

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE REPORT ON 2021 GROUNDFISH STOCK ASSESSMENTS

The California Department of Fish and Wildlife (CDFW) would like to acknowledge the months of work by Stock Assessment Teams (STAT) to complete both the full and new length-based stock assessments prioritized by the Pacific Fishery Management Council (Council), and offers the following comments.

In 2020, the Council undertook a deliberative and public process to recommend and prioritize which stock assessments should be conducted in 2021, from among the more than 90 groundfish species managed under the Pacific Coast Groundfish Fishery Management Plan. Considerations included data availability and the date of the last assessment, as well as National Marine Fisheries Service (NMFS) and other capacity for assessment and review. Both copper rockfish and quillback rockfish were considered for full stock assessments in these discussions, given the significant availability of data ([Agenda Item H.2., Supplemental GMT Report 1, March 2020](#), [Agenda Item F.2, Supplemental NMFS Report 1, June 2020](#)). With limited staff available to conduct assessments and review capacity for no more than three Stock Assessment Review (STAR) panels, the Council prioritized Dover sole, lingcod and vermilion/sunset rockfish, for full stock assessments reviewed at STAR panels ([Agenda Item C.5, Attachment 1, September 2020](#)).

While copper rockfish and quillback rockfish were considered for prioritization as full assessments for the next biennium in 2023 ([Agenda Item H.2., Supplemental GMT Report 1, March 2020](#); [Agenda Item F.2., Supplemental GMT Report 1, June 2020](#)), the high Productivity and Susceptibility Analysis scores and recent catch overages ([Agenda Item F.2, Attachment 2, June 2020](#)) motivated pursuit of length-based data-moderate assessments to provide a better understanding of stock abundance before the next assessment cycle in 2023. Following the GMT's recommendation ([Agenda Item F.2., Supplemental GMT Report 1, June 2020](#)), the Council recommended copper rockfish, quillback rockfish, and squarespot rockfish for data-moderate length-based assessments in addition to the full assessments, update assessments, and catch-only projections recommended for other priority stocks.

While ambitious, the stock assessment plans for 2021 were aimed to maximize the use of available staff capacity by utilizing the newly developed length-based method to assess a greater number of stocks across their range. While the method would increase the number of assessments produced by reducing the workload, documentation, and review requirements per the [Terms of Reference](#) (TOR), the scope of data that can be included in the length-based methods is confined to catch, lengths, and fishery independent indices of abundance produced with standardized methods.

The 2021 length-based assessments were intended to better inform stock status today, superseding outcomes of the data-poor Depletion-Based Stock Reduction Analysis (DB-SRA) for quillback rockfish conducted in 2011, and the 2013 index-based data-moderate assessment for copper rockfish south of Point Conception ([Agenda Item F.5.a, Attachment 1, June 2013](#)). Though the length-based methods utilize length data not included in DB-SRA, additional data sources in Table 1 below are available that could be incorporated in full benchmark or other data-moderate quillback rockfish, copper rockfish, and squarespot rockfish assessments.

The length-based assessments for quillback rockfish ([Agenda Item G.5., Attachment 10, June 2021](#)) and copper rockfish south of Point Conception ([Agenda Item G.5, Attachment 6, June 2021](#)) indicate that the stocks are below the minimum stock size threshold (<25%). The SSC statement notes the fishery length compositions for copper rockfish are the primary data source for this stock, yet these fish are collected only from habitat open to fishing ([Agenda Item G.5, Supplemental SSC Report, June 2021](#)). CDFW recognizes

the need to include the length composition of the stock in closed areas as well (Appendix A). CDFW remotely operated vehicle (ROV) survey work is nearing completion in 2021, which includes length data inside and outside of Marine Protected Areas. The ROV methods have been reviewed and approved by the SSC to inform management ([Agenda Item G.5.a Supplemental SSC Report 1, November 2020](#)), in the context of a full stock assessment in 2023 (Table 1).

Though the results of the length-based method suggest that quillback rockfish is below the minimum stock size, this is the first indication of stock status, as the 2011 data-poor DB-SRA method did not provide any estimates. The 2013 data-moderate index-based assessment for copper rockfish south of Point Conception suggested a very healthy stock status of 76 percent of unfished spawning stock biomass, compared to 18 percent in the current assessment, which is contradictory. Although conducted eight years ago, the dramatic change in stock status between the two data-moderate assessment methods for copper rockfish south of Point Conception brings into question whether the newly-approved length-based method is a more reliable and/or better data-moderate assessment for this stock than the index-based method. This is a critical question, especially in light of the inconsistency in copper rockfish trends from this assessment when compared to recent trends in the status of other rockfishes off California, as noted by the SSC ([Agenda Item G.5, Supplemental SSC Report, June 2021](#)).

