Summary of the Management Strategy Integration Process for the North Coast Recreational Red Abalone Fishery Management Plan

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Table of Contents

Section I - Executive Summary

This summary provides an overview, results, and recommendations from the collaborative process to develop integrated management strategies for the North Coast recreational red abalone fishery management plan (FMP). The red abalone management strategy integration process (integration process) was initiated in January 2019 in response to results from a peer review led by the Ocean Science Trust (OST) of two proposed management strategies submitted by the California Department of Fish and Wildlife (CDFW) and a Nature Conservancy (TNC)-led stakeholder group. Guidance from the Commission, peer review panel, and the public informed the design and focus of an integration process to: (1) integrate the two peer reviewed management strategies and evaluate via Management Strategy Evaluation (MSE), (2) to allow for a *de minimis* fishery option within the FMP, (3) develop triggers for the *de minimis* fishery alongside stakeholders, and (4) allow for public and Marine Resources Committee (MRC) engagement. The Administrative (Admin) Team, Project Team (i.e., the public), and a team of quantitative fisheries modelers supported this collaborative project. See **Appendix I** for the Administrative and Project Team Charters.

The integrated management strategies focused on defining thresholds within an indicator-based framework to trigger the transition to and from closed to *de minimis*[1], *de minimis* to open, and open to closed management statuses. During the Project Team meetings, a recurring theme was the need to better coordinate and standardize data collection efforts across the state, as well as the importance and desire for stakeholder participation in data collection. The Admin Team, Project Team, and modelers supported harvest control rule (HCRs) that focused on near-term efforts to rebuild the red abalone resource. HCRs are applied at the fishing zone level and are structured in the form of a decision tree with two indicators (length-based spawning potential ratio (SPR) and density) that would be implemented using a “traffic light” method (see **Section III** and **Appendix A**). Both length and density data streams were considered in the original management strategies from CDFW and the TNC-led stakeholder group, and the associated indicators were extensively discussed by the peer review panel and were also supported by the Project Team. Finally, an Exceptional Circumstances strawman proposal (see **Appendix G**), outlining a draft protocol to respond to unforeseen or

1 ‘... level of catch that is anticipated to have little to no effect on the health or recovery of a fishery resource.’ See glossary in **Appendix H**

extreme environmental conditions was included as a precautionary first step before consulting the decision tree.

The Project Team aligned on exploring two or three fishing zones to monitor and manage the fishery. The two-zone approach considered one zone with Marin and Sonoma counties and a second zone with Mendocino, Del Norte, and Humboldt counties. The three-zone approach considered one zone with Marin and Sonoma counties, a second zone with Mendocino county, and a third zone with Del Norte and Humboldt counties. The three fishing zone approach received significant support (in the form of a support letter from over 2,000 recreational divers), emphasizing the need to manage Humboldt and Del Norte counties separately because of biological and ecological differences in the marine environment. There was significant interest in exploring how to collect data in and ultimately manage data-poor zones like Humboldt and Del Norte counties, with the potential to mirror any outlined approach in southern California.

Within each fishing zone, three management statuses are possible - closed, *de minimis*, open. If the status of a fishing zone is designated '*closed,*' there would be no harvest allowed and the TAC would be defined as zero. Data collection and research activities must continue under a closed fishery to increase understanding of the status of the red abalone resource and the environment. A biological fishery (bio-fishery) was discussed that would allow for limited harvesting activities to fishermen in alignment with pre-defined research objectives, even when the fishery is closed. If the status of a fishing zone is designated '*de minimis*' then a limited level of harvest is allowed through a static (i.e. fixed) TAC. In a *de minimis* fishery it is possible to harvest at all sites within the zone (excluding Marine Protected Areas or closed sites). Over the course of six Project Team meetings, a draft *De Minimis* Fishery Strawman Proposal (see **Appendix F**) was developed that outlined management tools to provide adequate flexibility within the FMP that allows for more responsive and adaptive management, particularly under changing environmental conditions. Finally, if the status of a fishing zone is designated '*open*' this signals an end to the rebuilding period, at which point higher levels of harvest (beyond those of *de minimis* fishery or bio-fishery) could occur at all sites within the zone (excluding Marine Protected Areas or closed sites).

The Project Team helped to identify and refine a range of options for management measures, particularly with respect to the *de minimis* fishery, some of which could carry over into an open fishery. Management measure options included season length, daily bag/possession/annual limit, number of permits, size limit, number of management zones, as well as a data collection scheme, allocation scheme for permits, and potential special conditions for permits. The proposed management

strategies outlined in this process are also expected to function in conjunction with other existing management regulations.

This report and its appendices (see **Appendix A, Sections 3B** and **3G**) provide a comprehensive overview of base model configurations for the MSE, management strategies and catch levels evaluated, and results from the simulation modeling conducted for the two fishing zone configuration, as well as theoretical analyses to begin exploring a third fishing zone. Two operating models are explored in the MSE that consider uncertainty in how long poor environmental conditions will persist (e.g. through 2020 or prolonged through 2022). Originally, four management strategies were evaluated within each operating model for the two fishing zone configuration, each representing a different combination of reference points for SPR and density. Four total allowable catch (TAC) levels were also simulated for a *de minimis* fishery - 5,000, 10,000, 20,000 and 40,000 individuals per fishing zone. In addition to analyses to evaluate the sensitivity of the operating models to alternative red abalone productivity levels, assumptions about fecundity, and population scaling, an additional six management strategies were evaluated to assess the impact of changing factors such as size limit, density reference points, and density confidence intervals (CIs).

The length of time that it will take for the red abalone resource to recover to a point where it is possible to support an open fishery (i.e., time to recovery) is a function of four primary factors: (1) how depleted the red abalone resource is in the year 2021, (2) the productivity level of the stock, (3) the reference points selected, and (4) future environmental conditions. Median rebuilding times from a closed status to a *de minimis* fishery varied between 11 and 31 years across the different operating models, fishing zones, and rebuilding strategies. Simulated prolonged poor environmental conditions resulted in a longer recovery period, with an additional 8-10 years needed until *de minimis* fishery status was achieved. In the absence of fishing, the median recovery times from closed status to an open fishery status ranged between 28 and 59 years, depending on the operating model, fishing zone, and rebuilding strategy reference points. It was also possible to determine what level of fishing would be possible during a *de minimis* fishery. In the zone including Mendocino, Del Norte, and Humboldt counties, a *de minimis* TAC at levels between 20,000 to 40,000 would affect recovery. In the zone including Marin and Sonoma counties, a *de minimis* TAC greater than 10,000 would affect recovery.

There are considerable trade-offs to be considered with respect to the selection of a management strategy and *de minimis* TAC for the North Coast recreational red abalone fishery. While some management strategies (see A & C in **Section III**) offered the shortest times to open fishery status, others (see B & D in **Section III**)

had a longer recovery timeline to achieve an open fishery, but result in greater red abalone biomass recovery before fishing activities occur. More conservative (i.e. higher) SPR and density reference points will provide the greatest biological protection but fewer fishing opportunities, and the reverse is true where lower reference points result in increased fishing opportunities but reduce biological protections for the resource. Layered on top of this, the magnitude of the TAC chosen for the *de minimis* will impact how long it takes to rebuild the stock to a level where an open fishery could be triggered. Increasing the *de minimis* TAC results in a longer timeline to achieve an open fishery status. Additional management considerations, such as increasing size limits to 8” or 9” could reduce the time to recovery for an open fishery by two to three years. Within this work, the modelers also acknowledged limitations and uncertainty of the simulation modeling work and how this was addressed in the MSE and within HCR design. Because of time constraints associated with the computational intensity of the analyses and the tight process timeline, it was not possible to examine all possible management strategies and narrowing down of the potential indicators also provided computational efficiencies.

The Project Team generally agreed to a lottery allocation approach to distribute recreational opportunities, in the event that the demand to fish exceeded the number of available permits. They also considered how Tribal subsistence fishing could occur within the FMP and suggested that Tribal subsistence fishing could occur by allocating a subset of the overall TAC designated for either a *de minimis* or open fishery to Tribes and Tribal communities.

At the conclusion of the integration process, the Admin Team considered Project Team feedback and modeling results to develop the following eight recommendations for consideration by the Commission to guide FMP development (see **Section VI** for more detail):

1 Consider selecting a management strategy (or consider developing a new one) that addresses the charge provided by the Marine Life Management Act and Commission goals, while being mindful of the Project Team guidance.
2 Explore a citizen science-driven data collection program for Humboldt and Del Norte counties that could inform the development of a management strategy and inform future management of these data-limited counties.
3 Consider a bio-fishery as a means of allowing for near-term recreational harvest opportunities, that also helps support the state's data collection needs.
4 Consider adopting the *De Minimis* Fishery Strawman Proposal as guidance for CDFW to incorporate into the draft recreational red abalone FMP.
5 Support further development of the Exceptional Circumstances Strawman Proposal with interested stakeholders, ensuring that any indicators used are aligned with peer review guidance.
6 Prioritize research needs to enhance the management of the red abalone resource off California.
7 Request that CDFW develop a data management plan with stakeholders to better coordinate and streamline data collection efforts across the state.
8 Consider selecting an allocation scheme for recreational permits that uses a preference point lottery system for recreational permits and explore a pathway for the Commission to gain authority to consider allocating a subset of the recreational fishery TAC to Tribes and Tribal communities for subsistence.

Section II - Summary of Management Strategy Integration Process

This section is intended to provide an overview of the management strategy integration process developed to ensure collaborative and transparent decision-making and strengthen the scientific merits of the North Coast recreational red abalone fishery management plan (FMP). This includes a summary of those processes and events that were precursors to and influential in shaping the scope of the integration process, as well as a synthesis of key milestones throughout.

A. Overview of Peer Review Process

As set forth in the Marine Life Management Act (MLMA), the scientific basis of a draft FMP may undergo external, independent peer review prior to submission to the California Fish and Game Commission (Commission); this process is one way to provide the Commission and stakeholders with assurance that FMPs are based upon the best scientific information available. The Ocean Protection Council (OPC) provided a grant to OST to facilitate a scientific peer review for the management chapter of the FMP for the North Coast recreational red abalone fishery. At the request of the Commission, at its December 2017 meeting in San Diego, CA, two management strategies, one provided by CDFW and one provided by TNC-led stakeholder team, were included within the peer review. The peer review assessed the scientific and technical components of both the CDFW and TNC-led management strategies to provide a rigorous underpinning for management decisions and regulatory action for the recreational fishery, should they be implemented.

From May 2018 to October 2018, the peer reviewers conducted a thorough review. Peer reviewers acknowledged that data were very limited to describe the red abalone resource and associated ecosystem, and concluded that both management strategies should be revised to reduce uncertainty; they recommended that any final management strategy incorporate a suite of indicators to present the clearest picture of red abalone status. Additionally, they recommended that the management strategies could be strengthened through integration to reduce uncertainty, take advantage of the best available science, and to "ensure accurate and timely tracking of the red abalone population, subject to cost constraints." The final Recreational Red Abalone Peer Review Report, including a key themes summary from the first public community webinar, is accessible online.[2]

2 http://www.oceansciencetrust.org/wp-content/uploads/2018/10/AbalonePeerReview_Final_Oct2018.pdf

The peer review panel outlined nine key recommendations (see below). Within **Section V** of this report, we provide further clarity on how these recommendations were explicitly considered and incorporated.

1 These two management strategies should be integrated to reduce uncertainty and take advantage of the best available science.
2 The way to integrate indicators, data streams, and analysis should be tested and analyzed using simulation testing from a formal operating model specified to capture low-density population dynamics specific to red abalone.

When Managing Under a Closed Fishery -

3 All indicators chosen must be clearly defined, and ideally, all candidate reference points for any indicator should be tested using simulation testing in a closed loop analysis.
4 A multi-indicator approach, with little to no tiering, where not all indicators need to be met (i.e. not adopting a “one out, all out” approach), may be more flexible and informative given the uncertainty of changing ocean conditions and the response of red abalone to these changes. The structure of this approach and choice about whether to make it sequential (single indicators triggering another single indicator and so on), tiered (groups of indicators that trigger next tiered group of indicators and so on), or simultaneous (all indicators assessed simultaneously) can and should be tested using a formal operating model, thus building in a structure that is not subjective.

When Managing Under an Open Fishery -

5 Setting reference points for every indicator is critical. (See also recommendation 3)
6 All indicators should be evaluated alongside each other in formal simulation modeling to set reference points and to test and determine the appropriate suite of indicators.
7 All indicators need to transparently indicate, and then formalize, the way in which they deal with uncertainty.
8 The science underlying setting catch levels needs to be re-evaluated and re-configured.
9 Align the re-opening plan to match how the fishery is managed under other management scenarios to streamline data collection, analysis, and the decisions that follow.

B. Fish and Game Commission Directive

The recommendations from the OST-facilitated peer review were first presented to the Commission at its October 2018 meeting in Fresno, CA. Following the October 2018 Commission meeting, Commissioners and staff had time to synthesize peer review outcomes. They also engaged in additional conversations with stakeholders about the desire for limited harvest opportunities while the red abalone resource recovered, referred to as a *de minimis* fishery.[3] The Commission then made the following motion at its December 2018 meeting in Oceanside, CA to inform the development of the North Coast recreational red abalone FMP:

(1) Support addressing peer review recommendations to integrate aspects of both draft management strategies, based on a simulation modeling approach co-developed by CDFW and the TNC-led stakeholder team, including engagement with abalone divers and other stakeholders; (2) revise Fishery Management Plan (FMP) goals to allow for a de minimis fishery option; (3) develop triggers for the de minimis fishery option in consultation with stakeholders; and (4) request that CDFW develop a proposed process and timeline which accounts for active public and Marine Resources Committee (MRC) engagement.

C. Structure and Timeline of Process

With guidance provided by the Commission motion, the management strategy integration process was initiated in January 2019 and originally outlined on a one-year timeline. This timeline was revised throughout the process to be more responsive to the needs of the public, including allowing more time to incorporate public comment and allowing for meeting rescheduling due to wildfires and power outages that would have decreased participation. Groups critical to this integration process included the Admin Team and Project Team, where the Project Team (i.e., the public) was provided quantitative support from a group of modelers.

The Admin Team is a consensus-based decision-making group charged with ensuring that the management strategies integration process occurred in a collaborative, efficient, and timely manner and informs a revised management chapter for the recreational red abalone FMP, in line with the motion from the Commission (see **Appendix I** for charter). The Admin Team is comprised of one

3 The concept of a *de minimis* fishery continued to evolve over the course of the management strategy integration process, as reflected in the summaries in **Appendix B**. The final definition updated in the glossary defines it as *"A fishery with a level of catch that is anticipated to have little to no effect on the health or recovery of a fishery resource. It is applied at the fishing zone level and occurs based on predefined thresholds set in an associated harvest control rule."*

representative from the CDFW, OPC, Commission, TNC, recreational red abalone fishing industry, and the Tribes, with designated alternates (Table 2.1).

Table 2.1. Admin Team Members and Roles

Name	**Role**
Sonke Mastrup	CDFW Primary Representative [Secretary]
Ian Taniguchi	CDFW Alternate
Paige Berube	OPC Primary Representative
Jenn Eckerle	OPC Alternate
Elizabeth Pope	Commission Primary Representative
Maggie McCann	Commission Alternate
Alexis Jackson	TNC Primary Representative [Chair]
Kate Kauer	TNC Alternate
Joshua Russo	Industry Primary Representative
Jack Likins	Industry Alternate
Javier Silva	Tribal Representative, Sherwood Valley Pomo

Admin Team engagement began in January 2019. The group met, on average, bi-weekly for 1.5-hour conference calls, and was integral to engaging the broader public in the integration process, largely through Project Team meetings. Preparation for Project Team meetings and overall process management organization involved coordination and tasking of the modeling work, reviewing and responding to stakeholder proposals for the *de minimis* fishery, and developing meeting materials for review by the public, including a glossary (see **Appendix H**) to ensure a common understanding of technical vocabulary, the Data Stream Comparison table (see **Appendix E**), and strawman proposals for the *de minimis* fishery (see **Appendix F**) and management in the face of unusual or extreme environmental circumstances (see **Appendix G**). Strategic Earth Consulting was contracted to provide neutral facilitation support for and between Project Team meetings. The Admin Team also provided updates in March, July and November 2019 to the Commission's MRC, as well as the full Commission in October 2019.

The Project Team was an advisory group open to members of the public (see **Appendix I** for charter), including all members of the Admin Team and the modelers. Its primary purpose was to discuss and provide feedback on all scientific analyses conducted and provide input on the framework for a *de minimis* fishery. Such advice is critical to informing the revised management chapter for the North Coast recreational red abalone FMP. Throughout the integration process, representation included non-governmental organizations (NGOs), academic researchers, recreational and commercial industry, Tribes and Tribal communities, and state and federal agency staff. Members of the public who consistently engaged in Project Team meetings had the opportunity to identify themselves as 'core' Project Team members. Core Project Team members were helpful in reviewing Project Team meeting summaries to ensure they accurately captured key discussion points and next steps before they were finalized and shared with the full Project Team, as well as this Admin Team report.

Project Team engagement began in May 2019. The Project Team met six times throughout the process in a combination of two four-hour webinars and four full day, in-person meetings (see **Appendix B** for key themes summaries and meeting highlights). All in-person meetings were convened in Santa Rosa, CA. Project Team meetings provided an opportunity for the quantitative fisheries modelers and Admin Team to share new information and results and engage in a multi-directional dialogue with the Project Team to learn of their perspectives, priorities, and recommendations. In advance of and following all Project Team meetings, materials from the Admin Team and/or modelers were circulated to Project Team members via email and posted to the OPC website for their review and feedback. Meeting materials included, but were not limited to: agenda, strawman proposals or modeling summaries, and PowerPoint presentations. Project Team meetings convened by webinar were also recorded and made available on the OPC website.

The Project Team and quantitative fisheries modelers exchanged information and ideas during meetings to guide the development of the MSE. The MSE was conducted by lead modeler (Bill Harford, University of Miami), who worked in consultation with state agency and NGO staff (Table 2.2).

Table 2.2. Modeling Consultants.

Name	Organization
Julia Coates	CDFW
Laura Rogers-Bennett	CDFW
Jono Wilson	TNC

The lead modeler led on all scientific analyses, as well as on report and presentation drafting. Separate modeling-focused calls, focused on the technical details of the models that were beyond the scope of Project Team discussions, were scheduled and attended by the Chair of Admin Team and facilitated by Strategic Earth. These calls provided opportunities for input and feedback to be incorporated by supporting CDFW and TNC staff based on the latest model revisions and results from the MSE. Given the highly technical nature of these calls, they were not open to the Project Team. A full day in-person meeting was also scheduled in August 2019 for the modelers and Admin Team to outline potential scenarios for the MSE and discuss assumptions and parameters of the operating model. While the Project Team was not engaged at the level of modeling-focused calls, the results of these discussions, as well as a high-level summary of the modeling efforts, were shared and discussed with the Project Team.

Upon conclusion of the public-facing portion of the integration process (i.e., the Project Team) in December 2019, the Admin Team was charged to deliver a final report to the Commission. Next steps for the development of this report, and opportunities for future public engagement were outlined at the final Project Team Meeting (see **Appendix B**). The Admin Team noted that it would provide a draft of its report to the core Project Team for review before submitting to the MRC for consideration and discussion. If endorsed by the MRC, the Admin Team would then incorporate any necessary changes and deliver a final report to the Commission at its April 2020 meeting. Upon approval by the Commission, the CDFW-led FMP redrafting process will occur during the remainder of 2020, with potential FMP adoption in 2021.

Milestone meetings and guidance from the management strategy integration process are outlined below:

January 2019

- Management strategy integration process was initiated, reflective of Commission directive.

- Modeling support acquired for Project Team (Dr. Bill Harford).

February 2019

- Management strategy integration process timeline and structure outlined for MRC consideration.
- Admin Team Charter and Project Team Charter drafts developed.

March 2019

- **March 20:** MRC Co-Chairs endorsed increased public engagement through Project Team and approved the overall process involving completion of simulation modeling work, design of a *de minimis* fishery, design of an integrated management strategy, and final Admin Team report development.
- Admin Team Charter finalized.

April 2019

- Admin Team continues preparation for first Project Team meeting (May 2019).

May 2019

- OPC finalized a grant to support third-party neutral facilitation of the Project Team meetings.
- Admin Team solicits proposals and ideas from the public related to the red abalone FMP process for the Project Team's consideration, including proposals for a *de minimis* fishery. Proposals received and accepted between May 22, 2019 and December 18, 2019 received a response from the Admin Team and were posted publicly on the OPC project webpage.
- **May 22:** Project Team Meeting #1: "*Review and Discuss Management Strategies and Brainstorm on Managed/Restricted Access Fishery Options,*" was held in-person in Santa Rosa. The Project Team Work Plan and Project Team Charter were shared and reviewed. See **Appendix B** for key themes and discussion highlights.

June 2019

- Admin Team developed a Glossary of Key Terms (**Appendix H**) for the red abalone management strategy integration process to help support Project Team discussions.
- Admin Team developed a Data Streams Comparison Table (**Appendix E**) that outlines available sources of information, as well as associated costs, to

inform ongoing management of the North Coast recreational red abalone fishery, which was continually updated to serve as a reference to inform ongoing red abalone FMP Project Team discussions. Tribes and Tribal communities are still working to provide traditional ecological knowledge data streams for this table.

- Admin Team developed a Proposed Next Steps for Modelers document.
- Admin Team followed up on data requests from the May 22 meeting (e.g., accessing Reef Check California data) and investigated other available data sources to inform the July 18 discussion.
- Admin Team developed a draft *De Minimis Fishery* Strawman Proposal (**Appendix F**) to inform July Project Team meeting.

July 2019

- **July 11:** Representatives from CDFW and TNC provided an update to the MRC on the progress of the overall red abalone management strategies integration process.
- **July 18:** Project Team Meeting #2: *"Update on Work Plan and Discussion of Data Streams and De Minimis Fishery Design Options,"* was held via webinar. See **Appendix B** for key themes and discussion highlights.
- Admin Team updated the Proposed Next Steps for Modelers document.
- The Admin Team continued updating the Data Stream Comparison Table to include the Marine Protected Area (MPA) monitoring data (which was shared with modelers) and to provide a more comprehensive picture of associated costs or potential cost savings associated with the available data streams to support a draft management strategy.
- The Admin Team broadened representation on the team by welcoming Javier Silva of the Sherwood Valley Band of Pomo Indians to continue learning how best to collaborate with Tribes and Tribal communities in FMP development and implementation.

August 2019

- **August 27**: Project Team Meeting #3 "*Discussion of Draft Management Strategies*," was held in-person in Santa Rosa. See **Appendix B** for key themes and discussion highlights.
- The Admin Team provided a high-level summary of the draft management strategy to support the Project Team discussion on August 27.
- During the August Project Team meeting, the Project Team reviewed a draft management strategy for a *de minimis* recreational red abalone fishery along

the North Coast, including a discussion of HCR design (i.e., decision tree using traffic light approach), proposed indicators, and potential data streams.
- Admin Team updated the Data Streams Comparison Table and developed an updated Next Steps for Modelers document following the August Project Team meeting.
- Following the August 27 Project Team meeting, the Admin Team facilitated an in-person working meeting for the modelers to discuss feedback from the Project Team and decide on next steps to advance work.

September 2019

- **September 19:** Project Team Meeting #4, *"Revised Management Strategy & Continued Discussion on De Minimis Fishery,"* was held via webinar. See **Appendix B** for key themes and discussion highlights.
- The draft Technical Report on the Revised Management Strategy was posted publicly for review.
- The modelers next steps included conducting a MSE for the proposed two fishing zones. Upon reviewing proposals for other fishing zone configurations, the modelers would assess current availability of data and run one additional zone alternative through the MSE. Proposals involving zones with very low TACs (like those indicated by the data-limited fishery that has been discussed) will not require MSE to evaluate and will continue to be discussed and evaluated by the Admin and Project Team outside of the framework of MSE.
- The Project Team was invited to submit county or landmark-based boundaries for alternative fishing zone configurations by October 4, 2019 for consideration by the modelers.
- The Admin Team updated the draft *De Minimis Fishery* Strawman Proposal to reflect the management measures and allocation ideas and priorities shared by the Project Team and identified elements requiring further discussion, as well as updated the Next Steps for Modelers document.

October 2019

- After careful consideration, a Project Team webinar that was initially scheduled for October 30, 2019 was rescheduled due to the wildfires and power outages that were impacting North and Central California where many stakeholders were based.

November 2019

- **November 5:** Admin Team provides update on MSE results and outstanding issues to the MRC
- Admin Team developed a draft Exceptional Circumstances Strawman Proposal (see **Appendix G**) to inform the November Project Team discussion.
- **November 21**: Project Team Meeting #5, "*Review Management Strategy Evaluation Results & Develop Recommendations for Draft De Minimis Fishery,*" was held in-person in Santa Rosa. See **Appendix B** for key themes and discussion highlights.
- Admin Team updated Next Steps for Modelers document, *De Minimis Fishery* Strawman Proposal, and Exceptional Circumstances Strawman Proposal to reflect the November 21 Project Team discussions and feedback.
- Project Team continued to submit public comments and/or proposals (see **Appendix D**).
- The Modelers completed the tasks outlined in the Next Steps for Modelers document, including evaluating additional management strategies for a two-zone MSE, impacts of increasing the size limit on abalone recovery and fishing opportunities, a sensitivity analysis on red abalone size limit, and hypothetical modeling of a sampling regime under a scenario with three fishing zones.

December 2019

- **December 19:** Project Team Meeting #6, "*Develop & Confirm Guidance for the North Coast Recreational Red Abalone Management Strategy*," was held via webinar; the Project Team developed specific feedback on MSE and *de minimis* options to inform the Admin Team's final report to the Commission. See **Appendix B** for key themes and discussion highlights.

January and February 2020

- Modelers finalize Technical Report on MSE.
- Admin Team developed draft report to the Commission to share with Project Team for feedback.
- Admin Team incorporating Project Team guidance and feedback and submits draft report to the Commission one month in advance of the March 2020 MRC meeting.

March 2020

- **March 17:** Admin Team presented draft report at the MRC

Please note that many of the aforementioned documents were updated continually throughout the management strategy integration process to incorporate Project Team feedback and inform ongoing Project Team discussions. All resources regarding the recreational red abalone Project Team, including Project Team meeting agendas, meeting materials, presentations, and webinar recordings, are available on the OPC red abalone management strategies integration webpage. For more information on the red abalone fishery management plan (FMP), please visit the CDFW Red Abalone Page.

