Blue Rockfish STAR Panel Report

National Marine Fisheries Service
Alaska Fisheries Science Center
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Overview

Blue rockfish assessment was initially reviewed by a STAR panel in May 2007. The draft assessment included information on blue rockfish life history and growth, time series of recreational fisheries CPUE, and fishery age and size composition. The draft assessment also presented results of model runs using ASPIC, an assessment program based on a biomass production model. A SS2 model had been attempted, but the STAT had not been able to get the model to run satisfactorily. The STAR panel did not consider that the assessment was adequate and recommended that a new assessment be provided for review a later meeting. At the June Council meeting, the SSC supported the effort to explore simpler approaches such ASPIC, but also encouraged the STAT not to rule out other models that may be able to utilize more of the available data, such as a simplified SS2 or delay-difference model. The SSC stated that it was willing to review any model that the STAT put forward as being the best choice to assess the stock.

The STAT was able to resolve the implementation problems with SS2, and the preliminary base model presented for review at this meeting was in SS2. During the initial presentation of the assessment, the STAT identified a new base model different than the model in the draft document. This model included conditional age-at-length data, and growth was estimated for both males and females, with the exception of the L1 growth parameter.

The STAT also reported on preliminary results of a genetic study, motivated by discussions at pre-assessment data workshop, that suggested that blue rockfish may actually be two species. The Panel considered whether the assessment could proceed given this discovery. The Panel concluded that the assessment would be robust if the two putative species had similar life history characteristics such as growth and longevity; if recruitment patterns were similar; and if they were intermixed such that they would have experienced similar patterns of historical exploitation. While limited life history information suggests similarity between the two species, no information is available on the other concerns. The Panel was willing to let the assessment proceed, but cautions that the two-species question adds additional uncertainty to the assessment that should be considered when making management decisions.

For this assessment the STAT followed a recommendation of the previous STAR panel to construct a catch history for blue rockfish as far back as feasible. The STAR was able to extend the catch time series back to 1916 for both recreational and commercial fisheries. Earlier estimates (i.e., pre-RecFIN and pre-CalCOM) were based on published time series of total rockfish catch and a percentage of blue rockfish gleaned from sporadic species composition samples. The uncertainty of early catch estimates is high. Comments during the pre-assessment workshop on the unreliability of historical catches were accommodated through sensitivity analyses with high and low catch histories rather than changes to the base catch history, which is a more defensible approach than the previous draft.

The Panel put considerable effort into understanding and attempting to improve the fit to the age data. While fits to length data and the recreational CPUE indices appeared reasonable, the fit to the age composition was extremely poor, suggesting a problem in model specification. The Panel recommended several changes to improve the fit. First, the Panel recommended extending estimation of recruitment deviations further back (to 1960). Second, the Panel recommended using a higher mortality for males (0.12) than females (0.10). Finally, the CVs for length at age were modified, based on model fits, so that there would be less tension between the age and the length data. These changes improved the fit to the age data to an acceptable level.

The Panel also attempted to improve the treatment of growth in the model. This effort was hampered by the complexity of the apparent patterns and by a lack of age data. A strong latitudinal cline in length at age was observed in early age samples. A temporal decline in length at age has also been documented. Male and female growth curves of blue rockfish are very different. No recent age samples have been collected that are representative of the blue rockfish population, or even of landings. A model with two

growth periods was evaluated during the meeting but eventually rejected because there was insufficient age data in the last 20 years to support the more complex model.

The Panel also recommended a number of other relatively minor changes to improve treatment of various aspects of the model. The initial CVs for the pre-recruit index set at 0.35 rather than using the much smaller CVs that came from the ANOVA. The ANOVA model accounted for both a year-latitude interaction, as well as depth, vessel, and period effects. The preliminary base model achieved a nearly perfect fit the pre-recruit indices because of the low initial variances and a tuning process that increased the weight on the indices. This result did not seem reasonable given the additional variability must exist in the relationship between the index and recruitment strength. The recruitment variability parameter σ_R was set to 0.5 rather than iterated to convergence. Panel did not consider the available data of sufficient quality or quantity to rely on an iterated estimate. The RecFIN CPUE index was split with a new catchability period starting 2000 to account for the change in the bag limit. Finally, an error in specification of spawning biomass corrected. The preliminary base model had intended to use spawning output (which increases as a function of body weight), but was actually using female spawning biomass.