CDFW acknowledges there is widespread confidence that the assessments followed the guidance outlined in the TOR. But that isn't the only consideration when determining whether to approve these assessments. While the STAT had good reason to limit analysis to the catch and length data from long-term sport and commercial fishery monitoring programs, there were additional data sources within the scope of the TOR available for analysis as noted in Table 2 of the SSC statement ([Agenda Item G.5, Supplemental SSC Report, June 2021](#), Table 2). In the interest of examining all available data sources allowed by the TOR, CDFW requests that the STAT conduct a sensitivity analysis for each California length-based assessment to evaluate the effects of including the data noted in Table 1 below. One option for review is for the GFSC at their August meeting, or at the mop-up meeting if additional time is needed.

CDFW would also like to highlight that analysis of the length-based data-moderate methods was not completed during last year's methodology review, and a number of outstanding issues are slated for review by the GFSC in winter of 2021. This effort should offer the scientific community, the Council, and the public some useful information about the reliability of these methods in status determination ([Agenda Item G.5.a Supplemental SSC Groundfish Subcommittee Report 2, November 2020](#), appended to the SSC report, page 3 and 4), a recommendation with which the SSC concurred ([Agenda Item G.5.a Supplemental SSC Report 1, November 2020](#)). In addition, the initial methodology review of the length-based data-moderate methods indicated that they are predisposed to providing estimates of status that were systematically biased low compared to full stock assessments ([Agenda Item D.4, Attachment 2, September 2020](#), page 9).

As many have remarked in discussions this week, implementing the Allowable Biological Catches derived from the new length-based assessments would have dire and significant consequences to California's sport and commercial fisheries, and would likely require management measures to end virtually all groundfish fishery opportunities in nearshore waters. An 'overfished' determination on copper rockfish south of Point Conception and quillback rockfish throughout California would also require the development of rebuilding plans for these stocks, adding significant new and unplanned work obligations for the STAT teams. Moreover, because the TOR requires only a very abbreviated assessment review process for length-based assessments by the GFSC and SSC, the Council and NMFS would need to proceed with developing these rebuilding plans in the absence of STAR panel reviews, which offer a week-long process for evaluating uncertainties, ensuring adequate model review, and providing a comprehensive list of research and data needs. As these assessments were never slated for a STAR, it also means they have proceeded without evaluation and input from reviewers from the Center for Independent Experts.

The new length-based assessments for these stocks withstood the scrutiny of the SSC and its Groundfish Subcommittee, yet it is unknown if the method can effectively determine status compared to full assessments, or how the significant amount of un-used available data would affect the outcome of stock status, OFL and ABC in a full benchmark assessment. As the 2021 stock assessment review process continues, and looking toward the specifications and management measures, CDFW believes that as a matter of public policy, the science behind the decisions to make major course adjustments in management should be comprehensive, compelling, and thoroughly vetted in more than just a brief SSC review and a single Council agenda item slated for one hour to cover seven assessments.

Table 1. Additional data sources available for use in quillback rockfish, copper rockfish, quillback rockfish stock assessments.

Data Source	Quillback Rockfish	Copper Rockfish North	Copper Rockfish South	Squarespot Rockfish
CDFW So Cal Onboard Sampling Data 1975-1979 Collins and Crooke			Length-based D-M/Full	Length-based D-M/Full
CDFW So Cal Onboard Sampling Data 1986-1989 Alley and Ono			Length-based D-M/Full	Length-based D-M/Full
CDFW Central California Onboard CPFV Sampling Data 1987-1998 Deb Wilson-Vandenberg	Length-based D-M/Full	Length-based D-M/Full		
California Collaborative Fisheries Research Program 2007-Present- https://mlml.sjsu.edu/ccfrp/about/	Index-based D-M/Length-based D-M/Full	Index-based D-M/Length-based D-M/Full		
California Department of Fish and Wildlife Remotely Operated Vehicle Biomass Estimates and Lengths 2014 and 2020- https://www.pcouncil.org/documents/2020/09/agenda-item-d-4-a-supplemental-ssc-report-1-2.pdf/	Full	Full	Full	Full
Southern California Observer Indexes (1999-2011) SoCalOBS- https://www.pcouncil.org/documents/2015/01/data-moderate-stock-assessments-for-brown-china-copper-sharpchin-stripetail-and-yellowtail-rockfishes-and-english-and-rex-soles-in-2013-published-january-2015.pdf/			Index-based D-M/Full	Index-based D-M/Full

<p>RecFIN (dockside sampling) 1980 to 2003 - https://www.pcouncil.org/documents/2015/01/data-moderate-stock-assessments-for-brown-china-copper-sharpchin-stripetail-and-yellowtail-rockfishes-and-english-and-rex-soles-in-2013-published-january-2015.pdf/</p>	<p>Index-based D-M/Full</p>	<p>Index-based D-M/Full</p>	<p>Index-based D-M/Full</p>	<p>Index-based D-M/Full</p>
<p>Central California Observer Indexes (1988-1998) https://www.pcouncil.org/documents/2015/01/data-moderate-stock-assessments-for-brown-china-copper-sharpchin-stripetail-and-yellowtail-rockfishes-and-english-and-rex-soles-in-2013-published-january-2015.pdf/</p>	<p>Index-based D-M/Full</p>	<p>Index-based D-M/Full</p>		

Appendix 1. Percent of Habitat Area Closed to Fishing for Groundfish in the RCAs, CCAs and MPAs in California from 2001-2021.

