Selected FishPath Results for Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

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Introduction and Definitions

The following report contains information about user-selected results from the FishPath questionnaire. (Note that this report might not include all results provided in FishPath.) The first section, "Summary of Selected Results" provides a table containing each selected option and a summary of its associated results. The second section provides detailed information about each the results for each selected option as well as any notes that were written within FishPath for the option.

Definitions

Criteria:

Criteria are the minimum requirements needed to implement the option. If all criteria for an option are met, then an option may be implemented, pending further consideration of the caveats. If one or more criteria is not met, then it will not be possible (or extremely difficult) to implement the option successfully. Whether or not a criteria is met is based upon the answers to the fishery questionnaire. Both data collection and assessment options have criteria associated with them. Additionally, assessment options further indicate the uncertainty around met criteria. The level of uncertainty is indicated by a "traffic light" of colors (red, orange, yellow, green). Red indicates a high level of possible uncertainty, while green indicates a low level of possible uncertainty. These are indicated as the background color in the met/failed column.

Multi-part Criterion:

A group of criteria that are considered together when determining if they meet the minimum requirements. To meet a multi-part criterion, at least one of the associated criteria must meet its minimum requirements. Multi-part criterions are signified in the table below by grouping each criteria together under the multi-part criterion (e.g. Group A).

Caveat:

Caveats indicate cautions to be aware of when implementing this option for this specific fishery. Caveats, except for static caveats, are determined based upon the answers to the fishery questionnaire. Caveats are ranked in severity from red to orange to yellow to light blue. Red caveats represent the strongest cautions, suggesting that those options should likely not be implemented without serious consideration for overcoming that caveat. Where yellow caveats may provide a caution to consider, but that may not prevent implementation. Light blue caveats are neutral and used to provide additional information about the option, given the context. Color assignments are based on expert experience and may vary among fisheries.

Static Caveat:

Static caveats provide additional information, assumptions, limitations, or warnings associated with the option that apply independently of fishery circumstances or user responses to the questionnaire. They are denoted with light blue.

Positive Attribute:

Positive attributes indicate reasons why an option might be a good fit for the fishery. They are determined based upon the answers to the fishery questionnaire and are denoted with green.

Summary of Selected Results

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

Section: Assessment

Option	Assessment Category	Assessment Output	Meets Criteria	Red Caveats	Orange Caveats	Yellow Caveats	Positive Attributes	Static Caveats
Single-indicator analysis using standardized CPUE	Abundance Indicators	Catch Limit, Fishing Rate, or Stock Status	No (0/1)	1	2	6	1	3
Use of biomass surveys to inform spatial management	Abundance Indicators	Catch Limit, Stock Scale, Stock Status	No (0/1)	0	1	2	1	3
Ecosystem Based Biomass Targets	Abundance Indicators	Catch Limit	No (0/2)	1	0	1	1	0
Depletion analysis	Catch Only	Stock Scale, Stock Status, Fishing Rate	No (1/2)	1	3	5	1	5
Boosted Regression Tree (BRT) model for stock depletion using catch data	Catch Only	Catch Limit	No (2/3)	1	2	3	0	4
Only Reliable Catch Stocks (ORCS)	Catch Only	Catch Limit	Yes (2/2)	1	2	2	0	5
Depletion-Corrected Average Catch (DCAC)	Catch Only	Catch Limit	Yes (4/4)	1	3	3	0	6
Depletion-Based Stock Reduction Analysis (DB-SRA)	Catch Only	Catch Limit	No (4/5)	1	3	5	0	6
Simple Stock Synthesis (SSS)	Catch Only	Catch Limit	No (7/8)	1	2	5	0	5
Stochastic Stock Reduction Analysis (SRA)	Catch Only	Catch Limit	No (3/4)	1	3	5	0	5
Catch-MSY/CMSY	Catch Only	Catch Limit	No (2/3)	1	3	3	0	4
Optimized catch-only method (OCOM)	Catch Only	Catch Limit	No (2/3)	1	3	3	0	4
Catch Only Model - Sampling Importance Resampling Model (COM-SIR)	Catch Only	Catch Limit	No (3/5)	1	3	3	0	2

Option	Assessment Category	Assessment Output	Meets Criteria	Red Caveats	Orange Caveats	Yellow Caveats	Positive Attributes	Static Caveats
State-space Catch Only Model (SSCOM)	Catch Only	Catch Limit	No (3/5)	1	3	3	0	1
Modified Panel Regression Model (mPRM)	Catch Only	Stock Status	No (1/2)	1	1	2	0	0
Analysis of change in a single (non-CPUE) indicator	Expert Judgement	Catch Limit, Fishing Rate, or Stock Status	No (1/3)	1	1	8	2	4
Yield-Per-Recruit	Life History-Based Methods	Fishing Rate	Yes (4/4)	0	0	4	0	1
B-K Life History Model	Life History-Based Methods	Catch Limit or Fishing Rate	Yes (2/2)	0	0	4	0	1
Matrix Models	Life History-Based Methods	Fishing Rate	Yes (2/2)	0	0	4	0	1
Intrinsic Rebound Potential	Life History-Based Methods	Fishing Rate	Yes (2/2)	0	0	4	0	1
Demographic FMSY	Life History-Based Methods	Fishing Rate	Yes (3/3)	0	0	4	0	1
SPRMER	Life History-Based Methods	Catch Limit or Fishing Rate	Yes (2/2)	0	0	3	0	1
Analysis of ratio of density inside and outside marine protected areas (MPAs), or established no-take zones/reserves	MPA or No-Take Zone/Reserve	Stock Status	No (0/1)	0	0	3	1	3
Analysis of length/size-specific catch-rate indicators for fish sampled inside and outside of marine protected areas (MPAs) or established no-take zones/reserves, and per-recruit	MPA or No-Take Zone/Reserve	Fishing Rate	No (4/5)	0	1	6	1	3
CUSUM Control Charts	Multiple Indicators	Catch Limit	Yes (1/1)	1	1	7	2	2
Traffic lights	Multiple Indicators	Catch Limit or Fishing Rate	Yes (1/1)	1	1	7	2	2
Hierarchical decision trees	Multiple Indicators	Catch Limit or Fishing Rate	Yes (1/1)	1	1	7	2	2

Option	Assessment Category	Assessment Output	Meets Criteria	Red Caveats	Orange Caveats	Yellow Caveats	Positive Attributes	Static Caveats
Sequential trigger framework (single or multi-indicator)	Multiple Indicators	Catch Limit, Fishing Rate, or Stock Status	Yes (1/1)	1	1	8	2	2
Production model	Population Dynamics Model	Catch Limit, Stock Scale, Stock Status	No (1/3)	1	1	4	0	7
Age Structured Integrated Models (ASIM)	Population Dynamics Model	Catch Limit, Fishing Rate, Stock Scale, Stock Status	No (8/10)	1	3	6	0	5
qR Method	Population Dynamics Model	Catch Limit	No (4/5)	1	3	5	0	5
Extended Simple Stock Synthesis (XSSS)	Population Dynamics Model	Catch Limit, Fishing Rate, Stock Scale, Stock Status	No (8/10)	1	2	5	0	2
Extended Depletion-Based Stock Reduction Analysis (XDB-SRA)	Population Dynamics Model	Catch Limit, Fishing Rate, Stock Scale, Stock Status	No (3/5)	1	2	4	0	2
Comprehensive assessment of risk to ecosystems (CARE)	Risk Analysis/Vulnerability	Stock Status	Yes (0/0)	1	0	0	1	1
Ecosystem threshold analysis	Risk Analysis/Vulnerability	Stock Status	No (0/2)	1	0	0	1	0
Productivity and Susceptibility Analysis (PSA) to estimate risk of overfishing	Risk Analysis/Vulnerability	Stock Status	Yes (0/0)	1	0	1	1	1
RAPFISH (Multi-dimensional scaling)	Risk Analysis/Vulnerability	Stock Status	No (3/4)	1	2	7	1	2
Sustainability Assessment for Fishing Effects (SAFE)	Risk Analysis/Vulnerability	Fishing Rate	Yes (3/3)	1	1	6	1	2

Option	Assessment Category	Assessment Output	Meets Criteria	Red Caveats	Orange Caveats	Yellow Caveats	Positive Attributes	Static Caveats
Analysis of sustainability indicators based on length-based reference points (LBRP)	Size/Age-Based	Stock Status	Yes (3/3)	1	2	4	1	3
Analysis of size relative to size at maturity	Size/Age-Based	Fishing Rate	Yes (2/2)	1	1	5	1	3
Catch curve analysis	Size/Age-Based	Fishing Rate	Yes (3/3)	1	2	7	0	5
Length-based Spawning Potential Ratio (LB-SPR)	Size/Age-Based	Stock Status	Yes (4/4)	1	3	5	0	10
Mean length mortality estimators	Size/Age-Based	Fishing Rate	Yes (3/3)	1	2	6	0	3
Length-Only Integrated Model	Size/Age-Based	Stock Status	Yes (5/5)	1	2	7	0	4
Length-based Bayesian Biomass Estimation (LBB)	Size/Age-Based	Stock Status	Yes (4/4)	1	2	7	0	4
Catch Curve Stock-Reduction Analysis (CC-SRA)	Size/Age-Based	Stock Status	No (5/6)	1	2	7	0	1
Catch and Length Integrated Model	Size/Age-Based	Stock Status	No (8/9)	1	2	8	0	4

Single-indicator analysis using standardized CPUE

Assessment Category: Abundance Indicators

Section: Assessment

Assessment Output: Catch Limit, Fishing Rate, or Stock Status

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (0 of 1 met)

Description

Using catch and fishing effort data over multiple years, catch-per-unit-effort (CPUE) data is typically standardized across multiple fleets, gear types, or changes in the fishery to derive a single proxy index of relative abundance. It requires information of confounding variables that may decouple the relationship between CPUE and abundance. These can include vessel type, the size or power of the different gear types, spatial or temporal and effects on fish availability, and environmental or oceanographic variables that affect availability.

Standardization methods can range from simple comparison techniques to advanced generalized linear mixed models (GLMMs) with non-normal distributions. As with all CPUE time series, variable targeting of species in geographic space or time reduces the relationship between the CPUE index and the actual abundance of the species in the water.

Standardized CPUE may be used as a single indicator or incorporated into multi-indicator frameworks like decision trees, or used as an input in more quantitative assessments.

Using standardized CPUE to augment quantitative assessments is also useful where uncertainty in more formal assessments is high, and/or where local changes (and hence management measures) may be important.

Another possibility is to perform linear regression on a time series of CPUE data. This yields an empirical indicator that provides an indirect estimate of stock status. Generally, CPUE is considered to be directly correlated with underlying abundance, particularly if statistically standardized for confounding variables. The slope of regressions fitted to CPUE time series can be used to infer the rate of change of the relative status of the stock.

The following link may serve as a useful resource for this assessment option: [http://www.datalimitedtoolkit.org/] (http://www.datalimitedtoolkit.org/)

Contacts

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Linear Regression of CPUE:
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Applications
Bigelow, K. A., Hampton, J. & Miyabe, N. (2002). Application of a habitat-based model to estimate effective longline fishing effort and relative abundance of Pacific bigeye tuna (Thunnus obesus). Fisheries Oceanography, 11, 143-155. doi:10.1046/j.1365-2419.2002.00196.x
Mateo, I., & Hanselman, D. H. (2014). A comparison of statistical methods to standardize catch-per-unit-effort of the Alaska longline sablefish. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-269, 71 p. [http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-269.pdf] (http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-269.pdf)
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Maunder, M. N., Piner, K. R., & Aires-da-Silva, A. (2014). Stock status of Pacific Bluefin tuna and the urgent need for management action. IATTC SAC-05-10a.
O'Neill, M. F., Campbell, A. B., Brown, I. W., & Johnstone, R. (2010). Using catch rate data for simple cost-effective quota setting in the Australian spanner crab (Ranina ranina) fishery. ICES Journal of Marine Science, 67, 1538-1552. [http://dx.doi.org/10.1093/icesjms/fsq095] (http://dx.doi.org/10.1093/icesjms/fsq095)
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User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (0 of 1 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	Multi A Failed	What time series of opportunistic (e.g., fishery-dependent) abundance indices exists?	0: Absent, or 1 year of relative abundance index, or effort not meaningful (if using CPUE).	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the index can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.
Failed	Multi A Failed	What time series of scientifically designed (e.g., fishery-independent) surveys of abundance exists?	0: Absent or 1 year of relative abundance index	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the survey can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	Yes	If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage

Orange Caveats

Question	Answer	Caveat

Is the species being actively and consistently targeted?	No	The use of CPUE to infer stock status assumes that fishing activity is excluded from the analysis that 1) is not fishing prime habitat, or 2) is using gear or fishing practices that are sub-optimal for the species of interest. Data sets need to be filtered to remove non-representative fishing activity. If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Be aware of the potential for hyperstability due to the potential for higher catches or catch rates when aggregations are encountered or inadvertently targeted, and as such, for abundance to be artificially over-estimated. Consider augmenting with indicators that inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Understanding selectivity when interpreting CPUE is advantageous - it allows a better understanding of what component of the population is being measured. Even if selectivity may be inferred, you need to be mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Need selectivity to be constant over time: if selectivity changes, CPUE data will not be commensurate over time. If selectivity is unknown, you need to be more mindful of your uncertainty.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.

Is fishing effort data available by location?	No	This method may be more informative if spatially specific effort data are available
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	Temporal changes in the fishery could compromise the interpretation of fishery-dependent time series data, if time series are being interpreted.
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

Question	Answer	Positive Attribute
Is it possible to define a meaningful reference point for an indicator and if so, with what level of uncertainty? Select the answer that best applies.	Yes-- a reference point can be established, but with high uncertainty	The value of this method is optimised if meaningful reference points can be defined.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
Additional information regarding application of assessment: Fisher targeting confounds interpretation of CPUE trend as proxy for abundance.

Links readily to/lends itself for use with the decision rules: "Catch Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point" and "Effort Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point"

Use of biomass surveys to inform spatial management

Assessment Category: Abundance Indicators

Section: Assessment

Assessment Output: Catch Limit, Stock Scale, Stock Status

Assessment 'Tier': Extremely Data-Poor

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (0 of 1 met)

Description

Direct estimates of local biomass from visual or capture-based surveys can inform fishing closures, rotational harvesting, threshold-based reference points for fishing pressure, and other management actions.

Contacts

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References

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Dowling, N. A., Smith, D. C., Knuckey, I., Smith, A. D. M., Domaschenz, P., Patterson, H. M., & Whitelaw, W. (2008). Developing harvest strategies for low value and data-poor fisheries: case studies from three Australian fisheries. Fisheries Research, 94, 380-390. [http://dx.doi.org/10.1016/j.fishres.2008.09.033] (http://dx.doi.org/10.1016/j.fishres.2008.09.033)

Applications
In the Bass Strait Central Zone Scallop fishery, spatial density is assessed via independent surveys, and fishing is not permitted in an area unless biomass (and other) criteria are met (Dowling et al., 2008).
Karr, K. A., Fujita, R., Halpern, B. S., Kappel, C. V., Crowder, L., Selkoe, K. A., ... & Rader, D. (2015). Thresholds in Caribbean coral reefs: implications for ecosystem-based fishery management. Journal of Applied Ecology, 52(2), 402-412.
Mayfield, S., McGarvey, R., Carlson, I. J., & Dixon, C. (2008). Integrating commercial and research surveys to estimate the harvestable biomass, and establish a quota, for an "unexploited" abalone population. ICES Journal of Marine Science, 65, 1122-1130. [https://doi.org/10.1093/icesjms/fsn105] (https://doi.org/10.1093/icesjms/fsn105)
Plaganyi, E. E., Skewes, T. D., Dowling, N. A., & Haddon, M. (2013). Risk management tools for sustainable fisheries management under changing climate: a sea cucumber example. Climatic Change, 119(1), 181-197. doi:10.1007/s10584-012-0596-0
Reuchlin-Hugenholtz, E., Shackell, N. L., & Hutchings, J. A. (2016). Spatial reference points for groundfish. ICES Journal of Marine Science, 73(10), 2468-2478. [https://doi.org/10.1093/icesjms/fsw123] (https://doi.org/10.1093/icesjms/fsw123) . In this application, authors suggest using threshold-based reference points in high-density areas. If high-density areas are allowed to be depleted past 70-80%, spawning stock biomass declines substantially

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (0 of 1 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	Multi A Failed	What time series of opportunistic (e.g., fishery-dependent) abundance indices exists?	0: Absent, or 1 year of relative abundance index, or effort not meaningful (if using CPUE).	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the index can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.
Failed	Multi A Failed	What time series of scientifically designed (e.g., fishery-independent) surveys of abundance exists?	0: Absent or 1 year of relative abundance index	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the survey can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.

Caveats and Attributes

Red Caveats

There are no red caveats.

Orange Caveats

Question	Answer	Caveat

Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	In designing surveys, be aware of the potential for hyperstability due to the potential for higher catches or catch rates when aggregations are encountered or inadvertently targeted, and as such, for abundance to be artificially over-estimated. Consider survey design carefully, and consider augmenting with indicators that inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	As a minimum you need to know the gear being used for the survey is effectively selecting for your species of interest.
Has the selectivity pattern changed over time?	Unknown	Beware if fishers are undertaking the surveys under alternate selectivity

Positive Attributes

Question	Answer	Positive Attribute
Is it possible to define a meaningful reference point for an indicator and if so, with what level of uncertainty? Select the answer that best applies.	Yes-- a reference point can be established, but with high uncertainty	The value of this method is optimised if meaningful reference points can be defined.

Static Caveats

These caveats always apply to this option.

Static Caveat
The assessment has the ability to quantify output uncertainty.
Links readily to/lends itself for use with the decision rules: " Spatial Closure: Closures invoked in response to some perceived stock status (feedback-driven): rotational/in response to trigger being reached/stock status indicating overfished" and " Temporal Restriction: Closure in response to trigger being reached/stock status indicating overfished (feedback-driven)"

Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).

Ecosystem Based Biomass Targets

Assessment Category: Abundance Indicators

Section: Assessment

Assessment Output: Catch Limit

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (0 of 2 met)

Description

Ecosystem based biomass targets was developed explicitly in response to the range of difficulties that often face multispecies coral reef fisheries management. In its simplest form (McClanahan et al 2015), this method shows how coral reef fisheries could use total biomass as a reference point for management decisions. McClanahan (2018) expands on this idea to further incorporate recovery rates, changes in yields, and ecological changes to estimate sustainable yields.

Contacts

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References

McClanahan TR. Multicriteria estimate of coral reef fishery sustainability. Fish Fish. 2018;19:807-820. (2018) https://doi.org/10.1111/faf.12293;
McClanahan, T. R., et al. "Biomass-based targets and the management of multispecies coral reef fisheries." Conservation Biology 29.2 (2015): 409-417.;
McClanahan, Tim R., et al. "Critical thresholds and tangible targets for ecosystem-based management of coral reef fisheries." Proceedings of the National Academy of Sciences 108.41 (2011): 17230-17233.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (0 of 2 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	Multi A Failed	What time series of opportunistic (e.g., fishery-dependent) abundance indices exists?	0: Absent, or 1 year of relative abundance index, or effort not meaningful (if using CPUE).	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: time series missing major moments of removals or with no contrast (e.g., flat series), significant gaps in spatial/habitat sampling of the population, species identification issues, non-ideal fleet/gear for tracking population abundance of a particular species of interest, changing gear selectivity, or other sampling issues.
Failed	Multi A Failed	What time series of scientifically designed (e.g., fishery-independent) surveys of abundance exists?	0: Absent or 1 year of relative abundance index	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: time series missing major moments of removals or with no contrast (e.g., flat series), significant gaps in spatial sampling of the population, species identification issues, non-ideal gear for the particular species of interest, opportunistic application of a survey to species outside the initial design, or other sampling issues. that may make samples biased.
Failed	Single Criteria	Is this a coral reef fishery?	No	Yes

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	Yes	If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage

Orange Caveats

There are no orange caveats.