Section III - Management Strategies

A management strategy provides a framework for optimizing a fishery to achieve desired ecological and/or socioeconomic objectives. It defines a feedback loop whereby information from the data collection program informs an assessment of the resource and/or fishery status relative to established reference points, which results in a change to management action. Performance of these management strategies is then evaluated via simulation testing known as management strategy evaluation (Smith et al. 1999, Butterworth 2007, Rademeyer et al. 2007, Punt et al. 2016). MSE is used to simulate the connections between field sampling, method of indicator calculation (i.e., data analysis), and decision-making via an HCR.

All proposed management strategies are structured in two parts - 1) Exceptional Circumstances (see **Section 3B** and **Appendix G**) and 2) an HCR structured using a decision-tree framework and traffic light approach (see **Section 3E)**. This section outlines critical components of the management strategies (see **Section 3G**) developed during the integration process, including data collection, HCRs, fishing zones, and management measures, in addition to a synthesis of modeling results.

These management strategies provide a decision-making framework to enable a recovering abalone population to go from a closed fishery, to a *de minimis* fishery, and eventually an 'open' fishery upon recovery. Modeling provides reasonable confidence in the viability of shorter-term management strategies (i.e., rebuilding plans), but various modeling limitations result in less confidence in much longer-term management actions. As such, specific guidance is not provided for how management should proceed during an open fishery, as the biology of red abalone and the state of the coastal environment suggest that full recovery (i.e., to move from closed to an open management stages [see **Section 3D**]) ranges from 28 years to several decades. Improved science in the future may be the best option for addressing 'open' regulations at the time when they are needed. Although the Project Team explored what thresholds would trigger the transition from closed to *de minimis* and from *de minimis* to an open fishery, given the estimated length of time to achieve the ‘open’ management status, the Project Team focused efforts on defining an approach to a *de minimis* fishery and not explicitly how an open fishery would function (e.g. how TACs would be adjusted year to year, etc.).

A. Data Collection

The optimal operation of any fishery management strategy is predicated on the premise that enough data is collected in a timely manner to inform the indicators that drive fishery management decisions. Throughout the integration process there were

ongoing conversations around data collection and data streams. As early as the first Project Team meeting, there was clear interest from members in better understanding what data sources were available, how to ensure data quality, how data could be made more accessible, and the importance of citizen science and coordinating data collection efforts among sampling entities across the state.

Available Data Sources

Project Team members identified a variety of available data sources that could inform future management efforts. The Admin Team also furthered conversations with the Tribes and Tribal communities to learn how best to incorporate traditional knowledge and Tribal data once broader intertribal coordination had occurred. A table was developed that highlighted the spatial and temporal scale of sampling efforts throughout the state, along with approximate costs, as documented in the Data Streams Comparison Table (see **Appendix E**). The Data Stream Comparison Table was critical to guide Project Team conversations around trade-offs associated with various data streams. It can also serve as an important reference for CDFW as they explore the need to track a broader variety of biological and environmental indicators as "early warning" signs (see **Section 3B** below). During this process, Project Team members also identified a wish list of data sources that could support management, but may be in development or currently unavailable including: size frequency and abundance data, enhanced recreational diver report card, reproductive indicators (e.g., gonadal data), size structure, nearest neighbor, crowdsourced underwater photos, traditional knowledge, kelp cover, chlorophyll reports, and socioeconomic data. Ongoing efforts to increase the quality and quantity of data available will require the support of the public (e.g., citizen scientists, NGOs, academics) and the state.

Length-based SPR and density were the primary indicators incorporated within the HCRs. Both these indicators were informed by data streams collected by CDFW and Reef Check California (RCCA). While only CDFW and RCCA field sampling designs are explicitly represented in the MSE, this does not preclude the addition of other sampling locations and data sets for these indicators from a larger network of collaborative organizations from being integrated into the proposed rebuilding strategy.

There were several reasons why only two indicators were included in the HCR. First, both length and density data streams were considered in the original management strategies from CDFW and the TNC-led stakeholder group, and the associated indicators were extensively discussed by the peer review panel and were also supported by the Project Team. Second, the Project Team felt that the indicators that

were directly related to the condition of the red abalone resource were the most useful to inform management decisions. Third, simulation modeling involved in MSE requires a clear mechanistic link between indicators and the red abalone resource. These mechanisms are not well defined or understood well enough for the majority of the proposed environmental and productivity indicators (e.g., urchin density, kelp density, etc.), although it is important to note that these indicators are still considered elsewhere (see **Section 3B** and **Appendix G**). Finally, reliability and cost-effectiveness were considered. The Project Team acknowledged the need to keep data collection programs simple and streamlined, and to select a reasonable number of indicators such that information conveyed is not too redundant and data coordination does not become overwhelming and cost prohibitive. While the Data Stream Comparison Table (see **Appendix E**) outlined a wide variety of potential data streams, robust data streams were unavailable to managers for many of these indicators, although there is some data available through outside programs (e.g., MPA monitoring, etc). With more time and resources, it could be possible to develop these and other data streams to allow for management at smaller spatial scales.

Data collection for length and density data is ultimately informed by the following considerations for annual decision-making:

- A management decision applied in year *y,* is informed from decision-making that occurs in the previous year (*y-1)*, and data analysis from field sampling that occurred in the three years previous to decision-making (*y-2*, *y-3*, *y-4)*.
- A one-year time-lag between data analysis and implementing a decision the following year was specified as a precaution to enable various entities time to carry out analysis and decision-making processes.
- Recursive annual decision-making relies on a 3-year moving window of field sampling. Need to utilize field sampling in years *y-2, y-3, y-4* reflected the desirability to have obtained sufficient geographic sampling coverage to most reliably characterize the fishing zone as a whole. In any instance where a site is visited two or more times within the 3-year moving window, the most recent site visit is to be used in data analysis.

In selecting length and density data streams, it is still important to acknowledge the limitations of this data and their associated indicators (see further discussion in Recommendation 7 of **Section V**). For red abalone density surveys, the precision with which this quantity can be estimated has been called into question, and directly reflects its information content (OST 2014). For length frequency distributions, information quality reflects the uncertain reliability of life history information used in analyzing this data stream and reflects a persistent information lag between changes

to spawning condition and subsequent detection of these changes (Prince 2016, OST 2018).

Coordinated Data Collection Efforts

Coordinating data collection efforts across the state could provide a more cost effective, comprehensive, and robust understanding of environmental conditions and the health of the red abalone resource.

Coordinated partnerships focused on leveraging additional data to supplement CDFW collected data streams have already proven effective on issues such as kelp (e.g., Noyo Center for MARINE Sciences, Kelp Ecosystem & Landscape Partnership for Research on Resilience (KELPRR), Greater Farallones Association, RCCA). Based on the breadth of entities highlighted in the Data Stream Comparison table, recommendations were made several times throughout the integration process by Project Team members on the need to better partner and coordinate data collection efforts among these entities.

When coordinating across sampling entities, data collection efforts can be standardized and formalized through a data management plan. Such a data management plan would outline data collection standards and activities to best meet management needs and goals outlined within the final FMP could meet these needs. A data management plan also provides an opportunity to improve data accessibility, exploring a path for all data that is used to inform management of the red abalone fishery to be made publicly available in a timely manner. The management strategies developed within this process were also constructed on the premise of coordination. They assume that CDFW maintains its historical site sampling regiment and additional sampling by other entities like Reef Check is needed to meet the data coverage expectations for a given management unit (see discussion of fishing zones in **Section 3C)**.

Stakeholder Participation in Data Collection

The Project Team also highlighted the importance of citizen scientists and fishermen to collect data. During Project Team discussions, members emphasized that involving harvesters in data collection was critical to keep fishermen involved in the fishery, provide revenue to CDFW to cover management costs, and could disincentivize poaching. The recreational fishing report card could be updated to allow recreational stakeholders to provide data on abalone size, catch location, depth, gonad indices, body condition indices, behavior, aggregations beyond density, and general observations. This is particularly valuable for those sites where CDFW and RCCA are not actively monitoring. Technology could also play an

important role in supporting citizen science data collection effort by harvesters, particularly with respect to length data; length data could be acquired manually or using applications that utilize machine learning and benefit from generating more reliable estimates.

Biological Fishery

Recreational divers in particular, emphasized that assistance with data collection efforts also provides a small opportunity for harvest as some biological data requires abalone mortality. The concept of a biological fishery was created to address this need, where a bio-fishery is defined as '*a fishery in which limited harvesting activities are permitted to fishermen to collect biological information in alignment with pre-defined research objectives. A bio-fishery can be site-specific or applied at the fishing zone level and may occur even when the recreational fishery is at a closed status.*' This allows for some harvest opportunities, regardless of whether the fishery is at an open, *de minimis*, or closed management status, and most likely provides the most near-term pathway to recreational harvest opportunities. Should the state implement a bio-fishery, the Project Team generally believes that fishermen should receive training from CDFW and scientists before being allowed to participate.

B. Accounting for Environmental Variability

In accordance with the MLMA 2018 Master Plan for Fisheries, changing climate and ocean conditions should be considered across all state-managed fisheries. There has been broad consensus that any FMP developed for the recreational red abalone fishery should be responsive to a broad array of potential future environmental scenarios. Throughout the process, Project Team members recounted extreme environmental conditions seen off the North Coast over the past several years, with an observed "perfect storm" of mass die offs, disease outbreak, species movements, and critical habitat loss. Significant attempts have been made through proposal development (see discussion below and **Appendix G** on Exceptional Circumstances) and modeling work to support more precautionary and responsive decision-making to reduce negative impacts to the red abalone resource.

Environmental variability and recent environmental conditions were first accounted for within the base operating model for the MSE (see Technical MSE Report in **Appendix A**). It was important to include such considerations given the impact of stochastic environmental conditions on growth and natural mortality of red abalone. First, the two operating models explored consider uncertainty in how long unfavorable environmental conditions will persist - continuing either through 2020 (Operating Model #1) or continuing through 2022 (Operating Model #2). Mass die off events associated with environmental changes or disturbances were also included in

the model based on empirical and experimental evidence (Tegner et al. 2001, Vilchis et al. 2005, Jiao et al. 2010, Rogers-Bennett et al. 2010, 2019, Cavanaugh et al. 2011). Increases in natural mortality of red abalone, driven by the El Niño-Southern Oscillation (ENSO), were also incorporated into both the historical and forward forecasts within the model. Evidence of a 35% average reduction in density associated with a harmful algal bloom event in 2011 (Rogers-Bennett et al. 2019) was incorporated in the model as an additional instantaneous mortality rate of 0.43 per year. Finally, a decline in density detected in both the RCCA and CDFW data sets from 2015 through 2017, which could be a result of unfavorable environmental conditions was accounted for in the model (imposed through visual tuning) with an additional instantaneous mortality rate (0.3 per year).

The Project Team also conceived of the idea to consider environmental and productivity indicators before applying the HCR, initially referred to as performing an "environmental safety check" to gain an understanding of current environmental conditions. This part of the management strategy was intended to serve as an ecological safeguard and is reflective of the Project Team's desire to incorporate a variety of environmental and red abalone productivity indicators into a more holistic decision-making framework. Throughout several meetings, the Project Team brainstormed a list of potential indicators. In support of the Project Team recommendation, these environmental and productivity indicators were incorporated into the first part of the management strategy (see **Appendix G** - Exceptional Circumstances). In the event that unusual or extreme conditions were observed in the ecosystem, either Commission direction would be solicited or collection of additional or more up-to-date abalone data would be triggered. Because of limited time during the integration process, the specific details and protocol within the Exceptional Circumstances strawman proposal have yet to be defined (including rules, triggers, and an implementation protocol), and requires more detail than has been provided by the Project Team thus far. Members of the Project Team expressed that there may be value in convening an organized committee (with leads and logistics to be determined) to review the data and indicators associated for this portion of the management strategy. The Recreational Abalone Advisory Committee (RAAC) was identified as a possible body of people to perform this work.

C. Fishing Zones

For any FMP, it is critical to outline the spatial scale at which the resource will be monitored and managed. The recreational red abalone fishery is currently authorized to only occur in northern California, tracking information across 56 report card sites. In the past, when abalone abundance was higher and before the advent of a number of the unique environmental challenges now present, this fishery was effectively

managed as one region. Management of the fishery evolved towards a two region system using differential management measures beginning with the 2011 harmful algal bloom and subsequent die off. This approach acknowledged that 95% of the catch and fishing effort historically came from Mendocino and Sonoma counties, with the remainder occurring in Marin, Del Norte, and Humboldt counties. There was also more focus around site-specific management to occur (e.g. closures/openings) at the established index sites.

The management strategies evaluated in this integration process use a fishing zone as the only unit of management, where a fishing zone is defined as *"geographic areas of the coastline comprising a number of the formerly defined abalone report card sites."* Use of larger fishing zones is an alternative to managing at the individual site level (i.e., for each report card site). Fishing zones were designed to simplify the management strategy and rely on established sampling programs (from CDFW and other research and non-profit entities in the state) for density and length data. Additionally, the fishing zone approach helps to ensure a pragmatic approach to coordination of data collection and the application of management via the use of existing indicators and corresponding reference points within an HCR.

A major topic of discussion during Project Team meetings was the rationale and approach to delineate fishing zones within the recreational red abalone fishery. Proposals ranging from one to four fishing zones were discussed and considered. These largely considered exploring management using the county lines as boundaries (e.g., separate zones for Marin, Sonoma, Mendocino, and Humboldt and Del Norte counties, and combinations thereof). There were also some discussions about defining fishing zones based on alternative boundary lines such as eco-regions or a four-zone approach including - 1) Marin and Southern Sonoma counties, 2) Northern Sonoma county, 3) Southern Mendocino county (south of Cabrillo Lighthouse in Caspar), and 4) Northern Mendocino, Humboldt, and Del Norte counties (north of Cabrillo Lighthouse in Caspar to Oregon border). There were also requests to consider much smaller report card site-specific management strategies, but this proposal was not further pursued or evaluated via MSE largely due to the fact that: 1) current and near future monitoring efforts are insufficient to cover the amount of data collection needed at this fine scale of management, 2) serial depletion of the abalone resource could be more problematic when fishing is concentrated at only a few sites, relative to effort being dispersed across many sites within a zone, and 3) concerns from enforcement staff in exploring beyond three fishing zones.

Numerous trade-offs were considered around how many fishing zones should be considered. If too many zones are considered, there was concern that managers

would not have enough information to make a decision about when and how fishing should occur while ensuring the recovery and sustainability.

of the resource. Managing under fewer fishing zones would potentially lower data collection costs and increase ease of enforcement efforts. However, by managing with fewer zones, zones must be larger in size (incorporating more report card sites) and thus density and SPR survey data (as well as other monitoring efforts) may yield conflicting information due to the heterogeneity of and among sites.

Based on stakeholder interest aligning around a two or three fishing zone proposal, time constraints associated with the computational intensity of the analyses, and the tight process timeline, only a two-fishing zone and three-fishing zone configuration were evaluated via modeling efforts. The two fishing zone approach considered the following spatial configuration - 1) Marin and Sonoma counties and 2) Mendocino, Del Norte, and Humboldt counties. The two-zone approach was formally evaluated by MSE and was the primary focus of the modeling efforts within this integration process. This approach is most similar to the scale of management currently used for the North Coast recreational fishery. The three fishing zone approach considered the following spatial configuration - 1) Marin and Sonoma counties, 2) Mendocino county, and 3) Humboldt and Del Norte counties. The three fishing zone approach received significant support (in the form of a support letter from over 2,000 recreational divers), emphasizing the need to manage Humboldt and Del Norte counties separately because of biological and ecological differences in the marine environment. Due to limitations in quantity of data currently available to support a multi-indicator HCR in Humboldt and Del Norte counties, an analysis was conducted to examine whether limited collection of length frequency data could theoretically support a SPR-based HCR. The HCR focused on length data given the challenges associated with using currently established protocols to estimate density for this geographic area and the fact that these counties lack historical baseline density data.

Acknowledging severe data limitations in the third potential zone (Humboldt and Del Norte counties), there was interest in exploring how to manage data-poor zones, with the potential to mirror any approach outlined to explore pathways to revisit recreational harvest in southern California. Results suggested that an HCR could be designed relying upon 60 to 300 observations every three years. Based on this outcome, it is worth further conversations to explore how the state and other research and non-profit entities in the state could work together to develop a coordinated approach to data collection in this proposed fishing zone. With a data collection program in place in this area, it would be possible to generate enough data to explore an MSE and associated HCR in the near future. It should be noted,

however, that Tribes and Tribal communities did express concerns with a two fishing zone approach to manage the North Coast fishery. They also indicated the desire to increase the number of zones to consider ecological and geographical factors but understand the limited data to manage this approach. Tribes are in support of increased data to increase the number of management zones, but support the two-zone approach in the meantime.

D. Management Status

The FMP would subdivide the fishery management area (i.e., North Coast) into distinct fishing zones. Within each fishing zone, an HCR (see **Section 3E**) would be applied on an annual basis to assign a management status to guide fishing activities within the zone. If a third zone were to be considered, an alternative approach would need to be developed and considered given the challenges unique to Humboldt and Del Norte counties that have been discussed. The management strategies, and associated HCR, designed during the integration process consider three management statuses: closed, *de minimis*, and open. When the HCR is applied, it is possible to determine whether management status will be maintained or changed based on indicators outlined within the HCR. Rules associated with how fishery managers would transition between statuses in any given year is pre-defined (see **Figure 3.1**) and is codified into the HCRs. If the status of the resource is improving, it is possible to only move one step (i.e. from closed to *de minimis* or from *de minimis* to open but not closed to open). If the status of the resource is deteriorating, multiple steps can be taken as needed (i.e., from open to closed, open to *de minimis*, or *de minimis* to closed). Additionally, as the HCR is applied for each individual fishing zone, the associated management status of each zone is also independent of one another. In other words, one fishing zone could be closed, while the others operate under a *de minimis* or open fishery.

Closed Fishery

If the status of a fishing zone is designated '*closed,*' there would be no harvest allowed and the TAC would be defined as zero. Recreational harvest activities would be prohibited for one year, after which the HCR would be applied to determine if the health of the resource had improved and a *de minimis* status could be designated. Data collection and research activities must continue under a closed fishery to increase understanding of the status of the red abalone resource and the environment. Thus, mortality associated with a biological fishery would be allowed.

De Minimis Fishery

The *de minimis* fishery was a request that came from stakeholders after the peer review was completed, that addressed a desire for near-term harvest by stakeholders and to ameliorate the negative socioeconomic impacts to local communities affected by the fishery closure. As part of its 2018 motion, the Commission recommended that a framework be developed for a *de minimis* fishery in consultation with the public. The Admin and Project Teams worked to refine a definition to more clearly describe *de minimis* levels of harvest. A *de minimis* fishery was defined as '*a fishery with a level of catch that is anticipated to have little to no effect on the health or recovery of a fishery resource. It is applied at the fishing zone level and occurs based on predefined thresholds set in an associated harvest control rule.*' If the status of a fishing zone is designated '*de minimis*', there would be a limited amount of harvest allowed through a static (i.e. fixed) TAC. If the status of a fishing zone is designated '*de minimis,*' it is possible to harvest at all sites within the zone (excluding Marine Protected Areas or closed sites). During these discussions there was interest from recreational divers in exploring a more site-specific approach to a *de minimis* fishery, which could occur at an individual site and not the zone level. Despite interest from Project Team members, this was not further pursued from the modelers because of logistical and financial constraints associated with establishing a data collection protocol that would allow for tracking of the red abalone resource at the individual site level. Based on MSE results, a *de minimis* fishery is unlikely to occur for another 11 to 31 years.

Over the course of six Project Team meetings, a draft *de minimis* fishery framework was developed (see **Appendix F**). This framework outlines management tools available to help inform guidelines for future regulatory consideration. It will ensure adequate flexibility is incorporated into the FMP that allows for more responsive and adaptive management, particularly under changing environmental conditions that put sustainability of the resource at increased risk. Break out groups and discussions were facilitated during Project Team meetings, and proposals submitted to the Admin Team continued to inform framework design. The Admin Team developed and updated a strawman proposal as new ideas were added or expanded upon during Project Team discussions. Framework development was also guided by principles that were shared by the Admin and Project Teams, including: ensuring recovery and long-term productivity of the stock while maximizing recreational fishing/diving opportunities, optimizing economic values to local communities, and supporting cost-effective, reliable data collection that includes more opportunities for interested stakeholders (including fishermen). The Project Team helped to identify and refine a range of options for management issues including season length, daily bag/possession/annual limit, number of permits, size limit, number of management

zones, as well as a data collection scheme and allocation scheme for permits and potential special conditions for permits.

Open Fishery

The open management status is used to signal the end of the rebuilding period, at which point higher levels of harvest (beyond those of *de minimis* fishery or bio-fishery) could occur. If the status of a fishing zone is designated 'open', it is possible to harvest at all sites within the zone (excluding Marine Protected Areas or closed sites). Recreational harvest under an open fishery, however, would still experience a level of effort control as designed by a TAC. Prior to the closure of the recreational red abalone fishery in December 2017, the fishery operated with effort controls (e.g., bag and annual limit) to keep harvest at a target level of catch (although there was no formally defined TAC or quota). Based on MSE results, an open fishery is unlikely to occur for another 28 to 59 years.

E. Harvest Control Rules

HCRs developed during the management strategy integration process focused on the near-term efforts to rebuild the red abalone resource. It is important to clarify that while HCRs developed could be applied under either a two or three fishing zone scenario, at this time, because of limited density and length data currently available, they could not specifically be applied to the third zone in Humboldt and Del Norte counties.

The Project Team was supportive of HCRs being structured in a decision-tree format and implemented using a 'traffic light method'. Indicators derived from density and length frequency data streams (i.e. SPR and density) are assigned a color category (red, yellow, green; see **Figure 3.2**) that is determined by comparing the indicator value against pre-agreed reference points. Red indicates a dangerous condition, far from enabling open fishery status. Yellow reflects unsatisfactory conditions, occurring during transition from red to green. Green reflects satisfactory conditions aligned with enabling open fishery status.

Generally speaking, the traffic light method enables a coarse characterization of a defined geographic region according to the measurement of prevailing conditions (via indicators). The traffic light method enables multiple indicators (specifically SPR and density in this case) to inform decision-making. It also simplifies data into a set of value judgements, presented in an understandable form, and enables uncertainty in indicators to be embraced while providing a basis for coarse adjustment to management status (Mangel and Levin 2005, Caddy 2015) on an annual basis, based on a running average of the previous three years of data.

A suite of candidate reference points (see Table 3.1 in Appendix A) were defined and evaluated via MSE, for both density and SPR, and used to assess performance of proposed management strategies. Target reference points define the desirable expectations of the fishery and the stock, where the level of concern for fishery sustainability is low. Intermediate reference points are established so that management actions are triggered as concern for sustainability of the resource grows. Limit reference points define a state of the resource that is to be avoided, aiming to select a value that is conservative enough to buffer abundance away from low levels, given red abalone are vulnerable to environmental conditions in terms of their survival, growth, and reproductive success.

In the case of SPR, categories are assigned relative to a limit reference point (see Technical MSE Report in **Appendix A**). SPR limit reference points (0.4, 0.5) were selected based on theoretical work applied to other long-lived marine species. Several studies have concluded that SPR targets greater than or equal to 0.4 should produce close to optimum harvest, especially for long-lived species (Mace 1994, Clark 2002, Punt and Ralston 2007, Harford et al. 2019b). And like other studies, maintaining SPR above such a target during an open fishery may be a reasonable means to buffer against environmentally-induced abundance fluctuations in the longer-term (Harford et al. 2018). Percentiles are used to score this indicator relative to the limit reference point within the HCR. If more than 75% of the SPR estimates fall below the limit reference point, RED is assigned in the decision tree. If less than 25% of the SPR estimates fall below the limit reference point, GREEN is assigned. All other scenarios are considered YELLOW.

In the case of density, a more involved approach was used that requires specification of limit, intermediate, and target reference points (see Technical MSE Report in **Appendix A**). Density reference points were proposed by CDFW and were accordingly specified as 0.2 abalone per m^2 (limit reference point), 0.3 abalone per m^2 (intermediate reference point), and 0.4 abalone per m^2 (target reference point). These quantities appear to be consistent with historical density levels and align with evidence that productivity could be compromised below 0.2 abalone per m^2, as seen for red abalone populations at Santa Rosa and Santa Cruz Islands (Tegner et al. 1989a, Karpov et al. 1998). Northern abalone have also showed reduced productivity along the west coast of Vancouver Island, British Columbia, Canada following declines in density below 0.3 abalone per m^2 (Tomascik and Holmes 2003). In South Australia at West Island, given the assumption that declining parental stock contributed to poor recruitment, Shepherd and Brown (1993) measured densities between 0.25 and 0.015 abalone per m^2 prior to the period of poor recruitment. Although the limit reference point was set to avoid the onset of the Allee effect, however, it is still challenging to pinpoint this exact threshold (as discussed in detail

in **Section V** under Recommendation 2). Additional reference points, termed intermediate and target densities are also required and were considered relative to past CDFW density surveys in northern California. To guide scoring of density within the HCR, first a CI of the mean of each site is calculated. For each site, then determine whether the lower bound of its site-specific CI is greater than the density limit reference point (0.2). The established fraction (percentile; set at 75% or 100% depending on selected strategy) of the density CIs that meet this criterion will determine the traffic light color of the density limit indicator. If fewer than 75% (or 100% depending on selected strategy) meet this criterion, then the density limit indicator is RED, otherwise YELLOW. The above steps are separately repeated for the density intermediate reference point (0.3 per m^2), determining whether this indicator traffic light color should be YELLOW or GREEN. Finally, the above steps are separately repeated for the density target reference point (0.4 per m^2), determining whether this indicator traffic light color should be YELLOW or GREEN.

Having assigned color categories to both indicators, an HCR is then used to interpret indicator color combinations and produce a recommended management action. The same HCRs are applied for each fishing zone, with the same indicators and trigger therein applied as well across fishing zones. Selection of the correct decision tree to be applied is determined based on the management status in the previous decision interval:

- If the previous management status is closed, proceed to tree #1 (see **Figure 3.3**)
- If the previous management status is *de minimis*, proceed to tree #2 (see **Figure 3.4**)
- If the previous management status is open, proceed to tree #3 (see **Figure 3.5**)

In any instance where density or length frequency distribution data are unavailable to proceed to a decision tree, an interim decision is to be made at the discretion of the Commission. When following a path through a decision tree, paying attention to the text on the left side of the tree is important. This text will state which indicator to apply at each node, always beginning with the SPR, and following with density.