Introduction

At present, stock assessments reliant on fishery dependent data only represent the areas open to fishing, unless there is a fishery independent data source providing information on the relative abundance and length composition in closed areas. A network of marine protected areas (MPAs) was established between 2003 to 2012 through a regional siting process. The length composition and relative abundance inside and outside MPAs in part results from the presence of MPAs prohibiting take of groundfish established prior to expansion of the current network, duration of existence of new areas, degree of effort prior to protection and criteria for selection focusing on high productivity reefs. These areas are established in perpetuity and will provide substantial protections to nearshore fish stocks for the foreseeable future.

In addition to MPAs, extensive Rockfish Conservation Areas (RCAs) of varying depths over time and space, as well as the two cowcod conservation areas (CCAs) encompassing 4200 square miles of water area since 2001, were established to facilitate rebuilding of overfished species. While the depth restrictions in these closed areas can change or be eliminated, the areas closed become refugia that reduce fishing mortality, allowing accumulation of biomass within them. There has long been interest in quantifying the area of reef habitat for each assessed species that resides in protected areas, but until very recently, there was insufficient data on the distribution of rocky reef habitat. This analysis provides the percentage of habitat area for copper and quillback rockfish closed to fishing in MPAs, RCAs and CCAs where the take of groundfish was prohibited in each year from 2001 to 2021.

Methods

Descriptions of the habitat layers: A predictive substrate layer that identifies hard and soft substrate was used to analyze seafloor coverage within the 3 nautical miles from California's shore. Substrate types were generated algorithmically using rugosity analysis, to identify areas likely to have rocky reefs. This layer was derived from bathymetric data of 2, 5 and 10 m resolution and bathymetric data were collected by California Seafloor Mapping Project (CSMP). Potential issues with this rugosity analysis include noise and artifacts resulting from unusual substrate structure, original mapping data, and steep slopes. In addition, hard substrate might be underestimated in areas with canyon slopes, deep water, over smooth rock and where sediments cover rock.

Data from the CSMP is known to have nearshore data gaps referred to as the white zone. Contributors from The University of California Santa Cruz, California Ocean Science Trust, and California Department of Fish and Wildlife (CDFW) conducted a 30 m resolution interpolation analysis to estimate hard and soft substrate within the white zone. The interpolation analysis utilized data from the CSMP and National Oceanic and the National Oceanic and Atmospheric Administration Environmental Sensitivity Index (ESI). Accuracy of the interpolation is estimated to be best where the white zone bands are narrowest and worst where the white zone bands are widest. In addition, metadata indicates the interpolation is questionable at scales finer than 100 m.

Substrate data developed for an Essential Fish Habitat Review was incorporated into this analysis for seafloor occurring outside of California State Waters (3 nautical miles). This dataset was generated by Joe Bizarro of the National Marine Fisheries Service, Southwest Fisheries Science Center in Santa Cruz and was created by combining multiple sources of bathymetric data with varying resolutions including multibeam sonar, side-scan sonar, sediment grabs, core samples seismic reflection profiles, still photos and video. This habitat data is subject to georeferencing errors and data resolution errors. Currently this is the best available data that represents hard and soft substrate types offshore for the areas outside of California State waters.

Boundaries of the CCAs, RCAs and MPAs: Regulation histories for each type of closure were converted to Boolean fields with zeros and ones indicating absence and implementation, respectively from 2001-2020. The corresponding GIS layers were either available from previous CDFW GIS staff projects or approximated by the depth contour where specific weigh points were unavailable. The area in MPAs prohibiting take by the recreational and commercial fisheries were included in the estimates of area closed to fishing from the first year in which the MPA was in place for a full calendar year. The Western CCA area accounted for waters around islands and banks open to take of a limited suite of groundfish species including copper rockfish. The RCAs for commercial and recreational fisheries were based on the deeper of the depth restrictions for the sectors to reflect only areas where take was prohibited for both. Where the RCA lines for the stock in question were not available, depth contours were used to approximate the percent of area closed.

Delineating Habitat in Restricted Areas and Open to Fishing: The depth range of habitat for copper and quillback rockfish was between shore to 100 m, covering the primary depth distribution of both stocks observed in the CDFW ROV survey (Budrick, Ryley and Prall 2020) or noted in Love et al. (2002). The latitudinal range was set from the California/Mexican border to the California/Oregon border (42°N lat.), which was stratified north and south Point Conception (34° 27' N lat.). Quillback rockfish are relatively rare south of Point Conception, thus only estimates for the area north of Point Conception are pertinent to this stock, while copper rockfish are found in both areas.

The distribution and area of rocky reef habitat within a species range was delineated in ArcGIS Pro (2.6) by extracting specific values from a 10 m bathymetric raster based on species depth and latitudinal ranges. The resulting raster layer was converted into a shapefile and merged with a coastal boundary of California to account for gaps in the bathymetric raster. Hard habitat within the species range was identified and isolated using the intersect tool to create species range shapefile. This process was repeated to identify overlapping coverage between the species range and hard substrate, as well as intersecting the species range with a combination of different types of regulatory boundaries.