Yellow Caveats

Question	Answer	Caveat

Rank the level of understanding regarding the broader ecosystem threats affecting the fishery.	0: Absent	Knowledge of broader ecosystem threats is strongly desirable for this assessment

Positive Attributes

Question	Answer	Positive Attribute
Is the fishery multispecies, either in terms of target or bycatch species?	Yes	This method is specifically designed to aid management of species measured in groups, not as single-species

Static Caveats

These caveats always apply to this option.

There are no static caveats.

Depletion analysis

Assessment Category: Catch Only

Section: Assessment

Assessment Output: Stock Scale, Stock Status, Fishing Rate

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (1 of 2 met)

Description

Depletion analyses are typically applied to species with rapid growth rates, short life-spans,
little generation overlap and weak or no stock-recruitment relationships (they have been commonly applied to cephalopods). The approach assumes high reproductive compensation and a closed population (i.e. negligible recruitment, and immigration/emigration). While many applications also assume no within-season natural mortality, you can incorporate time varying natural mortality (e.g. Babcock et al. 2015).
Depletion analyses are conducted by plotting the in-season catch-per-unit-effort (CPUE) versus cumulative catch (i.e. total catch of the season thus far). Assuming linearity, the method extrapolates via linear regression to determine the projected 1) total catch and 2) length of the season. The slope of the regression approximates the catchability. The response would be to limit the season or limit the total catch. Violation of the linearity assumption (e.g. the pattern is one of exponential decline) may be overcome using exponential, logarithmic, or arc-sine transformations. However, if the stock moves from the fishing area during the season, a "broken-stick" pattern may occur and this is more difficult to overcome. Depletion analyses may be useful for within-season management and suits a short-lived, highly productive life history.
The following link may serve as a useful resource for this assessment option: https://cran.r-project.org/web/packages/fishmethods/index.html

Contacts

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Applications
Babcock, E. A., W. J. Harford, R. Coleman, J. Gibson, J. Maaz, J. R. Foley, and M. Gongora. 2015. Bayesian depletion model estimates of spiny lobster abundance at two marine protected areas in Belize with or without in-season recruitment. ICES Journal of Marine Science 72:232-243. [https://doi.org/10.1093/icesjms/fsu226]

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Keller, S., Robin, J. P., Valls, M., Gras, M., Cabanellas-Reboredo, M., & Quetglas, A. (2015). The use of Depletion Methods to assess Mediterranean cephalopod stocks under the current EU Data Collection Framework. Mediterranean Marine Science, 16(3), 513-523. [http://dx.doi.org/10.12681/mms.1127] (http://dx.doi.org/10.12681/mms.1127)
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User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (1 of 2 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	Multi A Failed	What time series of opportunistic (e.g., fishery-dependent) abundance indices exists?	0: Absent, or 1 year of relative abundance index, or effort not meaningful (if using CPUE).	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the index can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.
Failed	Multi A Failed	What time series of scientifically designed (e.g., fishery-independent) surveys of abundance exists?	0: Absent or 1 year of relative abundance index	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the survey can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.

Met	Single Criteria	What time series of total removal data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	This method cannot account for temporal changes in the fishery that compromise the interpretation of fishery-dependent time series data.
Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Be aware of the potential for hyperstability due to the potential for higher catches or catch rates when aggregations are encountered or inadvertently targeted, and as such, for abundance to be artificially over-estimated. Consider augmenting with indicators that inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Trends in size-based indicators may be compromised by changing selectivity. Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Rank the level of research and institutional capacity to implement a formal harvest/management strategy (i.e., data collection, assessment, management measures).	High	High research capacity required due to intensive within season updating.
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

Question	Answer	Positive Attribute
Is it possible to define a meaningful reference point for an indicator and if so, with what level of uncertainty? Select the answer that best applies.	Yes-- a reference point can be established, but with high uncertainty	The value of this method is optimised if meaningful reference points can be defined.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
Most useful for within-season management. Suits short-lived, highly productive life history.
The assessment has the ability to quantify output uncertainty.
Links readily to/lends itself for use with the decision rules: "Catch Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point", "Effort Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point", and "Temporal Restriction: Adjust season duration".
Assumptions: high steepness, a closed population (i.e. negligible recruitment, and immigration/emigration), and no within-season natural mortality.

Boosted Regression Tree (BRT) model for stock depletion using catch data

Assessment Category: Catch Only | Section: Assessment

Assessment Output: Catch Limit

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (2 of 3 met)

Description

This assessment option uses a Boosted Regression Tree (BRT) approach to infer stock depletion status based only on a time series of catch data. The method uses 8 predictors of depletion status based on linear regressions of scaled catch (i.e., the catch in a given year divided by the maximum historical catch). Although this assessment method only performs well for heavily fished stocks (a problem faced in any catch-only method), results can be used to provide depletion priors for other data-limited assessments or to directly estimate the probability that depletion is below a threshold.
The following link may serve as a useful resource for this assessment option: [https://github.com/cfree14/datalimited2] (https://github.com/cfree14/datalimited2)

Contacts

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References

References
Zhou S., Punt, A. E., Ye, Y., et al. (2017) Estimating stock depletion level from patterns of catch history. Fish and Fisheries, 18(4), 742-751. doi: 10.1111/faf.12201

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (2 of 3 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria

Failed	**Single Criteria**	**What time series of total removal data exists?**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.**	**3: Moderate to low bias, but high imprecision in time series. Moderate flaws that don't significantly bias time series data representativeness, but do create significant imprecision. Examples: "partial" time series that reflect only most major years of removals and major fleets/metiers; sampling that covers most of the temporal-spatial extent of the fishery, and is generally reported at species level (low bias), but sample sizes may be low (high imprecision).**
Met	Single Criteria	Rank the level of understanding of relative stock status.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.
Met	Multi A Met	Do you have the life history ratio (M/k) for the species? Select the answer that best describes the source and uncertainty.	3: Yes, individually estimated M and k, with low to moderate uncertainty (e.g., good sample size, up to date, covers the spatial range of the species)	1: Yes, M/k taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Multi A Met	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Multi A Met	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Be aware of the potential for hyperstability due to the potential for higher catches or catch rates when aggregations are encountered or inadvertently targeted, and as such, for abundance to be artificially over-estimated. Consider augmenting with indicators that inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Yellow Caveats

Question	Answer	Caveat
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific

Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
Assumes B0 (i.e., the initial condition of the stock) is constant.
Links readily to/lends itself for use with the decision rules: "Catch Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point" and "Effort Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point"
If catch controls are used, or are to be used as a management measure, these compromise the use of catch time series as an informative assessment input.

Only Reliable Catch Stocks (ORCS)

Assessment Category: Catch Only | Section: Assessment

Assessment Output: Catch Limit

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (2 of 2 met)

Description

The original ORCS working group method was an evidence-based scoring procedure for determining a fishery's overfishing limit (OFL) and an acceptable biological catch (ABC) using only landings data (Berkson et al., 2011). Stocks were assigned as "lightly," "moderately," or "heavily" exploited based on attribute scores derived from expert judgement. To set the OFL, the exploitation level was used alongside a "catch statistic" (typically an average landings value, ideally taken from a historically stable period of landings). The ABC was then calculated based on the OFL, the stock productivity, and the level of risk acceptable to stakeholders, managers, and scientists. However, in 2017, Free et al. showed that the original ORCS method needed revision, and it is no longer recommended for determining stock status. Free et al. (2017) refined the ORCS scoring attributes using Boosted Classification Trees (BCTs) to weight attributes by their relative importance). This refined ORCS approach substantially outperformed the original ORCS method. It is recommended for use (with conservative catch scalars to prevent overexploitation) instead of the original working group approach.
The following links may serve as useful resources for this assessment option: [https://marine.rutgers.edu/~cfree/refined-orcs-approach/] (https://marine.rutgers.edu/~cfree/refined-orcs-approach/)
[https://github.com/cfree14/datalimited2] (https://github.com/cfree14/datalimited2)

Contacts

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References

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Free, C. M., Jensen, O. P., Weidenmann, J. & Deroba, J. J. (2017). The refined ORCS approach: a catch-based method for estimating stock status and catch limits for data-poor fish stocks. Fisheries Research, 193, 60-70. [http://dx.doi.org/10.1016/j.fishres.2017.03.017] (http://dx.doi.org/10.1016/j.fishres.2017.03.017)

Applications

Wiedenmann, J., Wilberg, M. J., & Miller, T. J. (2013). An evaluation of harvest control rules for data-poor fisheries. North American Journal of Fisheries Management, 33(4), 845-860. [http://dx.doi.org/10.1080/02755947.2013.811128] (http://dx.doi.org/10.1080/02755947.2013.811128)

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (2 of 2 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Single Criteria	What time series of total removal data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.
Met	Single Criteria	Rank the level of understanding of relative stock status.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Be aware of the potential for hyperstability due to the potential for higher catches or catch rates when aggregations are encountered or inadvertently targeted, and as such, for abundance to be artificially over-estimated. Consider augmenting with indicators that inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Yellow Caveats

Question	Answer	Caveat
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).

Additional assessment requirement: Requires mean or median catches

The assessment has the ability to quantify output uncertainty.

Links readily to/lends itself for use with the decision rules: "Catch Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point" and "Effort Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point"

If catch controls are used, or are to be used as a management measure, these compromise the use of catch time series as an informative assessment input.

Depletion-Corrected Average Catch (DCAC)

Assessment Category: Catch Only

Section: Assessment

Assessment Output: Catch Limit

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (4 of 4 met)

Description

Depletion-Corrected Average Catch (DCAC) estimates sustainable yield for long-lived targeted species based on average catches from an extended time series of catch data that embrace a "windfall" period. A windfall harvest is defined as a harvest corresponding to the maximum sustainable yield. The "correction" to windfall depletion comes from recognizing that catch levels during the period in which a stock is moving toward Bmsy levels reflect the sum of two values: "sustainable yield" and "one-time windfall yield." Using DCAC, sustainable yield is mathematically estimated from the windfall harvest, as well as from expert judgment regarding current levels of depletion and natural mortality. DCAC is not recommended for severely depleted stocks or for fisheries targeting species with high natural-mortality rates (M > 0.2), though this latter suggestion may not always hold. Using DCAC should lead to more sustainable management practices than management decisions based solely on average catch.
The following link may serve as a useful resource for this assessment option: [http://www.datalimitedtoolkit.org/] (http://www.datalimitedtoolkit.org/)

Contacts

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References

References
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Applications
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Wiedenmann, J., Wilberg, M. J., & Miller, T. J. (2013). An evaluation of harvest control rules for data-poor fisheries. North American Journal of Fisheries Management, 33(4), 845-860. [http://dx.doi.org/10.1080/02755947.2013.811128] (http://dx.doi.org/10.1080/02755947.2013.811128)

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (4 of 4 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	What time series of total removal data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.
Met	Single Criteria	Rank the level of understanding of relative stock status.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.

Met	Single Criteria	Do you have an estimate of FMSY/M (the ratio of the annual exploitation rate that produces MSY at equilibrium, to natural mortality)? Select the answer that best describes the source and uncertainty.	3: Species-specific derived value with low to moderate uncertainty	1: Expert opinion, value taken from a nearest-neighbor taxonomic relationship, or selectivity does not equal maturity

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	This method cannot account for temporal changes in the fishery that compromise the interpretation of fishery-dependent time series data.
Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Be aware of the potential for hyperstability due to the potential for higher catches or catch rates when aggregations are encountered or inadvertently targeted, and as such, for abundance to be artificially over-estimated. Consider augmenting with indicators that inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).

The assessment has the ability to quantify output uncertainty.

Assumes B0 (i.e., the initial condition of the stock) is constant.

Links readily to/lends itself for use with the decision rules: "Catch Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point" and "Effort Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point"

If catch controls are used, or are to be used as a management measure, these compromise the use of catch time series as an informative assessment input.

Assumes no recruitment variability.

Depletion-Based Stock Reduction Analysis (DB-SRA)

Assessment Category: Catch Only

Section: Assessment

Assessment Output: Catch Limit

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (4 of 5 met)

Description

A combination of stochastic Stock Reduction Analysis and Depletion-Corrected Average Catch, Depletion-Based Stock Reduction Analysis (DB-SRA) uses an extended time series of catch, the species' approximate natural mortality rate, and the age at maturity to help estimate sustainable yields and management reference points. Probability distributions are provided for key management reference points dealing with yield and biomass; uncertainty is accounted for through Monte Carlo simulation.
The following links may serve as useful resources for this assessment option: [http://www.datalimitedtoolkit.org/] (http://www.datalimitedtoolkit.org/)
[https://cran.r-project.org/web/packages/fishmethods/index.html] (https://cran.r-project.org/web/packages/fishmethods/index.html)

Contacts

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Applications
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Wetzel, C. R., & Punt, A. E. (2011). Model performance for the determination of appropriate harvest levels in the case of data-poor stocks. Fisheries Research, 110(2), 342-355.
Wiedenmann, J., Wilberg, M. J., & Miller, T. J. (2013). An evaluation of harvest control rules for data-poor fisheries. North American Journal of Fisheries Management, 33(4), 845-860. [http://dx.doi.org/10.1080/02755947.2013.811128] (http://dx.doi.org/10.1080/02755947.2013.811128)

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (4 of 5 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	**Single Criteria**	**What time series of total removal data exists?**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.**	**3: Moderate to low bias, but high imprecision in time series. Moderate flaws that don't significantly bias time series data representativeness, but do create significant imprecision. Examples: "partial" time series that reflect only most major years of removals and major fleets/metiers; sampling that covers most of the temporal-spatial extent of the fishery, and is generally reported at species level (low bias), but sample sizes may be low (high imprecision).**
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available
Met	Single Criteria	Rank the level of understanding of relative stock status.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.

Met	Single Criteria	Do you have an estimate of FMSY/M (the ratio of the annual exploitation rate that produces MSY at equilibrium, to natural mortality)? Select the answer that best describes the source and uncertainty.	3: Species-specific derived value with low to moderate uncertainty	1: Expert opinion, value taken from a nearest-neighbor taxonomic relationship, or selectivity does not equal maturity

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	This method cannot account for temporal changes in the fishery that compromise the interpretation of fishery-dependent time series data.

Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Be aware of the potential for hyperstability due to the potential for higher catches or catch rates when aggregations are encountered or inadvertently targeted, and as such, for abundance to be artificially over-estimated. Consider augmenting with indicators that inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Beware changes in selectivity. Method assumes time-independent selectivity.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific

Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
The assessment has the ability to quantify output uncertainty.
Assumes B0 (i.e., the initial condition of the stock) is constant.
Links readily to/lends itself for use with the decision rules: "Catch Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point" and "Effort Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point"
Infers selectivity from age-at-maturity. Note that there is no flexibility in the method to accommodate alternate selectivities.
Assumes no recruitment variability.

Simple Stock Synthesis (SSS)

Assessment Category: Catch Only

Section: Assessment

Assessment Output: Catch Limit

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (7 of 8 met)

Description

Simple Stock Synthesis (SSS) is an assessment method that requires a time series of catch, life history parameters, and prior distributions for natural mortality rate (M), recruitment compensation (h), and current depletion, all of which are determined externally to stock synthesis (SS). It can also be run with the same inputs as DB-SRA. It has additional flexibility in the year to which the current depletion can be specified. SSS is capable of estimating overfishing limits (OFLs), as well as a posterior distribution of uncertainty surrounding OFL estimates. (Uncertainty surrounding OFL estimates comes from uncertainty in prior distributions derived from expert judgment.) While it can be argued that Stock Synthesis (Methot and Wetzel 2013) is too detailed and complex for appropriate use in data-limited situations, Cope (2013) showed that SS can be modified to behave as a catch-only approach (similar to DB-SRA), while also becoming a first step towards building a fully implemented quantitative stock assessment.
The following link may serve as a useful resource for this assessment option: [https://github.com/shcaba/SSS] (https://github.com/shcaba/SSS)

Contacts

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User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (7 of 8 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	**Single Criteria**	**What time series of total removal data exists?**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.**	**3: Moderate to low bias, but high imprecision in time series. Moderate flaws that don't significantly bias time series data representativeness, but do create significant imprecision. Examples: "partial" time series that reflect only most major years of removals and major fleets/metiers; sampling that covers most of the temporal-spatial extent of the fishery, and is generally reported at species level (low bias), but sample sizes may be low (high imprecision).**
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available

Met	Single Criteria	Do you have a length-fecundity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Use model default	1: Use model default
Met	Single Criteria	Do you have an estimate of recruitment compensation (i.e., termed "steepness" in some stock-recruit relationships) for the species? Select the answer that best describes the source and uncertainty.	3: Yes, species-specific value with low to moderate uncertainty	1: Yes, expert opinion or non-species-specific value
Met	Single Criteria	Do you have a length-weight relationship for the species? Select the answer that best describes the source and uncertainty.	3: Yes, species-specific value with low to moderate uncertainty	1: Yes, expert opinion or non-species-specific value
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or based only on length samples (e.g., ELEFAN)
Met	Single Criteria	Rank the level of understanding of relative stock status.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	This method can account for temporal changes in the fishery that compromise the interpretation of fishery-dependent time series data, but the default is to assume no changes.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note this method CAN handle multiple fleets/selectivities. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output. This method does have the flexibility to allow you to model changes in selectivity.

Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
The assessment has the ability to quantify output uncertainty.
Assumes B0 (i.e., the initial condition of the stock) is constant.
If steepness is not available, FMSY/M and BMSY/BO could be used together instead.
Assumes no recruitment variability.

Stochastic Stock Reduction Analysis (SRA)

Assessment Category: Catch Only

Section: Assessment

Assessment Output: Catch Limit

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (3 of 4 met)

Description

Stochastic Stock Reduction Analysis (SRA) is a stochastic age-structured population model that uses the Beverton-Holt stock-recruitment function to estimate stock status forward in time (Walters et al., 2006). This assessment method uses maximum sustainable yield (MSY) and Umsy (the annual exploitation rate producing MSY at equilibrium) as leading parameters. Given these parameters, the model simulates changes in biomass by subtracting estimates of mortality and adding recruits. A single trajectory of biomass over time is produced, as well as estimates of MSY, Umsy, exploitation in the terminal year, and stock status. Stochastic SRA is a less data-intensive method that helps estimate stock size based on how large the stock needed to have been in order to have produced the time series of observed landings. It requires a time series of observed catch, a range of values for MSY and Umsy, life history information, estimates of initial starting biomass, and exploitation. It outputs an estimate of MSY, Umsy, and biomass. Unlike deterministic SRA, which provides just one stock size trajectory, stochastic SRA can produce probable stock sizes over time under varying assumptions regarding recruitment and the stock-recruitment relationship (Walters et al., 2006).
Note that there are other assessment methods that use the concept of stock reduction analysis, including depletion-based stock reduction analysis (DB-SRA) and catch-curve stock reduction analysis (CC-SRA). Be aware that the parameterisations of these forms of stock reduction analysis are different from that described here.
The following links may serve as a useful resource for this assessment option:
[http://www.datalimitedtoolkit.org/] (http://www.datalimitedtoolkit.org/)
[https://cran.r-project.org/web/packages/DLMtool/DLMtool.pdf] (https://cran.r-project.org/web/packages/DLMtool/DLMtool.pdf)

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References

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Walters, C.J., Martell, S. J. D., & Korman, J. (2006). A stochastic approach to stock reduction analysis. Canadian Journal of Fisheries and Aquatic Sciences, 63, 212-223.

