SEDAR 77
HMS Atlantic Hammerhead Sharks
Research Track Assessment
Terms of Reference
April 2021

Data Workshop Terms of Reference

The following Terms of Reference apply to each individual stock as determined by the Stock ID process.

1. Definition of assessment unit stock will be developed through the Hammerhead Sharks Stock ID process and will be added to TORs once that process is complete.
2. Review, discuss, and tabulate available life history information for each stock being assessed.
   a. Evaluate age, growth, natural mortality, and reproductive characteristics
   b. Provide appropriate models to describe population- and area-specific (if warranted) growth, maturation, and fecundity by age, sex, or length as applicable.
   c. Evaluate the adequacy of available life history information for conducting stock assessments and recommend life history information for use in population modeling.
   d. Evaluate and discuss the sources of uncertainty and error and data limitations (such as temporal and spatial coverage) for each data source. Provide estimates or ranges of uncertainty for all life history information, where applicable.
3. Provide measures of population relative abundance that are appropriate for these stock assessments.
   a. Consider all available and relevant fishery-dependent and fishery-independent data sources
   b. Document all programs evaluated; address program objectives, methods, coverage, sampling intensity, and other relevant characteristics.
   c. Provide maps of fishery-dependent and fishery independent survey coverage.
   d. Develop fishery and survey CPUE indices by appropriate strata (e.g., age, size, area, and fishery) and include measures of precision and accuracy.
   e. Document pros and cons of available indices regarding their ability to represent abundance.
      i. Consider potential species identification issues between hammerhead shark species and, if present, whether the issue was adequately addressed during index development.
   f. Categorize the available indices into Recommended and Not Recommended; provide justifications for the categorization.
   g. For recommended indices, document any known or suspected spatial or temporal patterns not accounted for by standardization.
   h. Provide appropriate measures of uncertainty for the abundance indices to be used in stock assessment models.

4. Provide commercial catch statistics for each stock being assessed, including landings, dead discards, live discards, and potential post-release mortality in both weight and number. Consider species identification issues between hammerhead shark species and correct for these instances as appropriate.
    a. Evaluate and discuss the adequacy of available data for accurately characterizing landings and discards by fishery sector or gear.
    b. Provide length and age distributions for both landings and discards if feasible.
    c. Provide maps of fishery effort and harvest by fishery sector or gear.
    d. Provide estimates of uncertainty around each set of commercial landings (if possible) and discard estimates.
    e. Provide estimates of discard mortality rate by gear.
5. Provide recreational catch statistics for each stock being assessed, including landings, dead discards, live discards, and potential post-release mortality in both weight and number. Consider species identification issues between hammerhead shark species and correct for these instances as appropriate.
    a. Evaluate and discuss the adequacy of available data for accurately characterizing landings and discards by fishery sector or gear.
    b. Provide length and age distributions for both landings and discards if feasible.
    c. Provide maps of fishery effort and harvest by fishery sector or gear.
    d. Provide estimates of uncertainty around each set of recreational landings and discard estimates.
    e. Provide estimates of discard mortality rate by gear.
6. Identify and describe ecosystem, climate, species interactions, habitat considerations, and/or episodic events that would be reasonably expected to affect population dynamics.
    a. Report and summarize species that frequently co-occur or are associated with hammerhead sharks from survey data, if possible.
    b. Report and summarize species envelopes used for CPUE standardization, i.e. minimum and maximum values of environmental boundaries (e.g. depth, temperature, substrate, relief).
    c. Review and summarize available diet composition with respect to ontogeny, seasonality, and habitat, where available.
7. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on sampling intensity (number of length samples) and appropriate strata and coverage.
8. Prepare a Data Workshop report providing complete documentation of workshop actions and decisions in accordance with project schedule deadlines.

Assessment Process Terms of Reference

The following Terms of Reference apply to each individual stock as determined by the Stock ID process.

1. Review any changes in data or analyses following the Data Workshop. Summarize data as used in each assessment model. Provide justification for any deviations from Data Workshop recommendations.

2. Develop population assessment models that are compatible with available data and document input data, model assumptions and configuration, and equations (if necessary) for each model considered.

3. Identify preferred model approach if applicable.

4. Provide preliminary estimates of stock population parameters:

   a. Include fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship (if applicable), and other parameters as necessary to describe the population.

   b. Include appropriate measures of precision for parameter estimates.

5. Characterize uncertainty in the assessment and estimated values, if possible.

   a. Consider uncertainty in input data, modeling approach, and model configuration.

   b. Consider and include other sources of uncertainty as appropriate for this assessment.

   c. Provide appropriate measures of model performance, reliability, and 'goodness of fit'.

