DRAFT

A Guide to the Preparation of Bering Sea and Aleutian Islands Crab SAFE Report Chapters

A chapter should be produced for the SAFE report in all cases, and should include all sections listed in the "Outline of SAFE Report Chapters" below. This Outline is intended to provide a consistent structure and logical flow for stock assessments; using the numbering system outlined below will help to standardize the SAFE document and make the review process for assessments more straightforward. Some variation from this outline is permissible if warranted by limitations of data or other extenuating circumstances. Specifically, many of the items under Section E are not appropriate for stocks in Tier 5. However, it is particularly important that all of the items listed under "Projections and Harvest Alternatives" be included to the maximum extent possible, in that many of these are critical to the fishery management process. Careful consideration should be given to all applicable SSC and CPT comments from the previous assessment(s). Fishing mortality values (*F*) are always full selection fishing mortality (the *F* at fishing selectivity equal to 1.0).

Outline of SAFE Report Chapters

Title page and list of preparers

Executive Summary

1. Stock: species/area.
2. Catches: trends and current levels.
3. Stock biomass: trends and current levels relative to virgin or historic levels, description of uncertainty.
4. Recruitment: trends and current levels relative to virgin or historic levels.
5. Management performance: a table showing ABC and OY estimates, stock biomass estimates, overfishing levels (OFL and MSST), retained catch and discards in all fisheries; show results from 2007 to the current year.
6. Table listing *M*, Tier (previous year or recommended), projected total biomass, female spawning biomass, male spawning biomass and total spawning biomass or proxy values and MSST for the current year and for the next year. Male spawning biomass values at the time of mating for B_0 and B_{msy} and F_{msy} (if available from stock-recruit relationship) or proxy values, F_{OFL}, the maximum allowable value for F_{target}, the recommended value of OFL for the next year, and the maximum allowable total catch.

A. Summary of Major Changes

1. Changes (if any) to the input data.
2. Changes (if any) to the assessment methodology.
3. Changes (if any) to the assessment results, including projected biomass, TAC/GHL, total catch (including discard mortality in all fisheries and retained catch), and OFL.

B. Responses to SSC and CPT Comments

1. Responses to SSC and CPT comments specific to this assessment (for each comment that is addressed in the main text, list the comment and give the name of section where it is discussed; if the SSC or CPT did not make any comments specific to this assessment, say so).

2. Responses to SSC and CPT comments on assessments in general (for each comment that is addressed in the main text, list the comment and give name of the section where it is discussed; if the SSC or CPT did not make any comments on assessments in general, say so).

C. Introduction [Items in strikeout should be reported elsewhere in the SAFE]

1. Scientific name.
2. ~~Description of general distribution (including a map).~~
3. ~~Description of management unit(s) (include any spatial and/or seasonal management measures).~~
4. Evidence of stock structure, if any.
5. Description of life history characteristics relevant to stock assessments (e.g., special features of reproductive biology)
6. ~~Important features of the current fishery and relevant history of the fishery~~
7. ~~Summary of management history (e.g., recent relevant management or assessment changes that have influenced the choice of TAC/GHL; selectivity of the commercial fishing gear; or distribution of catch by gear, area, or season (e.g., changes in mesh size, gear allocations, pot limits, or harvest strategy)).~~

D. Data (Items in this section should be presented primarily in tabular form.)

1. Summary of new information.
2. Data which should be presented as time series:
   a. Total catch, partitioned by strata used in the assessment model, if any.
   b. Information on bycatch and discards.
   c. Catch-at-age or catch-at-length (with sample sizes), as appropriate
   d. Survey biomass estimates (with measures of uncertainty).
   e. Survey numbers-at-age or numbers-at-length (with sample sizes), as appropriate.
   f. Other time series data (e.g., predator abundance, fishing effort).
3. Data which may be aggregated over time:
   a. Length-at-age.
   b. Growth-per-molt; frequency of moulting, etc.
   c. Weight-at length or weight-at-age.
4. Information on any data sources that were available, but were excluded from the assessment.

