Final Report of the Scientific Review Committee

Scientific review of the reference point thresholds prescribed in the draft Fishery Management Plan for California Spiny Lobster (*Panulirus interruptus*)

Convened by the California Ocean Science Trust

Supported by the California Ocean Protection Council and the California Ocean Science Trust

May 2015

CALIFORNIA OCEAN SCIENCE TRUST

Review Participants

CALIFORNIA OCEAN SCIENCE TRUST

California Ocean Science Trust is a boundary organization. We work across traditional boundaries, bringing together governments, scientists, and citizens to build trust and understanding in ocean and coastal science. We are an independent non-profit organization established by the California Ocean Resources Stewardship Act (CORSA) of 2000 to support managers and policymakers on the U.S. West Coast with sound science, and empower participation in the decisions that are shaping the future of our oceans.

Ocean Science Trust served as the independent appointing agency in alignment with the Procedural Guidelines for the California Department of Fish and Wildlife's Ad Hoc Independent Scientific Advisory Committees. Ocean Science Trust convened the review committee and designed and implemented a scientific review process that promoted objectivity, transparency, and scientific rigor (see Appendix C).

SCIENTIFIC REVIEW COMMITTEE

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CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

The Mission of the Department of Fish and Wildlife is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public.

California Department of Fish and Wildlife staff were engaged throughout the review process. They delivered presentations to the review committee and supplied additional data, information, and feedback to Ocean Science Trust as necessary throughout the review process.

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The California Department of Fish and Wildlife Marine Region Program Manager, Tom Barnes, was the primary management contact for this review. California Wildlife Foundation was the grant manager for this project.

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Cover image: Ken Curtis

Background

Spiny lobster (*Panulirus interruptus*) populations support important commercial and recreational fisheries, and play a key role in the southern California kelp forest ecosystem. Over the last three years, the California Department of Fish and Wildlife (the Department) has developed a draft spiny lobster fishery management plan (FMP) to guide management of these fisheries in accordance with the Marine Life Management Act. An FMP assembles information, analyses, and management options, and serves as the vehicle for the Department to present a coherent package of information, and proposed regulatory and management measures to the California Fish and Game Commission (the Commission). The FMP becomes effective upon adoption by the Commission, following their public process for review and revision. Thus, it is important for the scientific underpinnings of the draft FMP to have undergone independent review prior to submission to the Commission.

The Department is committed to incorporating the best scientific information into management decisions. To this end, the Department approached the Ocean Science Trust to convene experts to conduct an assessment of key scientific and technical components within the FMP and supporting spawning potential ratio (SPR) cable model. Ocean Science Trust, an independent organization that works to advance independent science in management decisions, tailored this review to meet the science needs of the Department, and served as the appointed entity to design and coordinate all aspects of this review.

REVIEW SCOPE

Ocean Science Trust, in consideration of the management request, worked with the Department to develop a scope of review focusing on the scientific and technical underpinnings of the FMP and supporting materials. Thus, this was not a comprehensive review of the FMP, or the proposed approach to management contained therein. Rather, the central question of this review was:

Given the Department of Fish and Wildlife's available data streams and analysis techniques, are the technical components, models, and supporting documents that underpin the FMP scientifically sound and reasonable?

The review focused on the following components:

1. The three proposed reference point thresholds (i.e., catch, catch per unit effort (CPUE), and spawning potential ratio) that will serve as signals for when changes within the fishery may warrant management responses;

2. The underlying science that informed the decision to manage the fishery as a single stock;

3. The comprehensiveness of the data supporting the estimate of spiny lobster habitat contained within marine protected areas;

4. Estimates of stock productivity and its ability to support fishing (i.e., calculations for the lobster growth curves adopted in the Parrish Model for setting the spawning potential ratio threshold); and

5. The spawning potential ratio (SPR) model as presented in “DRAFT Report on the Cable-CDFW 1.0 Model and the Calculation of Spawning Potential Ratio” (cable model), including model assumptions, calculations, interpretation, and application of the model results in setting the SPR reference point threshold.

In addition to these specific sections of the FMP, reviewers were asked to identify priority research and monitoring gaps associated with the scientific and technical components of the FMP. Reviewers also provided recommendations for ways to work more closely with the academic community to collect and maintain the most up-to-date essential fishery information (EFI).

SUMMARY OF THE REVIEW PROCESS

This review took place from October 2014 – May 2015. Ocean Science Trust implemented a scientific review process[1] that sought to promote objectivity, transparency, candor, efficiency, and scientific rigor. A multidisciplinary, four-member review committee was assembled, representing international expertise in fisheries science and management, marine ecology, stock assessment, and modeling. Reviewer names remained anonymous until completion of this review to encourage candid feedback. Ocean Science Trust facilitated constructive interactions between reviewers and the Department through a series of remote meetings, where Department staff provided reviewers with the management context, presented an overview of the scientific and technical elements under review, and were available to answer reviewer's questions. In addition, Ocean Science Trust convened reviewers independently to allow the review committee to candidly discuss the review materials and conduct their assessment. Ocean Science Trust worked with the review committee to assemble and synthesize their written and verbal responses to guiding questions, as well as discussion from remote meetings into this final report. This report is publicly available on the Ocean Science Trust website[2].

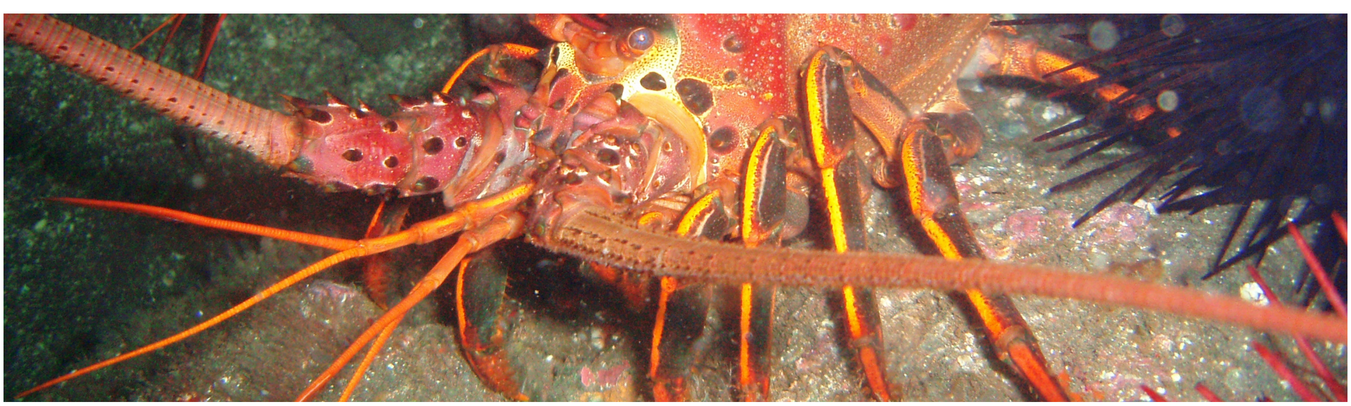
PROJECT MATERIALS UNDER REVIEW

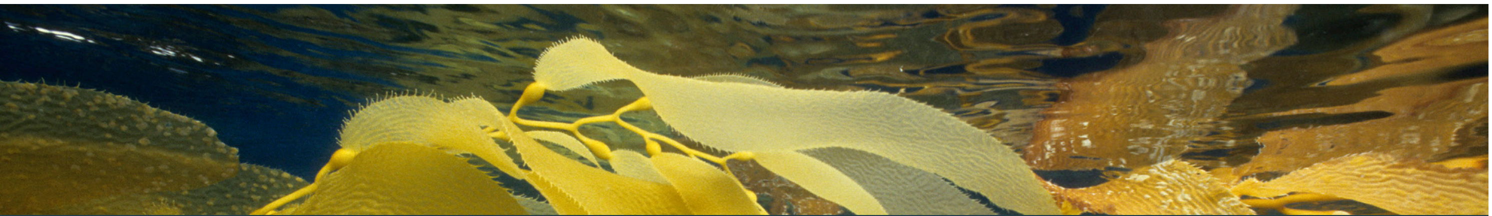
The following materials were provided by the Department to the review committee for scientific and technical review:

- Draft Spiny Lobster Fishery Management Plan, For Technical Review, 11/4/2014[3]
- Draft Report on the Cable-CDFW 1.0 Model and the Calculation of Spawning Potential Ratio
- Draft Spawning Potential Ratio Cable-CDFW 1.0 Model

Additional data and information were provided by the Department at the request of the review committee to assist with their assessment throughout the review process.