The Panel agreed that the final base model was best that could be produced with the available data and time for analysis and review. Given that this is a data-limited assessment, relatively strong assumptions were needed to obtain a well-behaved model. The major uncertainties, of which there are many, are listed in a section below. On the positive side, the model was apparently stable and sensitivity runs generally produced the results that would have been predicted prior to doing the run. Further, the different datasets used in the assessment are generally consistent with each other, or at least not strongly in conflict. The Panel ultimately concluded, despite qualms about model limitations and assessment uncertainties, that the final base model and bracketing model runs were suitable for use in management decision-making.

One robust result of the assessment is that blue rockfish may be more vulnerable to exploitation than other nearshore species with which it is typically caught, such as gopher rockfish and black rockfish. The available data indicate that blue rockfish have lower natural mortality than these species, and most of the catch consists of females. Consequently, for a given level of fishing intensity, spawning output will be reduced to a greater degree for blue rockfish than for other nearshore species.

Analyses requested by the STAR Panel

Round 1 Requests

Request 1: Plot double age-reading data.
Reason for Request: To examine the precision of the age data used in the assessment.
Response to Request: A plot of the data was presented.
Discussion/Conclusion: The plot showed fairly good precision. The data are multiple readings by one age reader (not between reader values).

Request 2: Plot length at age to compare growth for the two putative species of blue rockfish.
Reason for Request: What is the importance of two species to the assessment? If they are demographically similar, there is less concern.
Response to Request: A plot was presented.
Discussion/Conclusion: Mean length at age was similar for the two putative species.

Request 3: Prepare a table to describe the assumptions made for both commercial and recreational catch reconstructions during specific time periods. Indicate where actual data were used versus expansion factors. (See longnosed skate STAR Panel report for an example).
Reason for Request: Historical commercial and recreational catch are uncertain and should be evaluated.
Response to Request: There was not enough time for the STAT to respond to this request.
Discussion/Conclusion: The STAR Panel would like to keep this item on the list of requests as a priority for the next round of requests.

Request 4: Delta GLMs were used for the two CPUE indices of abundance: Provide diagnostics for goodness of fit, such as observed versus predicted for the proportion positive, and q-q plots.
Reason for Request: The Panel wanted to verify that the GLM error assumptions were reasonable.
Response to Request: A table was presented showing the number of CDFG CPFV trips by area. Plots were also prepared showing standardized residuals, normal q-q plots, leverage of residuals, and observed versus predicted values for the CDFG CPFV index. For the RecFIN CPUE Index, a table was presented showing sample sizes by area and year. A plot was prepared to show the RecFIN raw average CPUE by area and year. Plots were presented showing residuals, normal q-q plots, and leverage for the RecFin index as well. A plot was presented showing the predicted versus the observed proportion positive for the binomial component of the RecFIN index GLM.
Discussion/Conclusion: RecFIN sampling showed some thinness in the San Luis Obispo and Monterey areas. The STAT suggested dropping some years (1993-1996) from the RecFIN index, but this suggestion was not followed. Model residuals showed no severe departures from error assumptions.

Request 5: Provide histograms of bag frequency for pre and post bag-limit implementation.
Reason for Request: The STAR Panel wanted to look at the effect of changes in the bag limit.
Response to Request: A histogram of bag sizes over time was presented. A plot was presented of the ratio of the average catch divided by the average catch that would have resulted if there had always been a maximum bag limit of 10 fish.
Discussion/Conclusion: The STAT argued that the effect of the bag limit is minor. The STAR Panel suggested looking at the effect if the bag limit had not been put in place. When a new base model is selected, the Panel wanted to see a run with a change in CPUE catchability in 2000.

Request 6: Provide plots of age and length composition data and landed catch by stratum. Place priority on the age data.
Reason for Request: To look for potential problems of not weighting the age and length composition data.
Response to Request: Wade VanBuskirk (RecFIN) was contacted. He responded that he did not think that weighting by catch was an issue to be concerned about.
Discussion/Conclusion: When a new base model is selected, the Panel would like so see a model run with the weighted composition data.

Request 7: Ask Don Pearson to elaborate on his recollection of how the otoliths and lengths were collected for the 1979-1984 CDFG age dataset. Specifically enquire whether large fish were targeted to establish growth curves, or randomly selected.
Reason for Request: To see if there is any indication that biological sampling changed over time.
Response to Request: Don Pearson was queried and responded with his recollections. He did not recall a particularly non-random sampling process.
Discussion/Conclusion: The Panel concluded that it was appropriate to treat the sample as an unbiased sample of fishery length and age composition.