Applications
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Grubert, M. A., Saunders, T.(Thor), Martin, J. M., Lee, H. S., & Walters, C. J. (2013). Stock assessments of selected Northern Territory fishes. Northern Territory. Department of Primary Industry and Fisheries, Northern Territory.
Munyandorero, J. Application of Stock Reduction Analysis to goliath grouper (Epinephelus itajara) off southeastern USA. http://sedarweb.org/docs/wpapers/S23_RW_01_SRA.pdf
Thorson, J. T., & Cope, J. M. (2015). Catch curve stock-reduction analysis: an alternative solution to the catch equations. Fisheries Research, 171, 33-41. https://doi.org/10.1016/j.fishres.2014.03.024
Whitlock, R. E., & McAllister, M. K. (2012). Incorporating spatial and seasonal dimensions in a stock reduction analysis for lower Fraser River white sturgeon (Acipenser transmontanus). Canadian Journal of Fisheries and Aquatic Sciences, 69(10), 1674-1697. doi:10.1139/F2012-079

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (3 of 4 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	**Single Criteria**	**What time series of total removal data exists?**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.**	**3: Moderate to low bias, but high imprecision in time series. Moderate flaws that don't significantly bias time series data representativeness, but do create significant imprecision. Examples: "partial" time series that reflect only most major years of removals and major fleets/metiers; sampling that covers most of the temporal-spatial extent of the fishery, and is generally reported at species level (low bias), but sample sizes may be low (high imprecision).**
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived

Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or based only on length samples (e.g., ELEFAN)

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.

Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	This method cannot account for temporal changes in the fishery that compromise the interpretation of fishery-dependent time series data.
Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Be aware of the potential for hyperstability due to the potential for higher catches or catch rates when aggregations are encountered or inadvertently targeted, and as such, for abundance to be artificially over-estimated. Consider augmenting with indicators that inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output. Method assumes time-independent selectivity.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.

Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
The assessment has the ability to quantify output uncertainty.
Assumes B0 (i.e., the initial condition of the stock) is constant.
This approach can't account for regime shifts, major management interventions, or changes in price, gear, or economics.
Besides the listed criteria, this assessment also requires an input of the annual exploitation rate that produces MSY at equilibrium (Umsy or Fmsy). In practice, this parameter is often input using a wide prior, then it is refined from there.

Catch-MSY/CMSY

Assessment Category: Catch Only

Section: Assessment

Assessment Output: Catch Limit

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (2 of 3 met)

Description

The Catch-MSY and the updated version CMSY (Froese et al. 2017) are Monte-Carlo based methods that estimates maximum sustainable yield (MSY) from a time series of catch data, resilience of the species being assessed, and expert judgment regarding stock size during the first and terminal year of the time series. Upon completion of the assessment, model outputs are provided for MSY, Fmsy, Bmsy, relative stock size (B/Bmsy, which is directly related to the model input for stock status), and exploitation (F/Fmsy). The method partially relies on an Schaefer production model and requires priors on depletion and resilience, so the lower margin of error in terms of MSY estimates should be used in accordance with precautionary management practices.
The following links may serve as useful resources for this assessment option: [http://www.datalimitedtoolkit.org/] (http://www.datalimitedtoolkit.org/)
[https://github.com/datalimited/datalimited] (https://github.com/datalimited/datalimited)
[https://cran.r-project.org/web/packages/fishmethods/index.html] (https://cran.r-project.org/web/packages/fishmethods/index.html)

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References

References
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Applications
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Harford, W. J., & Carruthers, T. R. (2017). Interim and long-term performance of static and adaptive management procedures. Fisheries Research, 190, 84-94. [https://doi.org/10.1016/j.fishres.2017.02.003] (https://doi.org/10.1016/j.fishres.2017.02.003)

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Rodriguez-Dominguez, G., Castillo-Vargasmachuca, S. G., Perez-Gonzalez, R., & Aragon-Noriega, E. A. (2014). Catch-Maximum Sustainable Yield Method Applied to the Crab Fishery (Callinectes spp.) in the Gulf of California. Journal of Shellfish Research, 33(1), 45-51. https://doi-org.proxy.library.ucsb.edu:9443/10.2983/035.033.0106
Sabater, M. G., & Kleiber, P. (2013). Improving specification of acceptable biological catches of data-poor reef fish stocks using a biomass-augmented catch-MSY approach. Western Pacific Regional Fishery Management Council, Honolulu, HI 96813 USA.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (2 of 3 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	**Single Criteria**	**What time series of total removal data exists?**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.**	**3: Moderate to low bias, but high imprecision in time series. Moderate flaws that don't significantly bias time series data representativeness, but do create significant imprecision. Examples: "partial" time series that reflect only most major years of removals and major fleets/metiers; sampling that covers most of the temporal-spatial extent of the fishery, and is generally reported at species level (low bias), but sample sizes may be low (high imprecision).**
Met	Single Criteria	Rank the level of understanding of relative stock status.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.

Met	Single Criteria	Do you have a prior estimate or range for r (population intrinsic growth rate) and K (carrying capacity)? Select the answer that best describes the source and uncertainty.	3: Species-specific r values with low to moderate uncertainty. K with high uncertainty or better.	1: Assumed with very large prior ranges. The intrinsic growth rate may also be borrowed for a nearest-neighbor taxonomic method.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	This method cannot account for temporal changes in the fishery that compromise the interpretation of fishery-dependent time series data.

Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Be aware of the potential for hyperstability due to the potential for higher catches or catch rates when aggregations are encountered or inadvertently targeted, and as such, for abundance to be artificially over-estimated. Consider augmenting with indicators that inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
The assessment has the ability to quantify output uncertainty.
Assumes B0 (i.e., the initial condition of the stock) is constant.
Assumes no recruitment variability.

Optimized catch-only method (OCOM)

Assessment Category: Catch Only

Section: Assessment

Assessment Output: Catch Limit

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (2 of 3 met)

Description

The Optimized Catch-Only Method (OCOM) uses time series of catches and two priors-one for the intrinsic population growth rate derived from life history parameters, and another for stock depletion based on catch trends. The estimated parameters include carrying capacity, intrinsic population growth rate, maximum sustainable yield, and depletion.
The following link may serve as a useful resource for this assessment option: [https://github.com/cfree14/datalimited2] (https://github.com/cfree14/datalimited2)

Contacts

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References

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Applications
Dowling, N., et al. (2017). Low cost management regimes for sustainable, small low-value fisheries based on coastal inshore species. FRDC, 2015-215.
Clark, W., Dorn, M., Dunn, M., Fernandez, C., Haddon, M., Klaer, N., & Zhou, S. (2014). Review of biological reference points in domestic fisheries. Report of the third international workshop, held in Vina del Mar by IFOP, August 2014. 63 pp.
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User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (2 of 3 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	**Single Criteria**	**What time series of total removal data exists?**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.**	**3: Moderate to low bias, but high imprecision in time series. Moderate flaws that don't significantly bias time series data representativeness, but do create significant imprecision. Examples: "partial" time series that reflect only most major years of removals and major fleets/metiers; sampling that covers most of the temporal-spatial extent of the fishery, and is generally reported at species level (low bias), but sample sizes may be low (high imprecision).**
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have a prior estimate or range for r (population intrinsic growth rate) and K (carrying capacity)? Select the answer that best describes the source and uncertainty.	3: Species-specific r values with low to moderate uncertainty. K with high uncertainty or better.	1: Assumed with very large prior ranges. The intrinsic growth rate may also be borrowed for a nearest-neighbor taxonomic method.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	This method cannot account for temporal changes in the fishery that compromise the interpretation of fishery-dependent time series data.
Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Be aware of the potential for hyperstability due to the potential for higher catches or catch rates when aggregations are encountered or inadvertently targeted, and as such, for abundance to be artificially over-estimated. Consider augmenting with indicators that inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Yellow Caveats

Question	Answer	Caveat

Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
Assumes B0 (i.e., the initial condition of the stock) is constant.
If catch controls are used, or are to be used as a management measure, these compromise the use of catch time series as an informative assessment input.

Assumes no recruitment variability.

Catch Only Model - Sampling Importance Resampling Model (COM-SIR)

Assessment Category: Catch Only Section: Assessment

Assessment Output: Catch Limit

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (3 of 5 met)

Description

COM-SIR is a catch estimation method (COM) that combines a harvest dynamics model and a biomass dynamics (Schaffer) model in order to estimate maximum sustainable yield (MSY). Catch estimation is made using the Bayesian method of sampling importance resampling (SIR). The model used can be sensitive to changes in harvest dynamics over time, necessitating a different harvest dynamic formulation if this occurs (e.g., due to management). Another approach is to fit the model only to the time series without implemented management measures.
The following link may serve as a useful resource for this assessment option:
[https://github.com/datalimited/datalimited] (https://github.com/datalimited/datalimited)

Contacts

Kristin Kleisner

References

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Applications
Rosenberg, A. A., M. J. Fogarty, A. B. Cooper, M. Dickey-Collas, E. A. Fulton, N. L. Gutierrez, K. J. W. Hyde, K. M. Kleisner, C. Longo, C. V. Minte-Vera, C. Minto, I. Mosqueira, G. C. Osio, D. Ovando, E. R. Selig, J. T. Thorson, and Y. Ye. 2014. Developing new approaches to global stock status assessment and fishery production potential of the seas. FAO Fisheries and Aquaculture Circular, Rome, Italy.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (3 of 5 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	**Single Criteria**	**What time series of total removal data exists?**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.**	**3: Moderate to low bias, but high imprecision in time series. Moderate flaws that don't significantly bias time series data representativeness, but do create significant imprecision. Examples: "partial" time series that reflect only most major years of removals and major fleets/metiers; sampling that covers most of the temporal-spatial extent of the fishery, and is generally reported at species level (low bias), but sample sizes may be low (high imprecision).**
Failed	**Single Criteria**	**What time series of fishing effort data exists?**	**0: Absent, or not meaningful**	**1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.**
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Rank the level of understanding of relative stock status.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.	2: General understanding of relative stock status coming from other data sources. Bias and imprecision will remain an important issue to consider.

Met	Single Criteria	Do you have a prior estimate or range for r (population intrinsic growth rate) and K (carrying capacity)? Select the answer that best describes the source and uncertainty.	3: Species-specific r values with low to moderate uncertainty. K with high uncertainty or better.	1: Assumed with very large prior ranges. The intrinsic growth rate may also be borrowed for a nearest-neighbor taxonomic method.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	This method cannot account for temporal changes in the fishery that compromise the interpretation of fishery-dependent time series data.

Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Be aware of the potential for hyperstability due to the potential for higher catches or catch rates when aggregations are encountered or inadvertently targeted, and as such, for abundance to be artificially over-estimated. Consider augmenting with indicators that inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Is fishing effort data available by location?	No	This method may be more informative if spatially specific effort data are available
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat

The method implies a logistic relationship between biomass and the proportion of the biomass removed by the fishery.

Assumes no recruitment variability.

State-space Catch Only Model (SSCOM)

Assessment Category: Catch Only

Section: Assessment

Assessment Output: Catch Limit

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (3 of 5 met)

Description

SSCOM combines effort dynamics and population dynamics models to estimate maximum sustainable yield (MSY) and stock status based on a series of catches and assumed linear effort dynamics relative to the logarithm of biomass. A state space Bayesian model framework is used to estimate model parameters. Having more clearly defined priors around the life history parameters allows for more accurate estimations. This model performs poorly if the catch series is strictly increasing over time, so it is preferable if the catch time series shows "contrast" by exhibiting peaks and declines. This model also assumes that the catch time series starts approximately from the start of the fishery (unfished biomass).
The following link may serve as a useful resource for this assessment option:
[https://github.com/datalimited/datalimited] (https://github.com/datalimited/datalimited)

Contacts

Jim Thorson (james.thorson@noaa.gov)

References

Thorson, James T, et al. "A New Role for Effort Dynamics in the Theory of Harvested Populations and Data-Poor Stock Assessment." Canadian Journal of Fisheries and Aquatic Sciences Journal Canadien Des Sciences Halieutiques Et Aquatiques., vol. 70, no. 12, 2013, pp. 1829-1844.
Applications
Rosenberg, A. A., M. J. Fogarty, A. B. Cooper, M. Dickey-Collas, E. A. Fulton, N. L. Gutierrez, K. J. W. Hyde, K. M. Kleisner, C. Longo, C. V. Minte-Vera, C. Minto, I. Mosqueira, G. C. Osio, D. Ovando, E. R. Selig, J. T. Thorson, and Y. Ye. 2014. Developing new approaches to global stock status assessment and fishery production potential of the seas. FAO Fisheries and Aquaculture Circular, Rome, Italy.;

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (3 of 5 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	**Single Criteria**	**What time series of total removal data exists?**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.**	**3: Moderate to low bias, but high imprecision in time series. Moderate flaws that don't significantly bias time series data representativeness, but do create significant imprecision. Examples: "partial" time series that reflect only most major years of removals and major fleets/metiers; sampling that covers most of the temporal-spatial extent of the fishery, and is generally reported at species level (low bias), but sample sizes may be low (high imprecision).**
Failed	**Single Criteria**	**What time series of fishing effort data exists?**	**0: Absent, or not meaningful**	**1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.**
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Rank the level of understanding of relative stock status.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.	2: General understanding of relative stock status coming from other data sources. Bias and imprecision will remain an important issue to consider.

Met	Single Criteria	Do you have a prior estimate or range for r (population intrinsic growth rate) and K (carrying capacity)? Select the answer that best describes the source and uncertainty.	3: Species-specific r values with low to moderate uncertainty. K with high uncertainty or better.	1: Assumed with very large prior ranges. The intrinsic growth rate may also be borrowed for a nearest-neighbor taxonomic method.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	This method cannot account for temporal changes in the fishery that compromise the interpretation of fishery-dependent time series data.

Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Be aware of the potential for hyperstability due to the potential for higher catches or catch rates when aggregations are encountered or inadvertently targeted, and as such, for abundance to be artificially over-estimated. Consider augmenting with indicators that inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Is fishing effort data available by location?	No	This method may be more informative if spatially specific effort data are available
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat

Assumes no recruitment variability.

Modified Panel Regression Model (mPRM)

Assessment Category: Catch Only

Section: Assessment

Assessment Output: Stock Status

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (1 of 2 met)

Description

This method was developed by Costello et al. (2012) as a way to estimate the status of stocks for unassessed fisheries. A panel regression model (a linear model fit to longitudinal data) was developed by analyzing possible indicators of stock status for assessed fisheries around the globe. These indicators include "sets of catch history data, fishery development characteristics, biological characteristics, a time trend, and fixed effects for species type" and were used to predict stock status, measured as biomass relative to that at maximum sustainable yield, B/BMSY. Six different versions of the model were created, with each version requiring one less piece of data than the previous. Rosenberg et al. (2014) modified this approach to produce a model that does not require any detailed life-history information, only a broad life-history type for the species of interest. Be aware that this approach does not provide a precise estimate of stock status, only a general sense of what it might be.
The following link may serve as a useful resource for this assessment option:
[https://github.com/datalimited/datalimited] (https://github.com/datalimited/datalimited)

Contacts

Christopher Costello: costello@bren.ucsb.edu

References

Costello, C., D. Ovando, R. Hilborn, S. D. Gaines, O. Deschenes, and S. E. Lester. 2012. Status and solutions for the world's unassessed fisheries. Science 338:517-520.
Applications
Rosenberg, A. A., M. J. Fogarty, A. B. Cooper, M. Dickey-Collas, E. A. Fulton, N. L. Gutierrez, K. J. W. Hyde, K. M. Kleisner, C. Longo, C. V. Minte-Vera, C. Minto, I. Mosqueira, G. C. Osio, D. Ovando, E. R. Selig, J. T. Thorson, and Y. Ye. 2014. Developing new approaches to global stock status assessment and fishery production potential of the seas. FAO Fisheries and Aquaculture Circular, Rome, Italy.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (1 of 2 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	**Single Criteria**	**What time series of total removal data exists?**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.**	**3: Moderate to low bias, but high imprecision in time series. Moderate flaws that don't significantly bias time series data representativeness, but do create significant imprecision. Examples: "partial" time series that reflect only most major years of removals and major fleets/metiers; sampling that covers most of the temporal-spatial extent of the fishery, and is generally reported at species level (low bias), but sample sizes may be low (high imprecision).**
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat

Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Be aware of the potential for hyperstability due to the potential for higher catches or catch rates when aggregations are encountered or inadvertently targeted, and as such, for abundance to be artificially over-estimated. Consider augmenting with indicators that inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Yellow Caveats

Question	Answer	Caveat
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	This method cannot account for temporal changes in the fishery that compromise the interpretation of fishery-dependent time series data.
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

There are no static caveats.

Analysis of change in a single (non-CPUE) indicator

Assessment Category: Expert Judgement

Section: Assessment

Assessment Output: Catch Limit, Fishing Rate, or Stock Status

Assessment 'Tier': Extremely Data-Poor

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (1 of 3 met)

Description

This option considers changes in an indicator over time and encompasses a simple analysis of whatever empirical indicator is available. It is recommended when at least some data exists for one or more indicators, but are of insufficient quality to inform, or there is insufficient funding to undertake, a formal assessment. The approach is useful, for example, when there is a low exploitation rate or a low gross value of production (GVP) for a given species and/or fishery.

Alternatively, such an analysis may be a valuable supplementary component to augment focused, single species assessments in multi-species fisheries. For example, assessments on individual key target species may not detect changes in catch composition or the decline of more marginal species.

Such analysis may also be helpful in identifying spatial/temporal patterns or trends (such as serial depletion in aggregating species) that may not be detected by a whole-of-stock assessment, but that may warrant attention and, possibly, a management response.

The type of management metric you will obtain will depend on the indicator being monitored.

If multiple indicators are being monitored, then consider one of the multi-indicator framework options (CUSUM Control Charts, Traffic Lights, Multi-Dimensional Scaling, Sequential Trigger Frameworks, Hierarchical Decision Trees)

Examples of simple indicators include:

Species-composition

---Changes in the relative species composition, or in the dominant species in the catch, can reflect targeting, market, environmental and/or ecological changes. This indicator is particularly applicable to multispecies fisheries, either alone or in a multi-indicator framework, and can be used to define a control rule that responds to broad changes that may reflect either changes in fishing behaviour or changes in stock status.

Spatial distribution of fishing effort

---Changes in the spatial distribution of fishing effort can reflect the discovery of new fishing grounds, sequential overfishing of existing fishing grounds (serial depletion), or environmental/ecological changes unrelated to fishing. Particularly when paired with spatial closures, assessments of changes in the spatial distribution of fishing effort can be highly useful in data-poor fisheries targeting sedentary or spatially disaggregated stocks. The output of this method could be used to devise a control rule on fishing rate.

Spatial distribution of catch

---Changes in spatial distribution of catch can reflect the discovery of new fishing grounds, sequential overfishing of existing fishing grounds (serial depletion), or environmental/ecological changes unrelated to fishing. Particularly when paired with spatial closures, assessments of changes in the spatial distribution of catch can be highly useful in data-poor fisheries targeting sedentary or spatially disaggregated stocks. The output of this method could be used to devise a control rule on catch.

Gear type or manner of deployment

---Changes in gear type may be indicative of pressure on the fishery, or market-driven changes in targeting, resulting in the need for fishers to vary their manner of fishing. For example, a shift to smaller mesh size or escape ports can reflect growth overfishing. Significant changes in gear type may therefore warrant precautionary management measures.The output of this method could be used to devise a control rule on fishing rate

Mean length/weight or length/weight percentiles

---Measurements of mean length/weight (or upper/lower percentile), are empirical indicators of stock status.. In one application, a mean length-based assessment performed reasonably well, so long as variability in length-at-age was accounted for (Klaer et al., 2012). The use of length/size data to assess stock status is useful in data-poor fisheries where no other information may be available. Caution is warranted when using this approach, however, as deviations from steady-state recruitment or mortality can influence average length/size without reflecting stock status. For example, mean length/size may decrease when recruitment is abnormally strong; there would likely be a high proportion of smaller individuals in the catch, but this would not be indicative of worsened stock status (Ziegler et al., 2011). The use of multiple indicators and interpreting different indicator combinations will lead to a more robust understanding of stock status based on mean length/size in many cases (Rochet et al., 2005).