F. Management Measures

Throughout the management strategy integration process a number of management measures were discussed with the Project Team, particularly with respect to the *de minimis* fishery (see **Appendix F**). Management measures under consideration for the *de minimis* fishery, some of which could carry over to the open fishery, included: season length, daily bag/possession/annual limit, and size limits. Project Team

members emphasized the importance of maintaining flexibility and a range of management measures within the final FMP to allow for more adaptive management of red abalone. There were also discussions about defining a suite of management measures that would allow for equity between the various fishery sectors (e.g. recreational divers, bobbers, rock pickers, Tribes and Tribal communities). Discussions around annual limits and size limits, in particular explored the ability to increase or decrease these values based on the state of the resource to accelerate recovery and then maximize fishing opportunity. The impact of changing size limits was explored via MSE to address substantial public comments about the interest in increasing the size limit within a *de minimis* fishery. Results suggested that increasing the size limit from 7" to 8" or 9", would have little effect on the timeline to a *de minimis* fishery, but could reduce the time to recovery for an open fishery by two to three years. Noting this, there was continued interest by the Project Team in maintaining flexibility to increase size limits in the FMP, although there was not full consensus around a specific size limit.

The management strategies outlined in this process are also expected to function in conjunction with other existing management regulations including, but not limited to, the following: 7" size limit; required documentation of prescribed data (date of effort, catch, location, etc.); ban on scuba; no taking abalone for someone else; no high grading, taking a larger abalone and putting a smaller one back; no co-mingling abalone with another fishermen; uniform start time for fishery; and other existing CDFW regulations.

G. MSE Analysis and Results

Both the High Level Summary and Technical MSE Report (found in **Appendix A**) provide a comprehensive overview of base model configurations, management strategies and catch levels evaluated, and results from the simulation modeling that was done for the two fishing zone configuration, as well as theoretical analyses to begin exploring a third fishing zone. As mentioned earlier (see **Section 3B**), evaluation of the protocol outlined in the Exceptional Circumstances strawman proposal was excluded from this MSE analysis but can still play an important part in precautionary decision-making. **A thorough review of both the summary and technical report is essential to understanding analysis outcomes and limitations that will ultimately inform Commission decision-making on future management for the North Coast recreational red abalone fishery.** With this in mind, this sub-section is intended to highlight key components of the MSE, as well as results and takeaway messages, with modeling limitations highlighted in **Section 3H**.

Two Fishing Zone MSE

Ecological uncertainty was addressed within the MSE operating model. Two operating models (referred to as OM1 and OM2) were explored due to ecological uncertainties about the current state of the red abalone resource and how long unfavorable environmental conditions would persist. Differences in the persistence of such unfavorable conditions has an impact on the estimated recovery timeline.

The MSE was conducted to evaluate the performance of four primary management strategies (known as A, B, C, D). Two hundred simulations were run for each operating model and management strategy combination. Each management strategy represents a combination of different reference points for SPR (0.4 and 0.5) and percentiles of density ($T_{DL} = T_{DI} = T_{DT}$ 4=100% and $T_{DL} = T_{DI} = T_{DT}$ =75%) (**Figure 3.6**)

- Management Strategy A: SPR (0.5), density percentile (75%)
- Management Strategy B: SPR (0.5), density percentile (100%)
- Management Strategy C: SPR (0.4), density percentile (75%)
- Management Strategy D: SPR (0.4), density percentile (100%)

Four TAC levels were also simulated for a *de minimis* fishery: 5,000, 10,000, 20,000 and 40,000 individuals per fishing zone. Noting that a management strategy is applied separately to each fishing zone, it is not necessary to select the same TAC for each fishing zone.

Six additional management strategies were evaluated following the November 2019 Project Team meeting to address requests made by Project Team members and additional considerations from the lead modeler. These represent alternative configurations of management strategy A, at a *de minimis* TAC of 5,000 red abalone, in each fishing zone. The following changes were made:

- Strategy A.1 - change minimum harvest size to 8 inches (203 mm)
- Strategy A.2 - change minimum harvest size to 9 inches (229 mm)
- Strategy A.3 - change density reference points to limit: 0.2 m^{-2}, intermediate: 0.25 m^{-2}, target: 0.3 m^{-2}
- Strategy A.4 - change density percentiles to 90%
- Strategy A.5 - change density confidence intervals to 25%

4 Percentile of site-specific density estimates that must cross a corresponding threshold. Subscripts refer to limit, intermediate, and target density reference points.

- Strategy A.6 - change density confidence intervals to 10%

Finally, analyses were conducted to evaluate the sensitivity of the operating models (specifically using OM1 and evaluating against management strategy A) to different red abalone productivity levels, different assumptions about fecundity, and the impact of how overestimation of site-specific population size might impact rebuilding at various *de minimis* TAC levels.

As is common with MSE, a range of management strategies are evaluated so that policy makers can select a strategy that aligns with their desired level of risk tolerance. MSE results for the two-zone configuration indicated that it will be at least a decade until a *de minimis* fishery would occur, with median rebuilding times varying between 11 and 31 years (see Table 3.4 in Technical MSE Report in **Appendix A** and **Figure 3.7**). Considerations of prolonged environmental decline (OM 2) resulted in 8 to 10 years of additional delay in recovery relative to OM 1. Selection of reference points of each management strategy also contributed substantially to rebuilding times. Differences in time to achieve a *de minimis* fishery were most pronounced in the selection of density percentiles, principally reflecting the degree of among-site density variation that is allowed relative to density thresholds. Shorter recovery times were observed for less precautionary density triggers (management strategies A & C) and longer recovery times for more precautionary density triggers (management strategies B & D). The differences in recovery time between these two sets of management strategies also has an impact on how depleted the resource is when the *de minimis* fishery opens. For rebuilding strategies A & C, *de minimis* fishing would begin at a depletion[5] level of approximately 0.2, while rebuilding strategies B & D delayed *de minimis* fishing until a higher level of recovery has been achieved (approximate depletion of 0.3 to 0.4). In selecting a management strategy, the Commission must consider this trade-off. Although it is possible for fishing to occur sooner (management strategies A & C), the resource will have had less time to rebuild (relative to delayed fishing under management strategies B & D) (see **Figure 3.8**).

The next consideration for the Commission concerns the length of time to transition from a *de minimis* to an open fishery. As a point of reference, in the absence of fishing (i.e., TAC=0), the median recovery times to move from a closed status to an open fishery ranged between 28 and 59 years. Again, this variability is due to differences in the operating model evaluated, fishing zone evaluated, and reference

5 Depletion level is measured on a scale from 0 to 1 and used to understand proportion of stock available to reproduce. Higher levels indicate a more robust or stable stock status.

points used. With increased understanding of the median recovery time in the absence of fishing, it was then possible to determine what level of fishing would be possible during a *de minimis* fishery. In Zone 1 (Mendocino, Del Norte, and Humboldt counties), a *de minimis* TAC at levels between 20,000 to 40,000 would affect recovery. In Zone 2 (Marin and Sonoma counties), a *de minimis* TAC greater than 10,000 would affect recovery. Results of *de minimis* TAC evaluation, however, should be considered cautiously, as the performance of these quantities depends on total abundance specified in the operating model. Total abundance is likely to be a highly uncertain component of this data-limited MSE.

At the time of triggering an open fishery status, each of the rebuilding strategies varied with respect to how depleted the resource is when the open fishery is triggered and what cumulative catches look like. Rebuilding strategies A & C tended to trigger open fishery status at lower median depletion levels (i.e., the resource is more depleted), which correspondingly reflects initiation of a *de minimis* fishery at a lower depletion level. More conservative rebuilding strategies B & D tended to trigger open fishery status at higher median depletion levels (i.e. resource is less depleted), which similarly reflects initiation of a *de minimis* fishery at a higher depletion level. With respect to cumulative catch, higher catch occurs for high *de minimis* TACs. The impact of this, however, is that higher levels of *de minimis* TAC increase the length of time it takes to transition from a *de minimis* to an open fishery status.

Taken together, recovery to open status requires consideration of three trade-offs: 1) length of time to open fishery status, 2) depletion at open status, and 3) cumulative catches prior to achieving open status. To further examine and help visualize the trade-offs between these three performance metrics, trade-off plots were produced (**Figures 3.9 & 3.10**). These plots help to group sets of management strategies that are similar in performance. Rebuilding strategies A & C offer the shortest times to open fishery status, even under higher *de minimis* TAC levels. Rebuilding strategies B & D offer improved levels of depletion upon recovery (relative to A & C), and because recovery times are longer, can offer the highest levels of cumulative catch during rebuilding.

Notable trends in recovery time and depletion level were also observed in the additional management strategies (A.1 to A.6), and with respect to sensitivity analyses. Changing minimum harvest size (management strategies A.1 and A.2) and changing density reference points (management strategy A.3), had little effect on the recovery time to achieve a *de minimis* fishery. However, the recovery time to achieve an open fishery was reduced by 2 to 3 years and 5 years, respectively. Changing density percentiles to 90% (management strategy A.4) resulted in performance that was more similar to management strategy B (density percentile of 100%), than to the

original management strategy A (density percentile of 75%). Management strategies reducing the density confidence intervals (A.5 (25%) and A.6 (10%)) resulted in shorter time durations to *de minimis* fishing, but also allowed fishing to occur at a more depleted resource state relative to the base case density confidence interval of 50%. The three sensitivity analyses investigating the effect of lower productivity levels resulted in delayed recovery times and slightly lower depletion levels at the onset of both the *de minimis* and open fishery. Changes to model assumptions about fecundity ultimately had no effect on performance of the model. Finally, lowering site-specific estimates of fecundity resulted in notable increases to the length of time required to achieve an open fishery, particularly with *de minimis* TACs > 5,000.

Considerations for Sampling Under a Management Scenario with Three Fishing Zones

While an MSE was not conducted to explicitly look at three fishing zones, as a preliminary step, an analysis was conducted to examine whether limited collection of length frequency data could theoretically support a SPR-based HCR. Throughout the management strategy integration process there was extensive conversation about the need to consider Humboldt and Del Norte counties as a separate fishing zone. During Project Team discussions it became evident that data from these regions are extremely limited, presenting challenges to developing suitable indicators on which to inform decision-making.

A length-based management strategy was ultimately explored, due to challenges associated with using currently established protocols to estimate density for this geographic area. Two sampling regimes were considered one that gathered 20 length measurements per year (60 observations collected every three years, each time the HCR rule is applied) and a second that gathered 100 length measures per year (300 observations each decision interval). Results of the analysis indicate similar performance of the two sampling regimes. Results from this analysis could also be used to inform a data collection protocol for Humboldt and Del Norte counties and guide research priorities for the region. Further, it is an important step to explore management approaches in regions where there is limited to no data. Creativity is also needed in exploring a wider variety of management approaches (e.g., precautionary catch or size limits) that may be suitable for managing these counties as a distinct fishing zone.

While this analysis specifically focused on a length-based approach, a wide variety of options could be explored in the future. Such options could include using other indicators in a similar multi-indicator approach or other experimental approaches. Fishermen were also interested in exploring the use of precautionary TACs and the

effect of simply increasing the size limit as a way to limit harvest. If the Commission should decide to consider managing under three fishing zones, CDFW can work with stakeholders to design a pilot study or sampling protocol to acquire all necessary data and recommend how a potential third zone would be managed based on the data acquired.

H. Additional Considerations When Interpreting MSE Results

MSE is intended to approximate reality in a simulation model and to test hypotheses that can ultimately inform decision-making. However, as a simplified version of reality, models must make a number of assumptions that cause some differences between the model and reality. Some of these assumptions may add an added level of precaution, while others may be overly optimistic. Additionally, uncertainty is a factor that can and should be acknowledged around indicators used, trajectory of unfavorable environmental conditions, catch levels, depletion levels, population dynamics, and life history characteristics. A brief overview of limitations and uncertainty in relation to the MSE and management strategy design is provided below. Detailed discussions are provided in the relevant sections within the report, as well as in the Technical MSE Report (see **Appendix A**).

Indicators

Data limitations were a challenge throughout this process. Similar to other marine life, fine-scale spatial stock structure of red abalone is at odds with feasible scales of data collection. This constraint on data quantity required developing management strategies relying on site-specific signals about resource changes, while attempting to guide decision-making at much larger spatial scales. Within the modelers' technical report (see **Appendix A**), there is an evaluation of the measurable precision of the two data streams used for red abalone to help understand associated uncertainty.

Better understanding of sampling precision of these two datasets is critical in defining reference points and triggers for management action for the indicators associated with these data streams (SPR and density, respectively).

For red abalone density surveys, the precision with which this quantity can be estimated has been called into question, and directly reflects its information content (OST 2014). Challenges arise due to the length of time required to revisit and resample each site (three years), as well as the low levels in the power analysis at any scale smaller than that of the whole fishery. These make density challenging to use to inform annual management decisions, especially when environmental conditions change rapidly. Acknowledging the variability around estimates of density

(as measured by coefficient of variance), and a desire to not potentially cause the fishery to either close or re-open when not warranted, a confidence interval was calculated separately for density estimates for each individual site. Subsequently, the fraction (percentile) of the CIs that meet density criteria are used to determine the status of the resource within the harvest control rule. The density 50% CI was utilized as a way to identify a conservative threshold, as a metric aimed at ensuring sufficient red abalone abundance is present to support future catch. It does not appear advantageous to utilize 95% CI, as initial MSE exploration demonstrated overly detrimental effects on fishing opportunities when the 95% CI was used because imprecision in density can produce very wide tails. Additionally, because of a non-negligible number or zero count transects, a log-normal or delta log-normal sampling distribution was applied.

Performance of management strategies that rely on SPR can be sensitive to biases in life history parameters, especially when other indicators do not work to ameliorate such circumstances (Hordyk et al. 2015, Harford et al. 2019a). Because of this, and because SPR also reflects a persistent information lag between changes to spawning condition and subsequent detection of these change, density was paired with SPR within the HCR. Given additional concerns that when density declines to low levels SPR masks Allee effects, more precautionary SPR reference points were selected and evaluated to avoid population decline at small population numbers (i.e. Allee effects), given the exact level of depletion at which it occurs is unknown.

Trajectory of Environmental Conditions

It remains unclear how far into the future the current poor environmental conditions will persist. Given this uncertainty, environmental variability was accounted for within the base operating models. It was important to include such considerations given the impact of stochastic environmental conditions on growth and natural mortality of red abalone. The two operating models explored consider uncertainty in how long unfavorable environmental conditions will persist - continuing either through 2020 or continuing through 2022. If poor conditions do continue through 2022, it could increase the recovery period to achieve a *de minimis* fishery by 8 to 10 years.

Setting Catch Levels

Although several *de minimis* TAC options were evaluated under the operating models specified in this analysis, risk associated with *de minimis* TACs is the most uncertain component of the MSE analysis. Like other data-limited fisheries, historical trends in abundance are not well established for red abalone. Testing alternative TACs requires scaling of populations, using site-specific unfished recruitment parameters that lead to estimates of total abundance. The sensitivity analysis

conducted (see **Section 3G**) revealed that alternative assumptions about population scaling can have remarkable effects on rebuilding time frames depending on how high a *de minimis* TAC is set.

In general, data-limited management strategies tend to require catch limits that are more precautionary than those that could be implemented under equivalent data-rich fishery circumstances (Ralston et al. 2011, Dichmont et al. 2017). While there is little consensus on the precise approach to doing so, data-limited fishery management tends to reduce catch limits in acknowledgement of scientific uncertainty (Newman et al. 2015). Because of data limitations, the MSE is insufficient to provide complete guidance on the selection of a *de minimis* TAC. Continued discussion is likely warranted to determine whether additional research and analyses may be useful to inform TAC selection. Such studies, if feasible, could include abundance estimation from nearest neighbor data or mark-recapture study to ground-truth abundance estimates made through catch-only methods. As another option, implemented TACs could be coupled with rotating sites closure schedules, to reduce the likelihood of serial depletion of any site.

Depletion

A key ecological uncertainty is the exact current state of the red abalone resource based on limited data available. This is considered within the MSE as the level of depletion (i.e. relative spawning biomass) and addressed during model tuning. Predicted length of time required to achieve a *de minimis* and open fishery is very sensitive to the initial depletion levels specified. It should be noted that the resulting depletion levels associated with triggering a *de minimis* fishery or an open fishery are a function of the technical specification of the operating model, particularly the initial conditions specified for 2002. It was assumed that depletion was relatively stable prior to 2011. The overall process of tuning ultimately resulted in depletion levels that were consistent with expectations about SPR, and relative abundance trends consistent with observed red abalone density data (noting the aforementioned limitations of density).

Population Dynamics and Life History Parameters

The underlying population dynamics models used in the MSE were parameterized using currently available scientific information. Operating models include estimates of life history parameters, accounting for variation in space and time, based on the scientific literature. The spatial representation of population dynamics considers larval and adult movement and metapopulation dynamics. As a precaution against building reliance on larval exchange into management strategy performance, within the model sites have no such exchange of red abalone represented in simulations.

Alternate life history parameters were also explored via sensitivity analyses. As the stock-recruitment relationship for red abalone is not known, sensitivity to red abalone productivity was assessed by evaluating a lower value of stock-recruitment steepness (reduced from 0.7 to 0.6). Reducing steepness (i.e., lower productivity) delayed recovery times and slightly lowered depletion levels associated with the onset of both the *de minimis* and open fisheries. To address uncertainty about patterns in eggs production in the largest size classes, alternate fecundity was explored such that the exponential increase in egg production with increasing length plateaued at the length of 254 mm (baseline asymptotic length). Performance of the management strategy was insensitive to this change within the operating model.

Figure 3.1. Rules to move between management status in annual decision-making.

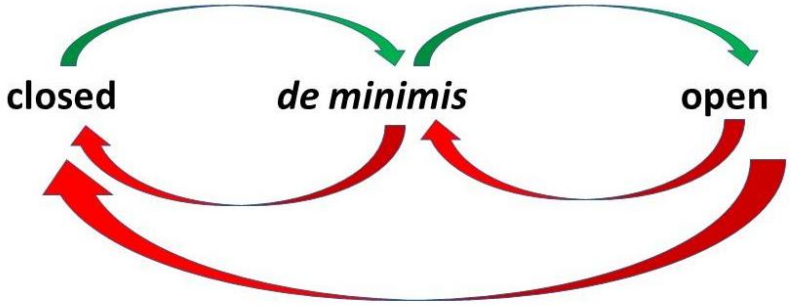


Figure 3.2. Traffic light method.

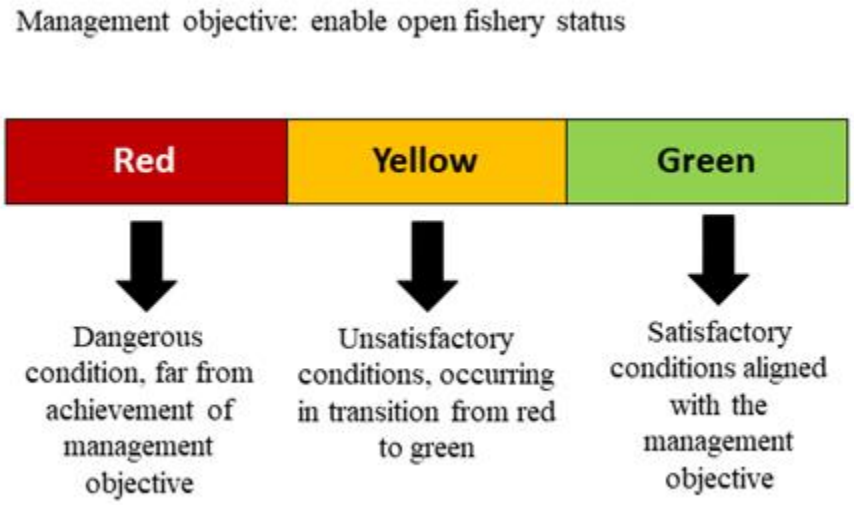


Figure 3.3. Part B of the management strategy. Decision tree #1. Applied when previous management status is closed.

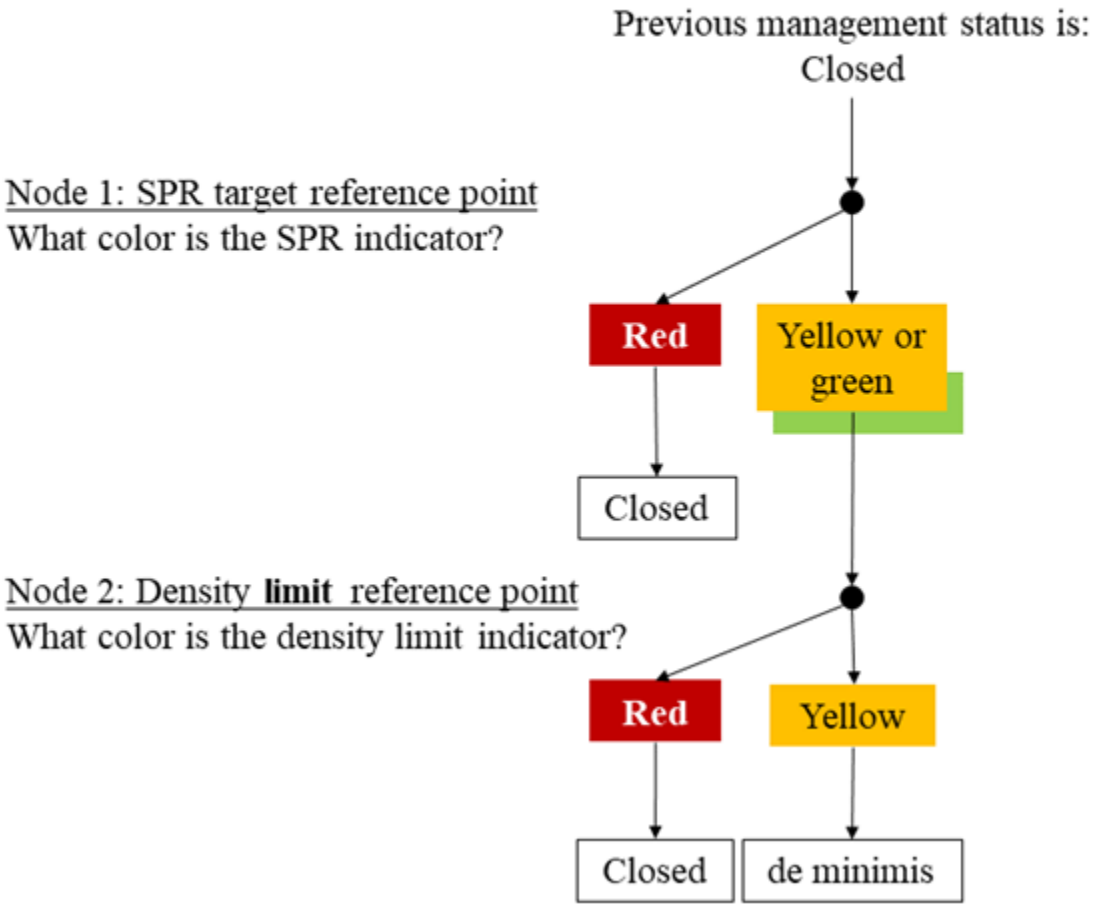


Figure 3.4. Part B of the management strategy. Decision tree #2. Applied when previous management status is *de minimis*.

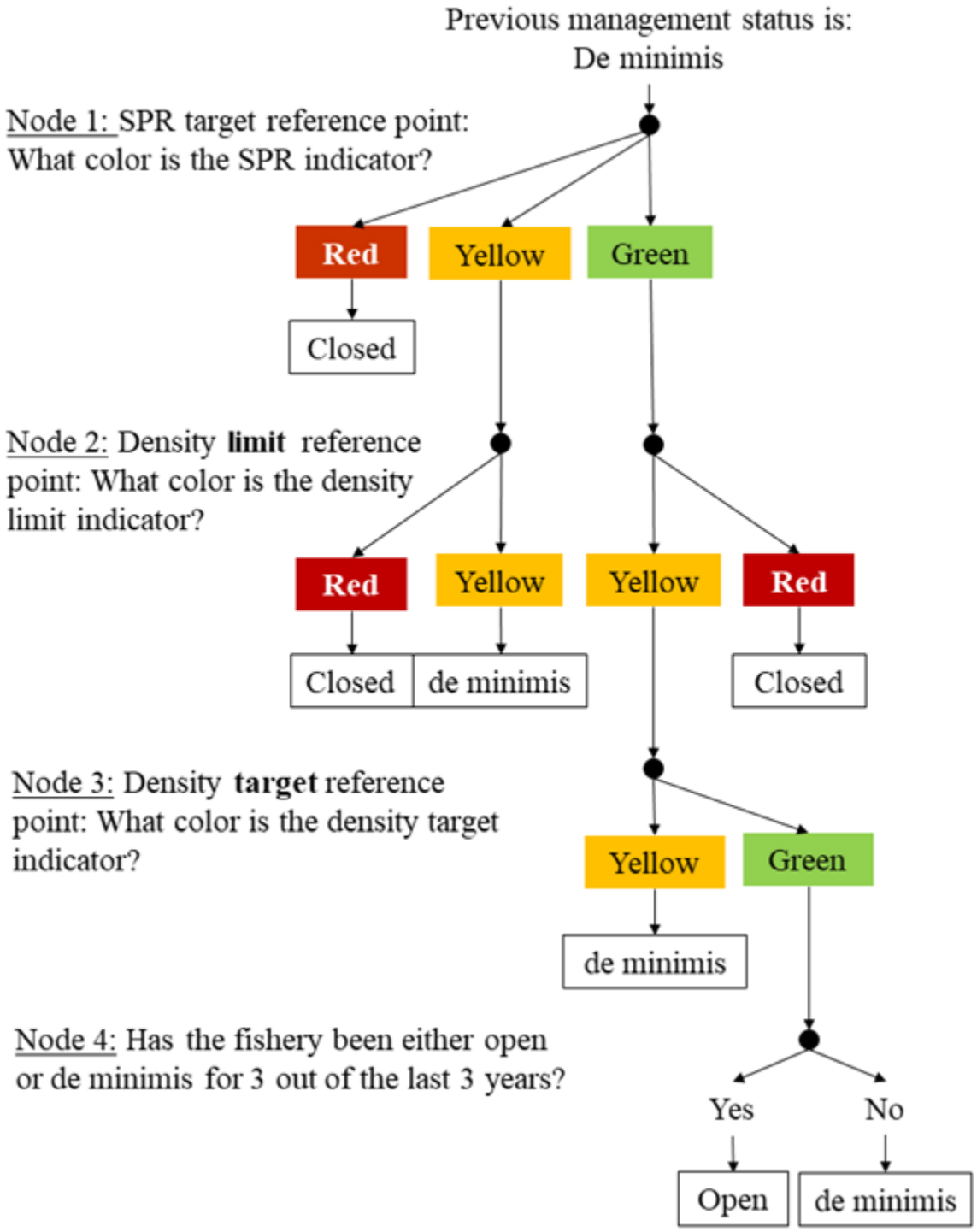


Figure 3.5. Part B of the management strategy. Decision tree #3. Applied when previous management status is open.

