Red Abalone FMP Project Team Meeting

High Level Summary of Management Strategy Evaluation (MSE) Results

Support material for December 19, 2019 Project Team Meeting

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*[1], 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 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

[1] 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

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%)[2].

- 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%

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]).

<u>Rebuilding Trajectories</u>

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[3], 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.

[2] 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).

[3] The red abalone season closure is in place through March 31, 2021.

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 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[4] 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

---

[4] 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.

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 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 also 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 Administrative 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.