Request 8: Explain how the model's estimates of growth compare to Tom Laidig's length-at-age data, and find out what the Laidig age likelihood component in the model is based on.
Reason for Request: The characteristics of Laidig's length-at-age data were unclear and needed an explanation.
Response to Request: There was not enough time for the STAT to respond to this request.
Discussion/Conclusion: When a new base model is selected, consider runs assuming Laidig growth parameters for the later period.

Request 9: For the STAT preferred model, explore the male selectivity dog-leg formulation: fix the slope and keep the shape the same while allowing the level to vary.
Reason for Request: The male selectivity curves were both much lower than the females and dome-shaped. The Panel wanted to see whether a simple offset to the female selectivity pattern would fit the data as well.

Response to Request: There was not enough time for the STAT to respond to this request.
Discussion/Conclusion: The Panel decided to keep this on the list of requests.

Request 10: For the STAT preferred model, try estimating M for males and/or females.
Reason for Request: To consider reasons for the lack of old males in the catch.
Response to Request: There was not enough time for the STAT to respond to this request.
Discussion/Conclusion: The Panel decided to keep this on the list of requests.

Round 2 Requests

Request 11: Follow-up on Request 3 (Round 1). Prepare a table to describe the assumptions made for both commercial and recreational catch reconstructions during specific time periods. Indicate where actual data were used versus expansion factors. (See longnosed skate STAR Panel report for an example).
Reason for Request: Historical commercial and recreational catch are uncertain and should be evaluated.
Response to Request: A detailed table was presented to document how the catch histories were assembled. The STAT also showed the spreadsheet calculations that were used to derive the assumed catch values, and explained the procedures used in detail.
Discussion/Conclusion: The Panel concluded that sensitivity runs where half and doubling of the historical catch should be evaluated.

Request 12: Develop a new STAT base model, using a σ_R of 0.5. Determine an appropriate start year for estimating recruit deviations. Use the standard deviation of the recruitment estimates as the basis for deciding when the age composition data is starting to become informative about recruitment strength.
Reason for Request: To refine the specifications of the base model.
Response to Request: The STAT showed plots which varied the start year of recruitment deviations. The STAT recommended starting at 1960.
Discussion/Conclusion: The Panel agreed with the STAT recommendation.

Request 13: Follow-up on Request 5 (Round 1) regarding bag limit changes. When the base model is chosen, do a run with a change in catchability in 2000 to account for bag limit changes.
Reason for Request: The STAR Panel wanted to look at the effect of changes in the bag limit.
Response to Request: There was not enough time for the STAT to respond to this request.
Discussion/Conclusion: The Panel decided to keep this on the list of requests.

Request 14: Follow-up on Request 6 (Round 1). When a new base model is selected, do a model run with weighted composition data.
Reason for Request: To look for potential concerns of not weighting the age and length composition data.

Response to Request: The STAT presented plots to show the effect of weighting the composition data.
Discussion/Conclusion: Differences between the weighted and un-weighted compositions were minor. The Panel concluded that use of un-weighted composition data would be acceptable.

Request 15: Follow-up on Request 8 (Round 1). When a new base model is selected, do a model run looking at two growth periods (using Laidig's growth parameters for the more recent period.
Reason for Request: To refine the specifications of the base model.
Response to Request: The STAT presented plots showing length at age for various areas and time periods. The most recent period (2000's) showed a lower growth curve when compared to other externally generated growth curves from earlier periods (80's and 90's), and particularly the model generated growth curve. The STAT currently has no confidence in the base model if length-based information is used with the present growth model.
Discussion/Conclusion: The Panel decided that models including periods with different growth curves should continue to be explored.

Request 16: Follow-up on Request 9 (Round 1). When a new STAT base model is selected, explore the male selectivity dog leg formulation; fix slope and keep shape the same while allowing the level to vary.
Reason for Request: The male selectivity curves were both much lower than the females and dome-shaped. The Panel wanted to see whether a simple offset to the female selectivity pattern would fit the data as well.
Response to Request: The STAT reported that this could not be accomplished in SS2.
Discussion/Conclusion: The Panel decided to drop this issue. This is a technical limitation of SS2.

