whether there were additional data or information to inform historical discard mortality rates that were estimated and used in the 2015 assessment. There was no indication that new or additional information is available. Consequently, the STAT plans to use the same rates as were used in the 2015 model. Recent recreational catches (both retained and discarded) were reviewed by the STAT, noting that the fraction of fish retained increased sharply following 2016. The need to derive pre-1980 recreational catch estimates for the Oregon recreational fishery to inform the model was highlighted. Alison Whitman will be working on developing these estimates, but suggests that a 1973 to 1979 "ramp" could be appropriate in the likely event that more robust estimates for this time period are not available in time for this model. Some differences in historical recreational catch estimates from 1980 to the recent time period were noted relative to the previous assessment. Recreational catches for Washington are reported in numbers of fish, while the 2015 assessment reported in metric tons, making a direct comparison to recently provided estimates to those used in 2015 difficult. The STAT also posed the question of what to use for depth-specific release mortality rates (specifically, are WA fisheries sufficiently similar to OR to allow for borrowing of OR rates). There will be continuing discussions about this issue between the STAT and state representatives.

With respect to age and length compositional data, the STAT reviewed available information, and noted that the majority of samples are derived from OR commercial trawl gear, and that recent age samples should add to available information. Age data will be used in the model as conditional age at length (CAAL) from surveys, and marginal from fisheries. The STAT provided information on samples that were excluded for various reasons (sampled outside of U.S. waters, special project samples, purposive sampling in WA state). The STAT does plan to include a suite of "special projects" age estimates in OR following discussions with ODWF staff. All three states have fairly robust length data for most years from the late 1970s through present, except for the "no retention period" from approximately 2000 through 2015. Both OR and WA have abundant commercial fishery age data, limited age data is available for CA commercial trawl. There are some non-trivial differences in length frequency data between trawl and non-

trawl gear in CA and OR, but only modest differences in WA, with very limited compositional data for the fixed gear fleet. The STAT asked for input regarding the merits of merging trawl and non-trawl data for WA state, in response there was perhaps a slight preference for at least exploring separate fleets and evaluating similarities or differences in these fleets.

There was some discussion of a comparison between surface versus break and burn ages, for which the previous assessment used two age composition types with unique error matrices. The STAT intends to exclude the surface age reads from the 2023 model, in order to simplify the model structure and in recognition of the likely bias associated with those data (this is comparable to what was done in 2005 and 2007 benchmark assessments). It would be interesting to know whether these age structures are still available and could be revisited to potentially inform future assessments (it is not clear who may have custody of these samples). The STAT also discussed length composition data from the shrimp trawl fishery in greater detail, noting that from retained fish it seemed apparent that length and age data from the shrimp trawl fishery were comparable to other trawl gears. However, as the discard length frequency data have not yet been evaluated, the STAT clarified that these data could potentially change their thinking on this approach.

The STAT noted that the previous assessment did not include recreational age composition data, due to the paucity of samples, but samples are now available from WA and OR and are anticipated to be used in this assessment. The previous assessment used a single unsexed length composition structure for OR (but not WA), and the STAT anticipates looking at sex-specific compositional data. The STAT raised the question of whether they could be missing important information by excluding released fish in compositional data (particularly given that such fish occurred more frequently during periods of no retention). In their early investigations, the STAT found that including released fish was not likely to have a significant effect on the model.

With respect to time blocks for selectivity functions, the STAT noted that the previous assessment had time breaks at the overfished declaration (1999-2000) and at the start of the transition to an Individual Transferable Quota (ITQ) management approach (2010-2011). The STAT noted that there were no selectivity time blocks in the recreational fleets, and that the previous assessment assumed that selectivity was mirrored across states for each fleet. There was discussion of considering an additional time block for commercial and/or recreational fisheries in the recent period (e.g., around 2016 or so) to reflect management changes that took place when the stock was declared rebuilt.