[1] Available at http://bit.ly/1Fd9A6X
[2] Available at http://bit.ly/1Fd9zA3
[3] Draft available on the Department of Fish and Wildlife website at http://bit.ly/1Fda254





Review and Recommendations

Foremost, the review committee valued the opportunity to provide independent scientific recommendations for consideration in management of the California spiny lobster fisheries. They acknowledged the extensive time and resources that went into the development of the FMP and supporting model by both the Department, the Lobster Advisory Committee, stakeholders, and outside experts, including modeler Dr. Richard Parrish. Reviewers appreciated the Department staff's constructive engagement throughout the course of the review, as well as their willingness to thoughtfully consider recommendations from this report. The Department produced an FMP that is user-friendly and readable by broad audiences, is well referenced, and incorporates the effects of no-take marine protected areas for the first time in a state-managed fishery. Reviewers noted that the FMP would complement the fairly robust management measures already in place.

This assessment is organized around the key focal points identified in the scope of review. These recommendations aim to improve the science supporting the proposed reference point thresholds prescribed in the draft FMP. Where possible, insight is provided on the implications of each recommendation.

The main recommendations concern the spawning potential ratio (SPR) cable model, several of which would need to be addressed before this model can provide a sound scientific basis for decision-making. Additional scientific guidance and considerations are included that would produce a more scientifically robust FMP, as well as longer-term recommendations, data and research needs that would strengthen the science contained within the model and FMP and its ability to inform management as new information and analyses become available.

This FMP is the first instance where state fisheries managers in California are employing a technical model (aside from a formal stock assessment) to inform the development of a harvest control rule. As such, reviewers thought it valuable to close the review with some insight into how scientific models are scoped, considered, and reviewed as FMPs are developed for other state fisheries in the future.

1. EVALUATION OF THE PROPOSED REFERENCE POINT THRESHOLDS

Three proposed quantitative reference points and associated thresholds – spawning potential ratio, catch, and catch per unit effort (CPUE) – are meant to serve as metrics to assess the state of the lobster fishery and stock. The FMP states that whenever a stock reaches a threshold reference point, resource managers must investigate the cause and potentially provide a response. The Department has to review the catch, catch per unit effort, and update the spawning potential ratio on an annual basis. This process is designed to monitor the fishery and its stock in order to prevent any of the metrics from reaching a threshold.

Below are the scientific review committee's recommendations for each reference point. For sections 1.1 (SPR) and 1.2 (catch, CPUE), recommendations are divided into those that reviewers suggest the Department address before adopting the FMP, and those that are longer-term considerations, which can be addressed after adoption of the FMP.

1.1 Spawning Potential Ratio (SPR) Cable Model and the SPR Reference Point

Much of the review focused on the SPR cable model, since it is the main measure of the spiny lobster spawning biomass structure and the only biological reference point in the FMP (i.e., it integrates information and assumptions about lobster growth, reproduction, and mortality). The model, starting with 1,000 recruits, calculates an equilibrium SPR value – a ratio of the number of eggs produced by the fished population over the number of eggs produced by the unfished population. Being an equilibrium model, it does not track cohorts or size trends over time, but does provide relative abundance estimates for the fixed number of recruits. Therefore, this SPR estimate is used to estimate an annual fishing mortality rate specific to a given year's observed mean size, with no temporal connection among the annual estimates. The FMP advises that when the $SPR_{CURRENT}$ falls below the "stable and productive" reference period between 2000-2010 ($SPR_{THRESHOLD}$, based on the average SPR value during this period), the Department is required to investigate the underlying cause and potentially provide a management response for the Commission to consider. The model also evaluates the effects that marine protected areas (MPAs) may have on the calculated SPR value of the lobster stock.

During the course of the review, reviewers were provided with three iterations of the SPR model. The model was originally developed by Dr. Richard Parrish, and underwent further development and revisions by the Department. The final version (referred to here as the cable model) is the version intended for use in the management of the fishery, and was the main focus of this assessment. The cable model includes the following revisions from the previous iterations:

1. a new growth model (i.e., changing the model from a von Bertalanffy growth model to a newly developed model)
2. changes to initial time step (i.e., size, age, season)

The draft FMP provided to reviewers for their work was developed based on the original model and did not reflect these revisions. The reviewers were instructed to assume that the draft FMP would be revised to reflect the most recent cable model. Additionally, following initial technical discussions between Department staff and the reviewers, the Department agreed to remove a prescribed value for the SPR threshold in order to allow for the ability to continually improve the model without amending the FMP.

1.1.1 Key Recommendations for Securing a Management-Ready SPR Model

Reviewers agreed that the cable model requires essential revisions before it can provide a scientific basis for management of the lobster fishery, but that these revisions are likely achievable before the FMP is adopted. In the longer term, more substantive data collection and research initiatives to better inform a model comparable to the current model, or an alternative modeling approach, are identified as priorities. Below are the key recommendations for securing a management-ready SPR model, organized around thematic areas.

Growth Model

- ***Rely on the von Bertalanffy growth modeling methods until the newly developed growth model can be robustly validated.***

  The primary revision to the SPR model by the Department was the replacement of a von Bertalanffy growth model, with a new set of Gaussian 4-parameter growth curves that were developed by Department staff. These were based on raw data from three tag-recapture studies in order to estimate male and female lobster growth rates. Growth curves are central to determining a stock's ability to replenish itself. Reviewers acknowledged the inherent difficulties in obtaining reliable growth rates for crustaceans, such as lobsters, that grow through molting. Though von Bertalanffy growth models are widely used and accepted, they represent a generic growth response; the Department examined multiple growth models in an attempt to employ an alternative that better represented the growth of *P. interruptus*.

The reviewer's main concern with the current SPR cable model is with the application of the new Gaussian growth curves. While reviewers recognized that the Gaussian 4-parameter curves may better fit the data, they had concerns that these growth models have not been subject to rigorous scientific discussion. The results of the Gaussian curves are not consistent with the existing literature regarding the growth patterns of lobsters in similar ecosystems, and lead to potentially unrealistic SPR model behavior and results. In particular, they lead to growth rate estimates that are very slow such that mature individuals can reproduce many times prior to being vulnerable to full fishing mortality. Slow growth rates in this particular SPR model implementation translate into lower harvest rates and a reduced impact of fishing on population reproductive output; the slower you make growth, the lower the estimated relative exploitation rate is in the SPR model. This is contrary to what is typically understood about growth rates and stock productivity. The fact that this model estimates a "snapshot" of relative exploitation rate in a given year with assumed constant recruitment, rather than tracking exploitation and cohort strength (and potential feedback to recruitment) over time contributes to this somewhat counter-intuitive result, but the unusually slow growth is the primary driver. The net effect of the Gaussian growth model as applied in SPR cable model is that fishing mortality of most legal lobsters has a reduced impact on the estimated SPR, relative to SPR estimation based on the von Bertalanffy growth model.

These Gaussian growth curves are not necessarily incorrect – in fact, they may well be a more accurate representation of lobster growth – and should be improved with additional research. Reviewers commend the Department for making strides to move beyond the standard growth model. Further studies showing that the approach has some precedent with crustaceans and more investigation of the underlying data is necessary before the Gaussian growth model can be applied with confidence. If and when an alternative growth model is considered to be sufficiently developed to incorporate into the SPR model, the Department should consider whether that model is consistent with growth models of lobsters in other (similar) ecoystems, and ensure that sensitivity analyses are conducted to evaluate the effects of any new growth relationships on SPR model performance.

von Bertalanffy growth expands the resolution of the SPR model compared to the Gaussian growth curves

With current understanding, the von Bertalanffy growth model is more appropriate for a relative metric of exploitation as it is more responsive to changes in exploitation, produces results that are comparable to methods used elsewhere for similar fisheries, and expands the resolution of the SPR model (see Appendix A for further analyses conducted by reviewers). Thus, reviewers recommend that the Department rely on the more standard and widely used von Bertalanffy growth modeling methods, until the newer Gaussian curves can be robustly validated.

Longer-term considerations are included in section 1.1.2, including the need to routinely collect length or other size compositional data (length or weight distributions) and information on actual selectivity and maturity curves, which would provide the basis for a more robust SPR model (e.g., more accurate estimates of fishing mortality). Reviewers recognized that there is inherent variability in the growth data at small sizes using the available tag-recapture studies, and provide some recommendations that may increase comfort with new Gaussian growth curves based on these data.

- ***Use SPR with caution at high exploitation rates.***

It is also important to note that the SPR cable model (with either growth model applied, although the problem is exacerbated at slower growth rates) becomes uninformative at very high exploitation rates (Appendix A). This is partially a result of the confounding of the maturity and selectivity curves described below. This constraint should be recognized explicitly in the SPR model documentation and the FMP, and the Department should be cautious when interpreting results at high exploitation rates.