Request 17: Follow-up on Request 10 (Round 1). When a new STAT base model is selected, try estimating M for males and/or females.
Reason for Request: To refine the specifications of the base model.
Response to Request: There was not enough time for the STAT to respond to this request.
Discussion/Conclusion: The Panel decided to keep this on the list of requests.

Request 18: When a new STAT base model is selected, profile over a range of values for σ_R.
Reason for Request: To refine the specifications of the base model.
Response to Request: The STAT presented plots showing results from runs with σ_R ranging from 0.1 to 0.5.
Discussion/Conclusion: The STAR Panel suggested looking at a run with $\sigma_R = 1.0$.

Round 3 Requests

Request 19: Follow-up on Request 11 (Round 2). Conduct sensitivity runs with the base model by halving and doubling recreational and commercial historical catches.
Reason for Request: Historical commercial and recreational catch are uncertain and should be evaluated.
Response to Request: Plots were presented to show the spawning biomass trends for the high catch, low catch and base case, and terminal depletion for each run.
Discussion/Conclusion: Little sensitivity was found in terminal depletion levels for the three runs. High – 29%, Base – 32%, Low – 36%.

Request 20: Follow-up on Request 18 (Round 2). Do a run with the base model using σ_R =1.0. Report the model output RMSE for comparison.
Reason for Request: To refine the specifications of the base model.
Response to Request: Runs were conducted to examine RMSE with respect to input σ_R. With input σ_R = 1.0, RMSE=0.93. With input σ_R = 0.5, RMSE = 0.63. The tuned σ_R was 0.83 (Input σ_R was 0.84).
Discussion/Conclusion: The tuned σ_R could be considered for the base model.

Request 21: Follow-up on Request 15 (Round 2). Explore time varying growth, possibly by time blocking in SS2.
Reason for Request: To refine the specifications of the base model.
Response to Request: The STAT presented the results of a run where growth was fixed for two periods, with the change occurring in 1987. Conditional age at length was not used in this run.
Discussion/Conclusion: The Panel would like see a run with two growth periods that estimates growth in the early period.

Request 22: Estimate the coefficient of variation (CV) of length at age in the new base model
Reason for Request: To refine the specifications of the base model.
Response to Request: Tables were presented to show the estimated CVs of length at age.
Discussion/Conclusion: The females ranged from 0.07 (low) to 0.09 (high). Males ranged from 0.07 (low-bound) to 0.16 (high). The STAR recommended estimating a young and an old growth CV and making it the same for both sexes.

Round 4 Requests

Request 23: Follow-up on Request 21 (Round 3). Explore time varying growth, by time blocking in SS2. Estimate growth in the early period. Address a potential area bias in the growth data for the later period. Estimate selectivity. Turn on conditional age at length. Specify the CVs of length at age as suggested in Request 22 discussion (above). Set σ_R = 0.5.
Reason for Request: To refine the specifications of the base model.
Response to Request: The STAT presented the model runs as requested.

Discussion/Conclusion: The STAT reported that attempts to model two growth periods resulted in model instability which could not be fully resolved in the time available. Panel agreed that further evaluation of models with two growth periods was not likely to be useful. The available age data for the post-1987 period are simply not sufficient to support a model with the additional complexity.

Request 24: For comparison with a time-varying growth model (Request 23, above), do a run with constant growth over time.
Reason for Request: To refine the specifications of the base model.
Response to Request: The STAT presented the model runs as requested.
Discussion/Conclusion: Given the results from trying two growth periods (see Request 23 discussion, above), and reasonable results from the constant growth model, the STAT preferred the simpler model with a time-invariant growth curve. The Panel accepted this argument.

Round 5 Requests

Request 25: Run base model with the following specifications:

1. Set values for males and females CV for length at age as a function of age as follows:
   Young females: 0.085
   Young males: 0.085
   Old females: 0.095
   Old males: 0.110
2. Set the initial CV for the pre-recruit index to 0.35.

Reason for Request: The initial CVs had been set to the GLM error estimates, which are very small, and do not account for all sources of potential variability. The model may be over-fitting the index.
Response to Request:
Change in the CVs for the pre-recruit index resulted in plausible (not too good fits) to the index.
Discussion/Conclusion: The higher input CVs for the pre-recruit index were recommended for the base model.