In deeper discussions of the survey data to be used, the STAT noted that key surveys to be included or explored were the West Coast Groundfish Bottom Trawl Survey (WCGBTS), the historical triennial trawl survey, and the rockfish recruitment and ecosystem assessment survey. The issue of "extreme catch events" for canary rockfish in trawl surveys was discussed, as these have historically inspired considerable discussion regarding modeling approaches and application of trawl survey data. The STAT mentioned that the state-specific indices for the WCGBTS were similar to those for the coastwide index. Several state-specific surveys are being explored based on recreational catch per unit effort (CPUE) data, visual survey data and others, several other surveys with limited information for canary rockfish were mentioned that are not

likely to be used. There was some discussion among the STAT and workshop participants regarding the merits of splitting, or not splitting, the triennial trawl survey given the observation that splitting that time series greatly reduces the influence of the index on the model. In discussions it was noted that the seasonality shift between those periods would likely have minimal impact on rockfish (but potentially greater impacts for stocks with seasonal migrations), and that the differences in depth coverage in the two time periods could potentially be addressed by spatiotemporal modeling approaches, or by limiting the data to only the consistently sampled depth strata.

With respect to additional discussions of biological data, the STAT noted that fecundity will be as used in the 2015 assessment (based on Dr. E.J. Dick's rockfish fecundity meta-analysis), maturity may be updated with additional data currently being developed, and that the prior for natural mortality has been updated, so will be updated in the model as well. The model will explore and likely include sex-specific growth. Key among the biological considerations is the lack of older females among all data sources, previously a major uncertainty and an important topic for deeper exploration in this model. Essentially, the STAT reports that nearly all of the oldest fish seem to be male. The previous assessment fixed M for males and young females and then used a ramp for females age 6-14. The approach here in this assessment will be to coordinate modeling approaches with the black rockfish assessment team, to consider a step function rather than a ramp, and to explore the sensitivity to the increased mortality assumption (e.g., kill 'em) relative to a hypothesis of dome-shaped selectivity (e.g., hide 'em). The STAT did note that the decline in the female to male ratio does not appear to be a major consideration until approximately age 20, suggesting that the natural mortality ramp used in the 2015 model may not be the optimal approach. It was noted in discussion that the lack of old females has been observed in data that extend back to the 1990s. As the uncertainty regarding an increased natural mortality rate for older females had a large influence in the 2015 perception of stock status in 2015, the STAT was strongly encouraged to explore this issue as rigorously as possible, and to include sensitivities into the alternative assumptions. The STAT also recognized recent research suggesting geographic differences in life histories (Brooks 2021), although it appeared that when separate growth curves are fit north and south of Coos Bay (OR), the regional differences seemed to be modest.

**Black Rockfish**

Dr. Jason Cope (Northwest Fisheries Science Center) and Dr. E.J. Dick (Southwest Fisheries Science Center) presented the data available and considerations for model structure for the 2023 black rockfish stock assessment for Washington (see https://shcaba.github.io/Sebastes_melanops_WA/) and Oregon (see https://shcaba.github.io/Sebastes_melanops_OR/), and California (see https://www.pcouncil.org/documents/2023/02/california-black-rockfish.pdf/), respectively. Genetic studies of stock structure indicate fish in Alaska are more differentiated than the along the contiguous west coast of the Unites States, and that genetic diversity varies in a non-systematic way from California to Oregon. Despite a lack of clear genetic structure within the

waters under the Council purview, the STAT proposes keeping assessment structure at a state level to account for differences in exploitation history and data availability given surveys conducted. Notes from the discussion below are organized accordingly.

Surveys and fisheries are encountering large female black rockfish, but not older female black rockfish. There is not a clear biological mechanism for the differences in longevity or availability between sexes. Large individuals are sometimes found 100s of miles offshore (Rasmuson pers. comm.; Tsou pers. comm.), though it is not clear how common this behavior is given the lack of consistent sampling efforts offshore, though this seems rare as most tagged individuals show smaller home ranges. Females become relatively rare over 20 years of age with only a few over 25 years old, while older males are still observed. The phenomenon is also observed in canary and yellowtail rockfishes. Efforts to better understand the mechanism and how to model the lack of older females in stock assessments by either assuming unavailable cryptic biomass as represented by a dome-shaped selectivity curve ("Hide Them Hypothesis") or to apply a higher natural mortality rate for females ("Kill Them Hypothesis"), or a mixture of both, will be a focal aspect of the assessments in each state.

**Washington Assessment**

The bridging model showed minor deviation from the previous assessment between versions of SS and only a minor deviation when the model is allowed to estimate parameters.