E. Analytic Approach

1. History of modeling approaches for this stock

2. Model Description

   a. Description of overall modeling approach (e.g., age/size structured versus biomass dynamic, maximum likelihood versus Bayesian). If the model has not been published in its current form, its equations should be listed in full in an Appendix. It there is a technical Appendix, Items b-f below should be included in the appendix, and only a short description of the model and its estimation scheme needs to be included in this section.
   b. Reference for software used (e.g., Synthesis, AD Model Builder).
   c. List and description of all likelihood components.
   d. Description of how the state of the population at the start of the first year of the assessment period is determined.
   e. Parameter estimation framework:
      i. List all of the parameters which are estimated outside of the assessment (e.g., the natural mortality rate, parameters governing the maturity schedule) along with how

the values for these parameters were estimated (methods do not necessarily have to be statistical; e.g., *M* could be estimated by referencing a previously published value).

ii. List all of the parameters that are estimated conditionally on those described above (e.g., full-selection fishing mortality rates, parameters governing the survey and fishery selectivity schedules, recruitments).

iii. List any constraints that imposed on the estimated parameters (including penalties on recruitment and selectivity).

f. Definition of model outputs

   i. Biomass measures (e.g., biomass of animals 50mm and larger).
   ii. Recruitment (e.g., number of males and females in the 50-55mm size-class).
   iii. Fishing mortality (e.g., full-recruitment F multiplied by selectivity for lengths 80 and above).

g. Critical assumptions and consequences of assumption failures.

h. Changes to any of the above since the previous assessment.

3. Model Selection and Evaluation

a. Description of alternative models, if any (e.g., alternative *M* values or likelihood weights; use a hierarchical approach where possible (e.g. asymptotic vs domed selectivities, constant vs time-varying selectivities)).

b. Evidence of search for balance between realistic (but possible over-parameterized) and simpler (but not realistic) models.

c. Convergence status and convergence criteria for the base-case model (or proposed base-case model) such as randomization run results or other evidence of a search for the global best estimates.

d. Do parameter estimates for all models make sense, are they credible?

e. Description of criteria used to evaluate the model or to choose among alternative models, including the role (if any) of uncertainty.

f. Residual analysis (e.g. residual plots, time series plots of observed and predicted values or other approach). Note that residual analysis is expected for the base-case model below.

g. Evaluation of the model, if only one model is presented; or evaluation of alternative models and selection of final model, if more than one model is presented.

4. Results (best models)

Results should be provided for all model runs that the assessment author considers sufficiently plausible that they could form the basis for management advice. Assessment authors should come to the April meeting with detailed results for all analyses conducted.

1. Tables of estimates (all quantities should be accompanied by confidence intervals or other statistical measures of uncertainty, unless infeasible; include estimates from previous SAFEs for retrospective comparisons):
   a. All parameters (include recruitments, selectivity parameters, any estimated growth parameters, catchability, etc.).
   b. Abundance and biomass time series, including spawning biomass and mature male biomass (MMB).
   c. Recruitment time series (including average recruitment).
   d. Catch/biomass time series.
2. Graphs of estimates (all quantities should be accompanied by confidence intervals or other statistical measures of uncertainty, unless infeasible):