The area of the resulting shapefiles were calculated in GIS and exported into tables using Python script. The combination of area closures in a given year were overlayed on the habitat maps, with the area in MPAs and CCAs extracted first, then the habitat in the remaining RCAs estimated. The residual habitat still open to fishing after accounting for the closed areas was then estimated. The area of rocky reef habitat closed to fishing within a species range was converted to a percentage of the total habitat. This process for identifying overlapping

boundaries and calculating areas were scripted in Python to reduce the possibility of human error.

Examination of bottom type coverage relative to habitat.

The extent of existing substrate data within a given species range was examined through geospatial analysis. This included hard, soft, and unknown substrate for data from California Seafloor Mapping Project, and hard, mixed, and soft data from the EFH project. Both datasets were merged within the species range for copper and quillback rockfish. The resulting combination of substrate data was erased from the species range.

Results

The tables reflecting the percent of habitat area in RCAs, MPAs, CCAs closed to fishing for groundfish and waters open to fishing are provided for north of Point Conception (Table A- 1) and south of Point Conception (Table A- 2). The potential habitat within the depth primary depth range of the species, rocky reef habitat within the potential habitat, MPAs and CCAs are depicted for the entire state (Figure A- 1) and various regions along the state in (Figure A- 2, Figure A- 3, Figure A- 4 and Figure A- 5).

We found minimal voids in coverage in habitat layers across the species range, with 0.13 square miles missing north of Point Conception and 4.95 square miles missing from the south of Point Conception.

Table A- 1. Percent of rocky reef habitat within 100 meters in MPAs, RCAs closed to fishing for groundfish and waters open to fishing in California north of Point Conception.

Year	Percent Protected by MPA	Percent Protected by RCA	Percent Open to Fishing
2001	3%	0%	97%
2002	3%	0%	97%
2003	3%	41%	55%
2004	3%	23%	73%
2005	3%	30%	67%
2006	3%	30%	67%
2007	3%	28%	69%
2008	11%	27%	62%
2009	11%	27%	62%
2010	11%	33%	56%
2011	17%	29%	54%
2012	17%	29%	54%
2013	20%	27%	53%
2014	20%	27%	53%
2015	20%	24%	56%
2016	20%	24%	56%

2017	20%	14%	66%
2018	20%	14%	66%
2019	20%	11%	68%
2020	20%	13%	67%
2021	20%	5%	75%

Table A- 2. Percent of rocky reef habitat within 100 meters in MPAs, RCAs, CCAs closed to fishing for groundfish and waters open to fishing in California south of Point Conception.

Year	Percent Protected by MPA	Percent Protected by RCA	Percent Protected by CCA	Percent Open to Fishing
2001	1%	0%	34%	65%
2002	1%	0%	34%	65%
2003	1%	16%	34%	49%
2004	4%	10%	34%	52%
2005	4%	10%	34%	52%
2006	4%	10%	34%	52%
2007	4%	10%	34%	52%
2008	4%	10%	34%	52%
2009	4%	10%	34%	52%
2010	4%	10%	34%	52%
2011	4%	10%	34%	52%
2012	8%	10%	34%	48%
2013	8%	10%	34%	48%
2014	8%	10%	34%	48%
2015	8%	10%	34%	48%
2016	8%	10%	34%	48%
2017	8%	10%	34%	48%
2018	8%	10%	34%	48%
2019	8%	10%	25%	57%
2020	8%	10%	25%	57%
2021	8%	10%	25%	57%