- ***Reconsider some of the tag-recapture data that were removed from the growth models.***

  The growth models are based on data sets (Engle 1979, Hovel et al. 2013, Kay 2011, Kay 2012a,b) from which some outliers and negative values were removed (per Department presentation to review committee). Juveniles can often show high growth rates in short timeframes, thus some of the data identified and removed might actually be informative. In addition, the Department should consider making the "negative growth" data points zero instead of removing them from the analyses if they are believed to be measurement error. Reconsidering how these data points are treated may reduce variability at small lobster sizes and lead to more accurate estimates of growth.

Model Functionality

- ***Update the vulnerability relationship.***

  In the cable model, the vulnerability function has precisely the same coefficients as maturity. If this is a true coincidence, it should be explained. However, recent data on female lobsters from Hovel et al. (2015) and Kay (2011) indicate that female lobsters may be reproductive at smaller sizes than previously thought. The Department should verify, and if appropriate, update this function in the cable model. In addition, the current function in the cable model is for the commercial fishery that uses traps. Traps have an upper limit based on the throat size of the trap while there is no upper limit in the recreational fishery. Therefore, there should be a separate vulnerability relationship for the recreational fishery in any future model that can account for recreational catch.

- ***Revisit the natural mortality function.***

  The natural mortality function assumes that natural mortality decreases as lobsters grow; however within the current cable model, a minimum rate occurs at an age of 17.92 years and then the rate increases again. This pattern of senescence is unusual, and the Department should provide additional references or data to support the assumption that older, larger lobsters experience higher natural mortality. If the proportion of 'plastered females' (i.e., female lobsters that have mated) is lower at larger sizes, suggesting that large females are not contributing as much to SPR, those data should be presented.

- ***Explain the ramifications of SPR being independent year to year.***

  Each model run begins with exactly 1,000 larvae, and ignores variable and episodic recruitment, and the relationship between spawning biomass and recruitment. The model also assumes constant carrying capacity and a constant function for density dependence, among other considerations. These limitations should be made more explicit in the FMP and model report.

Direct methods of growth and age determination are now possible for crustaceans

Sensitivity Analyses

- ***Make greater use of sensitivity analyses in explaining the model.***

  Sensitivity analyses are important for understanding the impacts of a model's input variables. They can help identify parameters that are likely to have no effect on the output (and could potentially be removed), as well as variables that have a large effect (where attention should be focused on ways to reduce uncertainty around these values/inputs). The Department should conduct explicit sensitivity analyses each time the SPR cable model is revised, and make this information available in the accompanying report to provide additional credibility to the reasoning behind such revisions. Standard practice is to double and halve the variable of interest and observe the impact to the outputs. The Department should consider assembling and formally communicating the error and uncertainty associated with the cable model results.

1.1.2 Longer-Term Considerations for the SPR Model

The review scope charged reviewers with conducting an assessment of the SPR model based on the Department's currently available data streams that would not require additional information or research. However, the model may benefit considerably from and be more robust as a result of addressing the following longer-term recommendations after adoption of the FMP.

Research Needs

- ***Explore alternative methods to estimate lobster growth.***

  Novel methods for age validation and improved growth estimation continue to emerge and should be explored, either by the Department or by academic and other independent research institutions. For example, direct methods of growth and age determination are now possible for crustaceans by measurements of annual molt-independent growth bands. Detection of growth bands in calcified regions of the eyestalk or gastric mill using the cold cure epoxy resin technique has been reported for cold-water shrimps (*Sclerocrangon boreas* and *Pandalus borealis*), snow crab (*Chionoecetes opilio*) and American lobster (*Homarus americanus*) (Kilada et al. 2012). A similar technique could be used to better estimate growth for the California spiny lobster (even on a spatially explicit basis), and perhaps elaborate or modify the 2011 stock assessment model to include an age-based parameter. Identifying these as key research priorities in the FMP may incentivize outside researchers and funders to pursue this research.

- ***Explore additional technical models that can account for variable recruitment.***

  Given that lobster recruitment is likely highly variable and episodic, a key longer-term research objective should be the development of a more sophisticated modeling approach that can track cohorts over time.

- ***Develop a sampling program to collect individual lobster length or weight composition data from both sectors of the fishery.***

  Estimates of fishing mortality used to obtain a corresponding SPR value each year are currently determined using average weight data from the commercial sector. The relevant parameters are derived using an extrapolation, linking logbook data to fish ticket data. These estimates would be greatly improved by a program in which actual length or weight measurements (by individual) could be collected. The sampling program needs to include the recreational sector as well because it accounts for approximately 30% of the landings and their vulnerable sizes may differ from commercial traps. Such data would be helpful in informing more sophisticated modeling approaches (e.g., that track cohorts over time) in the longer-term as well.

- ***Prioritize obtaining intermediate recapture data, which could be useful for better understanding the dynamics of lobster growth rates.***

  While alternative methods to estimate growth are ultimately necessary, reviewers provided a suggestion that may improve upon the existing estimates in the near term.

  The growth curves were developed from data sets with gaps at important size ranges. Tag-recapture data gaps exist between the Engle (1979) and Hovel et al. (2015) data sets, in the 30 mm and 55 mm size classes. Currently, juvenile data must be extrapolated out in any growth curve model. Additional data would be valuable in "filling in" the points between data sets for a more accurate estimate of California spiny lobster growth.

Model Functionality

- ***Develop a function or method to incorporate recreational catch into the model.***

  Recreational catch is a substantial portion of overall catch and is not accounted for in the SPR model. This sector is potentially harvesting larger lobsters, thus, the vulnerability to fishing differs between the recreational and commercial sectors. It is important to parse out the proportion of the spawning potential coming from larger individuals. If this is the case, the vulnerability curve applied in the SPR cable model for the recreational sector should not be dome-shaped, but rather should be asymptotic, and there may be other facets of the recreational fishery of significance in accurately assessing SPR.

- ***Revisit the SPR model as MPAs reach their full maturity.***

  The SPR cable model assumption that South Coast MPAs have reached full maturity (thus, are having a threshold impact on the fishery) is unlikely given the MPAs are newly established. A number of factors will differ as MPAs reach full maturity, including the possibility of increased density dependence which could affect movement and reproduction as well as that spawning stock (given growth curves) may not yet be optimized through size and density. In other words, the current SPR model inputs may be over- or underestimating the effects of MPAs.

- ***Formalize a process to review, revise, update, and evaluate the SPR model and its effectiveness in meeting management goals as new data, information, or analyses become available.***

  Models like SPR will require continual refinement as new information and data are obtained. Many such improvements can be accomplished within this FMP framework. The reviewers commend the Department for removing a prescribed SPR threshold from the language of the draft FMP. This allows the ability to recalculate an appropriate threshold as the model is improved rather than needing to delay implementing these changes by waiting for the FMP to be formally amended. It would be valuable to formalize a process for considering revisions to the model – which may have substantial implications for the SPR outputs – as changes and updates are made. Reviewers recommend convening fishery managers and biologists with independent experts to evaluate the input data, coding, and effectiveness of the model at regular intervals.

1.2 Catch- and CPUE-based Reference Points

As noted previously, the process of reviewing current seasonal catch and CPUE data should permit the Department to monitor the fishery and its stock, and prevent any of the measures from reaching a threshold. However, reviewer consensus is that the Catch and CPUE-based reference points are not very robust or sensitive to picking up trends or slow declines. There is concern that "sliding" calculations will rarely exceed the established thresholds. Even when a threshold is exceeded, no specific management responses are required, thus these measures act more as indicators than as reference points. Section 1.2.1 contains key recommendations that would allow for a more robust method to monitor the condition or trajectory of the fishery, and should be addressed before adopting the FMP. Section 1.2.2 includes recommendations that could be addressed in the longer-term.

1.2.1 Key Recommendations for Catch and CPUE-based Reference Points

- ***Describe the catch and CPUE thresholds as "fishery indicators" instead of reference points.***

  A more informative approach to identifying declines in the fishery may be to present the proposed catch and CPUE reference points as indicators of fishery condition, and set the thresholds to more conservative levels. This could provide a more sensitive measure (i.e., reference thresholds would be crossed more easily, making for earlier "warning signs") and allow the Department to elicit useful scientific information for interpreting any changes observed in SPR.

  Reviewers conducted some additional analyses to explore the sensitivity of the threshold to detecting changes in the fishery (see Appendix B for a description of the full method). They compared California's proposed approach to a method currently under development for the American lobster (*Homarus americanus*) in Canada. In 2014, Canada established a reference point for the American lobster using commercial catch based on the Precautionary Approach (PA) for the southern Gulf of St. Lawrence fisheries. Employing the PA on a 123-year long data series, American lobster landings were below an upper stock reference point 85 times (Appendix B, Figure 1). However, applying the California spiny lobster approach to the same American lobster data revealed that California's proposed 0.8 catch-based reference point would only be exceeded two times (Appendix B, Figure 2), indicating it may not be a very sensitive measure for detecting fishery declines.