Contacts

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References

References
Dowling, N. A., Smith, D. C., Knuckey, I., Smith, A. D. M., Domaschenz, P., Patterson, H. M., & Whitelaw, W. (2008). Developing harvest strategies for low value and data-poor fisheries: case studies from three Australian fisheries. Fisheries Research, 94, 380-390. http://dx.doi.org/10.1016/j.fishres.2008.09.033
Mean length/weight or length/weight percentiles:
Quinn, T. J., & Deriso, R. B. (1999). Quantitative Fish Dynamics. New York: Oxford University Press
Applications
Dowling et al. (2008) recommend exploratory/descriptive analysis for the low-value Australian Coral Sea Fishery (CSF), which has low current and historical catch. In order to set appropriate triggers, the authors recommend analyzing trends in the species composition of the catch, spatial fishing patterns, overall CPUE, and total catch.
Species-composition:
Species-specific triggers in the Australian Coral Sea Fishery's (CSF) trawl sector were based on descriptive analysis of whether the relative proportion of a given species in the catch rose above a minimum threshold, changed by a set percentage from its historical average, or whether it declined by a set percentage over a number of consecutive years (Dowling et al. 2008). This kind of analysis could lead to precautionary management action.
Spatial distribution of fishing effort:
Dowling et al. (2008) described exploratory spatial analyses in the Coral Sea Fishery (CSF) that could lead to spatial management or closures: 1) analyzing fishery expansion and contraction in terms of the percentage of areas fished; 2) analyzing whether the total catch is increasingly taken from a single area due to contraction or undue fishing pressure on one area; and/or, 3) analyzing whether once-exploited areas are no longer fished. In the Bass Strait Central Zone Scallop fishery, on the other hand, spatial density is assessed via independent surveys, and fishing is not allowed in an area unless estimated biomass criteria are met.
Spatial distribution of catch:
Dowling et al. (2008) described exploratory spatial analyses in the Coral Sea Fishery (CSF) that could lead to spatial management or closures: 1) analyzing fishery expansion and contraction in terms of the percentage of areas fished; 2) analyzing whether the total catch is increasingly taken from a single area due to contraction or undue fishing pressure on one area; and/or, 3) analyzing whether once-exploited areas are no longer fished. In the Bass Strait Central Zone Scallop fishery, on the other hand, spatial density is assessed via independent surveys, and fishing is not allowed in an area unless estimated biomass criteria are met.
Mean length/weight or length/weight percentiles:
Ault, J. S., Smith, S. G., & Bohnsack, J. A. (2005). Evaluation of average length as an estimator of exploitation status for the Florida coral-reef fish community. ICES Journal of Marine Science, 62(3), 417-423. https://doi.org/10.1016/j.icesjms.2004.12.001
Punt, A. E., Campbell, R. A., & Smith, A. D. M. (2001). Evaluating empirical indicators and reference points for fisheries management: application to the broadbill sword-fish fishery

off eastern Australia. Marine and Freshwater Research, 52(6), 819-832. [http://dx.doi.org/10.1071/MF00095] (http://dx.doi.org/10.1071/MF00095)
Klaer, N. L., Wayte, S. E., & Fay, G. (2012). An evaluation of the performance of a harvest strategy that uses an average-length-based assessment method. Fisheries Research, 134, 42-51. [https://doi.org/10.1016/j.fishres.2012.08.010] (https://doi.org/10.1016/j.fishres.2012.08.010)
Rochet, M. J., Trenkel, V., Bellail, R., Coppin, F., Le Pape, O., Mahe, J. C., ... & Verin, Y. (2005). Combining indicator trends to assess ongoing changes in exploited fish communities: diagnostic of communities off the coasts of France. ICES Journal of Marine Science, 62(8), 1647-1664. doi: [10.1016/j.icesjms.2005.06.009] (https://doi.org/10.1016/j.icesjms.2005.06.009)
Ziegler, P. E., Welsford, D. C., & Constable, A. J. (2011). Length-based assessments revisited-why stock status and fishing mortality of long-lived specIes such as toothfish cannot be inferred from length-frequency data alone. CCAMLR Science, 18, 57-73.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (1 of 3 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	**Single Criteria**	**What time series of fishing effort data exists?**	**0: Absent, or not meaningful**	**1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.**
Failed	**Single Criteria**	**Is fishing effort data available by location?**	**No**	**Yes**
Met	Multi A Met	What time series of percentile length data (mean, median, x percentile) exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Met	Multi A Met	What time series of total removal data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.
Met	Multi A Met	What time series of length composition data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.
Met	Multi A Met	Is catch data available by location?	Yes	Yes
Met	Multi A Met	Do you have an understanding of which gear types are being used in the fishery and how they are being deployed?	Yes	Yes
Failed	Multi A Met	For multispecies fisheries, what time series of species composition data exists?	0: Absent or not applicable	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Failed	Multi A Met	What time series for percentile weight data (mean, median, x percentile) exists?	0: Absent	1: Snapshot (1-2 years of data o1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.nly). Snapshot data can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise snapshot data.
Failed	Multi A Met	What time series of fishing effort data exists?	0: Absent, or not meaningful	1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.
Failed	Multi A Met	What time series of scientifically designed (e.g., fishery-independent) surveys of abundance exists?	0: Absent or 1 year of relative abundance index	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the survey can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.
Failed	Multi A Met	Is fishing effort data available by location?	No	Yes

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat

Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators. If using gear type as an indicator, consider is what is DRIVING the change in targeting and hence gear type. Is this due to changes in abundance/availability of a previously targeted species, or to external (e.g. market) pressures or forces?

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Trends in size-based indicators may be compromised by changing selectivity. Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Is fishing effort data available by location?	No	If using effort data, this method may be more informative if spatially specific effort data are available.

Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	Temporal changes in the fishery could compromise the interpretation of fishery-dependent time series data, if time series are being interpreted.
Is the biological data (e.g., length or age compositions) differentiated by sex?	No	If the indicator is life-history based and there is a strong sexual differentiation in life history parameters resulting in mixed length compositions by sex, then you need to have some understanding of the sex composition of the sampling.
Is the life history of the species sex-specific?	Yes	If the indicator is life-history based, be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

Question	Answer	Positive Attribute
Is it possible to define a meaningful reference point for an indicator and if so, with what level of uncertainty? Select the answer that best applies.	Yes-- a reference point can be established, but with high uncertainty	The value of this method is optimised if meaningful reference points can be defined.
Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Such indicators could be used to inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
The assessment has the ability to quantify output uncertainty.
Interpretation of results may be sensitive to major recruitment events.
The criteria indicators are intended to be all-inclusive; however, if users identify alternate novel indicators relevant to their fishery, then these can be used within this option.

Yield-Per-Recruit

Assessment Category: Life History-Based Methods

Section: Assessment

Assessment Output: Fishing Rate

Assessment 'Tier': Pre-assessment - Life-History Based Reference Points

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (4 of 4 met)

Description

This model is used to determine the maximum yield that can be captured from a fishery. It uses an age-structured model to determine at what size or age the yield (i.e, catches in numbers or biomass) is maximized and at what corresponding fishing rate (Fmax). Adding maturity, it can also track the spawning biomass per recruit at any given fishing level. This model makes a major assumption that the age structure of the fishery has reached an equilibrium and that the recruitment and mortality effects will be the same for all cohorts. Therefore it does not incorporate environmental or fishing rate stochasticity. This method is particularly useful in finding fishing rate reference points, though studies have demonstrated that setting targets at the maximum F rate (Fmax) can be unsustainable due when assumptions are violated.
The following link may serve as a useful resource for this assessment option:
[http://www.datalimitedtoolkit.org/] (http://www.datalimitedtoolkit.org/)
[https://cran.r-project.org/web/packages/TropFishR/index.html] (https://cran.r-project.org/web/packages/TropFishR/index.html)
[https://cran.r-project.org/web/packages/fishmethods/index.html] (https://cran.r-project.org/web/packages/fishmethods/index.html)
[https://nmfs-fish-tools.github.io/YPR/] (https://nmfs-fish-tools.github.io/YPR/)
[https://nmfs-fish-tools.github.io/YPRLEN/] (https://nmfs-fish-tools.github.io/YPRLEN/)

References

Haddon, M. 2011. Modelling and Quantitative Methods in Fisheries 2nd Edition. CRC Press.
Applications
Barbieri, L.R., Chittenden Jr, M.E., & Jones, C.M. (1997). Yield-per-recruit analysis and management strategies for Atlantic croaker, Micropogonias undulatus, in the Middle Atlantic Bight. Fishery Bulletin, 95(4), 637-645.
Nadon MO, Ault JS, Williams ID, Smith SG, DiNardo GT (2015) Length-Based Assessment of Coral Reef Fish Populations in the Main and Northwestern Hawaiian Islands. PLoS ONE 10(8): e0133960. [https://doi.org/10.1371/journal.pone.0133960] (https://doi.org/10.1371/journal.pone.0133960)

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (4 of 4 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available
Met	Single Criteria	Do you have a length-weight relationship for the species? Select the answer that best describes the source and uncertainty.	3: Yes, species-specific value with low to moderate uncertainty	1: Yes, expert opinion or non-species-specific value
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or based only on length samples (e.g., ELEFAN)

Caveats and Attributes

Red Caveats

There are no red caveats.

Orange Caveats

There are no orange caveats.

Yellow Caveats

Question	Answer	Caveat

Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.
Do you have an estimate of current absolute stock abundance? Select the answer that best describes the source and uncertainty.	0: No	You cannot use this method to estimate a catch limit without an absolute measure of stock abundance, but you can still define a fishing rate reference point.
Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Reference points based mostly on life history parameters could overestimate productivity if there is density-dependence in the aggregating behavior sensitive to fishing activity not being modelled in the YPR analysis.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Assumes equilibrium conditions

B-K Life History Model

Assessment Category: Life History-Based Methods

Section: Assessment

Assessment Output: Catch Limit or Fishing Rate

Assessment 'Tier': Pre-assessment - Life-History Based Reference Points

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (2 of 2 met)

Description

This model uses the life history invariants described in Beverton-Holt in order to estimate the potential yield and Fmax (fishing rate to produce maximum yield) of the fishery. This method assumes that Fmax is determined by an knife-edged asymptotic selectivity curve. Under this assumption, Fmax is a reference point than can be compared to estimates of current F. If a measure of abundance is used, it can also provide a measure of MSY. This model utilizes growth parameters, steepness (h), and the length of first capture (Lc). There are a number of assumptions used in order to simplify this model. These include that all fish larger than Lc are equally vulnerable to capture, and that natural mortality (M) is constant over the entire lifespan. In addition. stochastic effects are ignored.
The following link may serve as a useful resource for this assessment option:
[http://www.datalimitedtoolkit.org/] (http://www.datalimitedtoolkit.org/)

References

Beddington, J.R., Kirkwood, G.P., 2005. The estimation of potential yield and stock status using life history parameters. Philos. Trans. R. Soc. Lond. B Biol. Sci. 360, 163-170.

Applications:
Carruthers, T.R., Punt, A.E., Walters, C.J., MacCall, A., McAllister, M.K., Dick, E.J., Cope, J., 2014. Evaluating methods for setting catch limits in data-limited fisheries. Fisheries Research 153, 48-68. https://doi.org/10.1016/j.fishres.2013.12.014

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (2 of 2 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria

Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or based only on length samples (e.g., ELEFAN)

Caveats and Attributes

Red Caveats

There are no red caveats.

Orange Caveats

There are no orange caveats.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.

Do you have an estimate of current absolute stock abundance? Select the answer that best describes the source and uncertainty.	0: No	You cannot use this method to estimate a catch limit without an absolute measure of stock abundance, but you can still define a fishing rate reference point.
Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Reference points based mostly on life history parameters could overestimate productivity if there is density-dependence in the aggregating behavior sensitive to fishing activity not being accounted for in the steepness parameter. Added precaution may be needed in these cases.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Assumes equilibrium conditions

Matrix Models

Assessment Category: Life History-Based Methods Section: Assessment

Assessment Output: Fishing Rate

Assessment 'Tier': Pre-assessment - Life-History Based Reference Points

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (2 of 2 met)

Description

These are a demographic of methods that build off of general matrix population models from ecology. They have been applied most often with sharks, sea turtles and marine mammals. The method conducts a demographic analysis using age or stage-structured life-history data to construct life tables, aka matrix population models. Population demographics, such as the rate of population growth (lambda), are then calculated from the life-history data and can provide indicator targets for management. (Lamdba has an analog to the production model r in annual terms if the population was low enough that density dependence was not applicable (McAllister et al., 2001)). Fmsy can be estimated using the standard Fmsy=r/2. Cortes (2007) provides a good discussion of considerations to take into account when using this method. Elasticity analysis can also be used to indicate which inputs into the matrix model have the largest influence on the population growth rate.
The following link may serve as a useful resource for this assessment option:
[https://gist.github.com/noamross/4197507] (https://gist.github.com/noamross/4197507)

References

Caswell, H, 2001. Matrix Population Models. Sinauer.

Applications
Cortes, E. 1998. Demographic analysis as an aid in shark stock assessment and management. Fisheries Research 39: 199-208. ;
Cortes, E. 2002. Incorporating Uncertainty into Demographic Modeling: Application to Shark Populations and Their Conservation. Conservation Biology, 16(4), 1048-1062.
Cortes, E. 2007. Chondrichthyan demographic modelling: an essay on its use, abuse and future. Marine and Freshwater Research 58: 4-6
McAllister, M.K., Pikitch, E.K., and Babcock, E.A. 2001. Using demographic methods to construct Bayesian priors for the intrinsic rate of increase in the Schaefer model and implications for stock rebuilding. Can. J. Fish. Aquat. Sci. 58: 1871-1890.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (2 of 2 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	3: Yes, estimated with low to moderate uncertainty (e.g., good sample size, up to date, covers the spatial range of the species)

Caveats and Attributes

Red Caveats

There are no red caveats.

Orange Caveats

There are no orange caveats.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.

Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.
Do you have an estimate of current absolute stock abundance? Select the answer that best describes the source and uncertainty.	0: No	You cannot use this method to estimate a catch limit without an absolute measure of stock abundance, but you can still define a fishing rate reference point.
Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Reference points based mostly on life history parameters could overestimate productivity if there is density-dependence in the aggregating behavior sensitive to fishing activity not being accounted for in the fertility measure. Added precaution may be needed in these cases.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Assumes equilibrium conditions

Intrinsic Rebound Potential

Assessment Category: Life History-Based Methods

Section: Assessment

Assessment Output: Fishing Rate

Assessment 'Tier': Pre-assessment - Life-History Based Reference Points

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (2 of 2 met)

Description

This is a type of demographic analysis that uses life history parameters to determine the intrinsic rebound potential- a population's productivity that sustains a certain level of fishing (or bycatch) mortality, which can be used as a fishing mortality reference point. It is a life history method based on population resiliency. It was developed and applied to shark species. It can also be used to help place priority species for management.

References

Au, D. and S.E. Smith. 1997. A demographic method with population density compensation for estimating productivity and yield per recruit of the leopard shark (Triakis semifasciata). Canadian Journal of Fisheries and Aquatic Sciences 54: 415-420. ;
Smith, S. D. Au and C. Show. Intrinsic rebound potentials of 26 species of Pacific sharks. Marine and Freshwater Resources 49: 663-78;
Au. D. S. E. Smith and C. Show. 2015. New abbreviated calculation for measuring intrinsic rebound potential 1 in exploited fish populations-example for sharks. Can. J. Fish. Aquat. Sci. 72: 767-773.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (2 of 2 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	3: Yes, estimated with low to moderate uncertainty

Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	3: Yes, estimated with low to moderate uncertainty (e.g., good sample size, up to date, covers the spatial range of the species)

Caveats and Attributes

Red Caveats

There are no red caveats.

Orange Caveats

There are no orange caveats.

Yellow Caveats

Question	**Answer**	**Caveat**
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.
Do you have an estimate of current absolute stock abundance? Select the answer that best describes the source and uncertainty.	0: No	You cannot use this method to estimate a catch limit without an absolute measure of stock abundance, but you can still define a fishing rate reference point.

Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Reference points based mostly on life history parameters could overestimate productivity if there is density-dependence in the aggregating behavior sensitive to fishing activity.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Assumes equilibrium conditions

Demographic FMSY

Assessment Category: Life History-Based Methods | Section: Assessment

Assessment Output: Fishing Rate

Assessment 'Tier': Pre-assessment - Life-History Based Reference Points

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (3 of 3 met)

Description

An application of the surplus production theory when catch data are uninformative with respect to estimating the intrinsic growth rate r, (such as a catch series with little variation). This method instead estimates r using demographic methods. While the r for surplus production model is defined slightly different than the r in demographic models, McAllister et al. (2001) show that using the r estimated in the demographic model can provide a better estimate for the surplus production model than using an uninformative catch time series. Once r is established through this method, the surplus production model can be applied again with the estimate of r. An absolute abundance measure multiplied by this estimate of FMSY can provide an estimate of MSY.
The following link may serve as a useful resource for this assessment option:
[http://www.datalimitedtoolkit.org/] (http://www.datalimitedtoolkit.org/)

References

McAllister, M.K., Pikitch, E.K., and Babcock, E.A. 2001. Using demographic methods to construct Bayesian priors for the intrinsic rate of increase in the Schaefer model and implications for stock rebuilding. Can. J. Fish. Aquat. Sci. 58: 1871-1890.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (3 of 3 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria

Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or based only on length samples (e.g., ELEFAN)

Caveats and Attributes

Red Caveats

There are no red caveats.

Orange Caveats

There are no orange caveats.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.

Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.
Do you have an estimate of current absolute stock abundance? Select the answer that best describes the source and uncertainty.	0: No	You cannot use this method to estimate a catch limit without an absolute measure of stock abundance, but you can still define a fishing rate reference point.
Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Reference points based mostly on life history parameters could overestimate productivity if there is density-dependence in the aggregating behavior sensitive to fishing activity.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Assumes equilibrium conditions

SPRMER

Assessment Category: Life History-Based Methods | Section: Assessment

Assessment Output: Catch Limit or Fishing Rate

Assessment 'Tier': Pre-assessment - Life-History Based Reference Points

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (2 of 2 met)

Description

This method uses spawning potential ratio (SPR) and the concept of maximum excess recruitment (MER) to determine reference points for stock status. MER refers to the size of the stock (in numbers) that will produce the greatest number of recruits beyond the amount needed to maintain the current stock size. MER differs from MSY because it is not dependent on fishing effort. Therefore it can be calculated using life history parameters of the species, without the need for fishery-dependent data, such as catch or effort.

Contacts

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References

Brooks, E.N., J.E. Powers, and E. Cortes. 2009. Analytical reference points for age-structured models: application to data-poor fisheries. ICES Journal of Marine Science 67(1): 165-175.
Sissenwine, M.P. and Shepherd, J.G., 1987. An alternative perspective on recruitment overfishing and biological reference points. Canadian Journal of Fisheries and Aquatic Sciences, 44(4), pp.913-918.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (2 of 2 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria

Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	3: Yes, estimated with low to moderate uncertainty (e.g., good sample size, up to date, covers the spatial range of the species)
Met	Single Criteria	Do you have an estimate of recruitment compensation (i.e., termed "steepness" in some stock-recruit relationships) for the species? Select the answer that best describes the source and uncertainty.	3: Yes, species-specific value with low to moderate uncertainty	3: Yes, species-specific value with low to moderate uncertainty

Caveats and Attributes

Red Caveats

There are no red caveats.

Orange Caveats

There are no orange caveats.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.

Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Reference points based mostly on life history parameters could overestimate productivity if there is density-dependence in the aggregating behavior sensitive to fishing activity not being accounted for in the steepness parameter. Added precaution may be needed in these cases.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Assumes equilibrium conditions

Analysis of ratio of density inside and outside marine protected areas (MPAs), or established no-take zones/reserves

Assessment Category: MPA or No-Take Zone/Reserve Section: Assessment

Assessment Output: Stock Status

Assessment 'Tier': Extremely Data-Poor

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (0 of 1 met)

Description

This is a method for estimating localized abundance and determining target fishing rates in unprotected areas based on the ratio of fish density inside a no-take protected area to fish density in the unprotected area. Using this method, Babcock and MacCall (2011) and McGilliard et al. (2011) evaluated the use of the density ratio (DR) of fish inside and outside marine protected areas (or established no-take zones/reserves) in a management action to determine the direction and magnitude of change in fishing effort in the next year. They established that this comparative method can be used in any location that contains established MPA or no-take marine zones/reserves with similar environmental and habitat characteristics to fished areas. According to Babcock and MacCall, this method is advantageous because historical data is not required, it can be used at localized spatial scales, and it is robust to environmental changes.
The following link may serve as a useful resource for this assessment option: [http://www.datalimitedtoolkit.org/] (http://www.datalimitedtoolkit.org/)

Contacts

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Carey McGilliard: carey.mcgilliard@noaa.gov

References

References
Babcock, E.A., & MacCall, A.D. (2011). How useful is the ratio of fish density outside versus inside no-take marine reserves as a metric for fishery management control rules? Canadian Journal of Fisheries and Aquatic Sciences, 68(2), 343-359. [http://dx.doi.org/10.1139/F10-146] (http://dx.doi.org/10.1139/F10-146)
McGilliard, C. R., Hilborn, R., MacCall, A., Punt, A. E., & Field, J.C. (2011). Can information from marine protected areas be used to inform control-rule-based management of small-scale, data-poor stocks? ICES Journal of Marine Science, 68, 201-211. [http://dx.doi.org/10.1093/icesjms/fsq151] (http://dx.doi.org/10.1093/icesjms/fsq151)

Applications
Lester, S., Halpern, B., Grorud-Colvert, K., Lubchenco, J., Ruttenberg, B., Gaines, S., . . . & Warner, R. (2009). Biological effects within no-take marine reserves: a global synthesis.

Marine Ecology Progress Series, 384, 33-46. Retrieved from [http://www.jstor.org/stable/24873394] (http://www.jstor.org/stable/24873394)
Starr, R. M., Wendt, D. E., Barnes, C. L., Marks, C. I., Malone, D., Waltz, G., et al. (2015) Variation in responses of fishes across multiple reserves within a network of marine protected areas in temperate waters. PLoS ONE, 10(3), e0118502. [https://doi.org/10.1371/journal.pone.0118502] (https://doi.org/10.1371/journal.pone.0118502)

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (0 of 1 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	**Single Criteria**	**What data exists of scientifically designed (e.g., fishery-independent) sampling to compare the species of interest inside and outside of no-take reserves or marine protected areas (MPAs)?**	**0: Absent or not applicable**	**1: No baseline available. The no-take reserve has not had time to fully recover, is highly variable, or is not well enforced.**

Caveats and Attributes

Red Caveats

There are no red caveats.

Orange Caveats

There are no orange caveats.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Selectivity needs to be similar within and outside the MPA
Has the selectivity pattern changed over time?	Unknown	Beware if the selectivity of the sampling is changing outside the MPA (relative to how sampling occurs within the MPA).

If there are any no-take reserves or marine protected areas (MPAs) in the fishery, are populations within the MPA representative of unfished fish sizes and densities? Select the answer that best applies.	No, the no-take reserves or MPAs not representative	Requires mature MPA, well enforced, similar habitat.

Positive Attributes

Question	Answer	Positive Attribute
Is it possible to define a meaningful reference point for an indicator and if so, with what level of uncertainty? Select the answer that best applies.	Yes-- a reference point can be established, but with high uncertainty	The value of this method is optimised if meaningful reference points can be defined.

Static Caveats

These caveats always apply to this option.

Static Caveat
The assessment has the ability to quantify output uncertainty.
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
This approach typically assumes inside conditions are a proxy for unfished conditions.

Analysis of length/size-specific catch-rate indicators for fish sampled inside and outside of marine protected areas (MPAs) or established no-take zones/reserves, and per-recruit

Assessment Category: MPA or No-Take Zone/Reserve

Section: Assessment

Assessment Output: Fishing Rate

Assessment 'Tier': Extremely Data-Poor

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (4 of 5 met)

Description

This is an assessment option developed by Wilson et al. (2010). It is a tiered decision tree based on four levels of length/size-specific catch-rate indicators for fish sampled inside and outside of MPAs, or established no-take zones/reserves, and per-recruit. These four levels of length/size-specific catch-rate indicators are:
1--The catch rates of "prime"-sized individuals (CPUEprime), inside versus outside MPAs or established no-take zones/reserves.
2--Whether CPUEprime is increasing, decreasing, or stable in fished areas over a 5-year period.
3--The catch rates of old fish and the proportion of old fish in fished areas compared to the spawning potential ratio (SPR) targets derived from per-recruit models.
4--The catch rates of new recruits relative to reference levels (to inform whether recruitment overfishing is occurring).
In a decision tree framework to adjust the allowable catch, these four levels of catch-rate indicators provide the length/size composition when fishing at the target rate. While Wilson et al.'s (2010) method is fairly data-intensive, similar metrics can be monitored and assessed to detect sustainability trends in fishing pressure and to obtain a proxy indication of stock status (i.e., the ratio of CPUEprime inside vs. outside an MPA, or established no-take zone/reserve). See, for example, Kay et al. (2012).

Contacts

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References

References
Wilson, J. R., Prince, J. D., & Lenihan, H. S. (2010). A management strategy for sedentary nearshore species that uses marine protected areas as a reference. Marine and Coastal Fisheries, 2(1), 14-27. [http://dx.doi.org/10.1577/C08-026.1] (http://dx.doi.org/10.1577/C08-026.1)

Applications
Kay, M. C., Lenihan, H. S., Guenther, C. M., Wilson, J. R., Miller, C. J. & Shrout, S. W. (2012). Collaborative assessment of California spiny lobster population and fishery responses

to a marine reserve network. Ecological Applications, 22, 322-335. doi:10.1890/11-0155.1

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (4 of 5 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	**Single Criteria**	**What data exists of scientifically designed (e.g., fishery-independent) sampling to compare the species of interest inside and outside of no-take reserves or marine protected areas (MPAs)?**	**0: Absent or not applicable**	**1: No baseline available. The no-take reserve has not had time to fully recover, is highly variable, or is not well enforced.**
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have a length-weight relationship for the species? Select the answer that best describes the source and uncertainty.	3: Yes, species-specific value with low to moderate uncertainty	1: Yes, expert opinion or non-species-specific value
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or based only on length samples (e.g., ELEFAN)

Met	Single Criteria	What time series of length composition data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Caveats and Attributes

Red Caveats

There are no red caveats.

Orange Caveats

Question	Answer	Caveat
Are data that are to be used within an assessment collected using a different gear than used by fishers?	Yes	Data may create biased results in this method. Reconsider using the data or determine a modification of the data to approximate the selectivity of the fishery.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred, and selectivity needs to be similar within and outside the MPA. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Trends in size-based indicators may be compromised by changing selectivity

If there are any no-take reserves or marine protected areas (MPAs) in the fishery, are populations within the MPA representative of unfished fish sizes and densities? Select the answer that best applies.	No, the no-take reserves or MPAs not representative	Requires mature MPA, well enforced, similar habitat.
Is the biological data (e.g., length or age compositions) differentiated by sex?	No	If there is a strong sexual differentiation in life history parameters resulting in mixed length compositions by sex, then you need to have some understanding of the sex composition of the sampling.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage. Data may create biased results in this method. Reconsider using the data or determine a modification of the data to approximate the selectivity or other characteristics of the fishery.

Positive Attributes

Question	Answer	Positive Attribute
Is it possible to define a meaningful reference point for an indicator and if so, with what level of uncertainty? Select the answer that best applies.	Yes-- a reference point can be established, but with high uncertainty	The value of this method is optimised if meaningful reference points can be defined.

Static Caveats

These caveats always apply to this option.

Static Caveat

The assessment has the ability to quantify output uncertainty.

Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).

This approach typically assumes inside conditions are a proxy for unfished conditions.

CUSUM Control Charts

Assessment Category: Multiple Indicators Section: Assessment

Assessment Output: Catch Limit

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (1 of 1 met)

Description

CUSUM analyses keep track of persistent deviations from a center value in observed processes and can be used on a time series of any monitored data type. Originally used for statistical quality control, CUSUM has been applied to fisheries to diagnose trends in key fishery metrics, such as catch and CPUE. While trends frequently reflect stock status, it is important to note that CUSUM by itself is not an assessment of stock status. Rather, it detects persistent deviations in monitored indicators. Expert judgment or additional data may be needed to adequately interpret results if an estimation of stock status is desired.
Mesnil & Petitgas (2009) developed r scripts for the purpose of the EU project FISBOAT, which may help readers to implement a CUSUM monitoring scheme:
CusumTutorial.r is generic, for exploring CUSUM charts with "free-format" time series vectors;
FBCusumCharts.R is designed to automate the production of standard tables of results for the FISBOAT report ("traffic light template"), with input from the standard case studies files (the data must comply with a specific format with standard names etc.).
Both use a set of functions stored in the separate file CusumFuncs.r that must be sourced into the user's R workspace (on first use) as instructed in the scripts. The scripts are meant to
be run in a stepwise fashion (select a line or a block and submit to R console) and are amply commented to guide the user. The scripts only use basic R commands and do not require any
special library. The scripts may be found in the supporting information for Mesnil & Petitgas (2009) at https://www.alr-journal.org/articles/alr/olm/2009/02/alr038-08/alr038-08.html

The following link may also serve as a useful resource for this assessment option:
https://www.rdocumentation.org/packages/qcc/versions/2.6/topics/cusum

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Deepak Pazhayamadom: deepakgeorgep@gmail.com

References

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Applications
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Pazhayamadom, D. G., Kelly, C. J., Rogan, E., Codling, E. A., & Jacobson, L. (2016). Self-starting cumulative sum harvest control rule (SS-CUSUM-HCR) for status-quo management of data-limited fisheries. Canadian Journal of Fisheries and Aquatic Sciences, 73(3), 366-381. [https://doi.org/10.1139/cjfas-2015-0039] (https://doi.org/10.1139/cjfas-2015-0039)

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (1 of 1 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Multi A Met	What time series of percentile length data (mean, median, x percentile) exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Met	Multi A Met	What time series of total removal data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.
Failed	Multi A Met	For multispecies fisheries, what time series of species composition data exists?	0: Absent or not applicable	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.
Failed	Multi A Met	What time series for percentile weight data (mean, median, x percentile) exists?	0: Absent	1: Snapshot (1-2 years of data o1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.nly). Snapshot data can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise snapshot data.
Failed	Multi A Met	What time series of fishing effort data exists?	0: Absent, or not meaningful	1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.
Failed	Multi A Met	What time series of opportunistic (e.g., fishery-dependent) abundance indices exists?	0: Absent, or 1 year of relative abundance index, or effort not meaningful (if using CPUE).	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the index can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.
Failed	Multi A Met	What time series of scientifically designed (e.g., fishery-independent) surveys of abundance exists?	0: Absent or 1 year of relative abundance index	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the survey can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output. Beware if framework uses size-based indicators

Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Is fishing effort data available by location?	No	This method may be more informative if spatially specific effort data are available
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	Temporal changes in the fishery could compromise the interpretation of fishery-dependent time series data, if time series are being interpreted.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

Question	Answer	Positive Attribute
Is it possible to define a meaningful reference point for an indicator and if so, with what level of uncertainty? Select the answer that best applies.	Yes-- a reference point can be established, but with high uncertainty	The value of this method is optimised if meaningful reference points can be defined.

Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Such frameworks can incorporate indicators that can be used to inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
Additional information regarding application of assessment: Can be based on any single indicator (size, catch, effort) or multiples thereof.

Traffic lights

Assessment Category: Multiple Indicators

Section: Assessment

Assessment Output: Catch Limit or Fishing Rate

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (1 of 1 met)

Description

The traffic light method is used to monitor one or more indicators. It assigns a color-based designation showing that conditions-based on indicator value-are "safe" (green), "dangerous" (red), or possibly somewhere in between. This method may be particularly useful where multiple independent indicators are reliably recorded but are disparate and not easily related to one another. On their own, these traffic lights provide an indirect notion of stock status, but these "quasi assessments" can also be incorporated into hierarchical decision trees (see the description of hierarchical decision trees assessment option for more details). This can be done, for example, by establishing a primary control rule based on one indicator and a secondary control rule (or rules) based on other indicator(s). However, a traffic light system can simply operate as a sum of the numbers of lights hit across a set of indicators. The challenge is defining the threshold values between traffic light colors and how management will interpret and respond to the variety of indicator combinations.

Contacts

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References

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Halliday, R. G., Fanning, L. P., & Mohn, R. K. (2001). Use of the traffic light method in fishery management planning. CSAS Research Document 2001/108, 41 pp.

Applications

Ceriola, L., Ungaro, N., & Toteda, F. (2007). A "Traffic" Light approach for the assessment of the Broadtail shortfin squid Illex coindetii Verany, 1839 in the Southern Adriatic Sea (Central Mediterranean). Reviews in Fish Biology and Fisheries, 17(2-3), 145.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (1 of 1 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Multi A Met	What time series of percentile length data (mean, median, x percentile) exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.
Met	Multi A Met	What time series of total removal data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.
Failed	Multi A Met	For multispecies fisheries, what time series of species composition data exists?	0: Absent or not applicable	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Failed	Multi A Met	What time series for percentile weight data (mean, median, x percentile) exists?	0: Absent	1: Snapshot (1-2 years of data o1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.nly). Snapshot data can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise snapshot data.
Failed	Multi A Met	What time series of fishing effort data exists?	0: Absent, or not meaningful	1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.
Failed	Multi A Met	What time series of opportunistic (e.g., fishery-dependent) abundance indices exists?	0: Absent, or 1 year of relative abundance index, or effort not meaningful (if using CPUE).	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the index can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.
Failed	Multi A Met	What time series of scientifically designed (e.g., fishery-independent) surveys of abundance exists?	0: Absent or 1 year of relative abundance index	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the survey can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Is fishing effort data available by location?	No	This method may be more informative if spatially specific effort data are available

Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	Temporal changes in the fishery could compromise the interpretation of fishery-dependent time series data, if time series are being interpreted.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

Question	Answer	Positive Attribute
Is it possible to define a meaningful reference point for an indicator and if so, with what level of uncertainty? Select the answer that best applies.	Yes-- a reference point can be established, but with high uncertainty	The value of this method is optimised if meaningful reference points can be defined.
Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Such frameworks can incorporate indicators that can be used to inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).

Additional information regarding application of assessment: Can be based on any single indicator (size, catch, effort) or multiples thereof.

Hierarchical decision trees

Assessment Category: Multiple Indicators

Section: Assessment

Assessment Output: Catch Limit or Fishing Rate

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (1 of 1 met)

Description

Hierarchical decision trees combine assessments and management actions in a sequential series of intermediate steps/decisions, with the most important criteria (e.g. the most reliable assessment) appearing in the first part of the tree. The first branch of the hierarchical decision tree yields a preliminary stock status estimate and corresponding decision rule, the latter of which is adjusted according to a series of subsequent decision branches according to one or more sets of secondary indicators. Each set of indicators may reveal new insight regarding the status of the stock. This method is particularly appropriate when multiple indicators are available but a more formal stock assessment is unable to be undertaken.

Contacts

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References

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Applications
Basson, M., & Dowling, N. A. (2008). Development of a robust suite of stock status indicators for the Southern and Western and the Eastern tuna and billfish fisheries. FRDC Project No. 2003/042. 348 pp.
Bastardie, F., Nielsen, J. R., Andersen, B. S., & Eigaard, O. R. (2013). Integrating individual trip planning in energy efficiency-Building decision tree models for Danish fisheries. Fisheries Research, 143, 119-130. [http://dx.doi.org/10.1016/j.fishres.2013.01.018] (http://dx.doi.org/10.1016/j.fishres.2013.01.018)
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User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (1 of 1 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Multi A Met	What time series of length composition data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.
Met	Multi A Met	What time series of percentile length data (mean, median, x percentile) exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.
Met	Multi A Met	What time series of total removal data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.

Failed	Multi A Met	What time series for percentile weight data (mean, median, x percentile) exists?	0: Absent	1: Snapshot (1-2 years of data o1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.nly). Snapshot data can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise snapshot data.
Failed	Multi A Met	What time series of fishing effort data exists?	0: Absent, or not meaningful	1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.
Failed	Multi A Met	What time series of opportunistic (e.g., fishery-dependent) abundance indices exists?	0: Absent, or 1 year of relative abundance index, or effort not meaningful (if using CPUE).	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the index can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.
Failed	Multi A Met	What time series of scientifically designed (e.g., fishery-independent) surveys of abundance exists?	0: Absent or 1 year of relative abundance index	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the survey can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.
Failed	Multi A Met	For multispecies fisheries, what time series of species composition data exists?	0: Absent or not applicable	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat

Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output. Beware if framework uses size-based indicators
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.

Is fishing effort data available by location?	No	This method may be more informative if spatially specific effort data are available
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	Temporal changes in the fishery could compromise the interpretation of fishery-dependent time series data, if time series are being interpreted.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

Question	Answer	Positive Attribute
Is it possible to define a meaningful reference point for an indicator and if so, with what level of uncertainty? Select the answer that best applies.	Yes-- a reference point can be established, but with high uncertainty	The value of this method is optimised if meaningful reference points can be defined.
Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Such frameworks can incorporate indicators that can be used to inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Static Caveats

These caveats always apply to this option.

Static Caveat

Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).

Additional assessment requirement: Indicators need to be independent.

Sequential trigger framework (single or multi-indicator)

Assessment Category: Multiple Indicators

Section: Assessment

Assessment Output: Catch Limit, Fishing Rate, or Stock Status

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (1 of 1 met)

Description

A trigger system represents a harvest strategy framework in which the assessment evaluates indicators relative to particular reference values (triggers), that may not be directly related to stock status but that are deemed to correspond to a state of the fishery that requires a management response to be invoked ("triggered"). The reference values can range from proxies for biomass and fishing mortality targets or limits (though these are rare), to fishery situations that are determined to require management intervention by expert judgement. Reference values can be based on a single indicator (e.g., catch, fishing effort, length, CPUE, or sex ratio), or they can be based on several indicators. There is high risk around setting trigger level values in a way that purports to correspond to formal reference points, as the assumption that a trigger level value corresponds to some status of the underlying stock is very loose.

These systems were developed in the context of small-scale, arguably low-impact fisheries that had the potential to expand and/or had the potential for latent fishing effort to be activated, and where the available data were unable to inform a more quantitative stock assessment. The purpose of these systems was to avoid uncontrolled expansion by putting checks and balances in place (Dowling et al., 2008). Typically, there are 3 trigger levels. The higher levels invoke stronger management responses (e.g., increasing catch, fishing effort, etc.) While the "Level 3" trigger is a proxy limit reference point that should result in the cessation of fishing effort, the "Level 2" trigger typically invokes the response that a more defensible assessment needs to be undertaken before further catch or effort can be permitted. As such, trigger systems are usually designed to become self-redundant, and to strongly encourage improved data collection and adaptive management.