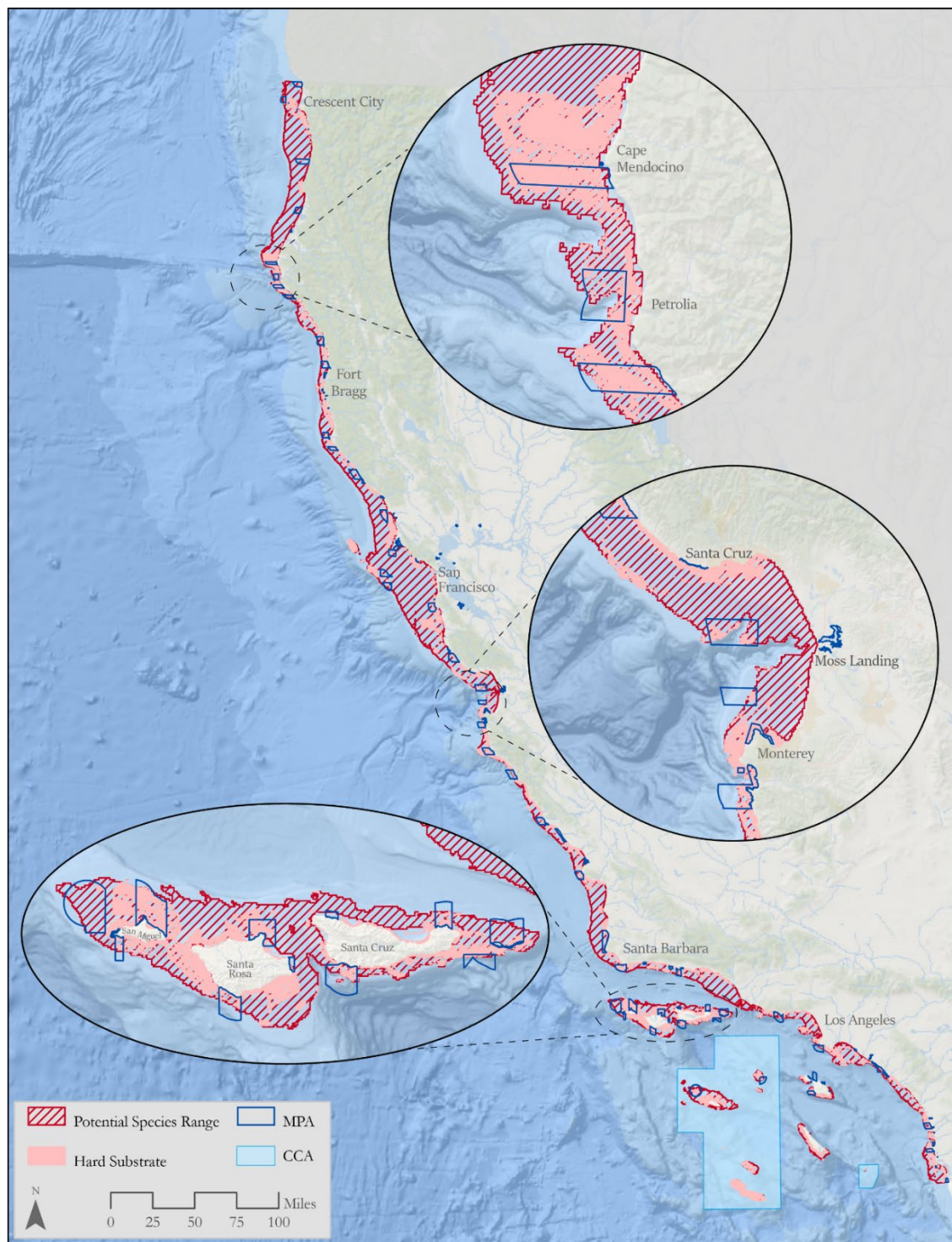


Figure A- 1. Copper and quillback rockfish potential depth range off California in red hatched polygon, hard substrate occurring within the potential range in pink, MPAs in dark blue outline, and the CCAs in light blue.