  Reviewers then applied Canada's Precautionary Approach to the California spiny lobster commercial landings data (Appendix B, Figure 3). Based on the PA and using a three year running average for landings, California spiny lobster commercial landings would have dropped below an upper stock reference point 31 times between 1935 and 2013, compared to 11 times as indicated in the draft FMP using the current 0.8 catch-based reference point (FMP Figure 4-6).

Based on these preliminary analyses, the 0.8 thresholds are not very sensitive to picking up trends in the fishery. If catch and CPUE data were used as contextual information for interpreting SPR, the thresholds could be set to more conservative levels to allow for greater sensitivity to detect fishery declines.

Another approach for detecting trends would be to report both a static number for $CATCH_{threshold}$ and $CPUE_{threshold}$ in addition to the moving averages, along with a discussion of the pros and cons of each method and what information they can provide.

- ***Clarify rationale for the use of 0.8 thresholds prescribed in the FMP.***

  The FMP should provide more clarity about how the thresholds were derived. They appear to be derived from the Hilborn 2010 citation referenced in the FMP. That study made the point that a broad range of relative abundance levels are typically associated with a more narrow range of relative yield (e.g., most give 80% or more of theoretical maximum), such that declines below 80% of the theoretical maximum could indicate substantial stock declines (if not driven by declines in effort or markets). This is an important aspect of the Catch and CPUE component, and should be better explained in the text.

- ***Report the CPUE statistic in mass per unit effort.***

  The current approach to calculating the CPUE statistic in the FMP is in numbers of individual lobster, not total weight of catch. Using weight (linked to fish tickets) may be more appropriate and is a more typical metric used in such fisheries.

- ***Include greater discussion of the reliability of recreational catch estimates.***

  Recreational catches are a substantial portion of the total catch for spiny lobsters, but seem to have a different trajectory, and one might expect trends to vary from commercial trends in the future as well. The Department should discuss the uncertainty around these recreational catch estimates in greater detail, and clarify whether they were adjusted or tuned to account for non- or under-reporting. Understanding the magnitude and significance of recreational catch is key in considering control rules.

1.2.2 Longer-Term Considerations for Catch and CPUE Data

Again, the review scope charged reviewers with conducting an assessment of the existing reference points and associated thresholds. However, the model may benefit considerably from, and be more robust as a result of addressing the following longer-term recommendations.

- ***Explore other technical models to obtain additional or alternative biological reference points that account for inter-annual variability in recruitment and other variables.***

  The Department could consider estimating the annual fishing mortality rates with a modified Delury depletion model (González-Yáñez et al. 2006, Puga et al. 2013) rather than the moving average approaches for catch and CPUE from average size used in the FMP. A Delury model includes the total numerical catch, the effort and the index of abundance in number (CPUE) as input data, which also takes into account inter-annual variability in recruitment. This approach would allow for both the commercial and recreational sectors to be modeled and there are extensions of the model that include a stock-recruit relationship for obtaining biological reference points. If size composition data become available in the future, the Department may also want to consider a more robust population dynamics analysis similar to one used for Australian southern rock lobsters (*Jasus edwardsii*) (Punt and Kennedy 1997). Additional age-structured analyses (Muller et al. 1997) or yield or egg production models that account for individual variability in growth (Fogarty and Idoine, 1988) may also be informative and should be explored further.

- ***Standardize commercial and recreational catch data to the same spatial reference points.***

  Commercial and recreational fishermen report location at different spatial scales. In comparing Figures 2-3 and 2-10 in the FMP, it appears that commercial fishermen report by Department of Fish and Wildlife block, while recreational fishermen may report by various specific locations (e.g., each of the Channel Islands has a single location code). This discrepancy will confound comparisons in evaluating questions such as the extent of spatial overlap in the commercial and recreational fisheries (e.g., line 825-26 in the FMP).

2. SCIENCE SUPPORTING THE DECISION TO MANAGE AS A SINGLE-STOCK

The FMP provides evidence to suggest that California spiny lobster larvae are well mixed throughout the Southern California Bight ("…complete population mixing due to the species' protracted larval phase"). Accordingly, the Department proposes considering the entire lobster stock within the U.S. border with one spawning potential ratio (SPR) value and threshold. However, Department data show that individuals in the northern Channel Islands are notably larger than the minimum legal size, while lobsters in the south are generally caught very close to the legal size, suggesting northern lobsters participate in more spawning seasons than southern lobsters before capture.

Reviewer's evaluation of the literature and existing research on the population structure of California spiny lobster suggests there is some potential for localized recruitment, and that the species does not maintain a single homogenous population despite the extended pelagic larval duration (Iacchei et al. 2013). However, reviewers recognize that the decision on single-stock management must take into account social, economic, and other factors in addition to the science. It is ultimately up to the Fish and Game Commission to determine the most appropriate method to manage the stock.

- ***Assess and report any spatially explicit differences between regions of the fishery.***

  Available data suggests there are clear regional differences in size distribution, catch, timing of catch, and effort – several of which are meaningful to the calculation of SPR and to determining how it varies in space and time. There is also evidence that growth and reproduction differ spatially, which could lead to spatially structured source-sink dynamics that may interact with fishing in a way inconsistent with single stock predictions. While lobsters have an extended larval period with extreme dispersal potential (which could lead to assumptions of complete larval mixing), studies in other lobster species suggest substantial localized recruitment (Iacchei et al. 2013).

Reviewers recommend reporting any spatial differences among regions of the fishery to assist decision-makers with parsing out trends in catch and life history traits across the region, and assess whether current harvest control rules are adequately meeting management goals.

Reporting spatial differences among regions of the fishery can help decision-makers parse out trends in catch and life history traits

- ***Interactions with the Mexican spiny lobster stock should be considered and discussed in greater detail throughout the FMP.***

The reviewers expressed concern about the decision to neglect potential interactions between California and Mexico lobster populations. Given how the biology and management of Mexico's portion of the stock has implications for the entire range of the species, the FMP should include discussion of the potential uncertainty in SPR calculations associated with neglecting potential contributions from the south.

For example, regardless of the genetic structure of California spiny lobster, if the larval pool for California's population includes a large contribution from the Mexican portion of the stock, the actual SPR may be insensitive to management actions in California. The Department should discuss uncertainty around larval transport and reproductive interactions between California and Mexico's lobster populations. This should include a more comprehensive review of the literature (e.g., bolstering literature citations supporting the idea that stock is, or is not, well mixed).

- ***Prioritize longer-term research needs relating to regional differences in the species' biological parameters.***

The Department should prioritize collection of data aimed at better understanding lobster population genetics, plankton connectivity modeling, and the benthic stage. This could provide greater insight into source and sink populations, interactions with Mexican spiny lobster populations, and how management in California will affect the population.

Evidence from multiple lobster fisheries suggests local recruitment processes are possible. A recent microsatellite and mitochondrial DNA study in California spiny lobster suggests that the genetic structure of the *P. interruptus* exhibits genetic patchiness (Iacchei et al. 2013). The species does not maintain a single homogenous population, despite the species' 240-to 330-day pelagic larval duration. Instead, these lobsters appear to either have substantial localized recruitment or maintain planktonic larval cohesiveness whereby siblings more likely settle together than disperse across sites. However, DNA analysis in the Caribbean lobster (*P. argus*) suggest that populations of this spiny lobster are highly interconnected throughout its range, with a single genetic stock structure (Truelove et al. 2014, Lipcius and Cobb 1994; Silberman and Walsh 1994), except for a few sites where self-recruitment is enhanced by persistent offshore gyres. Lastly, a genetic study in the American lobster *(Homarus americanus*) indicated a genetic homogeneity of the northern region of the lobster population (suggesting a single genetic stock) within the Gulf of St. Lawrence (Kenchington et al. 2009). However, a larval transport model for this species also showed an extensive pelagic connectivity with some level of local recruitment (Chassé and Miller 2010) and no physical features that restrict benthic stage exchanges (Comeau and Savoie 2002).

Research suggests California spiny lobster populations exhibit localized recruitment

3. ESTIMATE OF LOBSTER HABITAT CONTAINED WITHIN MARINE PROTECTED AREAS

The FMP factors in the effects of California's network of MPAs by including them as a component of the fishing mortality calculation in the SPR cable model. The model includes an estimate that 14.6% of all available lobster habitat is protected by MPAs. This is based on available hard-bottom habitat data, augmented by proxy information where suitable bottom-type data are not available, for all the areas that comprise lobster habitat. Only areas that prohibit both recreational and commercial take were used for this calculation. In the near term, reviewers would like to see additional discussion in the FMP of the data sources used, and going forward, refinements to these estimates as the model is improved. Given other uncertainties in the spatial analyses, reviewers suggested that an estimate of 15% is likely adequate.