***Catch History***

The proposed fleet structure is unchanged from the last assessment with a trawl sector with significant contributions and jig fishery in the 1980s that was eliminated in the early 1990s. The scale of the population is uncertain due to catch history considerations. Large trawl landings from Astoria, Oregon of unknown rockfishes assumed taken off Washington waters and limited data informing species composition caused high historical catch values, particularly in the 1940s. Further analysis of the implications is warranted since this may make the population appear larger in scale than it might be. Washington state-specific catch compositions will be compared to Oregon catch compositions to help resolve the commercial removal history. The recreational catch was the predominant source of contemporary fishing mortality. There are 13 years of discard estimation with eight more years that do not affect the relationship of retained to discarded dead that indicate the vast majority are retained.

***Indices of Abundance***

The assessment will consider the following indices:

- Dockside recreational index.
- Tag-release time series.
- The statewide coastal rod and reel survey may be linked to the sport fishery index for recent years, since they are not expected to be very different in terms of gear or representation of the stock, the survey is fishery independent. Compiling data with the time series in Marine Area 2 in the later portion of the time series may be preferred at present given the duration of the survey.

- The NWFSC dive survey data from 2015-2022 can be included to see if there is a similar trend in a recruitment index.

The recreational fishery provides most of the data since the late 1990s when the commercial fishery in the nearshore was closed in deference to the recreational fishery. Likely to use asymptotic selectivity curves in the base model. There is no indication whether there needs to be a selectivity block yet, though input from the Groundfish Management Team (GMT) or State representatives may help inform blocks for consideration. Recreational length composition for males and females shows females are a little bigger than males. The percent sexed and unsexed shows a low proportion of unsexed fish allowing comparison of compositions, indicating the unknown sex is not much different than male or female composition allowing its inclusion.

***Biology***

The Washington assessment will borrow results from a recent analysis of maturity for fish collected in Oregon. The weight and fecundity relationships are from the meta-analysis (Dick et al. 2017) noted in the accepted practices will be used, as is standard for rockfish assessments. Length-weight relationships for males and females were similar and well informed. The age at length shows pattern of few old females as observed elsewhere along the coast. The Natural Mortality Tool will be used to produce the priors for males and females separately.

**Oregon Assessment**

A bridging model between versions of stock synthesis produced the same result when parameters are fixed and minor changes when allowed to vary, indicating there are negligible effects of the newer modeling platform. Uncertainty bounds were very small in the previous assessment due to a constrained model defined by catchability in one of the indices artificially shrinking the uncertainty, as well as the lack of recruitment variability. The prior on catchability could be freed up to evaluate a broader range of possibilities, and recruitment estimation will again be reconsidered. These confidence bounds will increase in the new assessment making it appear to be less precise but will in fact capture more of the true uncertainty. Uncertainty around spawning output was higher than relative abundance and the effect of freeing up catchability on both can be examined.

***Catch History***

One goal of the assessment is improving our understanding of uncertainty in historical catch reconstructions. There is great uncertainty in commercial black rockfish landings in Oregon. The STAT is re-evaluating this issue and will attempt to evaluate the effect of uncertainty across specific periods or sectors. Separate commercial fleets for trawl and non-trawl will be implemented given differences in composition.

Karnowski et al. (2014) provides a catch reconstruction for Oregon waters. Black rockfish was not its own category, so unknown rockfish categories have to be speciated to estimate removals. Area 3A catch designated area is mostly in Washington but includes Astoria and landings from Washington were landed there. This poses a potential error in assignment of catch contributing to a spike in 1945, resulted in a need to revisit the catch composition, what proportion of unknown rockfish should be black rockfish and what should be reattributed to Oregon vs. Washington. The

black rockfish catch taken in the trawl fishery in that year is a concern given lower magnitudes observed in the past. It is not clear what the proportion of the unknown rockfish should be assigned to if not black rockfish, which is a larger related question that needs further research outside this assessment cycle.

Recreational landings considerations are important given the magnitude of removals in the recent past. Changes relative to the 2015 assessment are likely, but also expected to be very small. There is no current sampling of the shore-based catch, but relatively low compared to boat modes in any case and uncertainty can be bracketed in a sensitivity analysis. In the recreational fishery, the private-rental boat and party-charter compositions were comparable and can be combined, but the shore-based modes were separated due to the presence of smaller fish. This results in two recreational fleets. Recreational length composition is much better sampled for boat modes as compared to shore modes, especially in recent years when sampling shore-modes was intermittent or discontinued, with no sampling of shore modes after 2004. Nonetheless, the shore modes contributed a sufficient number of lengths making the differences clear and selectivity estimable.