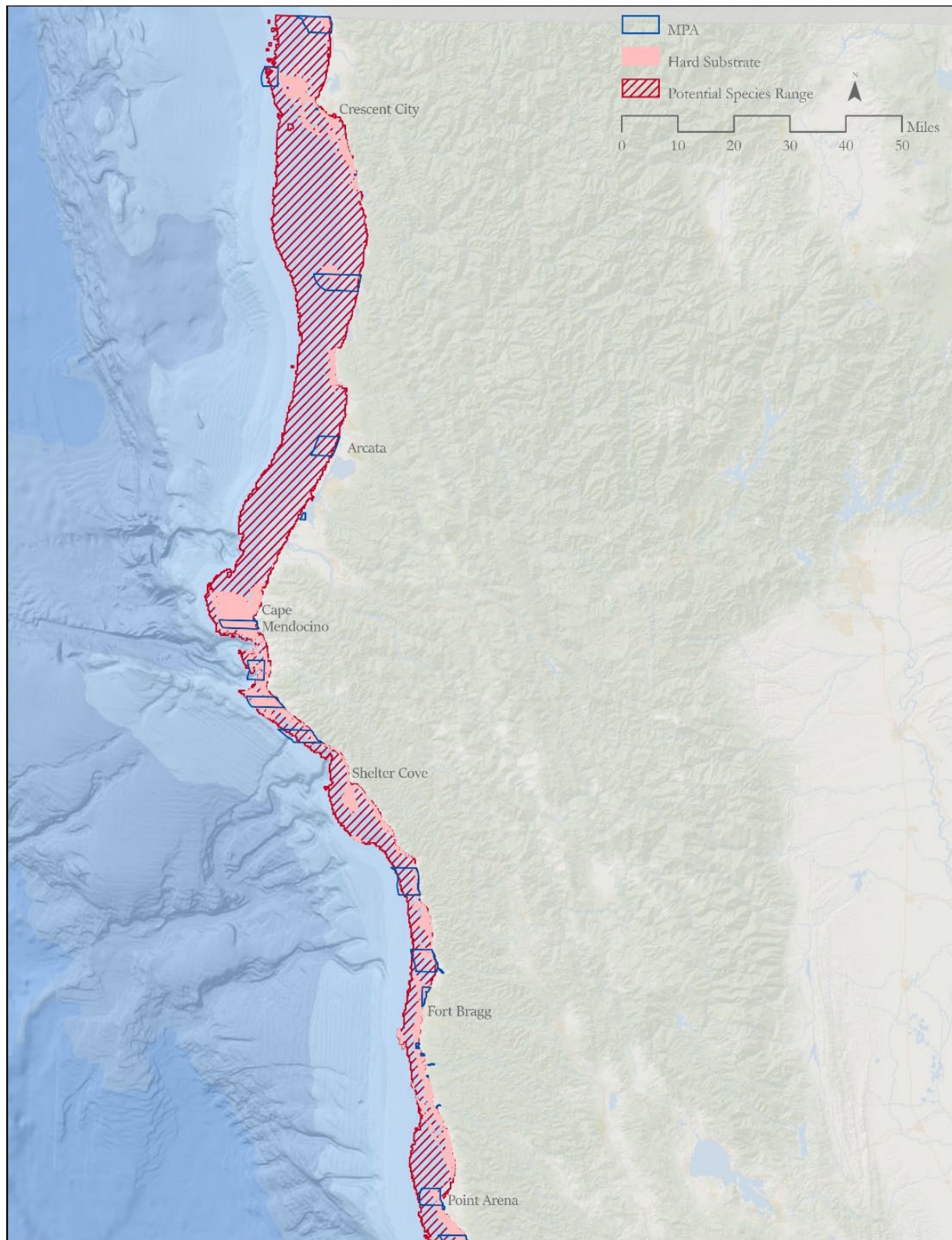


Figure A- 2. Copper and quillback rockfish potential depth range in red hatched polygon, hard substrate occurring within the potential range in pink and MPAs in dark blue outline between the Oregon/California border (42° N lat.) and Point Arena, California (38°57.5' N lat.).

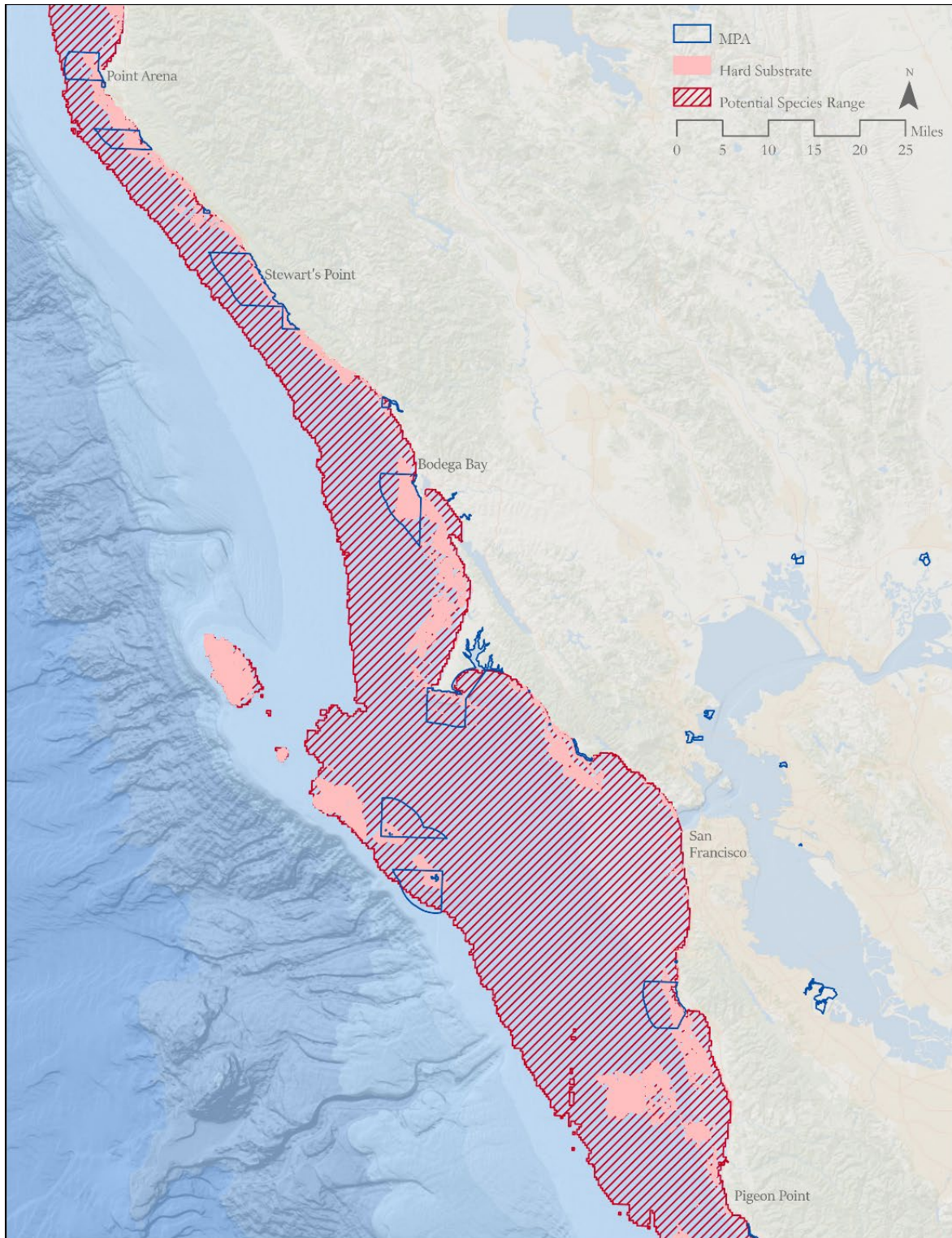


Figure A- 3. Copper and quillback rockfish potential depth range in red hatched polygon, hard substrate occurring within the potential range in pink and MPAs in dark blue outline between Point Arena (38°57.5' N lat.) and Pigeon Point, California (37°11' N lat.).