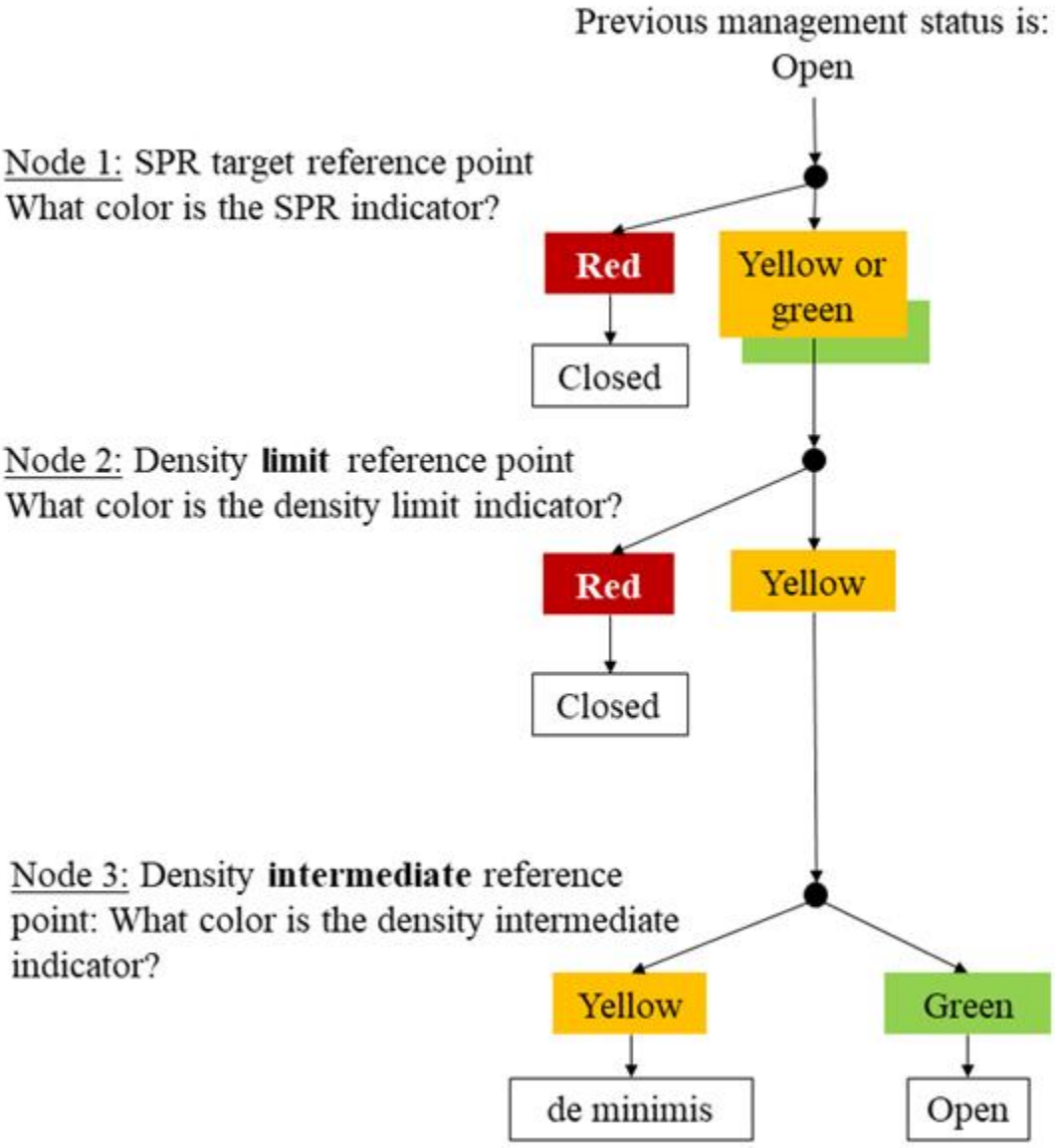


Figure 3.6. Factorial design of management strategies.

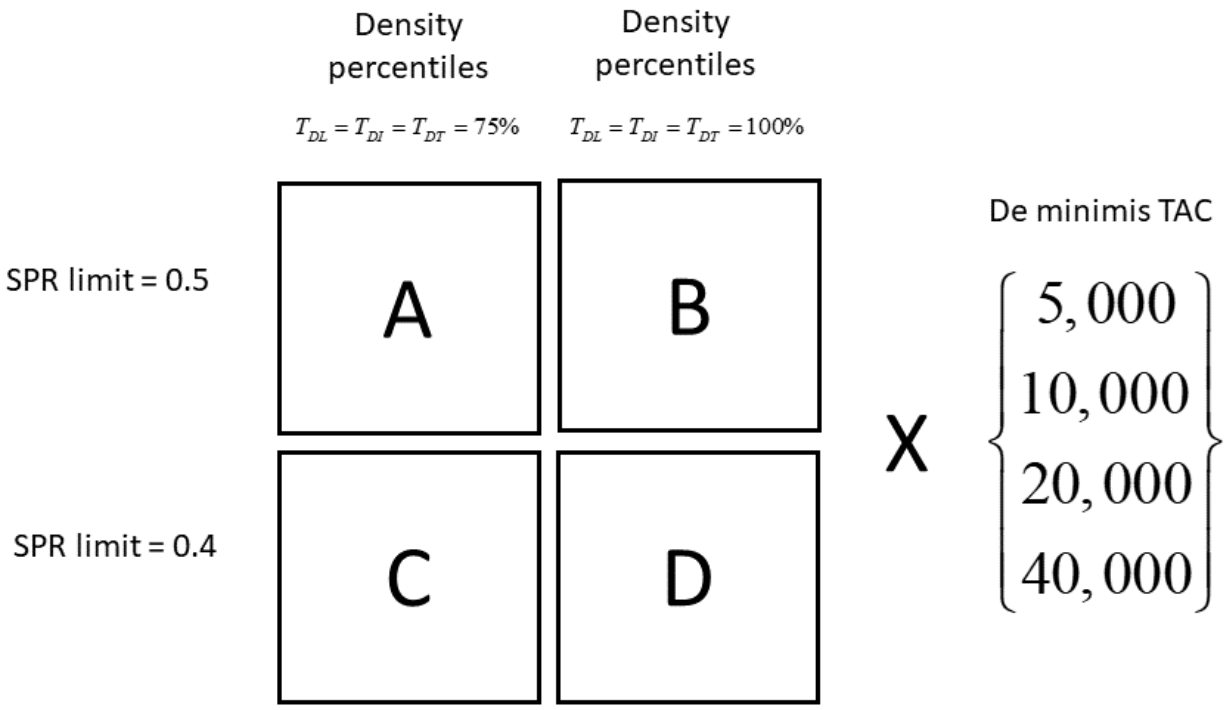


Figure 3.7. Box plots of time in years to reach *de minimis* fishery status for four management strategies. (A) through (D) indicate fishing zone and operating model (OM) configurations. Boxes are inter-quartile range, whiskers extend 1.5 times the inter-quartile range, and points are outliers.

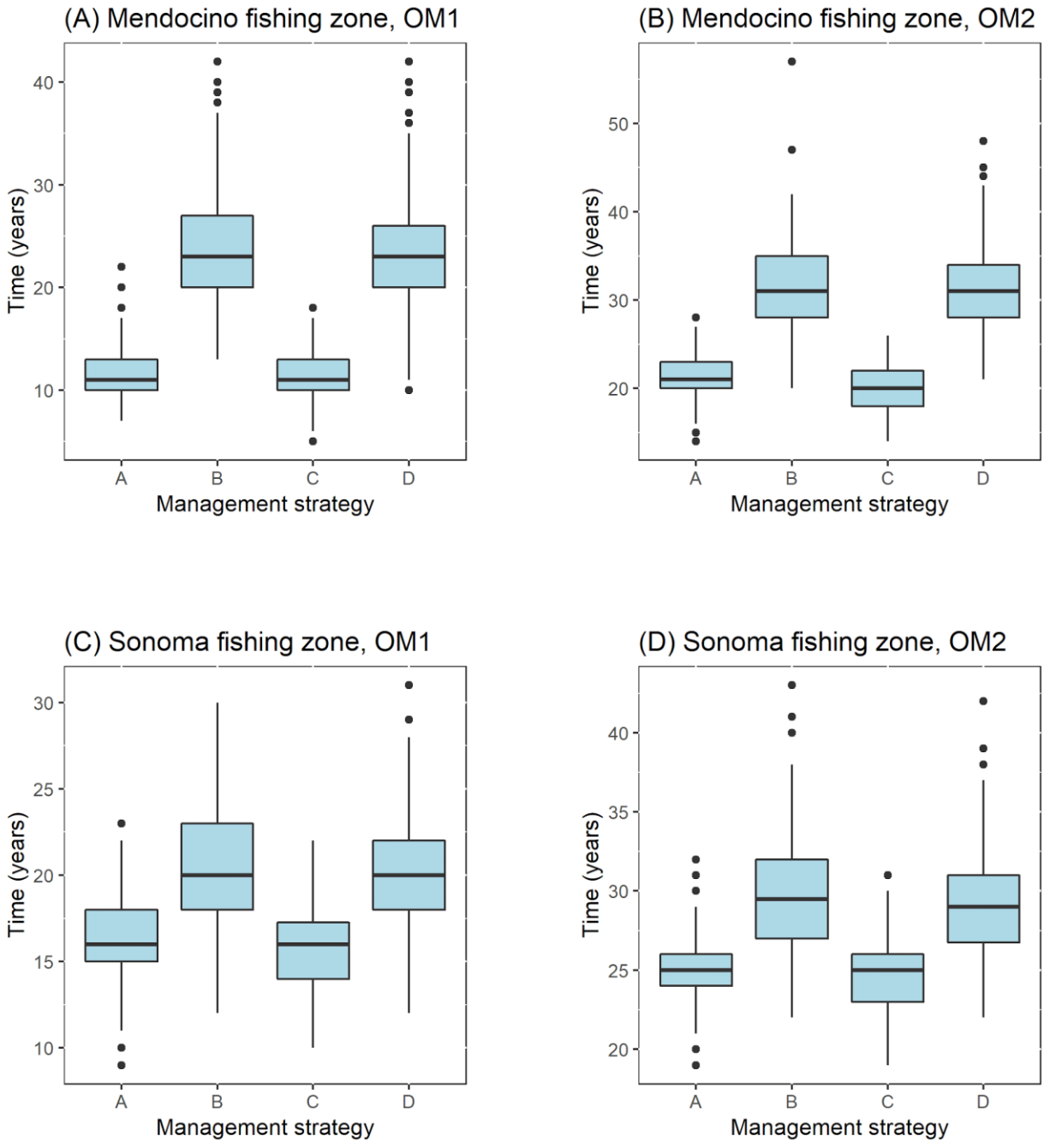


Figure 3.8. Management strategy description and summary of performance metric. (A) Highlights two operating model configurations that differ in the duration of poor environmental conditions, along with the measurement of depletion at different fishery statuses. (B) Demonstrates the transition from closed, to *de minimis*, to open fishery status and the measurement of rebuilding time performance metrics.

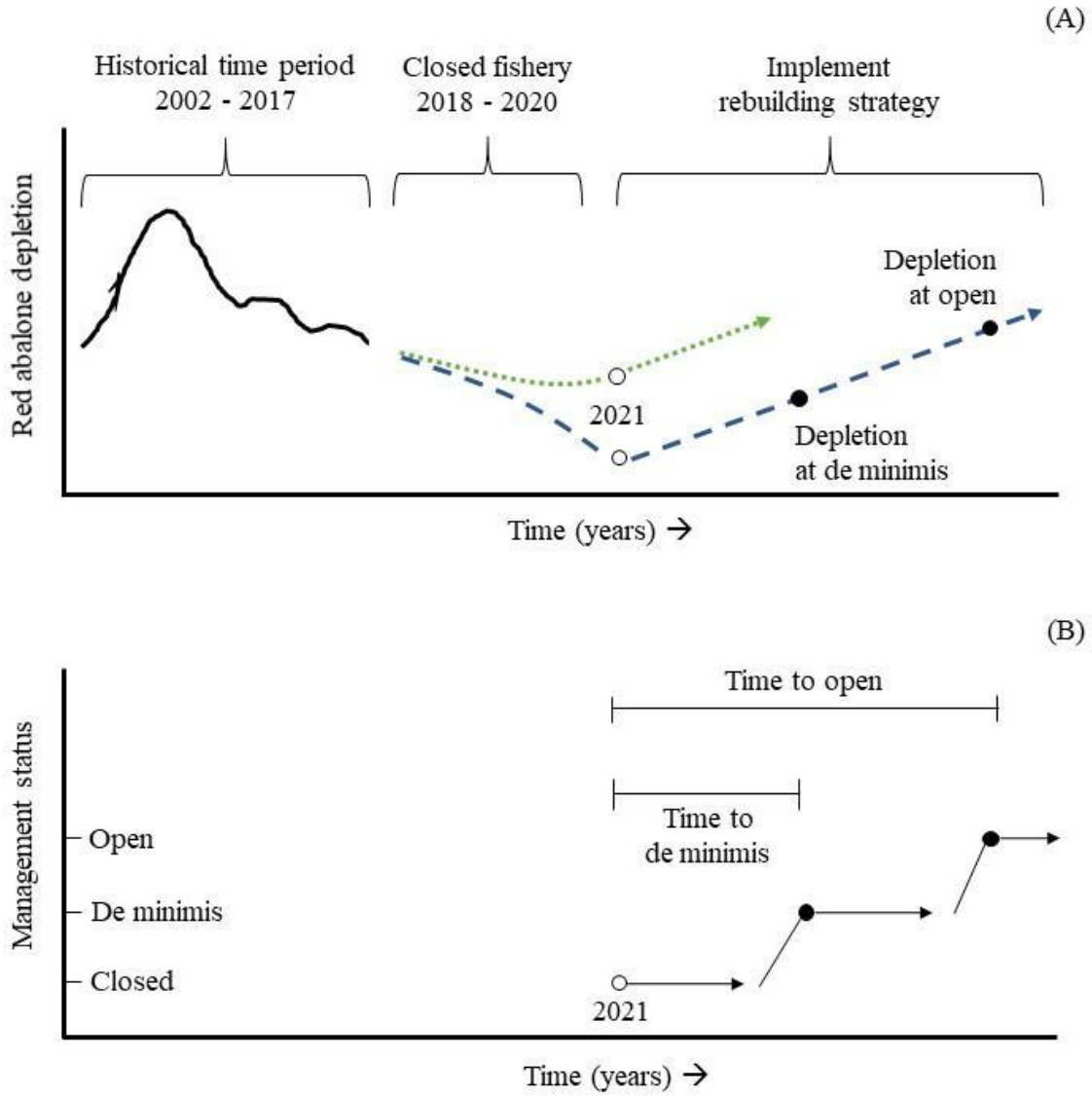


Figure 3.9. Trade-off plot of recovery to open fishery status for Mendocino zone shown for (A) Operating Model #1 (OM1) and (B) Operating Model #2 (OM2). Placement of letters on plot reflects median values for rebuilding strategies A through D. Color reflects median rebuilding time to open fishery status (see legend) and size of letters reflects the *de minimis* TAC options of 5,000, 10,000, 20,000, and 40,000 red abalone.

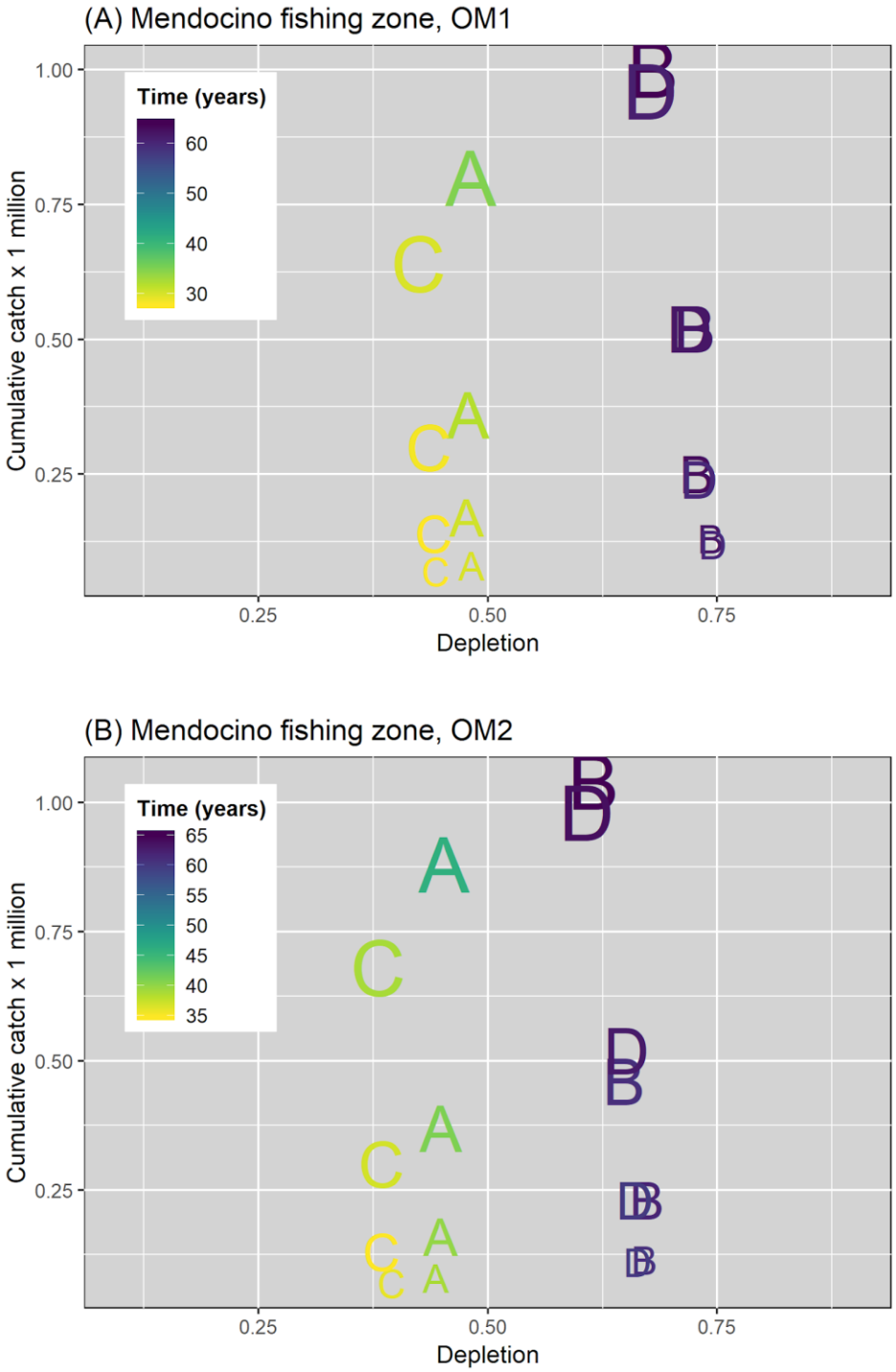
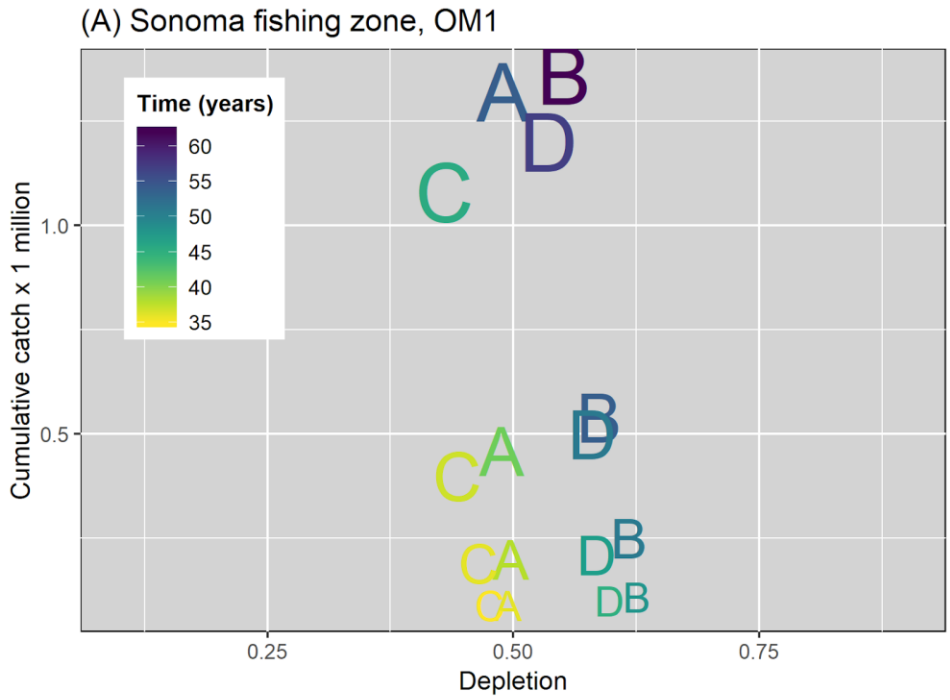
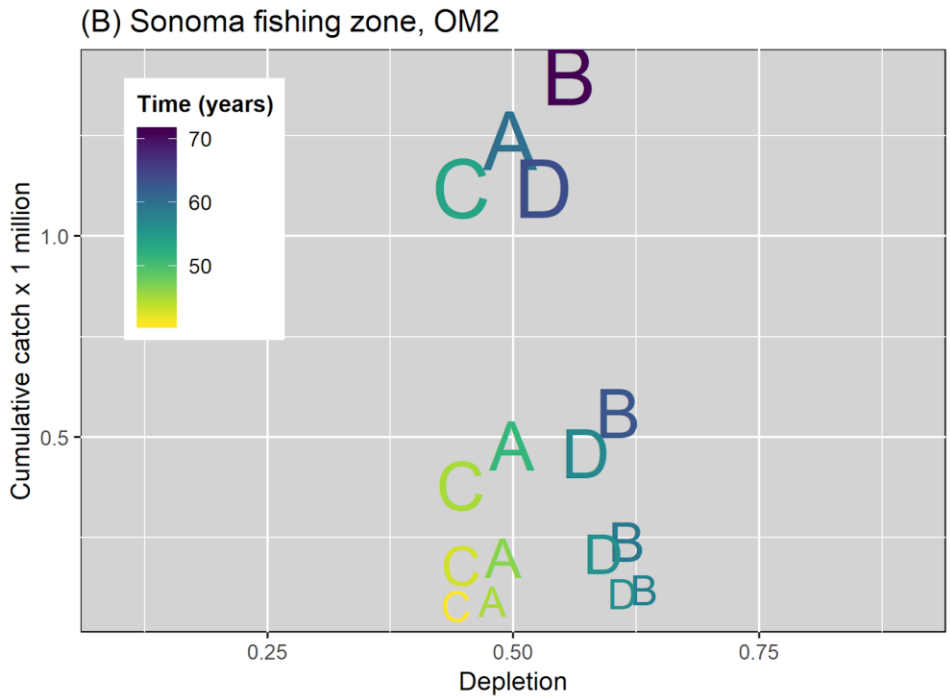


Figure 3.10. Trade-off plot of recovery to open fishery status for Sonoma zone shown for (A) OM1 and (B) OM2. Placement of letters on plot reflects median values for rebuilding strategies A through D. Color reflects median rebuilding time to open fishery status (see legend) and size of letters reflects the *de minimis* TAC options of 5,000, 10,000, 20,000, and 40,000 red abalone.





Section IV - Allocation of Fishing Opportunities

This section is intended to outline how harvest opportunities would be distributed among user groups, once a TAC is defined. Although MSE is a powerful tool for assessing the level of risk associated with a given level of harvest and estimating the length of time until the stock is rebuilt, it is not a tool for allocating quotas or TACs.

A. Recreational Fishing Opportunities

Assuming that the demand for recreational red abalone permits would exceed the opportunity, the Project Team engaged in discussions around how limited harvesting opportunities would be equitably subdivided among user groups and individuals. In management of deer, the lottery approach has been successfully utilized by CDFW. Three lottery approaches were discussed as options for permit allocation in the recreational red abalone fishery, particularly for *de minimis* status - 'random draw', 'pay to play', and 'preference point'. With a random draw allocation scheme, permit recipients are selected out of the pool for each opportunity and each person would have equal odds of being selected. A pay to play option was discussed where limited fishing opportunities would be provided to those willing to pay a higher price for permits, fishing outside the 10 index sites outlined in the Abalone Recovery and Management Plan (ARMP). Finally, with a preference point allocation scheme, permit recipients are randomly selected out of the pool. Those applicants not selected would receive a point, increasing their odds of getting a permit in the following year. The second year that opportunities are offered, applicants would be separated into two groups, with a random drawing occurring first for the group with one point and any remaining fishing opportunities would be distributed using a second random draw using the group with no points.

The majority of the Project Team favored the preference points approach over the random draw or pay to play allocation schemes, as well as the notion of a party tag (i.e., multiple individuals could apply for the lottery as a unit and if their application is selected everyone gets a tag). There was agreement that the allocation scheme should be simple in design, optimize economic support to local communities, promote safe harvesting practices, and support a cost-effective and reliable data collection that involves stakeholders. Project Team perspectives were that the preference point approach could provide the greatest number of opportunities to stakeholders and potentially decrease the amount of time before stakeholders could harvest again under the FMP. However, Tribes and Tribal communities expressed that they did not support any of the allocation schemes as subsistence harvest is not comparable to recreational harvest by fishermen.

B. Tribal Subsistence Fishing

At the August Project Team Meeting in Santa Rosa, representatives of the Tribes and Tribal communities first introduced the notion of exploring Tribal subsistence fishing within the FMP. Red abalone play a spiritual, cultural, and central role in the lives of Tribes and Tribal communities, with songs and dances providing an opportunity to honor red abalone and their family (the ecosystem). During the meeting, representatives of the Tribes and Tribal communities expressed that they did not feel their priorities, spiritual philosophies, or knowledge of red abalone and the ecosystem were being considered during the development of the management strategy. As such they requested that CDFW and the Commission collaborate with them to inform decision making and management. One way of doing so was to consider a fourth management status – tribal subsistence-only fishery – as is done in other states. It was suggested that the management status should progress from closed to subsistence-only to *de minimis* to open, and vice versa. The Project Team as a whole ultimately suggested that Tribal subsistence fishing could occur by allocating a subset of the overall TAC designated for either a *de minimis* or open fishery to Tribes and Tribal communities. This sentiment has been documented in the *De Minimis* Fishery Strawman Proposal (see **Appendix F**). Beyond this, the Admin Team suggested that the conversation and collaboration among CDFW and the Commission to discuss this issue occur outside the confines of Project Team meetings.