- ***Provide greater discussion of the data sources used to estimate suitable lobster habitat.***

  Reviewers acknowledge the rigor of the hard bottom data set used to generate the estimate, however the Department should provide more clarity on the locations where information was not available from this data set. It would also be informative to report a rough percent of unmapped habitat and percent of the estimate that was calculated using kelp canopy.

- ***Continue to refine the MPA estimate as new information becomes available.***

  The data used to estimate lobster habitat contain critical data gaps within the shallow nearshore regions (typically 10-15 meter depths) where remote sensing techniques are generally infeasible (known as the "white zone"). New research is providing better information to bridge these data gaps.

  Ongoing research through UC Santa Cruz, the California Department of Fish and Wildlife (staff contact: Paulo Serpa), and Ocean Science Trust is making progress on estimating sand versus rocky habitats across the State within this white zone. The first stage has been completed in the North Central coast and may be expanded statewide over the coming years, and could potentially provide an additional data source to incorporate into the Department's MPA estimate. The Seafloor Mapping Lab at California State University, Monterey Bay developed a shallow water mapping vessel, the R/V Kelp Fly, uniquely able to map the white zone. As these new data sources become available, the Department should include them as refinements to the cable model. The Department should also explore the contribution of habitat from breakwaters and artificial jetties.

- ***Consider developing a function or method to consider actual marine protected area sizes in the SPR cable model.***

  The SPR cable model makes coarse assumptions about the size and spacing of MPAs within the lobster range. The actual values of these parameters are well known, and accounting for California's actual MPA sizes and spacing – which differ regionally – could have implications for regional estimates of vulnerability because of the assumptions of movement that interact with the size and location of MPAs.

4. RESEARCH AND MONITORING

- ***Continue to update and prioritize research and data needs in the FMP.***

  The FMP includes Table 5-1, a prioritized list of research and data needs. Throughout this report, reviewers have identified additional research and data needs that would support more robust management of the fishery (some of which parallel those noted in the FMP). Additional recommendations from this review should be incorporated in the table as well. These science needs could provide further impetus for collecting the information identified and prioritized. A resource with up-to-date research and monitoring needs provides independent researchers (and potential funders), with the basis for assessing the applicability of given research or other proposals to spiny lobster management and/or state information needs. The Department should continue to update this prioritization and guidance.

5. ADDITIONAL RECOMMENDATIONS

This section contains additional recommendations reviewers considered important, but were not clearly outlined in the formal scope of review.

- ***The harvest control rule matrix should include predetermined management options.***

  While reviewers recognized that this recommendation might be outside of the review scope, they agreed that scientific recommendations are most successful when they are accompanied by predetermined management actions. The lack of pre-determined management response options when one or more of the management thresholds are exceeded has the potential for inaction if the indices or data suggest there are troubling in the fishery. Table 4-2 in the draft FMP lists the suggested management response sequence, including four scenarios in which "No response is required," and another four in which a response is required. However, the required response in these scenarios is an investigation of underlying causes and confirmation with multiple models and approaches; if management action is required, the FMP guidance is to "tailor management response to prevailing conditions." The reviewers found these requirements vague.

  One of the key benefits of pre-specified harvest control rules is a higher certainty of the actions that will be taken when reference points are exceeded. This allows models to be used to evaluate the effectiveness of these actions to restore the fishery to the desired condition.

  Other fisheries that have used SPR for developing harvest control rules may provide good resources for identifying appropriate management responses to thresholds that have been exceeded. Consider supplementing FMP Table 4-1 (summary of SPR thresholds for other lobster fisheries) with a discussion of the management response are in those various management scenarios, as well as whether any of those fisheries also include target SPR rates.

- ***Clarify the information required for setting total allowable catch (TAC).***

  Lines 1964-1965 state that "Creating a TAC for the CA lobster fishery would likely require the Department to estimate the total biomass of the stock…". This is not necessarily true. For example the Market Squid fisheries established a TAC based on historical high catch levels in the absolute absence of total biomass estimates or idealized CPUEs. For many groundfish and other exploited fishes, a common practice in the absence of a quantitative guidance for stocks or stock complexes is to set a TAC at some fraction (e.g., 0.5, 0.75) of the peak historical catch. Any TAC that might be implemented should have a rationale, but it does not mean it requires a sophisticated model.

Looking Forward: Considerations for developing scientific models for state fishery management plans

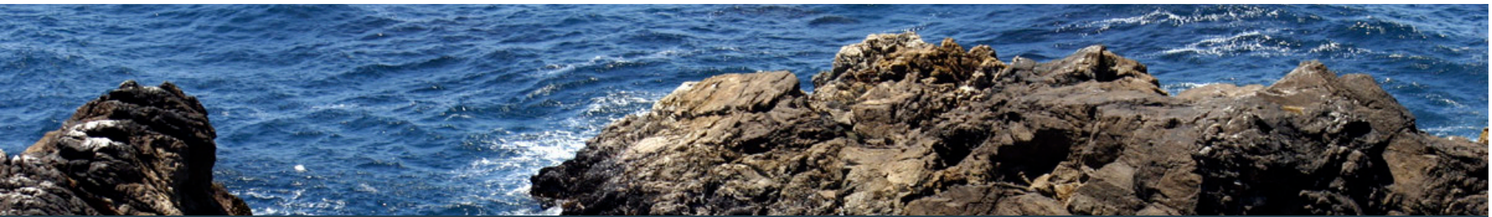
The California spiny lobster FMP represents one of the first examples of a state fishery management plan including the use of a technical model to obtain harvest control rules. The experts who participated in this review have experience developing and using fisheries models at the federal and international levels, and thought it valuable to provide insight into processes employed elsewhere.

When considering the development and use of other technical models going forward, the Department should ensure that the plan for producing the science is decoupled from any management concerns. This will include scoping the objectives, approaches, reporting requirements, and responsibilities of various participants in advance. Model development should take place from a position of academic freedom focused on developing the best model, given the resources and data. The Department should ensure the process is inclusive and transparent from the outset.

Reviewers also suggest decoupling the review of technical models from review of the FMP that such models inform. Future model reviewers should have the responsibility of ensuring that the models represent the best available science and the most robust methods. This review committee acknowledges that ideally an in-person, multi-day review workshop with the model development team would allow more detailed technical discussion and model improvement. It is advantageous to have several days to review, so that modelers can be given "homework" on sensitivity tests or alternative analyses that come up during the review and report back. Any future review team should include scientists from outside the region and fishery, and if possible, international expertise. A goal should be to ensure that the model is clearly understandable to those with no background in the particular fishery under consideration. Only models that have been accepted by reviewers as the best available science are advanced to managers. This way, managers can make recommendations and develop harvest control rules based on a model that has been independently recognized as scientifically rigorous.

As noted in this report, models like SPR will require continual refinement and review to ensure they are effectively meeting management goals. Formalizing a process to periodically review the model coding and configuration, and incorporate recent information is recommended. Groups like SouthEast Data, Assessment and Review[1] (SEDAR) and NOAA PFMC Stock Assessment Review (STAR) Panels may provide informative examples of successful approaches that vary in detail and level of time and analyses required.

[1] More information at http://sedarweb.org/



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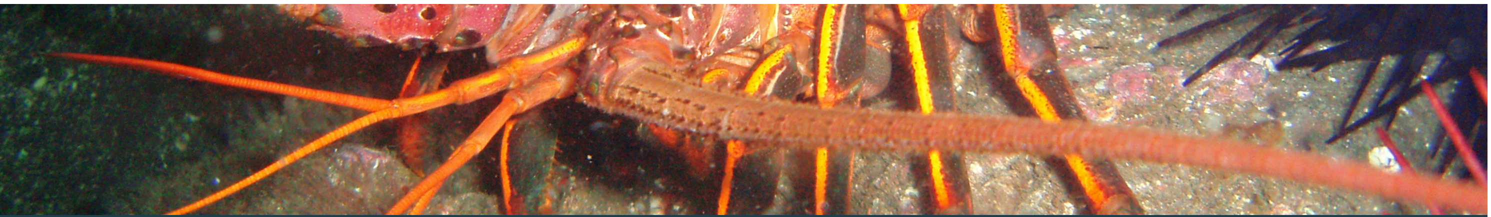