In extremely data-poor contexts, trigger systems can be based on a single indicator, but they often include multiple triggers. For multispecies fisheries, they can include: 1) species-specific catch-trigger values for high risk/vulnerable species; 2) species-specific catch-trigger values for "key" species (e.g., most frequently caught and/or most valuable species); or, 3) total catch triggers for all species combined, or for a subset of "key" species. Similar to traffic lights (see hierarchical decision trees), this method may be particularly useful where multiple independent indicators are reliably recorded but are disparate and not easily related to one another. They can be used on their own or as part of hierarchical decision frameworks.

Contacts

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References

References
Dowling, N. A., Smith, D. C., Knuckey, I., Smith, A. D. M., Domaschenz, P., Patterson, H. M., & Whitelaw, W. (2008). Developing harvest strategies for low value and data-poor fisheries: case studies from three Australian fisheries. Fisheries Research, 94, 380-390. [http://dx.doi.org/10.1016/j.fishres.2008.09.033] (http://dx.doi.org/10.1016/j.fishres.2008.09.033)

Applications
See Table 1 in Dowling et al. (2008) for trigger examples.
O'Neill, M. F., Campbell, A. B., Brown, I. W., & Johnstone, R. (2010). Using catch rate data for simple cost-effective quota setting in the Australian spanner crab (Ranina ranina) fishery. ICES Journal of Marine Science, 67, 1538-1552. [https://doi.org/10.1093/icesjms/fsq095] (https://doi.org/10.1093/icesjms/fsq095)

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (1 of 1 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Multi A Met	What time series of percentile length data (mean, median, x percentile) exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.
Met	Multi A Met	What time series of total removal data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.

Met	Multi A Met	What time series of length composition data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.
Failed	Multi A Met	For multispecies fisheries, what time series of species composition data exists?	0: Absent or not applicable	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.
Failed	Multi A Met	What time series for percentile weight data (mean, median, x percentile) exists?	0: Absent	1: Snapshot (1-2 years of data o1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.nly). Snapshot data can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise snapshot data.
Failed	Multi A Met	What time series of fishing effort data exists?	0: Absent, or not meaningful	1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.
Failed	Multi A Met	What time series of opportunistic (e.g., fishery-dependent) abundance indices exists?	0: Absent, or 1 year of relative abundance index, or effort not meaningful (if using CPUE).	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the index can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.
Failed	Multi A Met	What time series of scientifically designed (e.g., fishery-independent) surveys of abundance exists?	0: Absent or 1 year of relative abundance index	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the survey can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.

Failed	Multi A Met	Rank the level of understanding regarding the broader ecosystem threats affecting the fishery.	0: Absent	1: General understanding

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in setting target and limit reference points and in interpreting indicators relative to these. If the indicator is CPUE-based, then the use of CPUE to infer stock status assumes that fishing activity that is either not fishing prime habitat, or is using gear or fishing practices that are sub-optimal for the species of interest, is excluded from the analysis. That is, most data sets need to be filtered to remove non-representative fishing activity.

Yellow Caveats

Question	Answer	Caveat

Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	If the indicator is size-based, then need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	If the indicator is size-based, then time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Is fishing effort data available by location?	No	If the indicator is effort-based, then this method may be more informative if spatially specific effort data are available.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	Temporal changes in the fishery could compromise the setting and interpretation of reference points.
Is the biological data (e.g., length or age compositions) differentiated by sex?	No	If the indicator is life-history based and there is a strong sexual differentiation in life history parameters resulting in mixed length compositions by sex, then you need to have some understanding of the sex composition of the sampling.
Is the life history of the species sex-specific?	Yes	If the indicator is life-history based, be cautious regarding the interpretation of life-history parameters that may be sex-specific.

Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

Question	Answer	Positive Attribute
Is it possible to define a meaningful reference point for an indicator and if so, with what level of uncertainty? Select the answer that best applies.	Yes-- a reference point can be established, but with high uncertainty	The value of this method is optimised if meaningful reference points can be defined.
Does the species aggregate (e.g., schooling, or aggregates near desirable habitat or refugia)?	Yes, but not actively targeted while aggregated	Such frameworks can incorporate indicators that can be used to inform the extent of potential hyperdepletion (e.g., whether the spatial distribution of effort is increasingly concentrated, or is moving progressively offshore, or away from areas previously fished).

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
The criteria indicators are intended to be all-inclusive; however, if users identify alternate novel indicators relevant to their fishery, then these can be used within this option.

Production model

Assessment Category: Population Dynamics Model

Section: Assessment

Assessment Output: Catch Limit, Stock Scale, Stock Status

Assessment 'Tier': High Tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (1 of 3 met)

Description

Production models (e.g. Schaefer, Fox, Pella-Tomlinson models) offer a simplified approach to model population dynamics and estimate maximum sustainable yield (MSY). This is accomplished by modeling biomass instead of the age structure of the population. The data inputs required are a continuous time series of removals (any gaps in the series will need to be filled) and at least one index of abundance (often CPUE is used). The two major parameters of the model are the intrinsic population growth rate, r and carrying capacity, K. The intrinsic population growth parameter, r, encapsulates reproduction and recruitment, growth, and mortality of the population. The carrying capacity, K, represents the maximum size of the population. The index catchability and treatment of process and measurement error can also be treated as estimated or fixed parameters. This production modeling approach leads to a simple accounting of the undifferentiated biomass, as some part of it is caught, with the remaining biomass creating production (i.e., new biomass), as defined by r. The addition of the remaining biomass after catches and the new production lead to the population size in the next year. Additional assumptions on stock status in a given year may be needed if the removal time series does not include all of the major removal years.
Data quality and quantity influence model performance. Production models do not perform well when there is a lack of contrast in historical data (e.g, catch and CPUE show little variation over the period of collection). There are also some applications of production models that assume equilibrium conditions are maintained each year despite fluctuating removals. Such applications should only be considered with great caution because they carry strong assumptions of population compensation, and thus sustainable yield. The more common approach of fitting to removal time series (see, for example, Prager, 1992, 1994 and McAllister et al., 2000; [https://nmfs-fish-tools.github.io/ASPIC/] (https://nmfs-fish-tools.github.io/ASPIC/)) should be the application of choice (see Haddon, 2010, Ch. 11).
The current preferred method of surplus production models is to formulate them as Bayesian models. This allows for users to use known information about the stock in the model to help inform the parameter estimation and reduce uncertainties for the results. This approach can also help incorporate both process and observation errors into the model. Just Another Bayesian Biomass Assessment (i.e., JABBA-Select) (Winker et al., 2018; Winker et al. 2020) and Surplus Production model in Continuous Time (SPiCT); (Pederson and Berg, 2017) are open source tools created to help easily facilitate the use of this method in a reproducible way. A Stock Production Model Incorporating Covariates (ASPIC) (Prager, 1992) is another method that has had historically wide use. JABBA-Select has extended the JABBA implementation to allow for selectivity departures from maturity and performance comprable to age-structured models, but with less parameter load.
The following links may serve as useful resources for this assessment option:
[https://www.datalimitedtoolkit.org/] (https://www.datalimitedtoolkit.org/)
Stock Synthesis Tool: [https://vlab.ncep.noaa.gov/web/stock-synthesis] (https://vlab.ncep.noaa.gov/web/stock-synthesis)
JABBA-Select Tool: [https://github.com/jabbamodel/JABBA-Select] (https://github.com/jabbamodel/JABBA-Select)
SPiCT Tool: [https://github.com/DTUAqua/spict] (https://github.com/DTUAqua/spict)
More options for production models can be found at [http://toolbox.frdc.com.au/toolbox/#page-content] (http://toolbox.frdc.com.au/toolbox/#page-content)
Scroll down to the filter options in "Model type" and select "Surplus Production"

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User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (1 of 3 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	Single Criteria	What time series of total removal data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	3: Moderate to low bias, but high imprecision in time series. Moderate flaws that don't significantly bias time series data representativeness, but do create significant imprecision. Examples: "partial" time series that reflect only most major years of removals and major fleets/metiers; sampling that covers most of the temporal-spatial extent of the fishery, and is generally reported at species level (low bias), but sample sizes may be low (high imprecision).
Failed	Multi A Failed	What time series of opportunistic (e.g., fishery-dependent) abundance indices exists?	0: Absent, or 1 year of relative abundance index, or effort not meaningful (if using CPUE).	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: time series missing major moments of removals or with no contrast (e.g., flat series), significant gaps in spatial/habitat sampling of the population, species identification issues, non-ideal fleet/gear for tracking population abundance of a particular species of interest, changing gear selectivity, or other sampling issues.
Failed	Multi A Failed	What time series of scientifically designed (e.g., fishery-independent) surveys of abundance exists?	0: Absent or 1 year of relative abundance index	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: time series missing major moments of removals or with no contrast (e.g., flat series), significant gaps in spatial sampling of the population, species identification issues, non-ideal gear for the particular species of interest, opportunistic application of a survey to species outside the initial design, or other sampling issues. that may make samples biased.
Met	Single Criteria	Do you have a prior estimate or range for r (population intrinsic growth rate) and K (carrying capacity)? Select the answer that best describes the source and uncertainty.	3: Species-specific r values with low to moderate uncertainty. K with high uncertainty or better.	1: Assumed with very large prior ranges. The intrinsic growth rate may also be borrowed for a nearest-neighbor taxonomic method.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators. Use of CPUE to infer stock status assumes that fishing activity that is either not fishing prime habitat, or is using gear or fishing practices that are sub-optimal for the species of interest, is excluded from the analysis. That is, most data sets need to be filtered to remove non-representative fishing activity.

Yellow Caveats

Question	Answer	Caveat
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	Temporal changes in the fishery could compromise the interpretation of fishery-dependent time series data. Here, operational changes could be problematic if they are not accounted for when standardising the CPUE time series.

Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
The assessment has the ability to quantify output uncertainty.
Assumes B0 (i.e., the initial condition of the stock) is constant.
Links readily to/lends itself for use with the decision rules: "Catch Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point" and "Effort Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point"
Moving to a Bayesian state-space version like JABBA will require additional inputs or considerations not listed as criteria here
Absolute measures of abundance (i.e., an index with known catchability; e.g., population census) are more informative to stock abundance than relative measures of abundance, the latter which requires a time series in order to interpret abundance trend given catchability is, by definition, unknown.
Most production models assume the selectivity of the index is equivalent to the maturity relationship, thus the index tracks spawning biomass. The JABBA-Select approach overcomes this issue.

Age Structured Integrated Models (ASIM)

Assessment Category: Population Dynamics Model — Section: Assessment

Assessment Output: Catch Limit, Fishing Rate, Stock Scale, Stock Status

Assessment 'Tier': High Tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (8 of 10 met)

Description

At their most basic, age-structeured integrated models (ASIM) assessment models estimate annual abundance (at-age) from catch-at-age (or catch-at-length) data, an abundance index (e.g., CPUE or fishery-independent surveys), and/or biological data (growth, maturity, recruitment, and mortality). SCAA estimates fishing mortality rate (F), abundance, and survey and fishery catchabilities, along with fishery reference points (e.g., maximum sustainable yield) where possible. A statistical fitting procedure is used to determine which abundance and mortality values are most likely given the observed data. To consider uncertainty, observation error in catch-at-age data and abundance indices is typically included, along with appropriate likelihoods for estimated life history parameters. Basic models assume time-invariant selectivity, constant natural mortality rate (M), and a spawner-recruit relationship, but a large number of extensions and variations of SCAA models are possible. [Stock Synthesis] (https://vlab.ncep.noaa.gov/web/stock-synthesis) is just one ex ample of a freely available SCAA that also includes strong developmental and results visualization support via the R library r4ss (see contacts below for more information). (See also the [SS-DL Shiny application] (https://github.com/shcaba/SS-DL-tool) uses Stock Synthesis to implement several common data-limited assessment methods all in one modelling framework.) [CASAL2] (https://niwa.co.nz/fisheries/tools-resources/casal) is another flexible SCAA framework used in New Zealand. Dichmont et al. 2016 provides a review and list (see Table 1), and [online toolbox] (http://toolbox.frdc.com.au/toolbox/#page-content) , of other SCA A models and their associated references.
The following links may serve as a useful resource for this assessment option:
[https://vlab.ncep.noaa.gov/web/stock-synthesis] (https://vlab.ncep.noaa.gov/web/stock-synthesis)
[https://github.com/shcaba/SS-DL-tool] (https://github.com/shcaba/SS-DL-tool)
[https://niwa.co.nz/fisheries/tools-resources/casal] (https://niwa.co.nz/fisheries/tools-resources/casal)
More options for integrated models can be found at [http://toolbox.frdc.com.au/toolbox/#page-content] (http://toolbox.frdc.com.au/toolbox/#page-content)
Scroll down to the filter options in "Model type" and select "Integrated assessment"

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User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (8 of 10 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria

Failed	**Single Criteria**	**What time series of total removal data exists?**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.**	**3: Moderate to low bias, but high imprecision in time series. Moderate flaws that don't significantly bias time series data representativeness, but do create significant imprecision. Examples: "partial" time series that reflect only most major years of removals and major fleets/metiers; sampling that covers most of the temporal-spatial extent of the fishery, and is generally reported at species level (low bias), but sample sizes may be low (high imprecision).**
Failed	**Multi A Failed**	**What time series of opportunistic (e.g., fishery-dependent) abundance indices exists?**	**0: Absent, or 1 year of relative abundance index, or effort not meaningful (if using CPUE).**	**1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the index can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.**
Failed	**Multi A Failed**	**What time series of scientifically designed (e.g., fishery-independent) surveys of abundance exists?**	**0: Absent or 1 year of relative abundance index**	**1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the survey can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.**
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available

Met	Single Criteria	Do you have a length-fecundity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Use model default	1: Use model default
Met	Single Criteria	Do you have an estimate of recruitment compensation (i.e., termed "steepness" in some stock-recruit relationships) for the species? Select the answer that best describes the source and uncertainty.	3: Yes, species-specific value with low to moderate uncertainty	1: Yes, expert opinion or non-species-specific value
Met	Single Criteria	Do you have the level of recruitment variability (i.e., sigmaR) for the species? Select the answer that best describes the source and uncertainty.	1: Yes, expert opinion or non-species-specific value	1: Yes, expert opinion or non-species-specific value
Met	Single Criteria	Do you have a length-weight relationship for the species? Select the answer that best describes the source and uncertainty.	3: Yes, species-specific value with low to moderate uncertainty	1: Yes, expert opinion or non-species-specific value
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or based only on length samples (e.g., ELEFAN)

Met	Single Criteria	What time series of length composition data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Are data that are to be used within an assessment collected using a different gear than used by fishers?	Yes	Data may create biased results in this method. Reconsider using the data or determine a modification of the data to approximate the selectivity of the fishery.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	This method cannot account for temporal changes in the fishery that compromise the interpretation of fishery-dependent time series data.

Yellow Caveats

Question	Answer	Caveat

Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note this method CAN handle multiple fleets/selectivities. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output. The method can estimate time-varying selectivity.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Is the biological data (e.g., length or age compositions) differentiated by sex?	No	If there is a strong sexual differentiation in life history parameters resulting in mixed length compositions by sex, then you need to have some understanding of the sex composition of the sampling.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
This approach often assumes B0 is constant (typically the default assumption), but other initial conditions can be specified.
Absolute measures of abundance (i.e., an index with known catchability; e.g., population census) are more informative to stock abundance than relative measures of abundance, the latter which requires a time series in order to interpret abundance trend given catchability is, by definition, unknown.
A significant time commitment may be needed to run these models and process results.
This method assumes some value for the variability in length by age, which is often presented as the coefficient of variation at length (CVL). This value is often assumed to be 0.1, but generally ranges from 0.05 to 0.2.

qR Method

Assessment Category: Population Dynamics Model

Section: Assessment

Assessment Output: Catch Limit

Assessment 'Tier': High Tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (4 of 5 met)

Description

The qR method uses time series of catch by weight and in numbers, an average of weight-at-age, and an estimate for natural mortality rate (M). The inclusion of effort data, while not required, results in improved estimates. The model can then estimate biomass, population numbers at-age, exploitation rate, catchability (q), and yearly recruitment numbers (R; hence "qR" method) by region. Utilizing catch-in-numbers data greatly improves the accuracy of abundance and population estimates, as does the inclusion of effort data. In addition, counting and weighing individuals is faster and less erroneous than measuring lengths. As a result, this qR method may be a better option than traditional stock assessment techniques in data-limited situations.

Contacts

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References

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McGarvey, R., Matthews, J. M., & Prescott, J. H. (1997). Estimating lobster recruitment and exploitation rate from landings by weight and numbers, and age-specific weights. Marine and Freshwater Research, 48, 1001-1008. [https://doi.org/10.1071/MF97209] (https://doi.org/10.1071/MF97209)
McGarvey, R., Punt, A. E., & Matthews, J. M. (2005). Assessing the information content of catch-in-numbers: a simulation comparison of catch and effort data sets. In Kruse, G. H., Gallucci, V. F., Hay, D. E., Perry, R. I., Peterman, R. M., Shirley, T. C., Spencer, P. D., et al. (Eds), Fisheries assessment and management in data-limited situations (pp. 635-653). Alaska Sea Grant College Program, University of Alaska, Fairbanks. [http://nsgl.gso.uri.edu/aku/akuw03002/ak-sg-05-02p635-682.pdf] (http://nsgl.gso.uri.edu/aku/akuw03002/ak-sg-05-02p635-682.pdf)

Applications
McGarvey, R., Linnane, A., Matthews, J. M., & Jones, A. (2017). Decision rules for quota setting to support spatial management in a lobster (Jasus edwardsii) fishery. ICES Journal of Marine Science, 74(2), 588-597. [https://doi.org/10.1093/icesjms/fsw177] (https://doi.org/10.1093/icesjms/fsw177)

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (4 of 5 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	**Single Criteria**	**What time series for percentile weight data (mean, median, x percentile) exists?**	**0: Absent**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.**
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have an estimate of recruitment compensation (i.e., termed "steepness" in some stock-recruit relationships) for the species? Select the answer that best describes the source and uncertainty.	3: Yes, species-specific value with low to moderate uncertainty	1: Yes, expert opinion or non-species-specific value
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or based only on length samples (e.g., ELEFAN)

Met	Single Criteria	What time series of total removal data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Are data that are to be used within an assessment collected using a different gear than used by fishers?	Yes	Data may create biased results in this method. Reconsider using the data or determine a modification of the data to approximate the selectivity of the fishery.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	This method cannot account for temporal changes in the fishery that compromise the interpretation of fishery-dependent time series data.

Yellow Caveats

Question	Answer	Caveat

Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need to know relative vulnerability of age-1 individuals, an estimate of the fraction of this recruit age class that is above the legal size, and the release mortality of undersize individuals in age class 1. Information needs to match other data, i.e. is spatially specific. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
Assumes B0 (i.e., the initial condition of the stock) is constant.
The inclusion of effort data, while not required for the method to work, results in improved model estimates.
If catch controls are used, or are to be used as a management measure, these compromise the use of catch time series as an informative assessment input.
A time series of sex ratio data can be useful for calculating mean weights-at-age.