Tribes and Tribal communities will seek to work with the Commission and Legislature to understand how subsistence harvest can be supported in the FMP, ideally outside of an allocation scheme, as subsistence take fundamentally differs from recreational take. If the Commission supports the perspective of the Project Team in allowing for Tribal subsistence fishing under the FMP, it is still unclear whether they have the authority to create a Tribal member only allocation. Such authority may need to be created by the Legislature. Tribes and Tribal communities are also in discussions about what traditional ecological knowledge could be incorporated into the final FMP to guide management and designating a Tribal indicator that could ensure that the historical knowledge of Tribes is recognized and utilized.

Section V - Response to Peer Review Recommendations

This section is intended to provide clarity on how recommendations of the OST-facilitated peer review (described in **Section 2A**) were incorporated into the proposed integrated management strategies. Detailed responses are outlined below, as well as a brief discussion of the request for an additional peer review.

A. Response to Peer Review Recommendations

Recommendation 1: **These two management strategies should be integrated to reduce uncertainty and take advantage of the best available science.**

The Commission passed the following motion at its December 2018 meeting:

"(1) Support addressing peer review recommendations to integrate aspects of both draft management strategies, based on a simulation modeling approach co-developed by CDFW and the TNC-led stakeholder team, including engagement with abalone divers and other stakeholders; (2) revise Fishery Management Plan (FMP) goals to allow for a de minimis fishery option; (3) develop triggers for the de minimis fishery option in consultation with stakeholders; and (4) request that CDFW develop a proposed process and timeline which accounts for active public and Marine Resources Committee (MRC) engagement."

In direct response to components #1 and #4 of this recommendation, the management strategy integration process began in January 2019 to carry out the task of integrating components of the original two proposals to "reduce uncertainty and take advantage of the best available science" in partnership with stakeholders (i.e., Project Team). Section 3G of this report provides an overview of the proposed integrated management strategies developed during this process. Throughout the process, the Project Team was informed of modeling work, which incorporated best available science, and engaged in discussions with respect to components #2 and #3. With respect to component #2, the Admin Team co-developed a strawman proposal for the design of a *de minimis* fishery. With respect to component #3, the Admin Team and Project Team discussed and reviewed the reference points set to trigger management action within the HCR. Finally, at the last Project Team meeting and in subsequent communications, the Admin Team shared a draft timeline of upcoming Commission and MRC meetings where the management strategies integration process would be included in the agenda and invited the Project Team to continue their engagement by attending these public meetings.

Recommendation 2: **The way to integrate indicators, data streams, and analysis should be tested and analyzed using simulation testing from a formal**

operating model specified to capture low-density population dynamics specific to red abalone.

Density and length-based SPR were ultimately the only indicators that were integrated from the original two management strategies. Performance of these indicators within the various management strategies was evaluated via MSE, which uses a simulation modeling approach. As mentioned in the peer review report and the final MSE technical report (see Appendix A), these two indicators differ in their strengths. Density is responsive to rapid and catastrophic declines in abundance, like those seen in recent years, while SPR may be better characterized as a 'slow reacting' indicator. On the other hand, SPR reflects the reproductive status of the red abalone population (except when reduced gonad condition is present) and, unlike density, allows for decision-making in relation to a biological reference point. Furthermore, SPR reference points can be chosen in a manner that may better optimize long-term yield (Harford et al. 2019b).

With respect to incorporating low-density population dynamics (specifically the Allee effect), there is a lot of uncertainty around what the exact reproductive thresholds are for red abalone (Tegner et al. 1989b, Shepherd and Brown 1993, Catton et al. 2016). However, noting that these low density conditions are an important limitation around red abalone reproduction, the modelers addressed this in a few ways. First, density is included in the management strategies as a precautionary way to help to avoid reaching low-density situations and avoid encountering Allee effects. Stock-recruitment simulations were also conducted, during which recruitment failure occurred when the reproductive output fell below 1% of what would be seen for the egg production of an unfished red abalone resource. Additionally, modeling work explored the probability of depletion levels of the red abalone resource falling below 0.05., 0.10, or 0.20 during the period between triggering of a *de minimis* fishery and an open fishery to examine whether the rebuilding strategies would generally help avoid depletion levels that could be associated with the onset of an Allee effect (see Table 3.19 in Appendix A). Depletion did not fall below thresholds of 0.05 or 0.10 during any simulation runs.

Recommendation 3: **All indicators chosen must be clearly defined, and ideally, all candidate reference points for any indicator should be tested using simulation testing in a closed loop analysis.**

Only the two indicators selected for including in the harvest control rules underwent simulation testing - SPR and density. At the beginning of the Project Team process, a long list of candidate indicators (see Appendix E) were discussed for inclusion in the management strategy. The August Project Team meeting was critical in deciding

the final list of indicators to be included in the harvest control rules and the remainder of the management strategy. At this meeting, the Project Team proposed that only three indicators be included: SPR, density, and either gonad index or body condition. After a subsequent all-day meeting with the modelers, where the limitations of gonad and body condition data were discussed, this list was further refined to only include SPR and density. This change was shared with and approved by the Project Team at the September meeting. Narrowing down the list of potential indicators provided efficiencies, reducing unnecessary computational analyses given the short timeline of the integration process.

There were several reasons why only two indicators were included in the HCR. First, both length and density data streams were considered in the original management strategies from CDFW and the TNC-led stakeholder group, and the associated indicators were extensively discussed by the peer review panel and were also supported by the Project Team. Second, the Project Team recognized the indicators that were directly related to the condition of the red abalone resource were the most useful to inform management decisions. Third, simulation modeling involved in MSE requires a clear mechanistic link between indicators and the red abalone resource. These mechanisms are not well defined or understood well enough for the majority of the proposed environmental and productivity indicators (e.g., urchin density, kelp density, etc.). Finally, reliability and cost-effectiveness were considered. The Project Team acknowledged the need to keep data collection programs simple and streamlined, and to select a reasonable number of indicators such that information conveyed is not too redundant and data coordination across entities becomes overwhelming and cost prohibitive. While the Data Stream Comparison Table (see Appendix E) outlined a wide variety of potential data streams, robust data streams were unavailable to managers for many of these indicators, although there is some data available through outside programs (e.g., MPA monitoring). There were also cost efficiencies created by designing a management strategy centered around prioritizing existing and routinely collected data streams, rather than prioritizing new data streams or collection approaches (which would necessitate a larger research/analysis component separate from what was achievable under the set integration timeline).

Recommendation 4: **A multi-indicator approach, with little to no tiering, where not all indicators need to be met (i.e. not adopting a "one out, all out" approach), may be more flexible and informative given the uncertainty of changing ocean conditions and the response of red abalone to these changes. The structure of this approach and choice about whether to make it sequential (single indicators triggering another single indicator and so on), tiered (groups of indicators that trigger next tiered group of indicators and so on), or**

simultaneous (all indicators assessed simultaneously) can and should be tested using a formal operating model, thus building in a structure that is not subjective.

Within the information-limited context of red abalone management, the presence of observation error remains a primary motivation for considering a multi-indicator framework. Estimation of both density and SPR may be subject to non-trivial levels of error. Although alternate structures of the multi-indicator framework were not evaluated through simulation modeling, with only two indicators there were limitations in the sequential/tiering configurations that made sense for density and SPR. If more indicators become available that are regularly measured, have clear mechanistic linkages to abalone population dynamics, and have defined quantifiable reference points, it may be useful to revisit this recommendation. The structure was, however, developed based on the general agreement of the Project Team and flexibility was built in for instances where both data streams are not available.

Members of the Project Team were supportive of the harvest control rule design proposed - a decision-tree using the traffic light method. Use of the traffic light method within a harvest control can be implemented in various forms (Caddy 1999, 2015, Caddy et al. 2005), and offers several benefits in addressing the management circumstances facing red abalone. It simplifies data into a set of value judgements and enables uncertainty in indicators to be embraced while providing a basis for coarse adjustment to management status (Mangel and Levin 2005, Caddy 2015). Members of the Project Team generally agreed that the HCRs were presented in a format that made the management decisions to be made from the framework easy to understand.

Flexibility is also incorporated into the framework in a number of ways. First, with respect to the density indicator, noting that high variability exists within the data set, three different percentiles (75%, 90%, 100%) were explored for the number of site-specific density estimates required for an indicator to be triggered within the control rule; lower percentiles provided more flexibility. Second, recognizing that some instances may arise where there is no density or length frequency distribution data to proceed to a decision tree, the management strategies allow for an interim decision to be made at the discretion of the Commission.

Recommendation 5: **Setting reference points for every indicator is critical. (See also recommendation 3)**

A suite of candidate reference points (see Table 3.1 in Technical MSE report within Appendix A) were evaluated via MSE for both density and SPR, and used to assess performance of proposed management strategies. Target reference points define the

desirable expectations of the fishery and the stock, where the level of concern for fishery sustainability is low. Intermediate reference points are established so that management actions are triggered as concern for sustainability of the resource grows. Limit reference points define a state of the resource that is to be avoided, aiming to select a value that is conservative enough to buffer abundance away from low levels, given red abalone are vulnerable to environmental conditions in terms of their survival, growth, and reproductive success.

In the case of SPR, categories are assigned relative to a limit reference point (see Technical MSE Report in Appendix A). SPR reference points were chosen relative to theoretical work applied to long-lived species. Several studies have concluded that SPR targets greater than or equal to 0.4 should produce close to optimum harvest, especially for long-lived species (Mace 1994, Clark 2002, Punt and Ralston 2007, Harford et al. 2019b). And like other studies, maintaining SPR above such a target during an open fishery may be a reasonable means to buffer against environmentally-induced abundance fluctuations in the longer-term (Harford et al. 2018).

In the case of density, a more involved approach was used that requires specification of limit, intermediate, and target reference points (see Technical MSE Report in Appendix A). Density reference points were proposed by CDFW and were accordingly specified as 0.2/m^2 (limit reference point), 0.3/m^2 (intermediate reference point), and 0.4/m^2 (target reference point). These quantities appear to be consistent with historical density levels. Project Team and CDFW staff discussed a limit reference point in proximity to 0.2 abalone per m^2. The following rationale was shared, summarizing available evidence that appears to suggest that productivity could be compromised below this density level. At Santa Rosa and Santa Cruz Islands, Kelp Forest Monitoring Program (National Parks Service) data show that red abalone populations in 1983 were below 0.2 abalone per m^2, and following these densities, populations continued to decline to <0.05 abalone per m^2 (Tegner et al. 1989a, Karpov et al. 1998). Red abalone densities before 1983 at these island sites (1978-1982) were <0.3 abalone per m^2 (Tegner et al. 1989a). In Washington State, northern abalone *H. kamtschatkana* densities have declined by 77% with all sites now <0.15 abalone per m^2 (Rothaus et al. 2008). At these low densities, populations continued to decline and there is now apparent recruitment failure (Rothaus et al. 2008, Rogers-Bennett et al. 2011). Northern abalone have also showed reduced productivity along the west coast of Vancouver Island, British Columbia, Canada following declines in density below 0.3 abalone per m^2 (Tomascik and Holmes 2003). In South Australia at West Island, given the assumption that declining parental stock contributed to poor recruitment, Shepherd and Brown (1993) measured densities between 0.25 and 0.015 abalone per m^2 prior to the period of poor recruitment.

Additional reference points, termed intermediate and target densities, are also required and were considered relative to past CDFW densities surveys in northern California.

In the HCRs provided, indicators derived from density and length frequency data streams are assigned a color category that is determined by comparing the indicator value against pre-agreed reference points. Red indicates a dangerous condition, far from enabling open fishery status. Yellow reflects unsatisfactory conditions, occurring during transition from red to green. Green reflects satisfactory conditions aligned with enabling open fishery status indicators derived from density and length frequency data streams are assigned a color category that is determined by comparing the indicator value against pre-agreed reference points. These reference points are used as thresholds to trigger a change in management status when reference points are exceeded. It will ultimately be up to the Commission to select adequate reference points that meet the needs of the biological resource and stakeholders, as informed by MSE results.

Recommendation 6: **All indicators should be evaluated alongside each other in formal simulation modeling to set reference points and to test and determine the appropriate suite of indicators.**

As mentioned in the response to Recommendation #3, there were extensive discussions about the list of indicators listed in Table 1 of the peer review report. Although the Project Team recognized the merits of the range of indicators, only two were ultimately included in the proposed harvest control rules. A combination of cost-effectiveness of data collection and increased understanding of the mechanistic links between SPR and density and the red abalone resource were important factors in their selection. The remainder of environmental and productivity safeguard indicators (e.g. ocean temperature, canopy-forming kelp, and urchin density) were still included within the overall management strategy within the Exceptional Circumstances strawman proposal (see Appendix G). Performance of these indicators (using a variety of reference points) was then evaluated via MSE, which uses a simulation modeling approach.

Recommendation 7: **All indicators need to transparently indicate, and then formalize the way in which they deal with uncertainty.**

Within the modelers' technical report (see Appendix A), there is an evaluation of the measurable precision of the two data streams used for red abalone to help understand associated uncertainty -

length frequency composition and density surveys (from Reef Check California and CDFW). Better understanding of sampling precision of these two datasets is critical in defining reference points and triggers for management action for the indicators associated with these data streams (SPR and density respectively).

For length data, the precision of length frequency sampling is quantified by examining the observed sample sizes at each site. Given complications of field sampling, length samples collected from *n* sampling events (i.e., transects) may not represent a completely random sample, but instead may be subject to errors attributable to data collection methods, especially measurement of clusters of individuals with similar lengths (Hulson et al. 2012). Simulation modeling of length-based management strategies for red abalone ultimately revealed that observed sample sizes between 150 – 300 individual red abalone per site could be a reasonable rule of thumb for a minimum data collection standard. A bootstrap analysis was also conducted to provide guidance on the minimum number of sites that should be visited to sufficiently characterize the variation in SPR among sites. The analysis revealed that sampling more than 10 sites appears necessary to characterize variation in SPR at the geographic scales considered in the analysis. However, this analysis may still underestimate the number of sites needed to sufficiently characterize regional SPR variation because most SPR estimates made to date are obtained from the most heavily fished sites, rather than some randomized and/or stratified-random design with respect to fishing intensity. Within the MSE simulations, it was assumed that life history parameters that are needed to estimate SPR could be reliably obtained (see Prince 2016). Some care should be taken in ensuring that reliable life history information can be obtained before applying this indicator, as management strategies that rely on SPR can be sensitive to biases in life history parameters, especially when other indicators do not work to ameliorate such circumstances (Hordyk et al. 2015, Harford et al. 2019a).

For density data, whole site density of emergent red abalone should be calculated according to an appropriate statistical distribution thought to give rise to the data. This consideration is explored, revealing a right-skewed distribution of counts, which sometimes includes a non-negligible number of zero count transects. Occurrence of zero count transects is consistent with log-normal or delta log-normal sampling distributions (Pennington 1983, Lo et al. 1992, Fletcher 2008). Thus, for each year-site combination, summary statistics of density should be calculated by applying a delta-lognormal distribution to red abalone transect counts and estimating summary statistics (including confidence interval (CI) of the mean). Because of the variability around estimates of density (as measured by coefficient of variance), a CI was also calculated separately for density estimates for each individual site, and then the

fraction (percentile) of the CIs that meet density criteria are used to determine the status of the resource within the harvest control rule.

Additionally, the traffic light method used to structure the harvest control rule integrates indicators into decision-making according to their known information limitations. The traffic light method has been implemented in various forms (Caddy 1999, 2015, Caddy et al. 2005), and offers several benefits in addressing the management circumstances facing red abalone. It simplifies data into a set of value judgements, presented in an understandable form, and enables uncertainty in indicators to be embraced while providing a basis for coarse adjustment to management status (Mangel and Levin 2005, Caddy 2015).

Recommendation 8: **The science underlying setting catch levels needs to be re-evaluated and re-configured.**

Like other data-limited fisheries, historical trends in abundance are not well established for red abalone. Historical trends are used to initialize the simulation prior to the application of a management strategy. A scenario was re-constructed about red abalone stock dynamics from 2002 to 2017, based on fishery-independent data sets from CDFW and RCCA and the site-specific catch history from the fishery.

First, data-limited assessment methods are described that were used to gain insight into historical stock size and depletion. The operating model requires use of site-specific unfished recruitment (R_0) that scales relative abundance trends to absolute stock size at each site. This parameter was estimated using two data-limited assessment methods, each of which provides a site-specific estimate of maximum sustainable yield (MSY; in numbers of red abalone). After obtaining MSY, the operating model was tuned so that site-specific R_0 produced the corresponding estimate of MSY. Estimates of MSY were obtained using observed site-specific catch histories and the data-limited methods known as DB-SRA (Depletion-Based Stock Reduction Analysis) and catch-MSY. Ultimately, R_0 was tuned using MSY estimates from DB-SRA because this model accounts for skewness of the surplus production curve (i.e., the quantity B_{msy}/K), which is fixed at 0.5 in Schaefer form of surplus production used by catch-MSY. However, catch-MSY was useful as a comparison and MSY estimates were similar between approaches.

The management strategies developed during this process were ultimately focused on allowing for *de minimis* fishing opportunities, due to the extended length of time estimated until the red abalone resource is rebuilt. As such, analyses around catch setting largely focused on evaluating what level of catch would be considered *de minimis* (i.e., "*...having a level of catch that is anticipated to have little to no effect on the health or recovery of a fishery resource.*") This level of catch would be fixed

during the *de minimis* phase, and thus the harvest control rules are not designed to make annual changes to the TAC. Four TAC levels were simulated for a *de minimis* fishery: 5,000, 10,000, 20,000 and 40,000 individuals per fishing zone. Acknowledging the uncertainty associated with estimates of TAC with this modeling approach, results for Zone 1 (Mendocino, Del Norte, and Humboldt counties) in the two-fishing zone approach suggested a *de minimis* TAC at levels between 20,000 to 40,000 would affect recovery. In Zone 2 (Marin and Sonoma counties), a *de minimis* TAC greater than 10,000 would affect recovery.

The MSE was carried out within the realm of data-limited fishery management and because of this limitation, total abundance is highly uncertain. Because total abundance is uncertain, there is also uncertainty surrounding selection of a *de minimis* TAC. The MSE presented herein may be useful for advancing discussion of a *de minimis* TAC, but the MSE is insufficient to provide complete guidance on its selection. Continued discussion is likely necessary to determine whether additional research and analyses may be useful to support selection of a *de minimis* TAC. Further, data-limited management strategies tend to require catch limits that are more precautionary than those that could be implemented under equivalent data-rich fishery circumstances (Ralston et al. 2011, Dichmont et al. 2017). While there is little consensus on the precise approach to ensuring that these catch limits are sufficiently precautionary, data-limited fishery management tends to reduce catch limits in acknowledgement of scientific uncertainty (Newman et al. 2015).

A more detailed discussion of methodologies are outlined within the Technical MSE Report within Appendix A.

Recommendation 9: **Align the re-opening plan to match how the fishery is managed under other management scenarios to streamline data collection, analysis, and the decisions that follow.**

Neither of the original two management strategies provided alignment in how the fishery was managed across management scenarios. In the TNC-led stakeholder management strategy, there was no mechanism provided for re-opening the fishery; the strategy was developed before the December 2017 closure of the fishery, and simply used a relative adjustment based on the previous year's TAC. In the CDFW management strategy, different data streams were used to open and close the fishery. When re-opening the fishery at a specific site, three criteria are evaluated: 1) environmental conditions, 2) size distribution of abalone (legals and sub-legals), and 3) density. Assuming all these met the threshold, it was possible to re-open. Alternatively, when the fishery was open, a different suite of indicators was

evaluated to make adjustments to catch including environmental data, density, and productivity indicators such as abalone gonad index and body condition.

Under the harvest control rules proposed in Section III, density and SPR are used as indicators to guide decisions about when to open and close the fishery, as well as when to transition to or from a *de minimis* fishery. Using this approach, the same length and density data streams collected by CDFW and RCCA are used to guide annual decision-making to determine whether a management status (open, *de minimis*, closed) will be maintained in a fishing zone or whether it changes. Indicators calculated for the re-opening plan also mirrored those used to close the fishery and transition to a *de minimis* fishery. Across the management strategies provided through the integration process, multiple reference points were defined and evaluated which impact the timeline to recovery of the stock and allow for different risk tolerance thresholds for fishery managers to consider relative to the likelihood of stock rebuilding and fishing needs of stakeholders.

B. Requests for Additional Peer Review

The management strategy integration process, and resulting integrated management strategies outlined in this report, is in direct response to the recommendations made by the OST-facilitated peer review panel. The Commission then made a recommendation in December 2018 that endorsed the peer review recommendation to integrate the two peer reviewed management strategies. As such, the integrated strategies provided in this report are informed by an MSE model and significant content that has already undergone peer review.

During the December 2019 meeting, a member of the Project Team inquired about whether the integrated management strategy would undergo another peer review. The request arose based on the fact that at the time of the original peer review, the management strategies were not drafted to specifically consider a *de minimis* fishery. Commission and CDFW staff clarified that the Commission will ultimately determine whether an additional peer review is necessary. The Commission may look to guidance in the Code (§7059, §7075), in consultation with CDFW, as to whether another peer review is required or if the integrated management may be exempt from an additional peer review based on outlined criteria or if a prior peer review has occurred within a reasonable time period.

Section VI - Final Recommendations from Administrative Team

This section outlines recommendations from the Admin Team to the Commission for consideration as they provide guidance to CDFW in drafting the North Coast recreational red abalone FMP. These recommendations reflect Project Team discussions and guidance including alternative perspectives or issues of note. While recommendations reflect items where there was general support from the Project Team, not all members of the Project Team may agree with one or more of these recommendations. Where possible, the recommendations reference Commission directives from the Commission's December 2018 motion to inform the development of the North Coast recreational red abalone FMP:

(1) Support addressing peer review recommendations to integrate aspects of both draft management strategies, based on a simulation modeling approach co-developed by CDFW and the TNC-led stakeholder team, including engagement with abalone divers and other stakeholders; (2) revise Fishery Management Plan (FMP) goals to allow for a de minimis fishery option; (3) develop triggers for the de minimis fishery option in consultation with stakeholders; and (4) request that CDFW develop a proposed process and timeline which accounts for active public and Marine Resources Committee (MRC) engagement.

Recommendation #1: Consider selecting a management strategy (or consider developing a new one) that addresses the charge provided by the Marine Life Management Act and Commission goals, while being mindful of the Project Team guidance.

In addressing the Commission's first directive "to integrate aspects of both draft management strategies, based on a simulation modeling approach," it is important that the Commission consider selecting a management strategy that is informed by MSE results to best ensure the long-term recovery and sustainability of the red abalone resource.

As part of the selection of a management strategy, the Commission may consider the following potential actions:

- Approve the proposed harvest control design (HCR) that incorporates SPR and density or evaluate the possibility of developing an alternative.
- Select a management strategy (either A, B, C, or D) or evaluate the possibility of developing an alternative management strategy that incorporates aspects of A.1 through A.6 or sensitivity analyses.
- Determine the appropriate number of fishing zones (two or three).

- Select a *de minimis* TAC level for each fishing zone.

With respect to HCR design, the Admin Team recommends that the Commission consider approving the proposed HCRs, including identified indicators. Both design and selection of indicators have been supported by the Project Team. The HCR design satisfies the Commission's first directive "to integrate aspects of both draft management strategies, based on a simulation modeling approach," and to use trigger-based management where possible. The selection of indicators within the HCR can also be supported by existing sampling programs and available data, based on the understanding of the Commission's directive.

With respect to selection of an explicit management strategy or combination of strategies, it will be important for the Commission to consider its risk tolerance and how to best weigh the precautionary approach and need to manage in uncertain environmental conditions with a mandate to also allow for sustainable harvest opportunities. **Section 3G** highlights the trade-offs associated with any option. As stated earlier, these primary trade-offs include: (1) length of time to open fishery status, (2) depletion at open status, and (3) cumulative catches prior to achieving open status. In weighing these trade-offs, and ultimately selecting a management strategy, **Figures 3.9 and 3.10** provide a visual reference to inform Commissioners review of how the various management strategies perform against one another. Additionally, the Commission may consider stakeholder perspectives when selecting a management strategy, although this is difficult given the diversity of perspectives and priorities. Fishermen of the Project Team were more supportive of prioritizing management strategies that support a *de minimis* fishery in the near-term (e.g., strategies A or C) while others, including Tribes and Tribal community members favored more conservative and precautionary options (e.g., strategies B or D) to better protect the resource. It will be important for the Commission to consider priorities around resource recovery and harvest opportunity, to ultimately inform when take opportunities, including a *de minimis* fishery or a bio-fishery, may occur (see Recommendation #3).

There was Project Team support for either a two- or three-zone approach to management. There is currently no support for a one or four-zone approach. The Project Team acknowledged that management under a two-zone fishing configuration would closely resemble CDFW's current management approach. There was broad support for exploring data and sampling needs in Humboldt and Del Norte counties to learn if and how a third zone may be managed in this area. There is concern by some Project Team members that the lack of data, and/or low red abalone densities and population sizes in Humboldt and Del Norte counties will prevent the opening of a fishery if the same approaches and assumptions were used

for the northern counties as for Sonoma and Mendocino counties. Some participants suggested managers start with a two-zone strategy and move to three zones when a data sampling strategy and additional information (i.e., natural mortality rates, etc.) are available for the two northern counties. Site-specific management is challenging because of limited sampling and data availability. The modelers highlighted that MSE is not sensitive enough to model zones where low and/or no data is available; however, the modelers conducted a hypothetical modeling exercise to explore sampling intensity required to explore managing Humboldt and Del Norte counties as a third zone under a separate SPR-only management strategy. It is important that any decisions regarding fishing zones reflect the technical capabilities of MSE, directives set by the Commission for management strategy integration, CDFW capacity for both management oversight and enforcement, and stakeholder perspectives and priorities.

Finally, with respect to selection of a *de minimis* TAC, some members of the fishing sector suggested the Commission maximize fishing opportunities within the context of responsible fishing without overharvesting in the near-term. This could suggest a lower level of *de minimis* TAC either at or below levels indicated in **Section 3G** (i.e. 20,000 to 40,000 abalone for Mendocino, Humboldt, Del Norte and < 10,000 abalone for Marin and Sonoma). When considering harvest opportunities for recreational divers, some fishermen were also interested in exploring a TAC at a level between a bio-fishery and a *de minimis* fishery, which could include a TAC below what was modeled (i.e., a few hundred to 5,000 abalone). See Recommendation #3 regarding a bio-fishery as a means of allowing recreational harvest opportunities in the near-term, while also supporting data collection needs. See Recommendation #4 regarding a *De Minimis* Fishery Strawman proposal as guidance for developing the North Coast recreational red abalone FMP. Participants representing the Tribes and Tribal communities expressed that the recovery of the red abalone resource is the highest priority and supported a more precautionary management approach.