Appendices

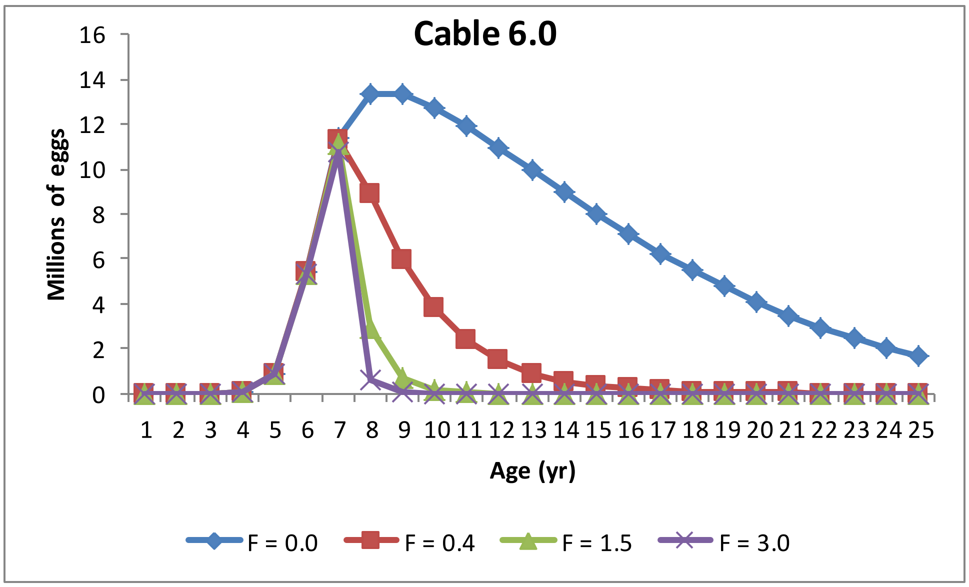
Appendix A: von Bertalanffy and Gaussian Growth Curve Comparison, and *Appendix B: Applying the Canadian Precautionary Approach to California Department of Fish and Wildlife Commercial Landings* contain additional analyses that were conducted by the review committee as part of their assessment in support of the recommendations contained within this report.

Appendix C: Scientific and Technical Review Process details the process Ocean Science Trust developed and implemented for this review.

APPENDIX A: VON BERTALANFFY AND GAUSSIAN GROWTH CURVE COMPARISON

We (the review committee) compared the von Bertalanffy and Gaussian growth models to determine which would be most appropriately applied in the SPR model. The first step was to examine the cumulative fecundities, in millions of eggs, over the projected 25-year lifetime. The age-specific fecundities from the Cable 6.0 model, which uses a von Bertalanffy growth curve, and those from the CDFW 1.0 model, that uses their new growth model, are shown in Figure 1 plotted at the same scale. The main difference is the levels of fecundity. In the Cable model, the cumulative fecundity at F = 0 is 147.2 million eggs while the fecundity at F = 0 in the CDFW model is 46.4 million. At high fishing mortality rates, the fecundities are similar (17.7 vs. 15.8 million eggs at F = 3.0) which means that the SPR ratio will be much higher in the CDFW model; the higher SPR is just the result of the much lower unfished cumulative fecundity (Figure 2).

A.



B.

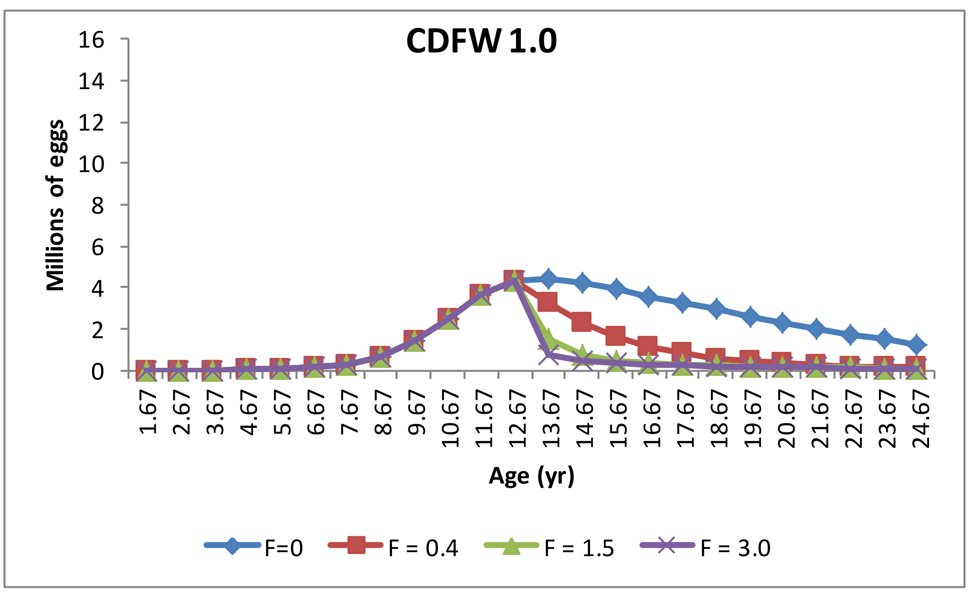


Figure 1. Fecundity by age for the two SPR models: a) the Cable 6.0 and b) CDFW 1.0 for a range of fishing mortality rates.

Even for a high fishing mortality rate of 3.0 per year, the CDFW model still has a SPR value of 34%. However, when we plotted the corresponding average lobster weight against fishing mortality (Figure 3), which is the basis of the control rule, we found that neither model would be a very sensitive way of determining fishing mortality and the corresponding fishing mortality rate that would be used to obtain the SPR value each year. Note that the axes in Fig. 3 are plotted to reflect that the average weight is what is measured so as to estimate the fishing mortality rate. With the current SPR model, fishing mortality would be undefined at average weights less than 1.40 lb. For comparison, the average weight at legal size (82.5 mm CL is 1.25 lb for males and 1.38 lb for females).

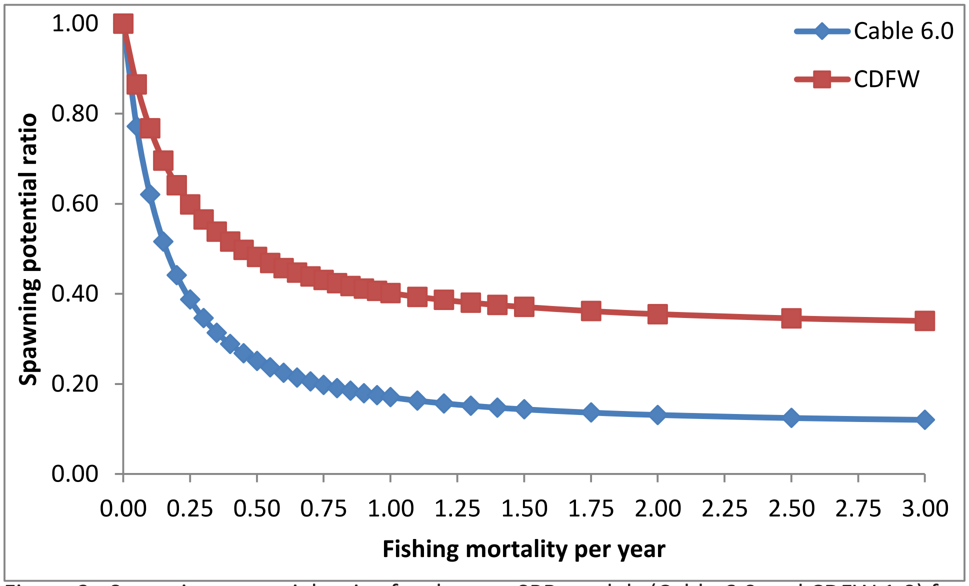


Figure 2. Spawning potential ratios for the two SPR models (Cable 6.0 and CDFW 1.0) for a range of fishing mortality rates.

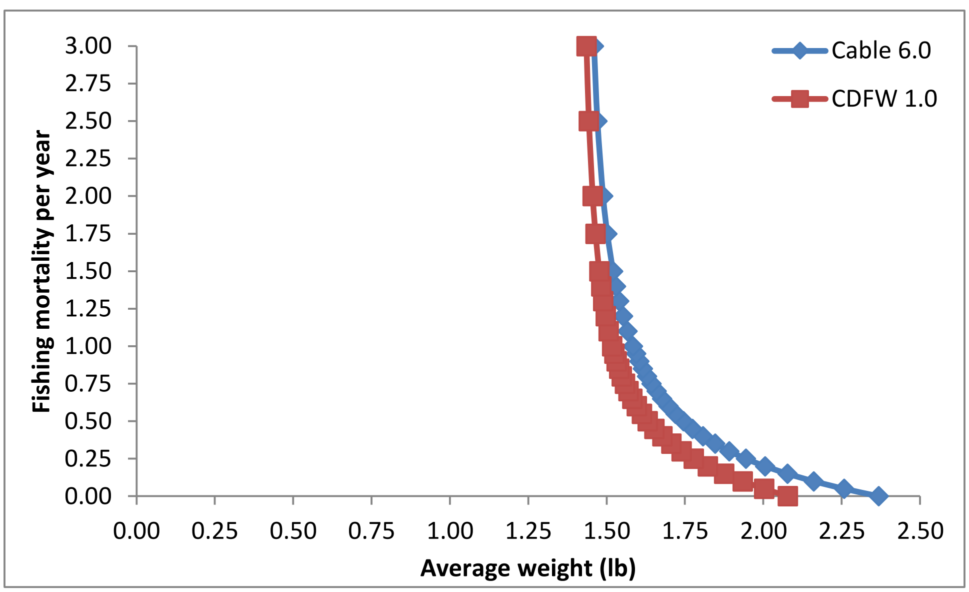


Figure 3. Average spiny lobster weights and the corresponding fishing mortality rates from the two SPR models (Cable 6.0 and CDFW 1.0).