***Indices of Abundance***

The adult tagging index was important in the 2015 assessment, but the acoustic survey now provides a new source of data on the absolute abundance off Oregon for evaluation in the 2023 assessment. Comparisons of scale initially indicate similar estimates from the assessment and survey. A new hydroacoustic survey is also available and will be used for the first time.

Fishery dependent indices are available for the recreational fishery from Marine Recreational Fisheries Statistics Survey (MRFSS) era dockside data and the Ocean Recreational Boat Survey (ORBs) onboard sampling as well as nearshore logbooks for the commercial fishery, which will be evaluated for inclusion. Commercial length composition for the fixed-gear fishery are much better sampled than the trawl. There are many recent fixed-gear samples from the live fish fishery, and evaluation of the nearshore logbook data may provide an informative index.

Bag limit changes have taken place in recent years, reducing sub-limits for black rockfish gradually ranging from 4 to 6 fish. Though the change was gradual, time blocks may be identified to account for the limitation on CPUE. A dome-shaped selectivity curve may be most appropriate for the shore-based mode to address the smaller fish observed in the shore and estuary sampling. Asymptotic selectivity may be appropriate for boat modes despite the potential for larger individuals to be found up to 500 miles offshore and depth restrictions as shallow as 20 fm in place over the last two decades, which could be evaluated as a sensitivity analysis for a dome-shaped selectivity and potential time blocks.

***Biology***

Functional maturity was accounted for in the last assessment. Biological maturity means the individual could reproduce compared to functional maturity that captures what is actually produced with skip spawning and atresia or senescence as only a proportion of fish may spawn at a given age. Parasite loads and other considerations regarding the health of individuals have been the subject of recent research. The apparent trend and the length of maturity (L50% mature)

shifts from 34 cm to 41.12 cm in accounting for functional maturity. Unusual ocean conditions during the large marine heatwave of 2014-2016 could have exaggerated this shift, if there was a greater decline in functional maturity for younger, smaller fish and a large fraction of the sampling occurred during that time period providing 320 samples for use in estimation of functional maturity. Parasite loads may play a role as well since female ovaries contain parasites around the time of maturity requiring more study. Sampling elsewhere to the south would help investigate the spatial extent of the parasite effects.

Length weight relationship will be revisited with more samples from recent years. Ageing error calculations will be conducted. The dearth of females older than 20 years of age indicate some difference in natural mortality. Growth will be estimated internally and externally for comparison. A Natural Mortality ramp from 0.17 to 0.2 to account for the absence of large females under the "kill them" hypothesis will be explored. The alternative is to implement a step in the natural mortality at maturity. The "hide them" hypothesis can be evaluated with dome-shaped selectivity, and a constant natural mortality for females will be evaluated, although in previous assessments this approach resulted in the model estimating a large cryptic biomass, which was thought to be less plausible. A consistent approach may be preferable among states as well as assessments for canary and black rockfish. The California assessment will pursue sex specific constant M as a starting place for comparison to other methods to explore uncertainty. Sensitivity of M and selectivity will be a key focus for uncertainty. Removal data assumptions are related, and data types and weighting of composition data will also be important to evaluate the contributions of various data types to the management quantities estimated from the model.

**California Assessment**

A single area model will be explored for California, since black rockfish are primarily found north of Point Conception (34°27′ N. lat.), thus there is not a need to break California into multiple models. Spatial differences in growth, exploitation and catch rates will be evaluated. The 2015 assessment spawning output was in the precautionary zone. Catch is approaching target levels. A major uncertainty is whether to hide (dome-shaped selectivity) or kill (asymptotic selectivity/higher natural mortality) old females that are not present in proportion to males in the catch.

***Indices of Abundance***

The California Cooperative Fisheries Research Program (CCFRP) expanded statewide in 2017 and includes sampling in Marine Protected Areas (MPAs), providing data for a fishery-independent index and composition data, which the STAT is exploring. Three additional recreational indices will be explored including two onboard CPFV observer indices, one of which is habitat weighted and a dockside MRFSS index. A new fishery dependent index using private and rental boat data will be evaluated for inclusion since there are lower sample sizes from CPFVs in the north due to issues with sampling onboard six passenger limitation vessels that are prevalent there. Analysis of the two onboard CPFV observer indices will include habitat-weighted estimates based on maps of rocky reef habitat in state waters. An index from earlier MRFSS dockside sampling will be re-evaluated using updated, Bayesian methods. In addition, a SWFSC pelagic juvenile rockfish survey index and Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)/SWFSC dive surveys will be evaluated for use.