Recommendation #2: Explore a citizen science-driven data collection program for Humboldt and Del Norte counties that could inform the development of a management strategy and inform future management of these data-limited counties.

The Admin Team recommends that the Commission support an effort to fill data gaps for a potential third fishing zone in Humboldt and Del Norte counties. Over the course of the integration process, there were substantial public comments about how to manage abalone in these counties and an interest in managing them as a third fishing zone for the reasons mentioned in Recommendation #1. However, due to logistical challenges of sampling in these regions, and naturally low occurring

abundance of abalone that make the current density survey protocols ineffective, CDFW has not historically sampled in those areas. Numerous conversations at Project Team meetings focused on how to potentially manage these areas of limited or no data, as it has implications for similar areas in southern California, where recreational and commercial harvest is currently closed under a moratorium (Fish and Game Code § 5521).

Citizen science could play a critical role in filling these data gaps, and there was broad support for CDFW to consider the use of citizen science data in the management of red abalone across the state. The simulation modeling efforts that occurred during this process provide a potential path forward, with a suggestion that collecting 20-100 samples of length data per year in Humboldt and Del Norte counties would meet the state's sampling needs for managing the area as a third zone. As mentioned earlier, technology could play an important role in supporting citizen science data collection effort by harvesters, particularly with respect to length data; length data could be acquired manually or using applications that utilize machine learning and benefit from generating more reliable estimates. Should data collection begin in any such zone(s) where there has been little to no previous data, the Commission could, in a future action, could consider conducting another MSE to inform the design of a decision-tree like framework that incorporates length or any other indicators of note (see **Appendix E**). Dependent on time and interest, a wider variety of management options could be considered for this zone using other indicators or other experimental approaches.

Recommendation #3: Consider a biological fishery (bio-fishery) as a means of allowing for near-term recreational harvest opportunities, that also helps support the state's data collection needs.

Throughout the integration process, members of the recreational diving community emphasized the importance of rebuilding the red abalone stock while maintaining any opportunity for harvest. While a number of divers originally envisioned this as a *de minimis* fishery, results of the MSE indicated that the timeline to recovery could be substantial, with median rebuilding times to move from a closed to de minimis fishery ranging from 11 to 31 years. As mentioned earlier in the report, even when the fishery is in closed status, it is crucial that data collection efforts continue so that adequate information is available to inform annual decision-making. Given the long recovery timeline to reach a de minimis fishery, and the high likelihood of the fishery remaining closed for the next few years, a bio-fishery would allow for limited harvest opportunities while also meeting the data needs for management. As such, the Admin Team recommends the Commission consider a bio-fishery within the northern California recreational red abalone FMP to fulfill the state's identified data needs while providing a near-term opportunity by interested stakeholders. Should the state

implement a bio-fishery, the Project Team supports training from CDFW and scientists for all participants prior to initial participation.

Recommendation #4: Consider adopting the De Minimis Fishery Strawman Proposal (Appendix F) as guidance for CDFW to incorporate into the draft recreational red abalone FMP.

Stakeholder buy-in can be a crucial element in ensuring compliance with any management measure. As such, the Admin Team recommends that the *De Minimis* Fishery Strawman proposal (see **Appendix F)** co-developed by the Admin and Project Teams be incorporated into the recreational red abalone FMP. The second and third components of the Commission's 2018 motion were to "revise Fishery Management Plan (FMP) goals to allow for a *de minimis* fishery option," and "to develop triggers for the *de minimis* fishery option in consultation with stakeholders." In response to and to inform this directive, a *De Minimis* Fishery Strawman proposal was developed and refined throughout the integration process to provide a framework for a *de minimis* fishery within the North Coast recreational red abalone FMP. This document outlines a range of management tools available to help inform guidelines for future regulatory consideration to provide for added flexibility in management and to capture the range of stakeholder perspectives. Its content has been informed by discussions at Project Team meetings, as well as email submissions from Project Team members. Modeling work conducted as part of the management strategy integration process will inform the appropriate level of take of such a fishery.

Recommendation #5: Support further development of the Exceptional Circumstances strawman proposal (Appendix G) with interested stakeholders, ensuring that any indicators used are aligned with peer review guidance.

During both the peer review and management strategy integration processes, there was significant discussion about how to manage red abalone effectively in the face of significant environmental changes. Project Team members recounted extreme environmental conditions seen off the North Coast over the past several years, with an observed "perfect storm" of mass die offs, disease outbreak, species movements, and critical habitat loss. The Exceptional Circumstances strawman proposal (see **Appendix G**) was created noting the interest of Project Team members to incorporate environmental indicators into the management strategy, while acknowledging that their mechanistic links were not as well defined to allow for incorporation within the MSE. Before the harvest control rule is consulted, environmental conditions within the proposal would be assessed as a precautionary measure. As part of these discussions, the Project Team recommended checking for whether exceptional circumstances had occurred, such as oil spills, harmful algal

blooms, and warm water anomalies, as well as reviewing a variety of biological and environmental indicators (e.g., urchin density, kelp abundance, oxygen levels) to determine if environmental conditions are poor or unusual. The latter might require a more immediate response to proactively protect red abalone rather than proceeding through the decision tree.

While the proposal developed was a good starting point, there are still a number of outstanding issues that warrant further discussion. A more detailed protocol is still needed, if this clause is eventually included in the FMP. The identification of indicators is in itself insufficient and does not negate the need for refining the justification for the types of information and the manner in which these indicators trigger an exceptional circumstance (as noted in **Section 3B**). For some indicators identified, additional research regarding the mechanistic linkages in system dynamics would also likely be beneficial. For these reasons, the Admin Team recommends that the Commission support further collaborative development of the Exceptional Circumstances strawman proposal by CDFW and stakeholders. Members of the Project Team expressed that there may be value in convening an organized committee (with leads and logistics to be determined) to review the data and indicators associated with the exceptional circumstances portion of the management strategy before it is implemented. This working group could outline a more clear set of rules and triggers (if warranted) for implementing this portion of the management strategy, and should look to peer review recommendations that cautioned about arbitrary or unjustified selection of reference points for indicators.

Recommendation #6: Prioritize research needs to enhance the management of the red abalone resource off California.

Through the management strategy integration process, a number of research needs and priorities were identified through modeling work and during Project Team meetings. The Admin Team recommends that the Commission endorse these research priorities to encourage state and academic researchers to more actively address filling data gaps. Some of the research needs identified included, but were not limited to:

- Additional research to more clearly define the mechanistic linkages between the red abalone resource and indicators outlined in **Appendix G** (as noted in Recommendation 5).
- Pilot studies to assess sampling feasibility for collection of 60-100 length (and size at reproductive maturity) samples per year in Humboldt and Del Norte counties.

- Exploring methodologies to obtain better life history parameters (including size at reproductive maturity and fecundity).
- Studies to estimate natural mortality rates and the magnitude of inter-site variation.

Recommendation #7: Request that CDFW develop a data management plan with stakeholders to better coordinate and streamline data collection efforts across the state.

The Admin Team recommends that the Commission request CDFW to work with stakeholders (e.g., academics, industry, NGOs, Tribes and Tribal communities) to develop a data management plan for the North Coast recreational red abalone fishery. During the Project Team meeting process there were several conversations about the variety of data collection efforts happening across the state (see **Appendix E**). Given data limitations expressed throughout the process by modelers, there is a need to fill data gaps and have a more comprehensive understanding of the red abalone resource and the broader ecosystem. Coordinating data collection efforts from state and non-state entities, as well as citizen scientists and fishermen, working along the North Coast could provide a more cost effective, efficient, and comprehensive approach. The Project Team strongly supported improving data coordination, where there can be more efficiencies across data collection efforts by the state and other organizations. When coordinating across sampling entities, data collection efforts should be standardized and formalized through a data management plan.

It would be important for such a data management plan to outline data collection standards and activities to best meet management needs and the goals outlined within the final FMP. It could also include an approach to making all data collected more broadly accessible to the public in a timely manner and provide a wish list of data sources that could support management. In the future, the Commission may consider the development of such data management plans as best practice and consider their application broadly across state-managed fisheries.

Recommendation #8: Consider selecting an allocation scheme for recreational permits that uses a preference point lottery system for recreational permits and explore a pathway for the Commission to gain authority to consider allocating a subset of the recreational fishery TAC to Tribes and Tribal communities for subsistence.

Assuming that the demand for recreational red abalone permits would exceed the opportunity, an approach is needed to equitably subdivide harvesting opportunities among user groups and individuals. The Admin Team recommends that the

Commission explore a preference point lottery (as outlined in **Section IV** to accomplish this, given the Project Team reached consensus on this approach. The lottery could apply to single individuals or groups of individuals; in the latter case, a party could apply as a group and all receive tags if drawn. This addresses the recreational diving culture, where groups of individuals engage in the activity together, and it may also increase safety considerations to allow dive buddies or dive groups to dive together.

However, Tribes and Tribal communities clearly expressed a lack of support for any of the allocation schemes, as subsistence harvest is not comparable to recreational harvest. For these reasons, and given the cultural importance of abalone to Tribes and Tribal communities, the Admin Team recommends the Commission continue working with Tribes and Tribal communities to consider allocating a subset of the overall TAC designated for either a *de minimis* or open fishery to Tribal subsistence fishing. This may require engaging in conversations with the Legislature to achieve a Tribal allocation for subsistence fishing and opportunities.

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Appendix A - Final Modeler Technical Report and High Level Summary

A high-level overview was generated for the Project Team meetings to describe operating models, management strategies, and updated results from a management strategy evaluation (MSE) for the North Coast recreational red abalone fishery. That overview can be found below, and a full technical report with additional details accompanies this summary document and is included here: Draft Technical Report on Management Strategy Evaluation.

This document provides a high-level overview of the operating models and updated management strategies and updated results from a management strategy evaluation (MSE) for the North Coast recreational red abalone fishery. All management strategies consider three states for the fishery - closed, *de minimis*[6], and open. Within these analyses, a two fishing zone configuration was evaluated using the boundary line between Sonoma and Mendocino county. An additional hypothetical analysis was also conducted to consider the level of sampling intensity required to support a three fishing zone configuration. A full technical report with additional details will accompany this summary document.

Operating Model

A key ecological uncertainty is the current state of the red abalone resource. Data from Reef Check California (RCCA) and the California Department of Fish and Wildlife (CDFW) have shown a downward trend in their density estimates that were assumed to reflect unfavorable environmental conditions, however it is unclear how long into the future such environmental conditions may occur. To account for this uncertainty, two operating models are explored in the MSE. Operating model #1 (OM1) assumes that unfavorable environmental conditions will continue through 2020, during which a mortality rate is imposed to deplete red abalone abundance in accordance with these unfavorable conditions. In operating model #2 (OM2), unfavorable environmental conditions are prolonged through 2022.

Within these operating models, sampling efforts for length-based spawning potential ratio (SPR) and density data from CDFW and RCCA were simulated. Utilizing data streams from both entities helps to maximize site coverage and better inform decision-making. The potential management strategies are designed to be applied

6 A *de minimis* fishery is defined as having a level of catch that is anticipated to have little to no effect on the health or recovery of a fishery resource

annually and independently at the individual fishing zone level. Decision-making relies on data analysis of the three previous years of data (using the most recent available) for length and density.

Management Strategies and Total Allowable Catch Evaluated

The performance of four management strategies were evaluated within each operating model for the two fishing zone figuration. Two hundred simulations were run for each operating model and management strategy combination. Each management strategy represents a combination of different reference points for SPR (0.4 and 0.5) and percentiles of density ($T_{DL} = T_{DI} = T_{DT}$ =100% and $T_{DL} = T_{DI} = T_{DT}$ =75%)[7].

- Management Strategy A: SPR (0.5), density percentile (75%)
- Management Strategy B: SPR (0.5), density percentile (100%)
- Management Strategy C: SPR (0.4), density percentile (75%)
- Management Strategy D: SPR (0.4), density percentile (100%)

Four total allowable catch (TAC) levels were also simulated for a *de minimis* fishery - 5,000, 10,000, 20,000 and 40,000 individuals per fishing zone. Noting that a management strategy is applied separately to each fishing zone, it is not necessary to select the same TAC for each fishing zone.

Six additional management strategies were evaluated following the November 2019 Project Team meeting to address requests made by Project Team members and additional considerations from the lead modeler. These represent alternative configurations of management strategy A, at a *de minimis* TAC of 5,000 red abalone in each fishing zone. The following changes were made:

- Strategy A.1 - change minimum harvest size to 8 inches (203 mm)
- Strategy A.2 - change minimum harvest size to 9 inches (229 mm)
- Strategy A.3 - change density reference points to 0.2 m^{-2}, 0.25 m^{-2}, 0.3 m^{-2}
- Strategy A.4 - change density percentiles to 90%
- Strategy A.5 - change density confidence intervals to 25%
- Strategy A.6 - change density confidence intervals to 10%

7 Confidence intervals (CI) for the density indicator were set to 50%, as a conservative threshold to ensure sufficient red abalone abundance is present to support future catch, given the variability in the data stream. Percentiles are then used to score density (as red, yellow, green) in the decision tree. Percentiles are based on the frequency with which confidence intervals contain the density limit (DL) reference point (0.2 per m^2), density intermediate (DI) reference point (0.3 per m^2), or density target (DT) reference point (0.4 per m^2).

Finally, analyses were conducted to evaluate the sensitivity of the operating models (specifically using OM1 and evaluating against management strategy A) to different red abalone productivity levels (measured by stock-recruitment steepness), different assumptions about fecundity, and the impact of how overestimation of site-specific population size might impact rebuilding at various *de minimis* TAC levels (measured by the unfished recruitment parameter in the model [R_0]).

Rebuilding Trajectories

The length of time that it will take for the red abalone resource to recover to a point where it is possible to support an open fishery (i.e., time to recovery) is a function of four primary factors - 1) how depleted the red abalone resource is in the year 2021[8], 2) the productivity level of the stock, 3) the reference points selected, and 4) the environmental conditions that may impact growth and mortality of red abalone in the future.

Recovery times were evaluated in two ways:

- Length of time until a *de minimis* fishery could occur
- Length of time until an open fishery could occur.

Median rebuilding times from a closed status to a *de minimis* fishery for management strategies A - D varied between 11 and 31 years across the different operating models, fishing zones, and rebuilding strategies.

In the absence of fishing, the median recovery times from closed status to an open fishery status for management strategies A - D ranged between 28 and 59 years, depending on the operating model, fishing zone, and rebuilding strategy reference points. Understanding the median recovery time in the absence of fishing, it was then possible to determine what level of fishing would be possible during a *de minimis* fishery. In Zone 1 (Mendocino, Del Norte, and Humboldt counties), a *de minimis* TAC at levels between 20,000 to 40,000 would affect recovery. In Zone 2 (Marin and Sonoma counties), a *de minimis* TAC greater than 10,000 would affect recovery.

Differences in times to a *de minimis* fishery for management strategies A - D varied by operating model. Prolonged poor environmental conditions simulated in OM2

8 The red abalone season closure is in place through March 31, 2021.

resulted in a longer time period, with an additional 8-10 years needed until *de minimis* fishery status was achieved.

Preliminary results also suggest there is a clear trade-off among the four rebuilding strategies. Management strategies A & C allow the opportunity to fish at a *de minimis* state sooner, however the abalone resource is much more depleted when fishing begins (depletion level[9] of 0.2). Because thresholds for fishing are generally lower, strategies A & C also reach the open status in the shortest amount of time, which was generally triggered at depletion levels between 0.4 and 0.5. Management strategies B & D delay fishing opportunities, however the red abalone resource would be in a much less depleted state (i.e., depletion levels between 0.3 and 0.4) once *de minimis* harvest was allowed. Recovery of the resource under management strategies B & D takes more time to reach an open status, which was generally triggered at higher depletion levels between 0.6 and 0.8.

In addition, recovery trends coupled with different *de minimis* TAC levels produce different recovery times. Higher TACs result in higher overall levels of harvest, however they extend the length of time necessary to achieve an open fishery status.

Notable trends were also observed upon evaluation of the additional management strategies A.1 to A.6. Changing minimum harvest size (management strategies A.1 and A.2) had little effect on shorter-term metrics like time to *de minimis* fishery; however, time to open fishery was reduced by two to three years on average. Similarly, changing density reference points to 0.25 m^{-2} and 0.3 m^{-2} (management strategy A.3) reduced time to open fishery by, five years on average, but had no effect on time to *de minimis* fishery. Changing density percentiles to 90% (management strategy A.4) resulted in performance that was more similar to management strategy option B (density percentile of 100%), than to the original management strategy option A (density percentile of 75%). Strategies A.5 and A.6 changed the density confidence intervals to 25% or 10%, respectively, relative to the base case density percentile of 50%. Strategies A.5 and A.6 resulted in shorter time durations to *de minimis* fishing, but also allowed fishing to occur at a more depleted resource state.

With respect to results from the three sensitivity analyses investigating the effect of lower productivity levels resulted in delayed recovery times and slightly lower depletion levels at the onset of both the *de minimis* and open fishery. Changes to model assumptions about fecundity ultimately had no effect on performance of the

9 Depletion level is measured on a scale from 0 to 1 and used to understand proportion of stock available to reproduce. Higher levels indicate a more robust or stable stock status.

model. Finally, lowering site-specific estimates resulted in notable increases to the length of time required to achieve an open fishery, particularly with *de minimis* TACs > 5,000.

Considerations for Sampling Under a Management Scenario with Three Fishing Zones

Throughout the management strategy integration process there has been extensive conversation about the need to consider Humboldt and Del Norte counties as a separate fishing zone. During Project Team discussions it became evident that data from these regions are extremely limited, presenting challenges to developing suitable indicators on which to inform decision-making. In response to these comments, and as a preliminary step, an analysis was conducted to examine whether limited collection of length frequency data could theoretically support a SPR-based harvest control rule (HCR).

This management strategy only serves to demonstrate how sampling intensity could affect decision-making and does not explore issues of risk in applying such a strategy (e.g., alternative reference points are not explored). A length-based management strategy was explored based on challenges associated with using currently established protocols to estimate density for this geographic area. Results of this analysis indicate that similar performance of the two sampling regimes - sampling of 20 length measurements per year (60 observations collected every three years, each time the HCR rule is applied) leads to reasonably similar recovery trajectories relative to sampling 100 length measures per year (300 observations each decision interval). Results from this analysis could be used as a preliminary step, with subsequent steps requiring identifying the feasibility of data collection and other research priorities, as well as creatively exploring a wider variety of management approaches that may be suitable for managing these counties as a distinct fishing zone.

Takeaway Messages

There are considerable trade-offs to be considered by the Project Team, the Admin Team, and ultimately the Fish and Game Commission, as they decide on the selection of a management strategy and *de minimis* TAC for the North Coast recreational red abalone fishery. Rebuilding strategies A & C offer the shortest times to open fishery status, while rebuilding strategies B & D have a longer recovery timeline to achieve an open fishery but result in greater red abalone biomass recovery before fishing activities occur. More conservative (i.e. higher) SPR and density reference points will provide the greatest biological protection but fewer fishing opportunities, and the reverse is true where lower reference points result in

increased fishing opportunities but reduce biological protections for the resource. Layered on top of this, the magnitude of the TAC chosen for the *de minimis* will impact how long it takes to rebuild the stock to a level where an open fishery could be triggered. Increasing the *de minimis* TAC results in a longer timeline to achieve an open fishery status. Additional management considerations, such as increasing size limits to 8” or 9”, while they would have little effect on the timeline to a *de minimis* fishery, could reduce the time to recovery for an open fishery by two to three years. Finally, if the Commission should decide to consider managing under three fishing zones, it needs to identify data collection and research priorities that would allow a management strategy, and associated HCR, to be developed for this zone.

Appendix B – Project Team Meetings: Key Themes Summaries and Meeting Highlights

Meeting summary documents were created after each Project Team meeting between May 2019 and December 2019. The Key Themes Summary documents were intended to provide an overview of the discussion topics, key questions, and identified next steps that emerged from the meeting discussions. The summaries were intended to capture high-level details and key themes, rather than a transcript of the discussion. Towards the end of the process the Admin Team and Strategic Earth transitioned to meeting highlight documents to generate a more streamlined and concise meeting overview. These Meeting Highlights documents are intended to provide a high-level overview of the key meeting discussion highlights and outputs including specific feedback on MSE and *de minimis* options to inform the Admin Team's final report to the Commission.

Key Theme Summaries and Meeting Highlights were developed by Strategic Earth to ensure the exchange of information and ideas was captured in neutral language and inclusive of the diverse perspectives shared during meetings. The Admin Team and core Project Team reviewed and refined the summary documents, providing assurance that the key discussion points and next steps were accurately characterized. Summary documents were then shared with the full Project Team and posted publicly on the OPC project webpage.

Key Theme Summaries and Meeting Highlights are linked below:

- May 22, 2019 Project Team Meeting: Key Themes Summary
- July 18, 2019 Project Team Meeting: Key Themes Summary
- August 27, 2019 Project Team Meeting: Key Themes Summary
- September 19, 2019, Project Team Meeting: Key Themes Summary
- November 21, 2019 Project Team: Meeting Highlights
- December 19, 2010 Project Team: Meeting Highlights

Additional resources regarding the recreational red abalone Project Team, including Project Team meeting agendas, meeting materials, presentations, and webinar recordings, are available on the OPC red abalone management strategies integration webpage.

Appendix C – De Minimis Fishery Proposals Received

Members of the Project Team were invited to share ideas, proposals, comments, and questions regarding the integration of red abalone management strategies and development of a *de minimis* fishery option for consideration and discussion during Project Team meetings. Proposals and comments were made publicly available on the OPC project webpage as they were received and reviewed by the Admin Team. The Admin Team responded to each submitted proposal via email (see **Appendix D**) with information on whether and how comments were considered and integrated. The Admin Team included reference to if/how comments were considered in presentations and relevant meeting materials (i.e., *De Minimis* Fishery Strawman Proposal) during Project Team meetings. Content from the Project Team proposals could be directed to either the Admin Team, peer review panel representatives, and/or the quantitative fisheries lead modeler and modeling team for consideration. Project Team members and others also conveyed their thoughts regarding proposals verbally during meetings.

Throughout the North Coast recreational red abalone management strategies integration process, nineteen proposals were received from Project Team between the first Project Team meeting on May 22, 2019 and the final Project Team meeting on December 19, 2019. These proposals are linked below:

- Jack Likins- Submitted May 22, 2019 Project Team meeting
- Steven Rebuck- Submitted May 22, 2019 Project Team meeting
- Brandi Easter- Submitted May 22, 2019 Project Team meeting
- Don Thompson- Submitted May 22, 2019 Project Team meeting
- Steven Rebuck- Submitted June 12, 2019
- Edward Schulze- Submitted June 19, 2019
- Ken Morrill- Submitted June 26, 2019
- Brandi Easter – Submitted July 10, 2019
- Doug Jung- Submitted August 11, 2019
- Steve Rebuck- Submitted August 12, 2019
- Scott Taylor – Submitted September 2019
- Jack Likins – Submitted September 24, 2019
- Jan Freiwald – Submitted October 3, 2019
- Ken Morrill – Submitted October 9, 2019
- Petition for New Abalone Management Zone – Submitted October 18, 2019
- Ken Morrill – Submitted November 18, 2019
- Ed Schulze – Submitted November 19, 2019
- Steven Rebuck – Submitted November 29, 2019
    - Supplemental materials here and here
- Don Thompson – Submitted December 18, 2019

Appendix D – Response to Comments Received throughout Integration Process

This appendix documents the responses provided by the Admin Team to proposals sent by Project Team members, with the exception of the petition which would have involved a response to over 2,000 individuals (see **Appendix C**). The petition was however highlighted in the Admin Team update presentation at the October Project Team meeting.