APPENDIX B: APPLYING THE CANADIAN PRECAUTIONARY APPROACH TO CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE COMMERCIAL LANDINGS

We compared the sensitivity of the Department's proposed catch-based threshold approach with another strategy in use for the American lobster in Canada. In 2014, Canada established a reference point for their southern Gulf of Saint Lawrence lobster fisheries using commercial catch based on the Precautionary Approach. Based on this approach, if landings are between an upper stock reference (USR) and the limit reference point (LRP, i.e., the caution zone) it automatically triggers management considerations. These harvest control rules are pre-set management actions aimed at exiting the caution zone and re-entering the healthy zone (i.e., above the upper stock reference point). Based on a 123-year data series for the southern Gulf of Saint Lawrence, management considerations would have been triggered for the American lobster 85 times, and 12 times in a recovery mode (i.e., drastic reduction of effort to a no fishing situation) (Figure 1). However, applying the California spiny lobster approach to the same American lobster data revealed that California's proposed 0.8 reference point would only be exceeded two times (Figure 2).

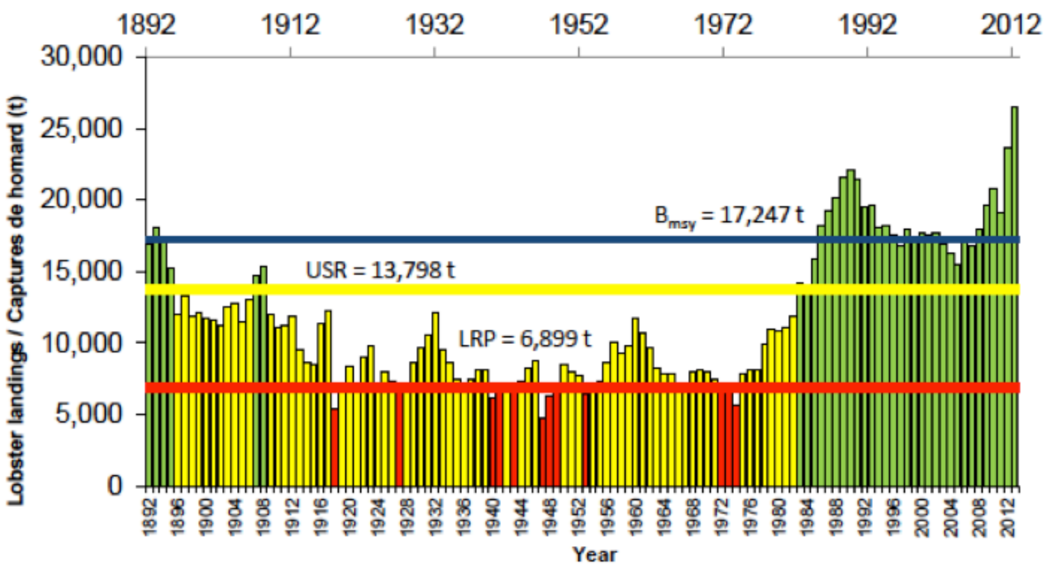


Figure 1. American lobster landings (1893-2013) in the southern Gulf of St. Lawrence; years in the healthy zone (i.e., above the upper stock reference [USR]) in green, caution zone (i.e., between the USR and the limit reference point [LRP]) in yellow, and below LRB in red. The biomass for the maximum sustainable yield (B_{msy}) is estimated at 17,247 t.

We then applied Canada's Precautionary Approach to the Department's California spiny lobster commercial landings data. To do this, we calculated a hypothetical biomass at maximum sustainable yield (B_{msy}) based on a time period from low landings followed by a "recovery" to higher and more sustained landings. Based on the information in the draft spiny lobster FMP, the lowest landings (with information available on effort) were observed in 1974 followed by increasing landings (with fluctuations) until 2013. Based on the trap pull haul (webinar presentation fig. 2.6), it seems that the effort level (traps hauled) increased 4 times: 200,000-400,000 between 1973-1979; 400,000-600,000 (with a drop in 1991-2) between 1980-94; ±800,000 between 1995-2011; and above 1 million in 2012-3. A reasonable assumption is that the stock could sustain the 800,000 trap haul level (16 years) since the landings did not drop during the time. Hence, the time period could be established between 1974 and 2011. However, please note that based on the CPUE reference values (see fig. 4.7 in FMP document), one could reasonably argue that the stock does not seem to react well to the level of effort in the last 7 years and that the time period should/could be 1974-2007. Nevertheless, using the 1974-2011 period

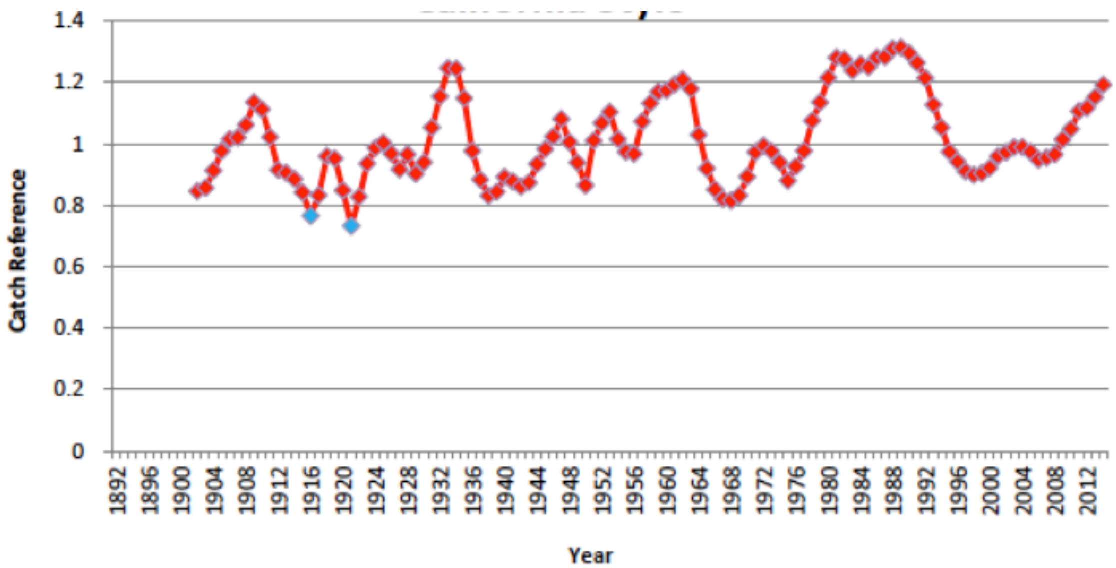


Figure 2. Catch reference for the American lobster landings (1892-2013) in the southern Gulf of St. Lawrence using the California spiny lobster catch-based threshold approach.

the B_{msy} is estimated at 587,409, given an upper stock reference (80% of B_{msy}; USR) of 469,927, and the limit reference point (40% of B_{msy}; LRP) of 234,963 (Figure 3). The draft FMP (Figure 4.6) indicates that between 1935 and 2013 management considerations would have been trigged 11 times, mostly between 1960-74. Based on the precautionary approach and using a 3-year running average for landings, the spiny lobster fishery was below LPR in 1975-6 (critical zone; normal because the time period stated at low values), which would trigger a recovery period (i.e., drastic reduction of effort to a no fishery situation). Since 1935, landings were between LRP and USR (caution zone) 31 times (latest 1977-87) that would have triggered immediate management actions from pre-established harvest control rules (mainly effort reductions) to, hopefully, exit the caution zone and re-enter the healthy zone. Landings between USR and Bmsy was observed 9 times (latest 1993-5) but does not trigger urgent management considerations, but could be used by managers to start a dialogue with the industry (e.g., to be cautious).