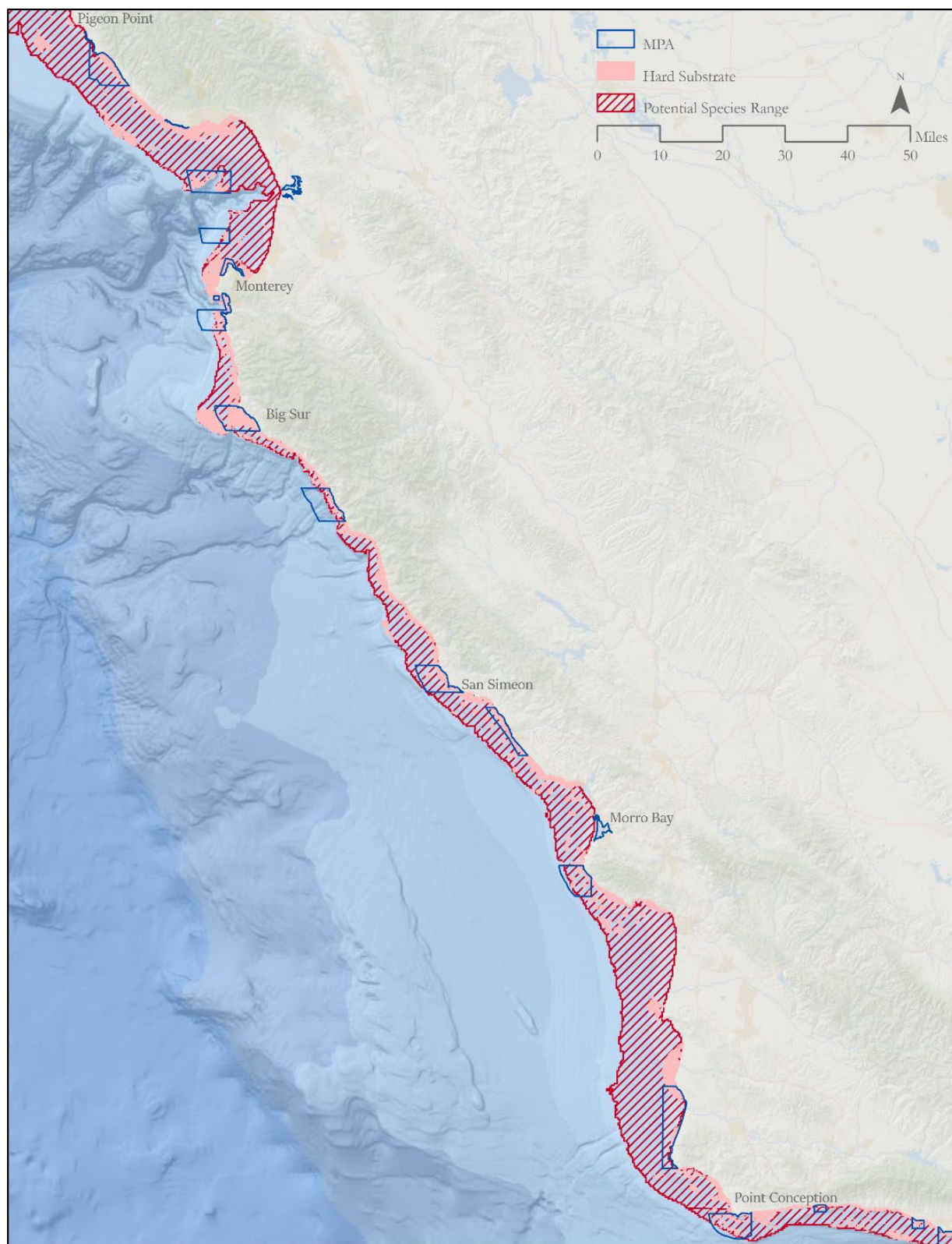


Figure A- 4. Copper and quillback rockfish potential depth range in red hatched polygon, hard substrate occurring within the potential range in pink and MPAs in dark blue outline between Pigeon Point (37°11' N lat.) and Point Conception, California (34° 27' N lat.).