Round 6 Requests

Request 26: Produce set of sensitivity runs with alternative values for male natural mortality:

1. Estimate male natural mortality.
2. Fix male natural mortality at 0.14.
3. Assume a ramp for male natural mortality between ages 10 and 20.
    a) Estimate old male natural mortality.
    b) Estimate both young and old male natural mortality.
    c) Fix young male mortality at 0.1 and the old male mortality at 0.15

Reason for Request: The lack of old males in the fishery data could be due to either selectivity or higher male mortality.

Response to Request: Run 1 produced modest improvements in fit and an estimate of 0.115 for male natural mortality. Run 2 resulted in some degradation of model fit compared to model 1. For the models with a ramp between ages 10 and 20 the estimate of old male mortality was 0.134. When both young and old male natural mortality were estimated, there was a counterintuitive result that the model estimated a higher natural mortality for the young males than the old males.
Discussion/Conclusion: The improvements in fit with a male natural mortality offset are large enough to justify inclusion in the model. The results with a ramp in male natural mortality are ambiguous, therefore it was decided that the new base model should have female natural mortality of 0.10 and male natural mortality of 0.12.

Request 27: Provide a run with a catchability break in the recreational fishery index in 2000.
Reason for Request: The bag limit was changed in 2000, and the panel wanted to see if adding an additional parameter would improve model fit.
Response to Request: Adding a catchability break (for 2000 bag limit change) reduced the estimated catchability by about one-half in the post-2000 period. Changes in assessment results are minor.
Discussion/Conclusion: The change in catchability is directionally consistent with prior expectations, and the approach is consistent with how black rockfish were treated. Therefore the Panel recommended including a catchability break in the base model. Initially the STAT had re-tuned the input variances for both portions of index after adding the catchability break. Upon further consideration, the Panel recommended that the model not be re-tuned. The addition of new parameter could only improve the fit to index, and it was considered inappropriate to reduce the assumed variances as a result of the catchability break.

Request 29: Provide a set of bracketing model runs with the following specifications:

Female M	Male M	Historical catches
0.08	0.10	High catch = Base catch * 2.0 (pre-CalCOM and RecFIN)
0.10	0.12	Base catch
0.12	0.14	Low catch = Base catch * 0.5 (pre-CalCOM and RecFIN)

Reason for Request: To identify a set of runs to bracket uncertainty.
Response to Request: The STAT presented the model runs as requested.
Discussion/Conclusion: There wasn't enough contrast between the high, base and low runs to capture the uncertainty thought to exist in the assessment.

Round 7 Requests

Request 30: Provide a set of bracketing model runs with the following specifications. (The response to this request was provided after the end of the meeting):

Female M	Male M	Historical catches
0.07	0.09	High catch = Base catch * 2.0 (pre-CalCOM and RecFIN)
0.10	0.12	Base catch
0.13	0.15	Low catch=Base catch * 0.5 (pre-CalCOM and RecFIN)

Also check to make sure that pairing high catch with low natural mortality, and low catch with high natural mortality gives the best contrast rather than the opposite pairing.
Reason for Request: To identify a set of runs to bracket uncertainty.
Response to Request: The STAT presented the model runs as requested.
Discussion/Conclusion: The requested bracketing runs gave depletion estimates (current biomass/unfished biomass) of 0.14, 0.30, and 0.49 respectively for the low M-high catch, base, and high M-low catch scenarios. The opposite pairing did not produce a useful result. The Panel recommended that the low M-high catch, base, and high M-low catch scenarios form the basis for a decision table. Because it is difficult to fully evaluate major uncertainties in the assessment, the Panel chose not to assign probabilities to the bracketing runs.

Final base model description

The final base model was a modification of the preliminary base model. Changes included:

- Recruitment deviations were estimated back to 1960.
- The recruitment variability parameter σ_R was set to 0.5 rather than iterated to convergence.
- Length at age CVs were revised based on model fits.
- Male natural mortality was increased from 0.10 to 0.12.
- The RecFIN CPUE index was split with a new catchability period in 2000 to account for the change in the bag limit.
- An error in specification of spawning biomass was corrected. The preliminary base model had intended to use spawning output (which increases as a function of body weight), but was actually using female spawning biomass.
- The initial CVs for the pre-recruit index set at 0.35 rather than using the much smaller CVs that came from the ANOVA.