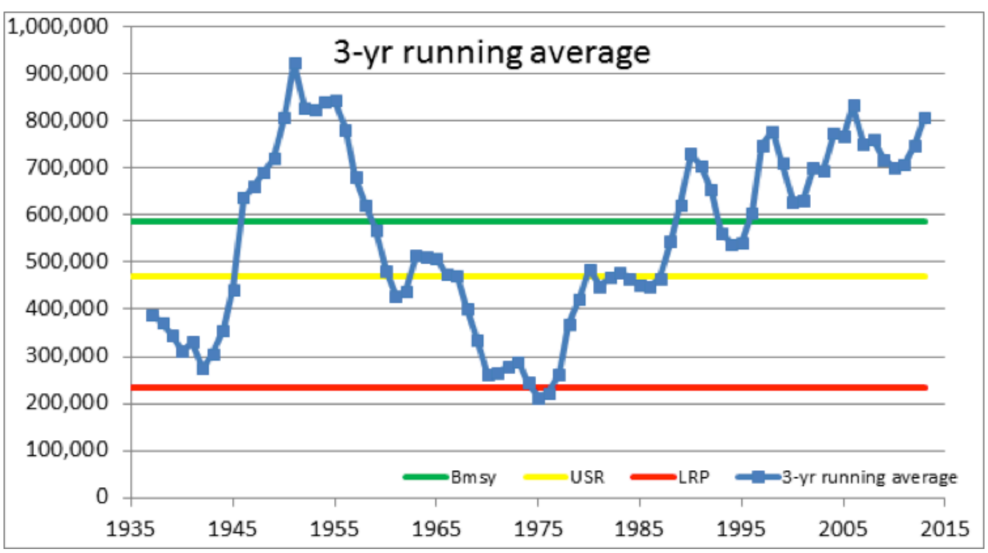


Figure 3. Application of Canada's Precautionary Approach to California spiny lobster commercial landings data; years in the healthy zone (i.e., above the upper stock reference [USR; yellow line]), caution zone (i.e., between the USR [yellow line] and the limit reference point [LRP; red line]), and below LRP. The biomass for the maximum sustainable yield (B_{msy}) is estimated at 587,409 lbs.

APPENDIX C: SCIENTIFIC AND TECHNICAL REVIEW PROCESS

The California Department of Fish and Wildlife (the Department) asked California Ocean Science Trust to coordinate an external scientific and technical review of the reference point thresholds prescribed in the California Spiny Lobster Fishery Management Plan (FMP) and supporting materials. Specifically, the Department sought an independent assessment of whether the technical components, spawning potential ratio model, and supporting documents that underpin the proposed reference point thresholds prescribed in the FMP are scientifically sound and reasonable given the Department's currently available data streams and analysis techniques. See the "Scope of Review" for details on the charge to reviewers.

Ocean Science Trust designed and implemented all aspects of the review process, including compiling appropriate background materials, drafting instructions to guide reviewers throughout the process, scheduling and hosting remote meetings as appropriate, and working with reviewers to produce a written final summary report, among other activities. Upon completion of the review, the final report was delivered to the Department and made publicly available on the Ocean Science Trust website. Throughout, Ocean Science Trust facilitated constructive interactions between the Department and reviewers as needed in order to ensure reviewers provide recommendations that are valuable and actionable, while maintaining the independence of the review process and outputs

Scientific Review Principles

In any review, it is our intent to provide an assessment of the work product that is balanced, fairly represents all reviewer evaluations, and provides feedback that is actionable. When building a scientific and technical review process, we seek to balance and adhere to six core review principles. These principles help guide the design and implementation of each review, and shape the final outputs:

- **Scientific rigor:** the process must yield an evaluation of whether scientific and technical components contained within products are valid, accurate and thorough.
- **Transparency:** given the context for the review, the process must include the appropriate level of information disclosure and openness in order to facilitate social recognition and accountability.
- **Legitimacy:** the process must yield an output that is viewed as authoritative in the eyes of scientific community, the requesting agency, and other constituents.
- **Credibility:** the process will seek to be unbiased and incorporate the best available science.
- **Salience:** the process will consider the most relevant scientific information while balancing management needs and timelines.
- **Efficiency:** the process will be as cost-effective as possible, and utilize time, resources, and effort in a proficient manner to create the most robust output possible.

Review Process

The review took place from October 2014 through May 2015. A timeline of each task is provided below.

	2014			2015				
Milestone	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Task 1 - Review Preparation								
Scope and process development; budget and administrative preparation; reviewer solicitation and selection process; collateral material development	X							
CDFW delivery of draft FMP to Ocean Science Trust		X						
Task 2 – Conduct Review								
Webinar 1: Initiation of Review (Attendees: CDFW, Review Committee, Ocean Science Trust)			X					
Webinars 2: FMP Assessment (Attendees: Review Committee, Ocean Science Trust)				X				
CDFW delivery of draft SPR model and report to Ocean Science Trust						X		
Webinar 3: SPR Model Assessment *(Attendees: CDFW, Review Committee, Ocean Science Trust)*						X		
Webinar 4: Cont. SPR Model Assessment, Develop Review Recommendations *(Attendees: Review Committee, Ocean Science Trust)*							X	
Task 3 – Finalize Summary Report								
Deliver final report to CDFW and make available online; publish membership of review committee; present findings to the Fish and Game Commission								X

Assembling the Review Committee

Ocean Science Trust implemented a reviewer selection process to assemble a review committee composed of four external scientific experts. Ocean Science Trust consulted with and accepted reviewer recommendations from the Ocean Protection Council Science Advisory Team (OPC-SAT), as well as Ocean Science Trust's own professional network among the academic and research community. Membership included experts from academia, research institutions, and government entities in order to deliver balanced feedback and multiple perspectives. Reviewers were considered based on three key criteria:

- **Expertise:** The reviewer should have demonstrated knowledge, experience, and skills in one or more of the following areas:
    - Fisheries biology, stock assessments and modeling, including spawning potential ratio analyses and application
    - Invertebrate ecology and/or population biology, with an understanding of California's coastal ecosystems, and how invertebrate stocks respond to fishing pressure, climate change and marine protected areas
- **Objectivity:** The reviewer should be independent from the generation of the product under review, free from institutional or ideological bias regarding the issues under review, and able to provide an objective, open minded, and thoughtful review in the best interest of the review outcome(s). In addition, the reviewer should be comfortable sharing his or her knowledge and perspectives and openly identifying his or her knowledge gaps.
- **Conflict of Interest:** Reviewers will be asked to disclose any potential conflicts of interest to determine if they stand to financially gain from the outcome of the process (i.e. employment and funding). Conflicts will be considered and may exclude a potential reviewer's participation.

Final selections for the review committee were made by the Ocean Protection Council Science Advisor (Ocean Science Trust Executive Director). Ocean Science Trust selected one member of the review committee to serve as chair to provide leadership among reviewers, help ensure that all members act in accordance with review principles and policies, and promote a set of review outputs that adequately fulfill the charge and accurately reflect the views of all members.

Series of Review Webinars

All meetings took place via a series of remote online meetings (webinars) and phone calls. At the outset of the review, Ocean Science Trust worked with the Department to develop detailed reviewer instructions that encouraged focused scientific feedback throughout the process. Instructions included directed evaluation questions and delegated tasks for reviewers based on their individual areas of expertise. The instructions were used to guide the development of meeting agendas, and track progress throughout the course of the review. For each meeting, advanced work was required of participants (e.g., conducting analyses, drafting responses to guiding questions, preparing presentations) in order for all parties to come prepared for meaningful discussions. Ocean Science Trust notified CDFW of additional requested materials and data prior to the first "Initiation of Review" webinar in mid-November.

- **Webinar 1: Initiation of Review (*December 2014*)**

Ocean Science Trust hosted an initial remote meeting (webinar) to provide the review committee and Department staff an overview of the scope and process, and clarify the roles and responsibilities of each participant. The Department provided a summary of the relevant management context to ensure reviewers understood the role of the review in the FMP development process, and how the outputs would be considered. The bulk of the webinar focused on a presentation by the Department of the scientific and technical components of the draft FMP. The webinar was an opportunity to develop a shared understanding of the tasks and allow reviewers to ask the Department any clarifying questions about the review materials before they convened independently to conduct their technical assessment.

- **Webinars 2-4: Reviewers convened with Ocean Science Trust to conduct review (*January through April 2015*)**

Ocean Science Trust convened three remote one- to two-hour webinars with the review committee to conduct an in-depth evaluation of the components identified in the Scope of Review. In advance of each webinar, reviewers were asked to prepare responses to guiding evaluation criteria questions from the review instructions. During each webinar, reviewers discussed their findings and developed conclusions and recommendations. Outputs from each webinar, as well as reviewer responses to the questions, guided the development of the final report.

Final Summary Report

Ocean Science Trust worked with the review committee to synthesize reviewer assessments (responses to the review instructions and input during webinars) into a cohesive, concise final report. The final report was delivered to the Department in May 2015, and made publicly available on Ocean Science Trust's website along with the identities of the review committee members. Ocean Science Trust presented the review results on behalf of the review committee at the June 10, 2015 California Fish and Game Commission public meeting in Mammoth, California.

Contact Information

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