   a. Fishery and survey selectivities, molting probabilities, and other schedules depending on parameter estimates.
   b. Estimated male, female, mature male, total and effective mature biomass time series
   c. Estimated full selection *F* over time.
   d. Estimated fishing morality versus estimated spawning stock biomass, including applicable OFL and maximum F_{target} definitions for the stock (see, for example, Fig. 54 of Turnock and Rugolo, 2008). Graphs of this type are useful to evaluate management performance.
   e. Fit of a stock-recruitment relationship.
3. Evaluation of the fit to the data:
   a. Graphs of model fits to catch numbers (include confidence intervals for the data and model predictions).
   b. Graphs of model fits to survey numbers (include confidence intervals for the data and model predictions).
   c. Graphs of model fits to catch proportions by age or length (e.g. using bubble and/or line plots).
   d. Graphs of model fits to survey proportions by age or length (e.g. using bubble and/or line plots).
   e. Other suggestions to come from this workshop
4. Retrospective and historic analyses
   a. Retrospective analysis (retrospective bias in base model or models).
   b. Historic analysis (plot of actual estimates from current and previous assessments).
5. Uncertainty and sensitivity analyses (this section should highlight unresolved problems and major uncertainties, along with any special issues that complicate scientific assessment, including questions about the best model, etc.):
   a. The best approach for describing uncertainty depends on the situation. Possible approaches (not mutually exclusive) are:
      i. Sensitivity analyses (tables or figures) that show ending biomass levels, OFLs, and/or likelihood component values obtained while systematically varying emphasis factors for each type of data in the model.
      ii. Likelihood profiles for parameters or biomass levels.
      iii. CVs for biomass or OFL estimated by bootstrap, the delta method or Bayesian methods.
      iv. Subjective appraisal of the magnitude and sources of uncertainty.
      v. Retrospective and historic analyses (see above).
      vi. Comparison of alternate models and or assumptions.
   b. It is important that some qualitative or quantitative information about relative probability be stated if a range of model runs (e.g., based on CV's or alternative assumptions about model structure or recruitment) is used to depict uncertainty. It is important to state that all scenarios (or all scenarios between the bounds depicted by the runs) are equally likely if no statements about relative probability can be made.
   c. Simulation results.

4. Projections and Harvest Alternatives

1. Specification of the Tier level for computing the OFL, along with the basis for the selection. For Tier 4 and 5 stocks, the rationale for the time period used to define B_{REF} (Tier 4) and the average retained catch used to compute the OFL needs to be specified.

2. List of parameter and stock size estimates (or best available proxies thereof) required by limit and target control rules specified in the fishery management plan.
3. Specification of the OFL:
   a. Provide the equations (from the Amendment) on which the OFL is to be based.
   b. Specification of F_{OFL} , OFL, the upper bound on F_{target}, and other applicable measures (if any) relevant to determining whether the stock is overfished or if overfishing is occurring (such as B_{REF}, $B_{35\%}$). Include estimates from the present assessment and the assessments since 2007. Table x lists examples of tables for Tiers 3, 4 and 5 [To be added after April CPT meeting].
   c. Basis for forecasting future discards and bycatch values by sex (the mathematical specifications for this need to be documented in a peer-reviewed publication or in a technical appendix).
   d. Basis for projecting MMB to the time of mating (the mathematical specifications for this need to be documented in a peer-reviewed publication or in a technical appendix).
4. List of standard harvest scenarios and description of projection methodology
5. Table of 12-year projected catches corresponding to the alternative harvest scenarios, using stochastic methods if possible (mean values or other statistics may be shown in the case of stochastic recruitment scenarios).
6. Table of 12-year projected spawning biomass and MMB corresponding to the alternative harvest scenarios, using stochastic methods if possible (mean values or other statistics may be shown in the case of stochastic recruitment scenarios).
7. Table of 12-year projected fishing mortality rates corresponding to the alternative harvest scenarios, using stochastic methods if possible (mean values or other statistics may be shown in the case of stochastic recruitment scenarios) .
8. Discussion of information, if any, that might warrant setting the TAC/GHL or total catch below the upper bound.
9. Recommendation for F_{OFL} , OFL total catch, OFL retained catch for coming year.
10. Include a subsection titled “Area Allocation of Harvests” and provide results and details of any apportionment schemes that are used.

E. Data gaps and research priorities

F. Ecosystem Considerations

Discussion of any ecosystem considerations (e.g., relationships with species listed under the ESA, prohibited species concerns, bycatch issues, refuge areas, and gear considerations).

The following subsections should provide information on how various ecosystem factors might be influencing the stock or how the fishery might be affecting the ecosystem and what data gaps might exist that prevent assessing such effects.

Stock assessment authors would be encouraged to rely on information in the Ecosystem Considerations chapter to assist them in developing stock-specific analysis and recommending new information to the Ecosystem Considerations chapter that might be required in future years to improve the analysis. Time-series that are in the Ecosystem Chapter would be referred to by the author and not duplicated in their chapter. In cases where the authors have time series or relationships that are specific to their stock, that information should be in their assessment chapter and not in the Ecosystem chapter.