6. Provide preliminary estimates of population benchmarks or management criteria consistent with available FMPs and amendments, proposed FMPs and amendments, other ongoing or proposed management programs, and the National Standards.

   a. Evaluate existing or proposed management criteria as specified in the management summary.

   b. Recommend and define proxy values when necessary, and provide appropriate justification.

7. Recommend preliminary stock status relative to management benchmarks or alternative data-poor approaches if necessary.

8. Provide uncertainty distributions of proposed reference points and stock status metrics that provide the values indicated in the management specifications. Include probability density functions for reference point estimates and population metrics (e.g., biomass and exploitation) used to evaluate stock status.

9. Project future stock conditions and develop rebuilding schedules, if warranted. Provide the estimated generation time for the stock. Stock projections shall be developed in accordance with the following:

   a. If the preliminary stock status is overfished, then utilize projections to determine:

      i. Year in which $F=0$ results in a 70% probability of rebuilding (Year $F=0_{p70}$).

      ii. Target rebuilding year (Year$_{rebuild}$).

         1. Year $F=0_{p70}$ if Year $F=0_{p70} \leq 10$ years, or

         2. Year $F=0_{p70} + 1$ generation time if Year $F=0_{p70} > 10$ years.

      iii. F resulting in 50% and 70% probability of rebuilding by Year$_{rebuild}$.

      iv. Fixed level of removals allowing rebuilding of stock with 50% and 70% probability.

   b. If the preliminary stock status is determined to be undergoing overfishing, then utilize projections to determine:

      i. $F=F_{reduce}$ (different reductions in F that should end overfishing with a 50% and 70% probability).

   c. If the preliminary stock status is determined to be neither overfished nor undergoing overfishing, then utilize projections to determine:

      i. The F needed and corresponding removals associated with a 70% probability of overfishing not occurring (analogous to a $P^* = 0.3$ approach), and/or

      ii. The constant catch associated with a 70% probability of overfishing not occurring and the stock not being overfished.

   d. If data limitations and/or model limitations preclude classic projections (i.e. a, b, and c above), explore alternate projection models.

10. Provide ABCs in accordance with HMS management needs.

11. Provide recommendations for future research and data collection. Emphasize items that will improve future assessment capabilities and reliability. Consider data, monitoring, and assessment needs.

12. Complete an Assessment Workshop Report in accordance with project schedule deadlines.

Review Workshop Terms of Reference

The following Terms of Reference apply to each individual stock as determined by the Stock ID process.

1. Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions. Consider the following:
   a. Are data decisions made by the DW and AW justified?
   b. Are data uncertainties acknowledged, reported, and within normal or expected levels?
   c. Is the appropriate model applied properly to the available data?
   d. Are input data series sufficient to support the assessment approach?

2. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, taking into account the available data. Consider the following:
   a. Are methods scientifically sound and robust?
   b. Are the methods appropriate for the available data?
   c. Are assessment models configured properly and used in a manner consistent with standard practices?

3. Consider how uncertainties in the assessment, and their potential consequences, are addressed.
   a. Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods.
   b. Ensure that the implications of uncertainty in technical conclusions are clearly stated.

4. Evaluate the provisional assessment findings and consider the following:
   a. Are abundance, exploitation, and biomass estimates reliable, consistent with input data and population biological characteristics, and useful to support status inferences?
   b. Are the provisional stock status determination methods for each stock or stock complex appropriate? If not, are there other indicators that may be used to inform managers about stock trends and conditions?

5. Evaluate the stock projection methods, including discussing strengths and weaknesses, and consider the following:
   a. Are the methods consistent with accepted practices and available data?
   b. Are the methods appropriate for the assessment model and outputs?
   c. Are the provisional results informative and robust, and useful to support inferences of probable future conditions?
   d. Are key uncertainties acknowledged, discussed, and reflected in the provisional projection results?

6. Provide, or comment on, recommendations to improve the assessment
    a. Consider the research recommendations provided by the Data and Assessment workshops in the context of overall improvement to the assessments, and make any additional long-term research recommendations warranted.
    b. Provide suggestions on key improvements in data analysis or modeling approaches that should be considered when scheduling the subsequent operational assessment. These recommendations should be described in sufficient detail for application in the subsequent operational assessment, and consequently should be practical for short- term implementation (i.e., achievable within ~6 months).
    c. Comment on the degree of environmental and climate linkage(s) incorporated in the stock assessments and make recommendations for improvements in the future.
7. Provide recommendations on possible ways to improve the Research Track Assessment process.
8. Prepare a Review Workshop Summary Report describing the Panel's evaluation of the Research Track stock assessment and addressing each Term of Reference.