Comments on the technical merits and/or deficiencies of the assessment

Technical merits

- SS2 was used effectively to model population dynamics, growth, and size-specific fishery impacts. SS2 brings the advantages of a standard and well tested package.
- Substantial improvements were made to the historical catch estimates.
- The model was fit to conditional age at length distributions.

Technical Deficiencies

- Male selectivity was modeled using a dog-leg formulation that produced a dome-shaped patterns that were difficult to justify.
- Development of historical catch estimates should also consider uncertainty, not just the best estimates.
- Composition data were not weighted by landings.
- The diagnostic plots for gamma GLM for the RecFIN CPUE data were not useful in evaluating model fit and the appropriateness of error assumptions.

Areas of disagreement regarding STAR Panel recommendations

There were no important areas of disagreement between members of the STAR Panel or between the STAR Panel and the STAT.

Unresolved problems and major uncertainties

- The assessment area is based on management boundaries and not on population structure. The assessment covers only the core of the species range. Blue rockfish south of Point Conception were not assessed, but anecdotal information suggests that they have declined steeply, potentially in response to climate change and loss of kelp forest habitat. The status of blue rockfish off Oregon (and further north) is unknown.
- Recent genetic studies suggest that blue rockfish is two closely-related species that intermix in the area covered by the assessment.
- Historical catches of blue rockfish are highly uncertain.
- Natural mortality is highly uncertain and cannot be reliably estimated. The scarcity of males in the landings could be either due higher male natural mortality or lower fishery selectivity for the males.
- The assumed value of stock-recruit steepness was based on Dorn's meta-analysis of steepness and represents average for all West Coast rockfish. The assessment itself provides little indication of the appropriate value of steepness for blue rockfish. Consequently, how the stock will respond to the Council's harvest policy for rockfish is not well known.
- Growth of blue rockfish shows complex spatial and temporal patterns. Data are not available to adequately describe these patterns.
- Assessment results depend on an assumption of a constant proportionality between recreational fishery CPUE and stock abundance.

Issues of concern raised by GMT and GAP representatives during the meeting

The GAP representative suggested that industry reports during the pre-assessment workshop of unrecorded catches and dumping of blue rockfish might be somewhat motivated by self-interest.

Recommendations for future research and data collection

- Further genetic studies are needed to confirm that blue rockfish is two species. The sampling for genetic samples should be designed to address management issues, such as differences in spatial distribution, the extent of intermixing, differences in growth, longevity, and maturation schedules between the two species.
- Development of a fishery independent time series using fixed sites and volunteer fishers properly supervised using standard protocols. The CPFV dataset consisting of reef-specific CPUE data has been repeatedly identified as most valuable index for monitoring stock trends of nearshore species.
- The next assessment should provide documentation of historical blue rockfish catches off Oregon and south of Point Conception. A comprehensive assessment of blue rockfish throughout its West Coast range should be considered.

- This assessment was limited by inadequate biological sampling of the California recreational and commercial fishery for blue rockfish. Recreational fishery length data could not be expanded to landings because strata with large landings were not sufficiently sampled. Reliable age data are unavailable for past 20 years, which made it impossible to evaluate temporal changes in growth or to compare geographic differences in growth. There have been positive steps towards sustainable management of nearshore species off California at the policy level, but the lack of investment in long-term sampling programs for biological data may make it difficult to achieve policy objectives.
- Given the availability of biological samples, studies are needed on spatial and temporal growth patterns of blue rockfish.
- Given the availability of biological samples, studies are needed on reproductive biology of blue rockfish. The apparent higher mortality of male blue rockfish, which is unique among assessed rockfish (female mortality is higher for several shelf and nearshore rockfish species), may also be linked to reproductive biology or behavior.
- The next assessment should provide a detailed justification for the use of fishery CPUE indices as indices of abundance. A detailed descriptive analysis of the data should be provided, with particular attention to annual changes that affect fundamental assumptions. Further, evaluate the robustness of the method to trip selection criteria and regulatory changes in the fishery.
- GLM diagnostics for both binomial and non-zero catch rate regressions should be provided routinely in all assessments that use this technique.
- For stocks whose primary assessment index is derived from recreational fishery CPUE, greater consideration should be given to the potential impact of management changes on the ability to assess the stock. Management tools such as bag limit and season closures may have different impacts on CPUE trend data. Each management change, e.g., a bag limit change, potentially reduces the value of fishery-dependent data.