1. Ecosystem Effects on Stock

There are several factors that should be considered for each stock in this subsection. These include:

1. Prey availability/abundance trends (historically and in the present and foreseeable future). These prey trends could affect growth or survival of a target stock.
2. Predator population trends (historically and in the present and foreseeable future). These trends could affect stock mortality rates over time.
3. Changes in habitat quality (historically and in the present and foreseeable future). These would primarily be changes in the physical environment such as temperature, currents, or ice distribution that could affect stock migration and distribution patterns, recruitment success, or direct effects of temperature on growth.

2. Fishery Effects on the Ecosystem

In this section the following factors should be considered:

1. Fishery-specific contribution to bycatch of prohibited species, forage (including herring and juvenile pollock), HAPC biota (in particular, species common to *YourFishery*), marine mammals and birds, and other sensitive non-target species (including top predators such as sharks, expressed as a percentage of the total bycatch of that category of bycatch).
2. Fishery-specific concentration of target catch in space and time relative to predator needs in space and time (if known) and relative to spawning components.
3. Fishery-specific effects on amount of large size target fish.
4. Fishery-specific contribution to discards and offal production.
5. Fishery-specific effects on age-at-maturity and fecundity of the target species.
6. Fishery-specific effects on EFH non-living substrate (using gear specific fishing effort as a proxy for amount of possible substrate disturbance).

Authors should consider summarizing the results of these analyses into a table as shown below (for example):

Analysis of ecosystem considerations for *YourStock* and the *YourFishery*. The observation column should summarize the past, present, and foreseeable future trends. The interpretation column should provide details on how the trend affects the stock (ecosystem effects on the stock) or how the fishery trend affects the ecosystem (fishery effects on the ecosystem). The evaluation column should indicate whether the trend is of: *no concern, probably no concern, possible concern, definite concern,* or *unknown.*

Ecosystem effects on *YourStock*			
Indicator	Observation	Interpretation	Evaluation
Prey availability or abundance trends			
Zooplankton	Stomach contents, ichthyoplankton surveys, changes mean wt-at-age	Stable, data limited	Unknown
Predator population trends			
Marine mammals	Fur seals declining, Steller sea lions increasing slightly	Possibly lower mortality on pollock	No concern
Birds	Stable, some increasing some decreasing	Affects young-of-year mortality	Probably no concern
Fish (Pollock, Pacific cod, halibut)	Stable to increasing	Possible increases to pollock mortality	
Changes in habitat quality			
Temperature regime	Cold years pollock distribution towards NW on average	Likely to affect surveyed stock	No concern (dealt with in model)
Winter-spring environmental conditions	Affects pre-recruit survival	Probably a number of factors	Causes natural variability
Production	Fairly stable nutrient flow from upwelled BS Basin	Inter-annual variability low	No concern

***YourFishery* effects on ecosystem**			
Indicator	Observation	Interpretation	Evaluation
Fishery contribution to bycatch			
Prohibited species	Stable, heavily monitored	Minor contribution to mortality	No concern
Forage (including herring, Atka mackerel, cod, and pollock)	Stable, heavily monitored	Bycatch levels small relative to forage biomass	No concern
HAPC biota	Low bycatch levels of (spp)	Bycatch levels small relative to HAPC biota	No concern
Marine mammals and birds	Very minor direct-take	Safe	No concern
Sensitive non-target species	Likely minor impact	Data limited, likely to be safe	No concern
Fishery concentration in space and time	Generally more diffuse	Mixed potential impact (fur seals vs Steller sea lions)	Possible concern
Fishery effects on amount of large size target fish	Depends on highly variable year-class strength	Natural fluctuation	Probably no concern
Fishery contribution to discards and offal production	Decreasing	Improving, but data limited	Possible concern
Fishery effects on age-at-maturity and fecundity	New study initiated in 2002	NA	Possible concern

G. Literature Cited

Include citations that are relevant to understanding the stock and its status, but are not cited in the report in a special "extra references" section.

References

Turnock, B.J. and L.J. Rugolo. 2008. Stock assessment of eastern Bering Sea snow crab.