

Scientific and Technical Review of the Survey Design and Methods Used by the California Department of Fish and Wildlife to Estimate Red Abalone (*Haliotis rufescens*) Density (Carr, Nielsen, Prince, Raimondi, Schroeter, Tissot)

- Recommendations
 - Provide estimates of means and confidence intervals
 - Generate probability functions and determine level of confidence desired (e.g. confidence that a threshold has not been crossed)
- Survey recommendations
 - 3 years sampling period too short to respond quickly
 - Survey approach not designed to determine stock-wide biomass
 - Size structure could be use more strategically
 - Unclear if error structure used (what counted as replicates) was appropriate
 - Statistical approaches may be affected by replication issues – leading to lack of inference for broader population. Other approaches might be more powerful and should include other collected information: habtiat, depth, recruitment

Recommendations for Moving Beyond a Density Metric

- **Transition to tracking the state of the abalone population**
 - CDFW now has a valuable long-term data set that could potentially serve as the foundation for restructuring the monitoring and management triggers around whole population indicators
- **Exploring alternative scientifically based management reference points**
 - Assuming there is a stock-recruitment relationship, a better metric in lieu of or in addition to density may be to use a fecundity index like Spawning Potential Ratio (SPR) adjusted by nearest neighbor distances.

Scientific Peer Review of Proposed Recreational Red Abalone Management Strategies (Cope, Raimondi, Fay, Jiao, Nielsen,

Tissot, White, Ramanujam, Williams)

Convened by the California Ocean Science Trust

- **Recommendations**

- The two management strategies (TNC, CDFW) should be integrated to reduce uncertainty and take advantage of the best available science
- 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.
- 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.

- Recommendations continued:
 - 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
 - Setting reference points for every indicator is critical
 - 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
 - All indicators need to transparently indicate, and then formalize the way in which they deal with uncertainty
 - Consider changing the order of operations for indicators when setting catch
 - 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