Proposal Author: Jack Likins

Date Submitted: May 22, 2019

Admin Team Response: Thank you for providing some context and demonstrating the added value of a *de minimis* fishery. Your proposal provides important context on how such a fishery could effectively balance science, management, and recreational needs. We agree that fishermen and citizen scientists can play an important role in data collection for a recreational fishery and that a *de minimis* fishery should be designed to align with those data collection goals. Finally, we will continue to take your questions into consideration as *de minimis* fishery discussions continue at the upcoming Project Team meetings. *Response sent 4:04pm 9/18/2019*

Proposal Author: Steven Rebuck

Date Submitted: May 22, 2019

Admin Team Response: Thank you for submitting your detailed proposal for a *de minimis* fishery. We agree that such a fishery can be designed that allows for harvest and data collection by fishermen while posing a minimal threat to the red abalone resource. We also agree with your outlined benefits, particularly those around a fishery benefiting coastal economies and providing additional resources to the Department of Fish and Wildlife. Unfortunately, the scope of the current management strategy integration process is limited to the North Coast recreational fishery. As such we are not exploring a fishery, recreational or commercial, for Southern california. However, we are hopeful that we can learn from the process, ideas shared, and final management strategy to inform future discussions about Southern California. *Response sent 4:12pm 9/18/2019*

Proposal Author: Brandi Easter

Date Submitted: May 22, 2019

Admin Team Response: Thank you for providing a number of interesting draft concepts for the Project Team to consider around a *de minimis* fishery. As you highlighted, we are seeking to strike a balance between allowing the stock to recover and allowing a limited, sustainable level of harvest. We also agree with the need to add clear criteria around fishery re-opening within the harvest control rule, and draft ideas have been included in the latest draft of the management strategy. We have also incorporated the idea of a random lottery or draw into the strawman proposals (here) that have been developed for consideration by the Project Team. *Response sent 4:15pm 9/18/2019*

Proposal Author: Don Thompson

Date Submitted: May 22, 2019

Admin Team Response: Thank you for your comprehensive comments which provide a thorough overview of the management history of red abalone. Although the scope of the current FMP is focused on the North Coast recreational fishery, as directed by the Fish and Game Commission, and thus cannot address your desire for a coastwide fishery, you raise a number of important issues that we are currently working to address. First, you mentioned a desire for a risk assessment of varying levels of harvest of the red abalone resource. A management strategy evaluation will allow us to do just this and explore trade-offs associated with increased harvest and the rate of recovery of the stock. This work will occur within the next few months and the results will be shared with the Project Team. Second, you highlighted a major concern with density as an indicator for management. Although the Project Team still feels density can be an informative indicator, through this management strategy integration process we are re-evaluating density and other potential indicators, how best to estimate them, address uncertainty around estimates, and set appropriate reference points for them. Lastly, we are hopeful that we can learn from the process, ideas shared, and final management strategy to inform future discussions about Southern California, as others have mentioned this concern as well. *Response sent 4:21pm 9/18/2019*

Proposal Author: Steven Rebuck

Date Submitted: June 12, 2019

Admin Team Response: Thank you for providing a comprehensive public comment, as well as citations to a broad body of literature around the value of advisory groups in management, marine protected areas, and red abalone research studies. To your point about the need to evaluate the effectiveness of management measures such as total allowable catch and trip limits on maintaining a healthy resource,

management strategy evaluation will be used to do just that. This work will occur within the next few months and the results will be shared with the Project Team. We also agree about the value of advisory groups, revisiting their past recommendations as they relate to peer review recommendations and the charge provided by the Commission; members of the Recreational Abalone Advisory Committee (RAAC) have also been invited and are participating in the management strategy integration process. We also appreciate a number of the management measures you have suggested for the *de minimis* fishery in Section 5 of your comment letter. The Administrative and Project Team, as well as the broader public, have access to your letter, and these specific management measures, as all public comments and proposals are posted on the Ocean Protection Council website (here). We welcome you to discuss these ideas in further detail during the ongoing Project Team meetings. Finally, we have passed on your requests that are outside the scope of the current management strategy integration process (e.g., delisting sea otters from the Endangered Species Act, allocating TAC to a commercial fishery, exploring sport or commercial fisheries from south of San Francisco to Santa Barbara county, exploring a fishery for green abalone, conducting an environmental impact analysis of the northern wine industry, tracking flows of fire retardants to the nearshore environment), to the members of the Administrative Team from the Department of Fish and to be responsive to the requests. *Response sent 4:36pm 9/18/2019*

Proposal Author: Edward Schulze

Date Submitted: June 19, 2019

Admin Team Response: Thank you for submitting a detailed proposal for a *de minimis* fishery. A number of the ideas you have presented such as considering zonal management, and assigning a specific total allowable catch (TAC) to each zone are concepts that have been incorporated into the latest draft of the management strategy (here). Depending on the management status of the fishery (open, *de minimis*, closed) that TAC would vary, as you suggested, based on what the selected indicators tell us about the health of the red abalone resource. We will continue to explore more specific management details for a *de minimis* fishery at upcoming Project Team meetings. Your thinking about a lottery or drawing for tags has been incorporated into the *de minimis* fishery strawman proposals (here) drafted by the Administrative Team for continued consideration by the Project Team. *Response sent 4:30pm 9/18/2019*

Proposal Author: Ken Morrill

Date Submitted: June 27, 2019

Admin Team Response: Thank you for providing comprehensive public comments, as well as for proposing specific elements of a *de minimis* fishery. A number of the ideas you have presented such as considering zonal management, and assigning a specific total allowable catch (TAC) to each zone are concepts that have been incorporated into the latest draft of the management strategy (here). Depending on the management status of the fishery (open, *de minimis*, closed) that TAC would vary based on what the selected indicators tell us about the health of the red abalone resource. Conversations to date at the Project Team meetings have focused on either a random or preference point lottery. We will continue to explore more specific management details, including allocation details, for a *de minimis* fishery at upcoming Project Team meetings. The strawman proposals discussed to date at Project Team meetings are linked here for reference. As you noted, this process is focused on the North Coast recreational red abalone fishery. We are hopeful that we can learn from the process, ideas shared, and final management strategy to inform future discussions about Southern California; however, those discussions are not within the scope of this current process. We look forward to your continued insights at upcoming Project Team meetings. *Response sent 3:30pm 9/18/2019*

Proposal Author: Brandi Easter

Date Submitted: July 10, 2019

Admin Team Response: Thank you for submitting a detailed proposal for a *de minimis* fishery, as well as additional draft ideas for Project Team and Admin Team consideration. A number of the ideas you have presented such as considering zonal management, and assigning a specific total allowable catch (TAC) to each zone are concepts that have been incorporated into the latest draft of the management strategy (here). Depending on the management status of the fishery (open, *de minimis*, closed) that TAC would vary, as you suggested, based on what the selected indicators tell us about the health of the red abalone resource. Conversations to date at the Project Team meetings have focused on either a random or preference point lottery, similar to your suggestions. We will continue to explore more specific management details, including allocation details, for a *de minimis* fishery at upcoming Project Team meetings. The strawman proposals discussed to date at Project Team meetings are linked here for reference. The “DATA” tag idea that you’ve proposed aligns well with the “bio-fishery” strawman proposal. We agree that fishermen and citizen scientists can play an important role in data collection for a recreational fishery and that a *de minimis* fishery should be designed to align with those data collection goals. We look forward to your continued insights at upcoming Project Team meetings. *Response sent 4:33pm 9/18/2019*

Proposal Author: Doug Jung

Date Submitted: August 11, 2019

Admin Team Response: Thank you for your comments and desire to inform the allocation of fishing opportunities for a *de minimis* fishery. Conversations to date at the Project Team meetings have focused on either a random or preference point lottery. As you suggested, an alternative to a lottery approach is the exploration of qualifying criteria for how to allocate TAC among stakeholders (e.g. involvement in volunteer urchin removals). However, because the utilization of qualifying criteria is an unprecedented concept for recreational fisheries, its use would require a discussion with the Fish and Game Commission before exploring it in any greater detail. Thus, as an alternative the Project Team could consider establishing some criteria whereby volunteers helping with management (via data collection efforts) could earn a "bonus" point that would apply to a preference point draw system. *Response sent 4:38pm 9/18/2019*

Proposal Author: Steven Rebuck

Date Submitted: August 12, 2019

Admin Team Response: Thank you for your ongoing involvement in this process. We recognize that red abalone is a resource that is found along the entire California coast, however, the scope of the current FMP provided by the Fish and Game Commission is focused on the North Coast recreational fishery. A successful management solution in the North could be a model for discussions regarding a Southern California fishery in the future. The California Department of Fish and Wildlife (CDFW) and The Nature Conservancy (TNC) have been working in partnership with the Ocean Protection Council (OPC), California Fish and Game Commission (Commission), Tribes and tribal communities, and representatives from the recreational red abalone fishing community to ensure a timely and collaborative integration process for the two management strategies that were peer reviewed in the Ocean Science Trust-facilitated process. You can find more information on the peer review process here. *Response sent 4:40pm 9/18/2019*

Proposal Author: Scott Taylor

Date Submitted: September 10, 2019

Admin Team Response: Thank you for sharing your thoughts around the value of fishery-dependent data. We agree that the North Coast recreational red abalone FMP can allow for harvest and data collection by fishermen while posing a minimal

threat to the red abalone resource. To address your concerns about the Department of Fish and Wildlife exploring new management methods and procedures, we are using management strategy evaluation and a host of new indicators to better manage the red abalone resource, with an open exchange of dialogue with the Project Team as you are aware. Although we can track densities of urchin in the environment, your recommendations around adjusting the current bag for purple urchins would have to be addressed in a separate regulation by the Commission. *Response sent 3:59pm 9/18/2019*

Proposal Author: Edward Schulze

Date Submitted: September 16, 2019

Admin Team Response: Thank you for providing comments and a draft data collection form. We will consider the recommended form fields as we continue to develop a proposal for the first tier of the decision tree, which incorporates environmental data and observations. The Admin Team agrees that harvester-collected information can play an important role in the North coast red abalone fishery. Your recommendation that harvesters/citizen scientists should be involved in data collection is in line with comments provided by Department of Fish and Wildlife staff during the August 27, 2019 Project Team meeting where they highlighted the value of harvesters providing observational data, in addition to the information already required on report cards. *Response sent 2:45pm 10/31/2019*

Proposal Author: Jack Likins

Date Submitted: September 24, 2019

Admin Team Response: Thank you for providing a proposal to consider three fishing zones. You have highlighted a number of important considerations for the modelers and Project Team as they continue exploring the appropriate number of zones to consider for management of the red abalone resource - including ecological boundaries, data availability, and ease of enforceability. We appreciate your comprehensive understanding of data collection efforts in California, and your concerns around data availability and data limitations are also in line with ongoing discussions at previous Project Team meetings. As these conversations are still ongoing, we have shared your proposal with the modelers and posted it online for the Project Team to help inform upcoming Project Team discussions. *Response sent 2:49pm 10/31/2019*

Proposal Author: Jan Freiwald

Date Submitted: October 2, 2019

Admin Team Response: Thank you for providing feedback on the four fishing zone proposal presented during the September 19, 2019 Project Team meeting, as well as for providing a three zone proposal. Given Reef Check California's leadership and involvement in ongoing data collection efforts, we value your perspectives on how to align the proposed scale of management with current data availability. As these conversations are still ongoing, we have shared your proposal with the modelers and posted it online for the Project Team to help inform upcoming Project Team discussions. *Response sent 2:52pm 10/31/2019*

Proposal Author: Ken Morrill

Date Submitted: October 9, 2019

Admin Team Response: Thank you for providing feedback around fishing zones and measures that could be used to manage the recreational red abalone fishery. Recent discussions by the Project Team, as well as the Commissioners at the October 2019 Fish and Game Commission meeting also emphasized your point about Humboldt and Del Norte counties being ecologically different, and a need to treat them as so in management. Additionally, your recommendation to use a total allowable catch and size limits are among the list of approaches currently under consideration by the Project Team for managing fishing zones. As conversations on zones are still ongoing, we have shared your proposal with the modelers and posted it online for the Project Team to help inform upcoming Project Team discussions. *Response sent 2:55pm 10/31/2019*

Proposal Author: Ken Morrill

Date Submitted: November 18, 2019

Admin Team Response: Thank you for your comment and for remaining engaged throughout the management strategy integration process. We agree that fishermen should be involved in discussions around ensuring a sustainable level of take (i.e. total allowable catch [TAC]) for the recreational fishery, and are working to ensure that the best science is available to ultimately inform these decisions. With respect to the evaluation of a third zone, due to substantial public comment the modelers will now be exploring what level of sampling intensity would be required to support management of a third zone for Humboldt and Del Norte counties. Relative to increasing size limits, the Department must ensure the interests of all user groups are considered, not just those that would cater to trophy hunters (as highlighted in your example). The modelers, however, will evaluate how rates of recovery would

change for the red abalone resource if the size limit were increased beyond 7” . *Response sent 9:00am 12/17/2019*

Proposal Author: Ed Schulze

Date Submitted: November 18, 2019

Admin Team Response: Thank you for your comment and request to consider enforceability in any management measures under consideration for the North Coast recreational red abalone fishery. We agree that management measures should be enforceable, and CDFW fishery managers will continue to work with enforcement staff throughout the FMP development process to ensure this. However, reviewing bail schedules and the level of infraction for violations are not within the scope of this FMP. *Response sent 8:31am 12/17/2019*

Proposal Author: Steven Rebuck

Date Submitted: November 29, 2019

Admin Team Response: Thank you for your comment and for remaining engaged throughout the management strategy integration process. We agree that current and former commercial divers bring a wealth of knowledge and expertise, and will continue to look for ways to engage these stakeholders to address challenges to the red abalone resource, unfortunately the Department is not in a position to hire outside divers**.** With respect to your recommendation to open an area to abalone harvest in southern California using Appendix H of the ARMP, this is outside the scope of the FMP. The scope is limited to the North Coast recreational fishery and, as previously mentioned, we are not exploring a fishery, recreational or commercial, for southern California. We are hopeful, however, that new FMP for northern California will develop approaches and concepts that might be applied to other parts of the state including southern California. *Response sent 9:00am 12/17/2019*

Proposal Author: Don Thompson

Date Submitted: December 18, 2019

Admin Team Response: Thank you for your perspectives around peer review and future management of the red abalone resource. With respect to the request for a peer review of the draft integrated fishery management plan (FMP), as was mentioned during the final Project Team meeting on December 19, 2019, the California Fish and Game Commission will ultimately determine whether an additional peer review is required, looking to guidance provided in Fish and Game Code and by CDFW. Further comments on this matter can be referred to the March

2020 Marine Resources Committee meeting. With respect to use of the SPR and density data, data poor methodologies were used in the MSE that take advantage of some of the indicators (i.e. SPR and density) highlighted by the peer reviewers because data available to inform the current status of the red abalone resource is extremely limited. Finally, with respect to recovery goals, the goal is to manage a fishery sustainably no matter the condition of the stock. California state law requires that there is an attempt to restore stocks to their former levels. The *de minimis* fishery discussed during the integration process would address the desire to maintain some level of fishing opportunity while the stock is recovering or rebuilding. *Response sent 2:15pm 1/15/2020.*

Appendix E – Data Streams Comparison Table

This Data Stream Comparison (Table E.1) will serve as a reference to inform ongoing Red Abalone Fishery Management Plan (FMP) Project Team discussions regarding trade-offs associated with evaluating which data streams to use in managing the North Coast recreational fishery. It is imperative to consider which combination of data streams will result in appropriate spatial and temporal coverage, as well as be scientifically robust and cost-effective to ensure long-term, sustainable management of the red abalone resource.

Data streams can be considered in four categories: red abalone fishery variables (1-3), red abalone population variables (4-17), red abalone body condition variables (18-19), and environmental variables (20-28). For each data stream within each section, we provide information on - 1) the data source, 2) sampling entity (e.g., government, NGO, academic, industry), 3) length of data set, 4) number of landing sites sampled, 5) frequency of sampling, and 6) total cost of survey (i.e. all associated survey costs including salary. Additionally, please note that in some instances survey costs are reflected in aggregate, as sampling entities can simultaneously collect multiple data streams on the same survey. For instance, during CDFW's creel survey they generate body condition and length data, for a total cost of $11,100. We will continue to update information as it is made available.

Table E.1. Data Stream Comparison Table.

Data Stream [Source/ Associated Survey]	**Sampling Entity**	**Length of Data Set [# years]**	**CDFW Landing Sites Sampled [# sites out of 56 total]**	**Frequency of Sampling**	**Total Cost of Survey [$ per year]**
1. Catch [Report cards]	CDFW	16-30	53	Sporadic (pre-2002); Annually (2002-2016)	$26,400
2. Catch [Creel Survey]	CDFW/ Citizen Scientists	42	10	Annually (pre-2003); Every 2 years (2003 onward)	$11,100
3. Length [Creel Survey]	CDFW/ Divers	42	10	Annually (pre-2003); Every 2 years (2003 onward)	Cost included in total survey estimate in Row 2
4. Length [Subtidal survey]	CDFW	5-29	3-15 ^^^	Sporadic (pre-2002); Every 3 to 4 years (2002-2018)	$125,000 *
5. Length [Subtidal survey]	MPA Monitoring [Reef Check]	13	15	Annually	$110,000 ++
6. Length [Random Swimming]	Reef Check	3	20	Annually	Cost included in total survey estimate in Row 5
7. Length [Subtidal survey]	MPA Monitoring (HSU, MARINe)	3-6	11	Annually	$123,000 +++
8. Length [Intertidal plot survey]	MPA Monitoring (MARINe/ PISCO UCSC)	1-17	4-11	Annually (for 4 funded sites); Sporadic (7 additional)	$32,000 ^^
9. Length [Intertidal swath survey]	MPA Monitoring (MARINe/ PISCO UCSC)	1-7	31	Every 3-5 years	$49,600 ^^

Data Stream [Source/ Associated Survey]	Sampling Entity	Length of Data Set [# years]	CDFW Landing Sites Sampled [# sites out of 56 total]	Frequency of Sampling	Total Cost of Survey [$ per year]
10. Density ^ [Subtidal survey]	CDFW	5-29	3-15 ^^^	Sporadic (pre-2002); Every 3 to 4 years (2002-2018)	Cost included in total survey estimate in Row 4
11. Density [Subtidal survey]	MPA Monitoring (HSU, MARINe)	3-6	11	Annually	Cost included in total survey estimate in Row 7
12. Density [Subtidal survey]	MPA Monitoring (Reef Check)	13	15	Annually	Cost included in total survey estimate in Row 5
13. Density/ Counts [Intertidal plot survey]	MPA Monitoring (MARINe/ PISCO UCSC)	1-17	4-11	Annually (for 4 funded sites); Sporadic (7 additional)	Cost included in total survey estimate in Row 8
14. Density [Intertidal swath survey]	MPA Monitoring (MARINe/ PISCO UCSC)	1-7	31	Every 3-5 years	Cost included in total survey estimate in Row 9
15. Recruitment module [Juvenile stage recruitment]+	CDFW	18	1	Annually	Cost included in total survey estimate in Row 4
16. Recruitment [Plankton tow]+	CDFW	10	2-3	Every 3 to 4 years (2002-2018)	Cost included in total survey estimate in Row 4
17. Recruitment [Boulder sampling]+	CDFW	10	2-3	Every 3 to 4 years (2002-2018)	Cost included in total survey estimate in Row 4

Data Stream [Source/ Associated Survey]	Sampling Entity	Length of Data Set [# years]	CDFW Landing Sites Sampled [# sites out of 56 total]	Frequency of Sampling	Total Cost of Survey [$ per year]
18. Gonad index [Creel Survey]	CDFW	10	2	Every 2 years	Cost included in total survey estimate in Row 2
19. Body condition [Creel Survey]	CDFW	3-4	10	Every 2 years	Cost included in total survey estimate in Row 2
20. Kelp Density [Aerial survey]	CDFW	12	53	Sporadic (annually in 2008, 2014-2016)	$250,000 **
21. Kelp Density [Subtidal survey]	MPA Monitoring (Reef Check)	13	15	Annually	Cost included in total survey estimate in Row 5
22. Kelp Density [Subtidal Survey]	MPA Monitoring [HSU, MARINe]	2-6	11	Annually	Cost included in total survey estimate in Row 7
23. Pacific Decadal Oscillation	NOAA Fisheries	129	---	Annually	---
24. Urchin Density [Subtidal survey]	CDFW	5-29	3-15 ^^^	Sporadic (pre-2002); Every 3 to 4 years (2002-2018)	Cost Included in total survey estimate in Row 4
25. Urchin Density [Subtidal survey]	MPA Monitoring (Reef Check)	13	15	Annually	Cost included in total survey estimate in Row 5
26. Urchin Density/ Counts [Intertidal Plot Survey]	MPA Monitoring (MARINe/ PISCO UCSC)	1-7	13	Annually (for 9 funded sites); Sporadic (4 additional)	$20,800 ^^

Data Stream [Source/ Associated Survey]	Sampling Entity	Length of Data Set [# years]	CDFW Landing Sites Sampled [# sites out of 56 total]	Frequency of Sampling	Total Cost of Survey [$ per year]
27. Water Temperature	CDFW	12	1	Annually	Cost included in total survey estimate in Row 4
28. Water Temperature	Reef Check	2	~10	Every 15 min (Year round)	$2,000

* Includes costs for various permanent and temporary staff salaries and factoring in pre-survey preparation, conducting surveys, and post survey data processing and QA/QC. This is an annual cost estimate for three weeks of survey on the North Coast.

** Cost is likely higher than listed amount; reflects the current cost for a contract to provide aerial survey and post processing of data for GIS use.

*** Cost likely higher than listed amount; reflect transect survey costs (e.g. survey operations and staff compensation beyond regular work hours) but does not account for costs associated with data entry and QA/QC

+ Data streams under development

++ Includes costs for all data collected by Reef Check (including length [i.e. “random swimming”] and density survey for kelp forest community), as well as staff time for Reef Check staff and part-time contractor

+++ Includes costs for all data collected by HSU (including length and density survey for kelp forest community), as well as staff time for HSU including travel, benefits, and boat usage

^^ Includes costs to survey all sites, travel, salary and benefits, overhead, and database support.

^^^ CDFW can either run the rapid assessments (i.e., 10 index sites per year) or the regular index site survey (i.e., 3 index sites per year) under this cost and FTE

Appendix F – De Minimis Fishery Strawman Proposal

At the direction of the Ocean Science Trust-facilitated peer review panel and the Fish and Game Commission (Commission), the Project Team, in partnership with the Administrative Team, has been exploring the design of a de minimis fishery for the North Coast recreational red abalone fishery. This document is intended to provide a framework for a de minimis fishery within the North Coast recreational red abalone FMP. It outlines management tools available to help inform guidelines for future regulatory consideration and has been updated to include additional options that were identified during the December 19, 2019 Project Team meeting. Its content has been informed by discussions at previous Project Team meetings, as well as email submissions from Project Team members[10] . This document has been streamlined for consideration by the Project Team. Modeling work being conducted as part of the management strategy integration process will continue to inform the appropriate level of take (if possible without impacting the resource) of such a fishery. Upon conclusion of the management strategy integration process, this proposal will be included as an Appendix in the final report to the Commission and will continue to be used as a resource to guide FMP development.

Updated De Minimis Fishery Proposal

Current components for consideration in the development of a de minimis fishery proposal are as follows:

- **Season Length:**
    - Maintain status quo (i.e., year-round harvest opportunities)

10 All proposals submitted by the Project Team were reviewed and considered by the Administrative Team:

- Jack Likins- Submitted May 22, 2019 Project Team meeting
- Steven Rebuck- Submitted May 22, 2019 Project Team meeting
- Brandi Easter- Submitted May 22, 2019 Project Team meeting
- Don Thompson- Submitted May 22, 2019 Project Team meeting
- Steven Rebuck- Submitted June 12, 2019
- Edward Schulze- Submitted June 19, 2019
- Ken Morrill - Submitted June 27, 2019
- Brandi Easter - Submitted July 10, 2019
- Doug Jung - Submitted August 11, 2019
- Steve Rebuck - Submitted August 12, 2019
- Scott Taylor - Submitted September 10, 2019
- Ed Schulze - Submitted September 16, 2019
- Jack Likins - Submitted September 24, 2019
- Jan Freiwald – Submitted October 3, 2019
- Ken Morrill – Submitted October 9, 2019
- Petition for New Abalone Management Zone – Submitted October 18, 2019
- Ken Morrill – Submitted November 18, 2019
- Edward Schulze – Submitted November 18, 2019
- Steve Rebuck – Submitted November 29, 2019
- Don Thompson – Submitted December 18, 2019

    - Condensed fishing season (i.e., July to October)
    - Consider different Seasons for rock pickers (e.g., April to May) and other sectors (e.g., May to October)

- **Daily Bag/Possession/Annual Limits:**
    - Discussed as few as 1 to 2 abalone per permit per season
    - Need flexibility to increase limits as stock recovers
    - Limits could vary or scale based on *de minimis* fishery TAC under consideration to maximize opportunity

- **Number of permits**: (*TBD, results from MSE will inform potential opportunity levels*)

- **Size Limit:**
    - Maintaining status quo (7”)
    - Include flexibility to increase size limit to ensure recovery (8” or 9” or 10”)

- **Management Zones:**
    - Option #1: Considers two fishing zones
        - Marin and Sonoma counties
        - Mendocino, Del Norte, Humboldt counties
    - Option #2: Considers three fishing zones
        - Marin and Sonoma counties
        - Mendocino county
        - Del Norte and Humboldt counties
        - Given current data limitations in Del Norte and Humboldt counties, additional discussions are needed to evaluate sampling needs and to outline what a management strategy could look like

- **Data Collection Scheme:**
    - Prioritize collecting length and density data (as the primary data streams feeding into harvest control rule)
    - CDFW to coordinate data collection with pre-determined governmental and non-governmental entities to inform collection of length [sources: Reef Check, harvesters] and density data [source: CDFW], as well as other data streams under consideration for Part A of decision tree [sources: *TBD*]
        - Can align data needs with permit conditions to have harvesters assist with collecting data that isn’t as easily attainable (e.g. body condition or gonad index)

- **Permit Allocation Scheme: Preference Point Lottery**
    - A random drawing would pick the permit recipients out of the pool of applicants for each opportunity
        - The first year that *de minimis* fishing opportunities are offered, licensed fishermen may apply for at least one of the opportunities
        - Those applicants not selected would receive a point
        - Selected applicants must purchase the applicable report card (permit) to fish
        - Failure to report the required data by the prescribed date would prohibit the person from applying for permits the following year
    - The second year that opportunities are offered, applicants would be separated into two groups: those with one point and those without any points
        - A random drawing for opportunities would be conducted using the group with one point
        - Any remaining fishing opportunities would be distributed using a second random draw using the group with no points.
        - All applicants not selected would receive one point.
    - Process repeated annually as/if resources allows
    - Potential to include party tags in a lottery system (e.g., up to 6 individuals). If group gets drawn all members get a tag.

- **Special Conditions:**
    - Permit holders must submit their completed report cards (permits) or enter required data online by October 31.
    - Punitive measures to incentivize data collection – consider fine, loss of preference points, and inability to re-apply the following year
    - Permit holders must provide length data (manually or using machine learning applications) and report on underwater observations
    - Potential Tribal subsistence fishing allocation for Tribes and Tribal communities[11]

This draft proposal incorporates feedback from the Project Team in the following ways –

- Avoids slot limits

11 During the September 19, 2019 Project Team meeting, it was highlighted that the preference point lottery allocation scheme would not meet subsistence needs of Tribes and Tribal communities. California Fish and Game Commission will need to explore whether they have the authority to allocate a portion of the overall TAC to subsistence only harvest by Tribes and Tribal communities.

- Limits season lengths to increase enforceability
- Uses size limits
- Conservative daily bag limits and spreads take across multiple dates to encourage multiple trips to North Coast
- Balances the priorities of supporting the recovery of red abalone while allowing fishing opportunities
- Involves fishermen in data collection efforts
- Provides a precautionary fishing opportunity by limiting access and spreading fishing pressure over a larger area
- Provides an opportunity to gather and provide data in a large region where very little data currently exists

Appendix G - Exceptional Circumstances Strawman Proposal

Framework Background

The North Coast recreational red abalone fishery management plan (FMP) will provide a framework to help ensure long-term management of the resource, where management is objective, transparent, and more responsive and adaptive, particularly under changing environmental conditions. The FMP is intended to serve as an overarching management document that identifies and discusses key issues that should be considered when drafting and adopting regulations to manage the fishery. Once developed, the Project Team may propose that a discussion on exceptional circumstances such as those identified in this draft proposal be included in the recreational red abalone FMP.

The State will need the ability to respond to anomalous and/or extreme environmental conditions, some of which have not been seen or cannot be predicted. In the face of unforeseen or extreme environmental conditions that could drastically impact the red abalone resource, more precautionary measures may be needed. Better monitoring for signs of these conditions will be critical to inform precautionary decision-making in red abalone management. At its August 27th meeting, the Project Team recommended conducting a “catastrophic environmental safety check” for major events like oil spills, harmful algal blooms, and warm water anomalies. They also recommended reviewing other “investigative triggers” (e.g. biological and environmental indicators such as urchin density, kelp abundance, oxygen levels) to determine if conditions are poor and a more immediate response is needed to proactively protect red abalone. These would be considered ‘exceptional circumstances’. Given the challenge of verifying the mechanistic links between some of these ecological and environmental indicators and the status of the red abalone resource, the harvest control rule was streamlined to include only density and length-based spawning potential ratio (SPR). Without clear mechanistic links it would have been difficult to include and evaluate other suggested ecological and environmental indicators in the management strategy evaluation (MSE). Recognizing the importance of monitoring other biological and environmental indicators, the Project Team decided to include these indicators as a precautionary check before consulting an indicator-based decision tree informed by density and length data.