***Catch History***

Spikes in mortality estimates in the recreational fishery may need further consideration and evaluation in sensitivity analyses. Recreational discards are captured in the mortality estimates. The shore mode may need to be further examined given differences in composition compared to boat modes, potentially necessitating a separate fleet. If landings by the shore modes are a small fraction of total mortality, these may be combined with the private/rental boat mode to simplify the model structure.

Commercial catch will be broken into three sectors including trawl, non-trawl live and non-trawl dead. Other minor gear types will be combined with fleets having similar size composition data. For the commercial fishery, it is not as critical to have area-specific fleets since recent (1981-present) catches have been landed primarily in the Crescent City and Eureka port complexes.

Angler reported fish may not be identified to species and end up in Rockfish Genus (RFGEN) in recreational catch data. A sensitivity analysis to evaluate the magnitude of RFGEN by year will be undertaken given potential for underestimating the scale of the assessment through biased low mortality. There may be difficulties in parsing RFGEN to species accurately as sampled retained and discarded catch may not be representative of RFGEN composition. Since Rockfish Genus catch is not included in total mortality estimates, this will cause estimates of total mortality to be biased low for some rockfish species. The extent to which this applies to black rockfish is currently unknown, as the magnitude of Rockfish Genus mortality differs by year, area, and mode. This issue may need to be documented this cycle, but addressed in future assessment cycles, and included in research recommendations.

***Composition***

A larger mean length is observed north of Point Arena (38°57′30” N. lat.) compared to the San Francisco Bay area and counties to the south, where smaller fish are observed on average. This leads the STAT to consider defining spatially explicit recreational fleets in the model using areas as fleets to allow area specific selectivity in the northern and central regions. Spatial differences in growth could also explain differences in mean length, and lengths at age will be examined, by sex, to identify potential spatial differences in size at age. The length composition of discarded catch can be modeled as a separate fleet with smaller size composition, and this option will be explored given discard length composition data available from the recreational fishery.

***Age Data***

Roughly 2500 additional ages are available since the last assessment. Sampling conducted by CCFRP and CDFW will provide growth data for the south, for comparisons to the north, to explore differential growth as the cause for differences in length composition in each area.

***Biology***

Length at age by sex, area and time block will be explored to test for differences in growth. The natural mortality tool and sex-specific maximum observed age will be used to estimate natural mortality. The percentage of mature females at length will likely be borrowed from the Oregon study since data may be lacking in California.

Smaller fish were observed south of Point Arena in California and at least four hypotheses could explain this pattern (listed below). To the extent possible, the plausibility and implications for management quantities for each hypothesis will be explored.

- Growth differences: Smaller fish south of Point Arena may result from differences in water temperature etc. affecting growth rates. The additional ageing efforts will provide data to further evaluate spatial differences in growth.
- Northward ontogenetic movement: Smaller fish may be further to the south due to the southward movement of larvae in the California current followed by ontogenetic northward movement as cohorts grow out.
- Higher harvest rates in the south: The fishery south of Point Arena generates a higher amount of effort and removals given their proximity to population centers in San Francisco, Monterey Bay and inland cities, thus there is the potential for the length composition to be concatenated due to higher fishing mortality over time. Length data from CDFW studies during the late 1950s and early 1960s in the Monterey Bay Area can be compared to present to explore whether average lengths have declined appreciably.
- Higher natural mortality in the south: While there is no apparent difference in predation or stress on larger females in the south, higher natural mortality could be explored as a cause for concatenation of maximum observed lengths.

Implementing consistent methods of exploration between assessment areas where possible would be beneficial for review and comparability of assessment results between assessment areas.

## References

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## Appendix 1.

### SSC Groundfish Subcommittee Members Present

Dr. John Budrick, (SSC Groundfish Subcommittee Chair; STAR Panel 2 Chair), California Department of Fish and Wildlife, San Carlos, CA
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### Stock Assessment Team Members Present

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02/24/23