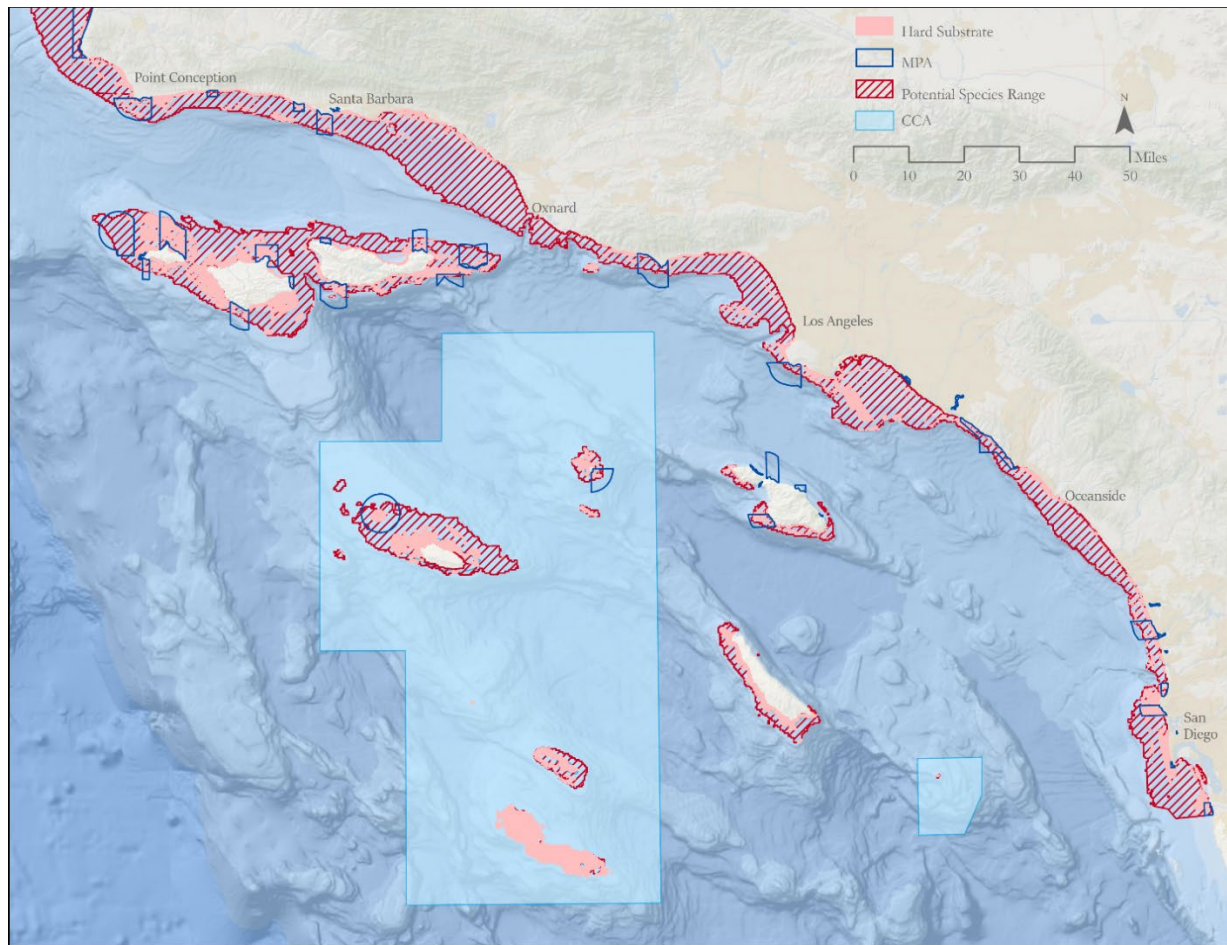


Figure A- 5. Copper rockfish potential depth range in red hatched polygon, hard substrate occurring within the potential range in pink, MPAs in dark blue outline, and the CCA in light blue between the Point Conception, California (34° 27' N lat.) and the U.S./Mexican border.

Discussion

Current assessments do not account for length/age composition and differing fishing mortality rates inside and outside MPAs or waters in long-established CCAs and RCAs. As biomass accrues inside these areas, accounting for protections through area-based assessment methods or effects on selectivity should be considered as fishery dependent data will only reflect the length composition and density outside. There is the potential for future assessments to account for differences in length composition, fishing mortality and relative abundance in a two-area model in Stock Synthesis with available data from long-term MPA monitoring.

Additional high resolution side scan sonar data in waters seaward of the CSMP coverage would improve coverage and resolution of habitat data. Similar analyses for each nearshore or shallower distributed shelf rockfish species (i.e., vermilion rockfish) would be a helpful addition to stock assessments to inform time blocking and selectivity considerations. The extent and design of the network to function in this way is unique to California and its efforts to conserve nearshore stocks. Until the closed areas can be accounted for explicitly in stock assessments, the

substantial areas in MPAs should be taken into consideration as a buffer against overfishing, since they were established in the interest of preserving spawning stock to seed areas outside and other MPAs in the network.

References

Budrick J.E., Ryley L. and M. Prall. 2019. Methods for using remotely operated vehicle survey data in assessment of nearshore groundfish stocks along the California coast. Pacific Fishery Management Council, Portland, OR.

Love M.S., Yoklavich M. and L. Thorsteinson. 2002. Rockfishes of the Northeast Pacific University of California Press, Berkeley, CA