The draft management strategy is currently structured in two parts - Part A and Part B. Part A, incorporates the precautionary thinking that came from the discussions at the August 27 Project Team meeting to account for the presence of unusual and/or extreme environmental conditions that may impact the red abalone resource. If an exceptional circumstance has occurred, then further action or decision making is

required before determining the status of the fishery (i.e., closed, de minimis, open). If no exceptional circumstances have occurred, Part B follows an indicator-based decision tree.

Exceptional Circumstances Strawman Proposal

Part A of the decision tree would evaluate presence of broader scale ecosystem events or impacts, and/or rapidly assess indicators to evaluate any risks that may result in a catastrophic decline of the red abalone resource.

Broader-scale ecosystem events and impacts could include:

- Persistence of large marine heat waves
- Presence of disease (e.g., withering syndrome)
- Presence of toxic harmful algal blooms
- Oil spills

Rapid assessment could include an evaluation of all or a subset of the indicators listed below. Baseline data would also be required to demonstrate a true deviation from 'normal' conditions, and peer review guidance on some of these indicators should be taken into consideration.

- Ocean Warming
    - Dissolved oxygen level
    - Ocean temperature
- Environmental Shifts
    - Kelp abundance
    - Sea urchin density
    - Sea star density
- Ocean pH/acidification
- Red Abalone Reproductive State
    - Body condition
        - Gonad condition (secondary check)
    - Presence of empty abalone shells

If/when an exceptional circumstance is triggered, four potential actions could occur

- Collect more data and evaluate whether to continue on to Part B
- Management action occurs in one or more fishing zone
- A stakeholder consultation process is triggered - an advisory group evaluates data before management action is taken
- Consult Fish and Game Commission for direction on management action

Questions for CDFW Consideration During FMP Development

As CFDW further refines Part A of the management strategy during the FMP development process, they should consider the following questions and work with peer review panelists, stakeholders, and Tribes and Tribal Communities to best address them.

- Given capacity and cost constraints and current data availability, which indicators could be prioritized for monitoring in Part A?
- Are the indicators under consideration directly or indirectly related to impacts on red abalone health and productivity? Is the mechanism clearly understood or does a clear threshold exist?
- Which exceptional circumstances would trigger closure of all fishing zones and which would trigger closures at the individual fishing zone? Could closures occur at the site level?
- What could data collection/sampling protocols look like during rapid assessments? Would data sources and sampling entities be pre-defined?
- How do we account for persistence of events like marine heat waves?

Appendix H – Glossary of Key Terms

This document is intended to serve as a resource to members of the Project Team to provide definitions for some common terminology encountered during their engagement in the fishery management plan (FMP) development process for the North Coast recreational red abalone fishery. Definitions are provided in normal font and context specific to the Red Abalone FMP process are indicated in *italics.* For a more comprehensive list of fishery terms please see the following glossaries: NOAA Fisheries, 2018 Marine Life Management Act (MLMA) Master Plan for Fisheries, California Water Board, and FAO.

For more information about the Project Team, and access to additional resources, visit: Recreational Red Abalone Management Strategies Integration and Red Abalone Fishery Management Plan.

Abundance: The total number of a kind of fish or invertebrate in a population.

- *True estimates of abundance are rarely known, and usually estimated from the relative abundance, such as the case with the red abalone density surveys.*

Administrative Team: A team comprised of representatives from the California Department of Fish and Wildlife (CDFW), the Ocean Protection Council (OPC), the Fish and Game Commission (Commission), the Nature Conservancy (TNC), Tribes and tribal communities, and the red abalone fishing community, charged with ensuring that the management strategies integration process occurs in a collaborative, efficient, and timely manner and informs a revised management chapter for the recreational red abalone FMP, in line with the recommendation from the Commission.

- *The Administrative Team Charter is available here*

Allee effect: Biological occurrence characterized by a correlation between population density and per capita growth rate. Either overcrowding (i.e., very high density) or under crowding (i.e., very low density) can have a negative impact on population survival, growth, and development. Below a critical density threshold**,** spawning success declines, resulting in population declines and even localized extinctions.

Allocation: In regard to fisheries, allocation means the direct and deliberate distribution of the opportunity to participate in a fishery, or to receive a share of a catch quota, among identifiable, discrete user groups or individuals.

Bag limit: A limit per day or per trip on the number or weight of fish, invertebrates, or plants that a recreational fisherman may legally retain.

Bobber: Anglers that search for abalone in between the waterline and a depth they can reach without fins by “bobbing”. They do not reach depths beyond about 6 ft.

Body condition: A metric used to assess red abalone health. It is scored from 0 to 3 based on the appearance of the foot muscle, where a 0 score represents a healthy abalone where the foot muscle fully fills the circumference of the shell and a 3 is the opposite where the foot is severely shrunken.

Biological fishery (Bio-fishery): A fishery in which limited harvesting activities are permitted to fishermen to collect biological information in alignment with pre-defined research objectives. A bio-fishery can be site-specific or applied at the fishing zone level, and may occur even when the recreational fishery is at a closed status.

Catch: The total number (or weight) of fish [or invertebrates] caught by fishing operations. Catch should include all fish [or invertebrates] killed by the act of fishing, not just those landed.

Citizen science: Public participation in data collection and/or scientific research.

Catch Per Unit Effort (CPUE): The catch obtained by a vessel, gear, or fisherman per unit of fishing effort (e.g., number or weight of fish [or invertebrates] caught per hour of trawling).

Data stream: A continuous flow of data (information) from a fishery which can be analyzed to inform management decisions.

Decision interval: Frequency or interval at which the management status recommendation is evaluated by re-assessing the harvest control rule.

- *For red abalone, an annual decision interval is proposed that is based on a running average of the previous three years of data.*

De minimis fishery: A fishery with a level of catch that is anticipated to have little to no effect on the health or recovery of a fishery resource . It is applied at the fishing zone level and occurs based on predefined thresholds set in an associated harvest control rule.

- *One approach to achieving a de minimis fishery for red abalone is through a managed or restricted access policy.*

Density: Number of organisms per unit of area.

- *In the case of current red abalone management, density represents the number of abalone per square meter (CDFW).*

Diver: A fisherman who uses free diving (i.e., being completely submerged underwater with the use of swim fins) as a method to catch fish or other species.

Eggs Per Recruit (EPR): Average number of eggs a recruit produces over its lifetime. Similar to Spawning Potential Ratio (SPR) [see below].

Exceptional Circumstance: A deviation from “normal” environmental conditions (i.e. anomalous and/or extreme environmental conditions) which may result in a catastrophic decline in red abalone

- *In the case of the proposed red abalone management, Part A of all proposed management strategies would involve a precautionary evaluation of environmental conditions and/or biological conditions for red abalone before proceeding to Part B (the decision-tree)*

Facilitation Team: In the context of this project, the facilitation team are third-party, neutral facilitators funded by a grant from the Ocean Protection Council in support of the FMP development process.

Fishery: The combination of fish and fishers in a region, the later fishing for similar or the same species with similar or the same gear types

- *For red abalone, refers to harvesting from commercial fishermen, recreational divers, rock pickers, and bobbers.*

Fishery-dependent data: Information collected directly from a fishery, such as sampling catch at landing sites and information from commercial landing receipts and commercial fishing passenger vessel logbooks.

- *For red abalone, refers to the data collected from abalone report cards and creel surveys.*

Fishery-independent data: Information collected separately or independent of fishery landing or catch data.

- *Examples include in-water subtidal surveys conducted by CDFW, ReefCheck, and MARINe/PISCO*

Fishery Management Plan: A planning document based on the best-available scientific knowledge and other relevant information that contains a comprehensive review of the fishery along with clear objectives and measures to ensure its sustainability. Components of an FMP are described in the MLMA.

Gonad index: The gonadosomatic index, abbreviated as GSI, is the calculation of the gonad mass as a proportion of the total body mass. It is represented by the formula: GSI = [gonad weight / total tissue weight] × 100.

Harmful Algal Bloom (HAB): HABs occur when colonies of algae — simple plants that live in the sea and freshwater — grow out of control and produce toxic or harmful effects on people, fish, shellfish, marine mammals and birds.

Harvest Control Rule (HCR): Describes how harvest is intended to be controlled by management in relation to the state of some indicator of stock status.

- *For example, a harvest control rule can describe the various values of fishing mortality that will be aimed at for various values of the stock abundance. It formalizes and summarizes a management strategy.*
- *A decision-tree is a type of harvest control rule, and may be used interchangeably during this management strategy integration process*

Index sites: The 10 landing locations used by the CDFW when conducting subtidal dive surveys and collecting data to inform decision-making.

- *Red abalone density data used in the Abalone Recovery and Management Plan (ARMP) are generated from these subtidal surveys.*

Indicator: A measure of a component or process that can serve as a proxy for values that are difficult to calculate, such as abundance of a species or ecosystem health.

- *For example, CPUE is often used as an indicator of stock abundance or availability. In the case of red abalone, density, SPR, and catch are some examples of indicators evaluated in the peer review process.*

Intertidal: The area on a seacoast between the highest and lowest tide.

Invertebrate: An animal lacking a backbone.

- *Examples include abalones, jellyfish, shellfish, etc.*

Landings: The number or poundage of fish or other species unloaded at a dock by commercial fishermen or brought to shore by recreational fishermen for personal use. Landings are reported at the locations at which fish are brought to shore.

Managed access: A fisheries management tool which seeks to protect the rights of fishermen by giving them exclusive access to fish certain areas.

Management strategy: A strategy adopted by a management authority to reach established management goals. In addition to the objectives, it includes choices regarding all or some of the following: access rights and allocation of resources to stakeholders, controls on inputs (e.g. fishing capacity, gear regulations), outputs (e.g. quotas, minimum size at landing), and fishing operations (e.g. calendar, closed areas, and seasons)**.**

- *For the red abalone FMP development process, the OST-facilitated peer review recommended that elements of each of the two management strategies should be combined into a single management strategy to form a more cohesive plan and reduce the risk of overfishing and increase management performance (i.e., management strategy integration)*

Management strategy evaluation (MSE): MSE is a modeling-based approach aimed at testing the robustness of possible management [strategies] by examining which sets of decision rules, which are used to adjust Total Allowable Catch or effort controls, perform the best in achieving the management objectives for a fishery. This simulation testing can also be used to determine how robust the management [strategies are] likely to be to uncertainties. These analyses enable the choice of which management planning option has the most reasonable likelihood of achieving the management goals.

Maximum Sustainable Yield (MSY): The highest average yield over time that does not result in a continuing reduction in stock abundance, taking into account fluctuations in abundance and environmental variability.

Model: A mathematical means of explaining a system, studying the effects of various components, and making predictions about behavior or management outcomes, as informed by hypothetical and/or measured values.

Open access: Condition in which access to a fishery is not restricted (i.e. no license limitation, quotas, or other measures that would limit the amount of fish that an individual fisher can harvest).

- *In the case of the abalone fishery, open access means that anyone may buy an abalone report card but they are still required to adhere to regulations/restrictions (e.g., bag limits, size limits).*

Operating model: A central model to a management strategy evaluation (MSE) that simulates all relevant aspects of the fisheries system and proposed management strategy. It includes all plausible hypotheses about the biology of the stock, such as recruitment, and aspects of the fishery, such as the level of illegal fishing activity.

Precautionary management: A resource management framework that implements conservation measures even in the absence of scientific certainty that fish stocks are being overexploited.

Project Team: A team charged with discussing and providing feedback on all scientific analyses conducted by the modelers to inform the management strategies integration process and provide input on de minimis (i.e., restricted/managed) fishery design in the red abalone FMP development process.

- *The Project Team is open to all members of the public, including members of the abalone fishing community, Tribes and tribal communities, non-governmental organizations, scientists, resource managers, the Recreational Abalone Advisory Committee, as well as staff of state agencies (i.e. CDFW, OPC, Commission). The Project Team Charter is available here.*

Quota: A limit on the amount of fish which may be landed in any one fishing season or year. May apply to the total fishery, a geographical area, or an individual share.

Recruitment: A measure of the number of fish [or invertebrates] that survive to a particular life stage, often used to predict future population size.

- *Some examples include the number of offspring that survive the larval stage and reach the juvenile stage (larval recruitment), the number of individuals that survive (i.e., recruit) to the next year (e.g., age two recruits), the number of fish that reach sexual maturity (i.e., recruit to the spawning population), or in the case of a fishery, the number of fish that recruit to the catchable component of the population.*

Reference point: Quantitative (numerical) values that inform managers about the current status of a stock. *Target reference point* is a numerical value that indicates that the status of a stock is at a desirable level; often times management is geared towards achieving or maintaining this target. *Threshold (limit) reference point* is a

numerical value that indicates that the status of a stock is unacceptable (e.g. overfished), and that management action should be taken to improve stock status.

Relative abundance: A relative measure of the weight or number of fish in a stock, a segment of the stock (e.g. the spawners), or an area. Often available in time series, the information is collected through scientific surveys or inferred from fishery data.

- *For red abalone, relative abundance is a comparison of density transect surveys at one period in time to another.*

Report card: Cards issued to recreational fishermen (i.e. divers, rock pickers, bobbers) for recording the landing location (out of a total of 56 sites), date and time, method used, and number of abalone taken. Also referred to as punch cards or tags.

Restricted access: Restriction of the right to participate in a fishery, using permits or other means. This is one method managers may use to ensure sustainable fisheries, reduce fishing effort, or protect recovering or threatened stocks.

Rock picker (or shore picker): An angler whose method of take involves searching for abalone in the exposed intertidal habitats during low tides without the use of fins.

Size limit: A minimum or maximum limit on the size of fish [or invertebrate] that may be legally be caught.

- *Minimum size limits are typically intended to prevent the harvest of juvenile or young individuals before they have reproduced. Maximum size limits are typically intended to prevent the harvest of highly fecund female fish. Size limits may be sex-specific for some species.*

Spawning Potential Ratio (SPR): A ratio of reproductive potential for a fished population relative to that of an unfished population, used to characterize the amount of impact that all forms of mortality (natural and fishing-based) have on a population's ability to reproduce. Similar to EPR.

Subtidal: Permanently below the level of low tide, an underwater environment.

Sustainable: "Sustainable," "sustainable use," and "sustainability," with regard to a marine fishery, mean both of the following: (a) Continuous replacement of resources, taking into account fluctuations in abundance and environmental variability; and 2018 Master Plan for Fisheries Glossary 85 (b) Securing the fullest possible range of present and long-term economic, social, and ecological benefits, maintaining

biological diversity, and, in the case of fishery management based on MSY, providing for a fishery that does not exceed optimum yield.

Total Allowable Catch (TAC): A specified numerical catch (including discard mortality) for each fishing season, the attainment (or expected attainment) of which may cause closure of the fishery.

Tribal Tradition and Culture: Uses of water that support the cultural, spiritual, ceremonial, or traditional rights or LIFEWAYS of CALIFORNIA NATIVE AMERICAN TRIBES, including, but not limited to: navigation, ceremonies, or fishing, gathering, or consumption of natural aquatic resources, including fish, shellfish, vegetation, and materials.

Tribal Subsistence Fishing: Uses of water involving the non-commercial catching or gathering of natural aquatic resources, including fish and shellfish, for consumption by individuals, households, or communities of California Native American Tribes to meet needs for sustenance.

Zones: Geographic areas of the coastline comprising several of the formerly defined abalone report card sites

Appendix I - Administrative and Project Team Charters

Red Abalone Management Strategies Integration | Administrative Team Charter

Updated October 2019

I. Background

The Ocean Protection Council (OPC) provided a grant to the Ocean Science Trust to facilitate a scientific peer review of the management strategies provided by the California Department of Fish and Wildlife (CDFW) and The Nature Conservancy (TNC)-led stakeholder team. The final Recreational Red Abalone Peer Review Report, including a key themes summary from the first community webinar, is accessible here.

After the completion of the peer review process and review of the final report, the Fish and Game Commission (Commission) made the following recommendation at its December 2018 meeting: (1) Support addressing peer review recommendations to integrate aspects of both draft management strategies, based on a simulation modeling approach co-developed by CDFW and the TNC-led stakeholder team, including engagement with abalone divers and other stakeholders; (2) revise Fishery Management Plan (FMP) goals to allow for a *de minimis* fishery option; (3) develop triggers for the *de minimis* fishery option in consultation with stakeholders; and (4) request that CDFW develop a proposed process and timeline which accounts for active public and Marine Resources Council (MRC) engagement.

II. Purpose of the Administrative Team

The primary function of the Administrative Team (Admin Team) is to ensure that the management strategies integration process occurs in a collaborative, efficient, and timely manner and informs a revised management chapter for the Recreational Red Abalone Fishery Management Plan (FMP), in line with the recommendation from the Commission.

In order to ensure a successful outcome, the Admin Team will conduct the following activities:

- Develop a charter to inform structure and charge of the Project Team;
- Assess funding needs to convene Project Team and secure necessary funding;
- Provide clear tasks and feedback to modeler(s) to inform modeling work based on recommendations of peer reviewers and Project Team;

- Schedule regular check-in calls before and after Commission and Project Team meetings, and as needed;
- Schedule third-party facilitated Project Team meetings;
- Draft progress reports for Commission and MRC meetings on overall progress of Project Team;
- Periodically update the OPC and CDFW websites to share information about the management strategies integration process (i.e. Project Team charter, work plan, meeting summaries); and
- At conclusion of management strategies integration process, develop and submit to the Commission a report for fishery managers that summarizes the discussions, proposals, and suggestions by the Project Team and lead modeler to inform the re-drafting of the FMP.

III. Membership

The Admin Team is comprised of one representative from the CDFW, OPC, Commission, TNC, and recreational Red Abalone fishing industry, with designated alternates for each organization (Table I.1):

Table I.1. Admin Team Members and Roles.

Name	**Role**
Sonke Mastrup	Primary CDFW Representative [Secretary]
Ian Taniguchi	CDFW Alternate
Paige Berube	Primary OPC Representative
Jenn Eckerle	OPC Alternate
Elizabeth Pope	Primary Commission Representative
Maggie McCann	Commission Alternate
Alexis Jackson	Primary TNC Representative [Chair]
Kate Kauer	TNC Alternate
Joshua Russo	Primary Industry Representative
Jack Likins	Industry Alternate
Javier Silva	Sherwood Valley Rancheria of Pomo Indians

If there is a need to update membership to the Admin Team due to transition or inability to participate actively and consistently in meetings, this will be discussed during an Admin Team call. Primary representatives will use a consensus-based approach to determine an appropriate and timely process for appointment of a new representative, or alternate will be determined and implemented on a consensus

basis. If the team is unable to reach consensus during discussions, they will seek guidance from either the MRC co-Chairs or from the full Commission.

The Admin Team will leverage the experiences, expertise, and insight of key individuals at organizations committed to the successful integration of management strategies. They may also solicit the expertise of the peer reviewers, as needed, throughout the process. Individually, Admin Team members should:

- Understand the significance of the management strategies integration process for coastal communities and conservation and represent those interests; and
- Commit to fully participate in the integration process by being an active contributor during Admin Team meetings and complete any assigned tasks.

All primary representatives on the Admin Team are:

- Expected to actively participate in Admin Team meetings;
- Responsible for keeping their peers, interest groups, and/or organizations informed about the Admin Team process;
- Act as a conduit to share information from interest group and responsible for ensuring accurate dissemination of information; and
- Represent interest group in formulating recommendations.

All alternates on the Admin Team:

- Represent interest group when Primary is absent;
- May listen to Admin Team meetings to ensure continuity, but defer to Primary to speak on behalf of respective interest group; and
- May ask clarifying questions but will not be included in any consensus to make a recommendation.

As members of the Admin Team, all agree to adhere to the following Meeting Agreements:

- Support CDFW during the FMP development to ensure a successful outcome;
- Listen to build mutual understanding;
- Openly and constructively discuss issues with others, respect differences;
- Focus on brainstorming ideas, with the intention to develop creative solutions;
- Arrive at each meeting prepared to discuss agenda items, including reviewing materials and information distributed in advance of the meeting or conference call;
- Contribute to and support constructive discussions focused on charge of group rather than personal interests; and

- When participating in a Project Team meeting as a key contributor, that individual is expected to stay for the duration of the meeting unless prior arrangements have been made with the meeting facilitators.

Failure to follow Meeting Agreements can result in removal from Admin Team.

IV. Administrative Team Meetings

The Admin Team shall hold meetings in advance of and immediately following Commission and/or MRC meetings, Project Team meetings, or as needed. All members of the Admin Team will work collectively to make consensus-based decisions. If the team is unable to reach consensus on any issue, they will seek guidance from either the MRC co-Chairs or from the full Commission, consistent with the process outlined in Section II.

The Admin Team shall have a Chairperson responsible for facilitating Admin Team meetings and a Secretary responsible for documenting discussions and follow-up actions. At each meeting, the Chair or other appropriate Admin Team member will report on project status using an agenda outline that includes but is not limited to:

- Introductory items including agenda review and review of actions from previous meetings;
- Review project status and agenda items requiring Admin Team approval or recommendations;
- Task actions for modeler(s) arising from the Project Team meeting;
- Assign responsibility to Admin Team members for actions arising from the meeting; and
- Plan for the next Project and Admin Team meetings.

Notes will be made available to the Admin Team via email or Google Drive within 3 days after an Admin Team meeting.

Red Abalone Management Strategies Integration | Project Team Charter

Updated June 2019

I. Background

The Ocean Protection Council (OPC) provided a grant to the Ocean Science Trust to facilitate a scientific peer review of the management strategies provided by the California Department of Fish and Wildlife (CDFW) and The Nature Conservancy (TNC)-led stakeholder team. The Final Recreational Red Abalone Peer Review Report, including a key themes summary from the first community webinar, is accessible here.

After the completion of the peer review process and review of the final report, the Fish and Game Commission (Commission) made the following recommendation at its December 2018 meeting: (1) Support addressing peer review recommendations to integrate aspects of both draft management strategies, based on a simulation modeling approach co-developed by CDFW and the TNC-led stakeholder team, including engagement with abalone divers and other stakeholders; (2) revise Fishery Management Plan (FMP) goals to allow for a *de minimis* fishery option; (3) develop triggers for the *de minimis* fishery option in consultation with stakeholders; and (4) request that CDFW develop a proposed process and timeline which accounts for active public and Marine Resources Committee (MRC) engagement.

II. Purpose of the Project Team

The primary purpose of the Project Team is to discuss and provide feedback on all scientific analyses conducted by the modelers to inform the management strategies integration process and provide input on *de minimis* (i.e., restricted/managed) fishery design. Such advice is critical to informing the revised management chapter for the Recreational Red Abalone FMP for the North Coast.

In order to ensure a successful outcome, the Project Team will conduct the following activities:

- Consider all recommendations from the final Recreational Red Abalone Peer Review Report;
- Review all scientific documents provided by the lead modeler and affiliates;
- Provide constructive feedback on science reported by the lead modeler and affiliates;
- Contribute to the design of *de minimis* fishery;

- Propose candidate management strategies based on outcomes of simulation modeling work; and
- Engage in productive and respectful discussions with all Project Team members and the facilitation team.

III. Participation

Participation on the Project Team will be open to all members of the public, including members of the abalone fishing community, Tribes and tribal communities, non-governmental organizations, scientists, resource managers, the Recreational Abalone Advisory Committee, as well as staff of state agencies (i.e. CDFW, OPC, Commission). The Project Team, with the assistance of the facilitation team, will leverage the experiences, expertise, and insights of all participants committed to the success of the management strategies proposal integration process. A quantitative fisheries modeler will support the work of the Project Team during and between meetings.

There will be no formal assigned seats unless it becomes necessary at a later time to maintain the productivity of the team. Project Team members are not directly responsible for managing project activities, rather they are charged with providing advice and guidance to inform activities of the Administrative Team in their role to "generate a summary report for fishery managers to inform re-drafting of (the recreational Red Abalone) fishery management plan."

As members of the Project Team, all agree to adhere to the following Meeting Agreements:

- Support CDFW during the FMP development to ensure a successful outcome;
- Listen to build mutual understanding;
- Openly and constructively discuss issues with others, respect differences;
- Focus on brainstorming ideas, with the intention to develop creative solutions;
- Arrive at each meeting prepared to discuss agenda items, including reviewing materials and information distributed in advance of the meeting or conference call;
- Contribute to and support constructive discussions focused on the charge of the group rather than personal interests; and
- When any individual is attending a Project Team meeting as a key contributor, that individual is expected to stay for the duration of the meeting unless prior arrangements have been made with the meeting facilitators.

Peer review panel representatives may attend Project Team meetings following the procedures below, as well as review work products to provide input to the process to ensure products are in line with peer review recommendations.

IV. Project Team Meetings and Procedures

The Project Team shall convene over a series of six full-day meetings (in-person or via webinar) between May and December 2019 in order to fulfill its advisory responsibilities. All Project Team meetings will be under third-party, neutral facilitation provided by Strategic Earth Consulting, and funded by the OPC. Project Team meetings will be informed by an agenda as put forth by the Administrative Team. Materials for review will be made available 1 week before any Project Team meeting.

During any small group breakout sessions for proposal development, each group will be provided with clear objectives, guidance, and background information. Breakout groups will incorporate a mix of scientists, industry, non-profit practitioners, and agency staff, with those individuals from any under-represented demographic or area of expertise floating between groups. Discussions held in break out groups will be reported out to the full Project Team in plenary to promote information sharing and to be captured in meeting summaries.

Project Team Decision Making

No formal voting will take place within the Project Team. While all proposed ideas and recommendations will be taken into consideration, those ideas/proposals that have strong support from a broad representation of Project Team members (i.e., across stakeholder interests) will be prioritized by the Administrative Team for consideration in their final report to the Commission. The Administrative Team's report will aim to articulate background/context on minority options/ideas where broad agreement by the Project Team is not reached.

Proposal Development

Members of the Project Team and other interested stakeholders are invited to share ideas, proposals, comments, and questions regarding the integration of management strategies and development of a *de minimis* fishery option for consideration and discussion during Project Team meetings. Input and guidance may be directed to the Administrative Team, peer review panel representatives, and the quantitative fisheries lead modeler and affiliates. Proposals and comments will be made publicly available and efforts will be made by the Project Team and/or Administrative Team to be responsive to proposals submitted for consideration. Participants and others

may convey their thoughts verbally during meetings (in-person only) or in a written format at any time.

For more information about the Project Team or the Recreational Red Abalone FMP process, please visit the OPC red abalone management strategy integration webpage.