Extended Simple Stock Synthesis (XSSS)

Assessment Category: Population Dynamics Model Section: Assessment

Assessment Output: Catch Limit, Fishing Rate, Stock Scale, Stock Status

Assessment 'Tier': High Tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (8 of 10 met)

Description

This approach builds on Simple Stock Synthesis (SSS) (see description of the SSS assessment method for more details) by incorporating an index of abundance. The index is used to help refine the user specified stock status priors by updating the posterior stock status with the information provided by the abundance index. By using the Stock Synthesis modelling framework, XSSS, like SSS, allows for flexibility in exploring uncertainty in any life history parameter, as the number of fleets and their associated selectivity values. This method outputs biomass (and thus yield estimated), stock status (if the posterior updates the prior), and fishing mortality.
The following link may serve as a useful resource for this assessment option:
[https://github.com/CWetzel/XSSS] (https://github.com/CWetzel/XSSS)

Contacts

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References

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Applications
Cope, J.M., Thorson, J.T., Wetzel, C.R., DeVore, J., 2015. Evaluating a prior on relative stock status using simplified age-structured models. Fisheries Research, Development, testing, and evaluation of data-poor assessment and fisheries management methods 171, 101-109. https://doi.org/10.1016/j.fishres.2014.07.018 ;
Wetzel, C.R., Punt, A.E., 2015. Evaluating the performance of data-moderate and catch-only assessment methods for U.S. west coast groundfish. Fisheries Research, Development, testing, and evaluation of data-poor assessment and fisheries management methods 171, 170-187. https://doi.org/10.1016/j.fishres.2015.06.005

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (8 of 10 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	Single Criteria	What time series of total removal data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	4: Bias and imprecision are minimal. There are few, if any, flaws in time series data representativeness and sampling, and bias and imprecision are not a major concern. Examples: time series that cover the recognized major removal histories, fleets and areas, as well as high resolution in species reporting and sufficient sample sizes to minimize imprecision.
Failed	Multi A Failed	What time series of opportunistic (e.g., fishery-dependent) abundance indices exists?	0: Absent, or 1 year of relative abundance index, or effort not meaningful (if using CPUE).	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: time series missing major moments of removals or with no contrast (e.g., flat series), significant gaps in spatial/habitat sampling of the population, species identification issues, non-ideal fleet/gear for tracking population abundance of a particular species of interest, changing gear selectivity, or other sampling issues.
Failed	Multi A Failed	What time series of scientifically designed (e.g., fishery-independent) surveys of abundance exists?	0: Absent or 1 year of relative abundance index	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: time series missing major moments of removals or with no contrast (e.g., flat series), significant gaps in spatial sampling of the population, species identification issues, non-ideal gear for the particular species of interest, opportunistic application of a survey to species outside the initial design, or other sampling issues. that may make samples biased.

Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	3: Yes, estimated with low to moderate uncertainty
Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	3: Yes, estimated with low to moderate uncertainty (e.g., good sample size, up to date, covers the spatial range of the species)
Met	Single Criteria	Do you have a length-fecundity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Use model default	1: Use model default
Met	Single Criteria	Do you have an estimate of recruitment compensation (i.e., termed "steepness" in some stock-recruit relationships) for the species? Select the answer that best describes the source and uncertainty.	3: Yes, species-specific value with low to moderate uncertainty	3: Yes, species-specific value with low to moderate uncertainty
Met	Single Criteria	Do you have the level of recruitment variability (i.e., sigmaR) for the species? Select the answer that best describes the source and uncertainty.	1: Yes, expert opinion or non-species-specific value	3: Yes, species-specific value with low to moderate uncertainty

Met	Single Criteria	Do you have a length-weight relationship for the species? Select the answer that best describes the source and uncertainty.	3: Yes, species-specific value with low to moderate uncertainty	3: Yes, species-specific value with low to moderate uncertainty
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	3: Yes, estimated from age and length data with low to moderate uncertainty
Met	Single Criteria	Rank the level of understanding of relative stock status.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.	2: General understanding of relative stock status coming from other data sources. Bias and imprecision will remain an important issue to consider.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	This method cannot account for temporal changes in the fishery that compromise the interpretation of fishery-dependent time series data.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Absolute measures of abundance (i.e., an index with known catchability; e.g., population census) are more informative to stock abundance than relative measures of abundance, the latter which requires a time series in order to interpret abundance trend given catchability is, by definition, unknown.
Assumes no recruitment variability.

Extended Depletion-Based Stock Reduction Analysis (XDB-SRA)

Assessment Category: Population Dynamics Model | Section: Assessment

Assessment Output: Catch Limit, Fishing Rate, Stock Scale, Stock Status

Assessment 'Tier': High Tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (3 of 5 met)

Description

An extension of the Depletion-Based Stock Reduction Analysis (DB-SRA) method (see the DB-SRA assessment option for its description) that incorporates indices of abundance. Indices are used to help refine the user specified prior on stock status, providing a posterior estimate of stock status informed by the index. In addition, the model outputs stock biomass (and thus sustainable yields) and fishing mortality.

Contacts

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References

Cope, J., Dick, E.J., MacCall, A., Monk, M., Soper, B., Wetzel, C., 2015. Data-Moderate Stock Assessments for Brown, China Copper, Sharpchin, Stripetail, and Yellow-tail Rockfishes and English and Rex Soles in 2013. Pacific Fishery Management Council, 7700 Ambassador Place NE, Suite 200, Portland, OR 97220, pp. 283.
Applications
Wetzel, C.R., Punt, A.E., 2015. Evaluating the performance of data-moderate and catch-only assessment methods for U.S. west coast groundfish. Fisheries Research, Development, testing, and evaluation of data-poor assessment and fisheries management methods 171, 170-187. https://doi.org/10.1016/j.fishres.2015.06.005

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (3 of 5 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	Single Criteria	**What time series of total removal data exists?**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.**	**4: Bias and imprecision are minimal. There are few, if any, flaws in time series data representativeness and sampling, and bias and imprecision are not a major concern. Examples: time series that cover the recognized major removal histories, fleets and areas, as well as high resolution in species reporting and sufficient sample sizes to minimize imprecision.**
Failed	Multi A Failed	**What time series of opportunistic (e.g., fishery-dependent) abundance indices exists?**	**0: Absent, or 1 year of relative abundance index, or effort not meaningful (if using CPUE).**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: time series missing major moments of removals or with no contrast (e.g., flat series), significant gaps in spatial/habitat sampling of the population, species identification issues, non-ideal fleet/gear for tracking population abundance of a particular species of interest, changing gear selectivity, or other sampling issues.**
Failed	Multi A Failed	**What time series of scientifically designed (e.g., fishery-independent) surveys of abundance exists?**	**0: Absent or 1 year of relative abundance index**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: time series missing major moments of removals or with no contrast (e.g., flat series), significant gaps in spatial sampling of the population, species identification issues, non-ideal gear for the particular species of interest, opportunistic application of a survey to species outside the initial design, or other sampling issues. that may make samples biased.**
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	3: Yes, estimated with low to moderate uncertainty
Met	Single Criteria	Rank the level of understanding of relative stock status.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.

Met	Single Criteria	Do you have an estimate of FMSY/M (the ratio of the annual exploitation rate that produces MSY at equilibrium, to natural mortality)? Select the answer that best describes the source and uncertainty.	3: Species-specific derived value with low to moderate uncertainty	3: Species-specific derived value with low to moderate uncertainty

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	This method cannot account for temporal changes in the fishery that compromise the interpretation of fishery-dependent time series data.

Yellow Caveats

Question	Answer	Caveat

Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat

Absolute measures of abundance (i.e., an index with known catchability; e.g., population census) are more informative to stock abundance than relative measures of abundance, the latter which requires a time series in order to interpret abundance trend given catchability is, by definition, unknown.

Assumes no recruitment variability.

Comprehensive assessment of risk to ecosystems (CARE)

Assessment Category: Risk Analysis/Vulnerability

Section: Assessment

Assessment Output: Stock Status

Assessment 'Tier': Stock Prioritization

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (0 of 0 met)

Description

Comprehensive Assessment of Risk to Ecosystems (CARE) uses scientific data and expert judgment to assess the threats facing marine ecosystems and species. It can be used for single or multiple sites to guide managers toward reducing the risks threatening their fisheries and ecosystems. The Environmental Defense Center's CARE fact sheet has an excellent summary of the method: [http://fisherysolutionscenter.edf.org/sites/catchshares.edf.org/files/CARE%20Fact%20Sheet.pdf] (http://fisherysolutionscenter.edf.org/sites/catchshares.edf.org/files/CARE%20Fact%20Sheet.pdf) .
The following link may serve as a useful resource for this assessment option: [http://fishe.edf.org/node/79] (http://fishe.edf.org/node/79)

Contacts

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References

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Fujita, R., Thornhill, D. J., Karr, K., Cooper, C. H., & Dee, L. E. (2014). Assessing and managing data-limited ornamental fisheries in coral reefs. Fish and Fisheries, 15(4), 661-675. [http://dx.doi.org/10.1111/faf.12040] (http://dx.doi.org/10.1111/faf.12040)

Applications
When Battista et al. (2017) applied the CARE assessment option in the Philippines, it showed that illegal fishing is the most severe threat to fishery sustainability and suggested that the case study site had good potential for improved fishery benefits with better management. The analysis also showed coral reefs to be the most vulnerable ecosystem and suggested, therefore, that conservation efforts should potentially focus on reefs. In a separate case study in Indonesia, fishing was only one of several important threats to ecosystem health. Other threats included climate change and coastal development. In this case, comprehensive threat reduction beyond improved enforcement will likely be necessary to improve management outcomes.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (0 of 0 met)

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Rank the level of understanding regarding the broader ecosystem threats affecting the fishery.	**0: Absent**	**Knowledge of broader ecosystem threats is strongly desirable for this assessment**

Orange Caveats

There are no orange caveats.

Yellow Caveats

There are no yellow caveats.

Positive Attributes

Question	Answer	Positive Attribute
Is the fishery multispecies, either in terms of target or bycatch species?	Yes	Risk assessments are recommended for multispecies fisheries, both to understand which species may warrant more specific attention (and assessment), and to maintain vigilance periodically over the fishery as a whole.

Static Caveats

These caveats always apply to this option.

Static Caveat
Additional information regarding application of assessment: info needs vary depending on whether a PSA is included

Ecosystem threshold analysis

Assessment Category: Risk Analysis/Vulnerability

Section: Assessment

Assessment Output: Stock Status

Assessment 'Tier': Stock Prioritization

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (0 of 2 met)

Description

This assessment option, specifically developed for coral reefs, uses critical reference points that have been determined for sustainable management of coral reefs. The developers of the ecosystem threshold analysis model used eight metrics of benthic cover, herbivory, predation, and diversity to reflect ecosystem state along a gradient of fishable biomass. "Threshold" values of fishable biomass were then determined, with a "threshold" being defined as "a marked change in the variance or relationship between an ecosystem driver and associated state variable" (McClanahan et al., 2011). For example, there is a marked increase in how frequently macroalgal cover dominates coral cover below a threshold of 850 kg/ha of fishable biomass. This increase may indicate a somewhat less resilient reef ecosystem. The threshold values determined by ecosystem threshold analysis can be used to guide sustainable management strategies for coral reefs in the Indian Ocean, Indonesia, and the Solomon Islands.

Contacts

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References

References
McClanahan, T. R., Graham, N. A. J., MacNeil, M. A., Muthiga, N. A., Cinner, J. E., Bruggemann, J. H., & Wilson, S. K. (2011). Critical thresholds and tangible targets for ecosystem-based management of coral reef fisheries. Proceedings of the National Academy of Sciences, 108(41), 17230-17233. www.pnas.org/cgi/doi/10.1073/pnas.1106861108

Applications
Fujita, R., Thornhill, D. J., Karr, K., Cooper, C. H., & Dee, L. E. (2014). Assessing and managing data-limited ornamental fisheries in coral reefs. Fish and Fisheries, 15(4), 661-675. [http://dx.doi.org/10.1111/faf.12040] (http://dx.doi.org/10.1111/faf.12040) . In this application, authors integrated McClanahan et al.'s thresholds into their framework for assessing the risk and vulnerability of coral reef fishery systems in Indonesia.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (0 of 2 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	Single Criteria	What time series of scientifically designed (e.g., fishery-independent) surveys of abundance exists?	0: Absent or 1 year of relative abundance index	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the survey can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.
Failed	Single Criteria	Is this a coral reef fishery?	No	Yes

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Rank the level of understanding regarding the broader ecosystem threats affecting the fishery.	0: Absent	Knowledge of broader ecosystem threats is strongly desirable for this assessment

Orange Caveats

There are no orange caveats.

Yellow Caveats

There are no yellow caveats.

Positive Attributes

Question	Answer	Positive Attribute
Is the fishery multispecies, either in terms of target or bycatch species?	Yes	Risk assessments are recommended for multispecies fisheries, both to understand which species may warrant more specific attention (and assessment), and to maintain vigilance periodically over the fishery as a whole.

Static Caveats

These caveats always apply to this option.

There are no static caveats.

Productivity and Susceptibility Analysis (PSA) to estimate risk of overfishing

Assessment Category: Risk Analysis/Vulnerability　　Section: Assessment

Assessment Output: Stock Status

Assessment 'Tier': Stock Prioritization

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (0 of 0 met)

Description

PSA is a semi-quantitative risk assessment method used to calculate the stock vulnerability to overfishing based on life history information (productivity) and fishery interaction (susceptibility). For this assessment option, "productivity" is defined as "the capacity of the stock to produce MSY [maximum sustainable yield] and to recover if the population is depleted." Susceptibility is defined as "the potential for the stock to be impacted by the fishery, which includes direct captures, as well as indirect impacts to the fishery" (Patrick et al., 2009). In practice, this means that productivity is largely determined by life history characteristics and less likely affected by potential management, while susceptibility largely reflects fishery operations, and thus more directly influenced by potential management action. PSA scores both productivity and susceptibility on a 1-3 scale using available data and expert judgement. A PSA in a core component of the "ecological risk assessment for the effects of fishing" method. The Patrick et al. implementation includes the ability to track the quality of scoring ("data quality") to indicate data gaps.
The following links may serve as a useful resource for this assessment option:
[https://nmfs-fish-tools.github.io/PSA/] (https://nmfs-fish-tools.github.io/PSA/)
[https://nathan-vaughan.shinyapps.io/psa_shiny/] (https://nathan-vaughan.shinyapps.io/psa_shiny/)

Contacts

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References

References
Patrick, W. S., Spencer, P., Link, J., Cope, J., Field, J., Kobayashi, D., Lawson, P., Gedamke, T., Cortes, E., Ormseth, O., Bigelow, K., & Overholtz, W. (2010). Using productivity and susceptibility indices to assess the vulnerability of United States fish stocks to overfishing. Fishery Bulletin, 108(3), 305-322.

Applications
Arrizabalaga, H., de Bruyn, P., Diaz, G. A., Murua, H., Chavance, P., de Molina, A. D.,
Gaertner, D., Ariz, J., Ruiz, J., & Kell, L. T. (2011). Productivity and susceptibility analysis for species caught in Atlantic tuna fisheries. Aquatic Living Resources, 24, 1-12.
[https://doi.org/10.1051/alr/2011007] (https://doi.org/10.1051/alr/2011007)
Cope, J.M., J. DeVore, E.J. Dick, K. Ames, J. Budrick, D. Erickson, J. Grebel, G. Hanshew, R. Jones, L. Mattes, C. Niles and S. Williams. 2011. An approach to defining species

complexes for U.S. west coast groundfishes using vulnerabilities and ecological distributions. North American Journal of Fisheries Management 31:589-604.
Cope, J.M., J.T. Thorson, C.R. Wetzel, J. DeVore. 2015. Evaluating a prior on relative stock status using simplified age-structured models. Fisheries Research 171: 101-109.
Cortes, E., Arocha, F., Beerkircher, L., Carvalho, F., Domingo, A., Heupel, M.,
Holtzhausen, H., Neves, M., Ribera, M., & Simpfendorfer, C. (2010). Ecological risk assessment of pelagic sharks caught in Atlantic pelagic longline fisheries. Aquatic Living Resources, 23, 25-34. DOI: 10.1051/alr/2009044
Cortes, E., Domingo, A., Miller, P., Forselledo, R., Mas, F., Arocha, F., Campana, S,. et al. (2015). Expanded ecological risk assessment of pelagic sharks caught in Atlantic pelagic longline fisheries. Collective Volume of Scientific Papers ICCAT, 71, 2637-2688.
Furlong-Estrada, E., Galvan-Magana, F., & Tovar-Avila, J. (2017). Use of the productivity and susceptibility analysis and a rapid management-risk assessment to evaluate the vulnerability of sharks caught off the west coast of Baja California Sur, Mexico. Fisheries Research, 194, 197-208. [https://doi.org/10.1016/j.fishres.2017.06.008] (https://doi.org/10.1016/j.fishres.2017.06.008)
McCully, S. R., Scott, F., Ellis, J.R., & Pilling, G.M. (2013). Productivity and susceptibility analysis: application and suitability for data poor assessment of elasmobranchs in northern European seas. Collective Volume of Scientific Papers ICCAT, 69, 1679-1698.
Osio, G. C., Orio, A., & Millar, C. P. (2015). Assessing the vulnerability of Mediterranean demersal stocks and predicting exploitation status of un-assessed stocks. Fisheries Research, 171, 110-121. [http://dx.doi.org/10.1016/j.fishres.2015.02.005] (http://dx.doi.org/10.1016/j.fishres.2015.02.005)

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (0 of 0 met)

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage. Be aware that this is explicitly considered when you score the PSA.**

Orange Caveats

There are no orange caveats.

Yellow Caveats

Question	Answer	Caveat

Is fishing effort data available by location?	No	This method may be more informative if spatially specific effort data are available

Positive Attributes

Question	Answer	Positive Attribute
Is the fishery multispecies, either in terms of target or bycatch species?	Yes	Risk assessments are recommended for multispecies fisheries, both to understand which species may warrant more specific attention (and assessment), and to maintain vigilance periodically over the fishery as a whole.

Static Caveats

These caveats always apply to this option.

Static Caveat
The assessment has the ability to quantify output uncertainty.

RAPFISH (Multi-dimensional scaling)

Assessment Category: Risk Analysis/Vulnerability

Section: Assessment

Assessment Output: Stock Status

Assessment 'Tier': Stock Prioritization

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (3 of 4 met)

Description

RAPFISH is a flexible, rapid appraisal technique used for evaluating fishery status in reference to a specific objective, such as sustainability or some other mandate or standard. The indicators used are derived from the Food and Agriculture Organization of the United Nations (FAO) Code of Conduct for Responsible Fishing and cover the ecological, technological, economic, and social dimensions of fishing. They are scored by expert judgement or quantitative information. The process of applying RAPFISH clarifies which indicators perform poorly and, therefore, which aspects of management need to be improved. To track fishery performance through time, the indicators should remain fixed so that analyses are comparable (Pitcher & Preikshot, 2001; Murillas et al., 2008; Pitcher et al., 2008; Pitcher et al., 2013). This methodology could be used as a harvest strategy framework if 1) it was used to identify a data collection program that would support future updates of the analysis, and 2) the indicator or integrated multi-dimensional scaling (MDS) scores were linked to specific management-action triggers.
The following link may serve as a useful resource for this assessment option: [http://www.rapfish.org/] (http://www.rapfish.org/)

Contacts

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References

References
Pitcher, T. J., & Preikshot, D. (2001). RAPFISH: A rapid appraisal technique to evaluate the sustainability status of fisheries. Fisheries Research, 49(3), 255-270. [http://dx.doi.org/10.1016/s0165-7836(00)00205-8] (http://dx.doi.org/10.1016/s0165-7836(00)00205-8)
Pitcher, T. J., Lam, M., Ainsworth, C., Martindale, A., Nakamura, K., Perry, R. I., & Ward, T. (2013). Improvements to Rapfish: a rapid evaluation technique for fisheries integrating ecological and human dimensions. Journal of Fish Biology, 83, 865-889. [http://dx.doi.org/10.1111/jfb.12122] (http://dx.doi.org/10.1111/jfb.12122)

Applications
37 references at [http://www.rapfish.org/the-team] (http://www.rapfish.org/the-team)
Andriguetto-Filho, J. M., Krul, R., & Feitosa, S. (2009). Analysis of natural and social dynamics of fishery production systems in Parana, Brazil: implications for management and sustainability. Journal of Applied Ichthyology, 25(3), 277-286. [https://doi.org/10.1111/j.1439-0426.2009.01273.x] (https://doi.org/10.1111/j.1439-0426.2009.01273.x)
Puspadewi, I. J. (2014). The use of MDS (Multidimensional Scaling) method to analyze the level of sustainability of fisheries resources management in Thousand Islands,

Indonesia. International Journal of Marine Science, 4.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (3 of 4 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	**Single Criteria**	**What time series of fishing effort data exists?**	**0: Absent, or not meaningful**	**1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.**
Met	Single Criteria	What time series of length composition data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.
Met	Single Criteria	What time series of total removal data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.
Met	Single Criteria	Rank the level of understanding of relative stock status.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.	1: Expert opinion on relative stock status. Large bias and imprecision should be considered with these values.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Are data that are to be used within an assessment collected using a different gear than used by fishers?	Yes	Data may create biased results in this method. Reconsider using the data or determine a modification of the data to approximate the selectivity of the fishery.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.

Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Is fishing effort data available by location?	No	This method may be more informative if spatially specific effort data are available
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	Temporal changes in the fishery could compromise the interpretation of fishery-dependent time series data, if time series are being interpreted.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

Question	Answer	Positive Attribute
Is it possible to define a meaningful reference point for an indicator and if so, with what level of uncertainty? Select the answer that best applies.	Yes-- a reference point can be established, but with high uncertainty	The value of this method is optimised if meaningful reference points can be defined.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
Additional assessment requirement: indicators should remain fixed so that analyses are comparable

Sustainability Assessment for Fishing Effects (SAFE)

Assessment Category: Risk Analysis/Vulnerability

Section: Assessment

Assessment Output: Fishing Rate

Assessment 'Tier': Stock Prioritization

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (3 of 3 met)

Description

The Sustainability Assessment for Fishing Effects (SAFE) was designed for assessing the fishing risks associated with data-poor species. The SAFE method has two components: an indicator (fishing mortality, F) and reference points (Fmsm, Flim, Fcrash). Fishing mortality (F) is estimated from the spatial overlap between species distribution and fishing effort distribution, fine-tuned by encounterability and gear selectivity. F-based reference points are derived from life history information, such as natural mortality, growth parameters, maximum age, age at maturity, etc. The sustainability risk for each species is evaluated by comparing calculated F values with derived reference points. For this assessment option, at least some notion of species distribution is needed, even if it is indirect (e.g., gleaned from a habitat map).
An enhanced version of SAFE (eSAFE) has been developed (Zhou et al. 2019) to allow for addressing cumulative risk from multiple fisheries. eSAFE also builds upon SAFE by estimating more precise gear efficiency and allowing for heterogeneous species distribution. Note that in addition to the data required by SAFE, eSAFE also requires some form of catch records, which can be sporadic or incomplete.

Contacts

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References

References
Zhou, S., Daley, R. M., Fuller, M., Bulman, C. M., & Hobday, A. J. (2019). A data-limited method for assessing cumulative fishing risk on bycatch. ICES Journal of Marine Science.
Zhou, S., Hobday, A. J., Dichmont, C. M., Smith, A. D. M. (2016). Ecological risk assessments for the effects of fishing: a comparison and validation of PSA and SAFE. Fisheries Research, 183, 183, 518-529. [http://dx.doi.org/10.1016/j.fishres.2016.07.015] (http://dx.doi.org/10.1016/j.fishres.2016.07.015)
Zhou, S., Smith, A. D. M., & Fuller, M. (2011). Quantitative ecological risk assessment for fishing effects on diverse data-poor non-target species in a multi-sector and multi-gear fishery. Fisheries Research, 112, 168-178.
Zhou, S., & Griffiths, S.P. (2008). Sustainability assessment for fishing effects (SAFE): A new quantitative ecological risk assessment method and its application to elasmobranch bycatch in an Australian trawl fishery. Fisheries Research, 91, 56-68. [http://dx.doi.org/10.1016/j.fishres.2007.11.007] (http://dx.doi.org/10.1016/j.fishres.2007.11.007)
Zhou, S. J., Griffiths, S. P., & Miller, M. (2009). Sustainability assessment for fishing effects (SAFE) on highly diverse and data-limited fish bycatch in a tropical prawn trawl fishery. Marine and Freshwater Research, 60(6), 563-570. [http:// dx.doi.org/10.1071/MF08207] (http://dx.doi.org/10.1071/MF08207)

Applications
Campbell, M. J., Courtney, A. J., Wang, N., McLennan, M. F., and Zhou, S. (2017). Estimating the impacts of management changes on bycatch reduction and sustainability of high-risk bycatch species in the Queensland East Coast Otter Trawl Fishery. FRDC Final Report Project number 2015/014, Brisbane, Queensland. CC BY 3.0
Zhou, S., Fuller, M., & Daley, R. (2012). Sustainability assessment of fish species potentially impacted in the Southern and Eastern scalefish and shark fishery: 2007-2010. Report to the Australia Fisheries Management Authority, Canberra, Australia. March 2012.
Zhou, S., Buckworth, R. C., Miller, M., & Jarrett, A. (2015). A SAFE analysis of bycatch in the Joseph Bonaparte Gulf fishery for Red-legged Banana Prawns. CSIRO Oceans and Atmosphere Flagship, Brisbane, Australia.
Zhou, S., Daley, R., Fuller, M., Bulman, C., Hobday, A., Courtney, T., Ryan, P., & Ferrel, D. (2013). ERA extension to assess cumulative effects of fishing on species. Final Report on FRDC Project 2011/029. Canberra, Australia.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (3 of 3 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or based only on length samples (e.g., ELEFAN)

Met	Multi A Met	What time series of total removal data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.
Failed	Multi A Met	What time series of fishing effort data exists?	0: Absent, or not meaningful	1: Snapshot (1-2 years of data only). Use caution when applying all Snapshot data, but be especially careful with data that is not well-sampled or representative.
Failed	Multi A Met	What time series of opportunistic (e.g., fishery-dependent) abundance indices exists?	0: Absent, or 1 year of relative abundance index, or effort not meaningful (if using CPUE).	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the index can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.
Failed	Multi A Met	What time series of scientifically designed (e.g., fishery-independent) surveys of abundance exists?	0: Absent or 1 year of relative abundance index	1: Short time series (e.g., 2-3 years). In addition to being a short time series of data, the survey can be well-sampled, representative data, or it can be poorly sampled and poorly representative of the assessed stock. The latter condition deserves even more consideration and caution when applying biased or imprecise short time series data.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat

Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Is fishing effort data available by location?	No	This method may be more informative if spatially specific effort data are available
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific

Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

Question	Answer	Positive Attribute
Is the fishery multispecies, either in terms of target or bycatch species?	Yes	This method is applicable to the assessment of groups of species

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
Additional assessment requirement: Need at least some notion of species distribution, even if indirect e.g. by habitat map.

Analysis of sustainability indicators based on length-based reference points (LBRP)

Assessment Category: Size/Age-Based

Section: Assessment

Assessment Output: Stock Status

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (3 of 3 met)

Description

This is an assessment option based on length-based reference points (LBRP). It was developed by Cope and Punt in 2009 and offers a more robust extension of the Froese (2004) assessment using size-based indicators. When establishing length-based reference points for sustainable management, Cope and Punt highlight the importance of distinguishing the selectivity pattern. They show that Froese's (2004) size indicators (Pmat, Popt, and Pmega), when used in isolation, can take on a wide range of values for an overfished stock. As such, they may not adequately reflect sustainable fishing practices. Instead, Cope and Punt suggest the use of Pobj, defined as the sum of the 3 size indicators used in the Froese (2004) assessment model. In their assessment model based on length-based reference points, Cope and Punt present a decision tree (Figure 10) that allows users to determine whether a stock's biomass is below a target or limit reference point using Pobj, the 3 catch proportions used in the 2004 model, and the ratio of Lmat/Lopt. The decision tree does not require fishing mortality rate (F), recruitment compensation (h), or spawning biomass data, and it should be used in concert with the size indicators used in the 2004 model when possible.
The following link may serve as a useful resource for this assessment option: [https://github.com/shcaba/LBRP] (https://github.com/shcaba/LBRP)

Contacts

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References

References
Cope, J. M., & Punt, A.E. (2009). Length-based reference points for data-limited situations: Applications and restrictions. Marine and Coastal Fisheries, 1(1), 169-186. [http://dx.doi.org/10.1577/C08-025.1] (http://dx.doi.org/10.1577/C08-025.1)

Applications
Babcock, E.A, Coleman R., Karnauskas, M., Gibson J. 2013. Length-based indicators of fishery and ecosystem status: Glover's Reef Marine Reserve, Belize. Fisheries Research 147: 434-445.
Merino, G., Murua, H., Arrizabalaga, H., & Santiago, J. (2014). Size based indicators of performance of Indian Ocean skipjack tuna towards developing specifically built Harvest Control Rules. Indian Ocean Tuna Commission, IOTC-2014-WPTT16-38.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (3 of 3 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or based only on length samples (e.g., ELEFAN)
Met	Single Criteria	What time series of length composition data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Are data that are to be used within an assessment collected using a different gear than used by fishers?	Yes	Data may create biased results in this method. Reconsider using the data or determine a modification of the data to approximate the selectivity of the fishery.

Yellow Caveats

Question	Answer	Caveat
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Is the biological data (e.g., length or age compositions) differentiated by sex?	No	If there is a strong sexual differentiation in life history parameters resulting in mixed length compositions by sex, then you need to have some understanding of the sex composition of the sampling.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

Question	Answer	Positive Attribute

Is it possible to define a meaningful reference point for an indicator and if so, with what level of uncertainty? Select the answer that best applies.	Yes-- a reference point can be established, but with high uncertainty	The value of this method is optimised if meaningful reference points can be defined.

Static Caveats

These caveats always apply to this option.

Static Caveat
This method determines the selectivity as an output.
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
Interpretation of results may be sensitive to major recruitment events.

Analysis of size relative to size at maturity

Assessment Category: Size/Age-Based

Section: Assessment

Assessment Output: Fishing Rate

Assessment 'Tier': Extremely Data-Poor

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (2 of 2 met)

Description

Length/size or weight relative to length/size or weight at maturity are empirical indicators for assessing the sustainability of fishing practices. The target value for the proportion of mature individuals in the catch (Pmat) should ideally be 100%. Although sustainable fishing is not guaranteed if this target is met, an increasing proportion of mature fish in the catch can reflect more sustainable fishing practices.

Contacts

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Natalie Dowling: natalie.dowling@csiro.au

References

References
Basson, M., & Dowling, N. A. (2008). Development of a robust suite of stock status indicators for the Southern and Western and the Eastern tuna and billfish fisheries. FRDC Project No. 2003/042. 348 pp.

Applications
See references from "Catch, CPUE by size indicators" and equate this assessment method to determining "Pmat."

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (2 of 2 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available
Met	Multi A Met	What time series of length composition data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.
Met	Multi A Met	What time series of percentile length data (mean, median, x percentile) exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat

Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.

Yellow Caveats

Question	Answer	Caveat
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	This may be a problem if the fishery moves to a place where they are sampling a different size structure (e.g. no longer catching adults).
Is the biological data (e.g., length or age compositions) differentiated by sex?	No	If there is a strong sexual differentiation in life history parameters resulting in mixed length compositions by sex, then you need to have some understanding of the sex composition of the sampling.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

Question	Answer	Positive Attribute
Is it possible to define a meaningful reference point for an indicator and if so, with what level of uncertainty? Select the answer that best applies.	Yes-- a reference point can be established, but with high uncertainty	The value of this method is optimised if meaningful reference points can be defined.

Static Caveats

These caveats always apply to this option.

Static Caveat
The assessment has the ability to quantify output uncertainty.
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
Interpretation of results may be sensitive to major recruitment events.

Catch curve analysis

Assessment Category: Size/Age-Based

Section: Assessment

Assessment Output: Fishing Rate

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (3 of 3 met)

Description

Catch curve analysis is a method for estimating the total mortality of a stock (Z): the rate at which individuals die can be estimated from the slope of the relative numbers present in each age class. It can be used whenever there is one or more years of catch-at-age data (or at-length data, if it can be converted to age, via von-Bertalanffy growth parameters). The data can be fishery dependent or independent so long as data are representative of the population's relative age/length structure. Given an estimate of natural mortality (M) from another source (e.g., from literature, from a marine protected area, or from tagging studies), fishing mortality (F) can be estimated as Z-M.
The following link may serve as a useful resource for this assessment option: [https://cran.r-project.org/web/packages/TropFishR/index.html] (https://cran.r-project.org/web/packages/TropFishR/index.html)

Contacts

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Derek Ogle: dogle@northland.edu

References

References
Chapman, D. G., & Robson, D. S. (1960). The analysis of a catch curve. Biometrics, 16, 354-368.
Dunn, A., Francis, R. I. C. C., & Doonan, I. J. (2002). Comparison of the Chapman-Robson and regression estimators of Z from catch-curve data when non-sampling stochastic error is present. Fisheries Research, 59, 149-159.
Gulland, J. A. (1971). The fish resources of the ocean. West Byfleet, UK: Fishing News Books.
Smith, M. W., Then, A. Y., Wor, C., Ralph, G., Pollock, K. H., & Hoenig, J. M. (2012). Recommendations for catch-curve analysis. North American Journal of Fisheries Management, 32, 956-967. [http://dx.doi.org/10.1080/02755947.2012.711270] (http://dx.doi.org/10.1080/02755947.2012.711270)

Applications
Allen, M. S. (1997). Effects of variable recruitment on catch-curve analysis for crappie populations. North American Journal of Fisheries Management, 17(1), 202-205.
Griffiths, S. P. (2010). Stock assessment and efficacy of size limits on longtail tuna (Thunnus tonggol) caught in Australian waters. Fisheries Research, 102(3), 248-257. [https://doi.org/10.1016/j.fishres.2009.12.004] (https://doi.org/10.1016/j.fishres.2009.12.004)

Oyarzun, C., Cortes, N., & Leal, E. (2013). Age, growth and mortality of southern rays bream Brama australis (Bramidae) off the southeastern Pacific coast. Revista de biologia marina y oceanografia, 48(3).
See references in [http://derekogle.com/fishR/examples/oldFishRVignettes/CatchCurve.pdf] (http://derekogle.com/fishR/examples/oldFishRVignettes/CatchCurve.pdf) .

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (3 of 3 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or based only on length samples (e.g., ELEFAN)
Met	Single Criteria	What time series of length composition data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat

Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Are data that are to be used within an assessment collected using a different gear than used by fishers?	Yes	Data may create biased results in this method. Reconsider using the data or determine a modification of the data to approximate the selectivity of the fishery.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Beware changes in selectivity. Sensitive to selectivity mis-specification (need to know if selectivity is asymptotic or dome-shaped). If you are doing a cohort analysis, need to ensure selectivity is not changing over time. If you are a single sample catch curve, need to ensure selectivity is logistic.
Has the selectivity pattern changed over time?	Unknown	Beware changes in selectivity. Method assumes time-independent asymptotic selectivity.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	Temporal changes in the fishery could compromise the interpretation of fishery-dependent time series data, if time series are being interpreted. Assumes equilibrium biomass; beware changes in selectivity.

Is the biological data (e.g., length or age compositions) differentiated by sex?	No	If there is a strong sexual differentiation in life history parameters resulting in mixed length compositions by sex, then you need to have some understanding of the sex composition of the sampling.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
The assessment has the ability to quantify output uncertainty.
This approach assumes that the population is currently in equilibrium.
Assumes B0 (i.e., the initial condition of the stock) is constant.
Interpretation of results may be sensitive to major recruitment events.

Length-based Spawning Potential Ratio (LB-SPR)

Assessment Category: Size/Age-Based

Section: Assessment

Assessment Output: Stock Status

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (4 of 4 met)

Description

The length-based spawning potential ratio (LB-SPR) assessment method estimates spawning potential ratio (SPR), the ratio of reproductive potential of a fished relative to an unfished population.

In total, the method requires at least on year of length composition information, an estimate for the ratio M/k, maximum size (L), the coefficient of variation (CV) of L, and knowledge of size-at-maturity, from which it SPR is calculated. The ratio of M/k is used because this value is less variable across stocks and species than either the individual parameters for natural mortality rate (M) or the von Bertalanffy growth coefficient (k). The method has an easy to use [Shiny app] (http://barefootecologist.com.au/lbspr) and is available in a [R package] (https://cran.r-project.org/web/packages/LBSPR/index.html) . Despite the ease of implementation, particular care should be taken with this assessment option to ensure that all the method's assumptions are fully understood and are valid for the stock of interest before performing LB-SPR analysis (see caveats). There has been some progress on dealing with the issue of dome-shaped selectivity in a sequential estimation approach (Hommik et al. 2020). This method provides a snapshot estimate of SPR assuming a constant, fishing rate. While it can be applied to multiple years, each year is treated independently, and thus this is not a true time series approach. Other approaches (e.g., length-only integrated models) should also be considered with multiple years of data.
The following links may serve as useful resources for this assessment option:
[http://barefootecologist.com.au/lbspr] (http://barefootecologist.com.au/lbspr)
[http://www.datalimitedtoolkit.org/] (http://www.datalimitedtoolkit.org/)
[https://CRAN.R-project.org/package=LBSPR] (https://cran.r-project.org/package=LBSPR)

Contacts

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References

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Hordyk, A., Ono, K., Valencia, S., Loneragan, N., & Prince, J. (2015). A novel length-based empirical estimation method of spawning potential ratio (SPR), and tests of its performance, for small-scale, data-poor fisheries. ICES Journal of Marine Science, 72(1), 217-231. [http://dx.doi.org/10.1093/icesjms/fsu004]

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Hordyk, A., Ono, K., Sainsbury, K., Loneragan, N., & Prince, J. (2015). Some explorations of the life history ratios to describe length composition, spawning-per-recruit, and the spawning potential ratio. ICES Journal of Marine Science, 71(1), 204-216. [http://dx.doi.org/10.1093/icesjms/fst235] (http://dx.doi.org/10.1093/icesjms/fst235)

Applications
Hordyk, A. R., Ono, K., Prince, J. D., & Walters, C. J. (2016). A simple length-structured model based on life history ratios and incorporating size-dependent selectivity: application to spawning potential ratios for data-poor stocks. Canadian Journal of Fisheries and Aquatic Sciences, 73(12), 1787-1799.
Hordyk, A. R., Loneragan, N. R., & Prince, J. D. (2015). An evaluation of an iterative harvest strategy for data-poor fisheries using the length-based spawning potential ratio assessment methodology. Fisheries Research, 171, 20-32. [https://doi.org/10.1016/j.fishres.2014.12.018] (https://doi.org/10.1016/j.fishres.2014.12.018)
Hommik, K., Fitzgerald, C.J., Kelly, F., Shephard, S., 2020. Dome-shaped selectivity in LB-SPR: Length-Based assessment of data-limited inland fish stocks sampled with gillnets. Fisheries Research 229, 105574. [https://doi.org/10.1016/j.fishres.2020.105574] (https://doi.org/10.1016/j.fishres.2020.105574)
Lindfield, S. (2017). Palau's reef fisheries: changes in size and spawning potential from past to present. Technical report, Coral Reef Research Foundation. 23 pp.
Prince, J., Victor, S., Kloulchad, V., & Hordyk, A. (2015). Length based SPR assessment of eleven Indo-Pacific coral reef fish populations in Palau. Fisheries Research, 171, 42-58. [https://doi.org/10.1016/j.fishres.2015.06.008] (https://doi.org/10.1016/j.fishres.2015.06.008)

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (4 of 4 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Single Criteria	Do you have the life history ratio (M/k) for the species? Select the answer that best describes the source and uncertainty.	3: Yes, individually estimated M and k, with low to moderate uncertainty (e.g., good sample size, up to date, covers the spatial range of the species)	1: Yes, M/k taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	2: Yes, estimated, but with high uncertainty (e.g., low sample size, outdated data, sampling from a small area of a bigger spatial range, or unable to differentiate sex-specific values)

Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or based only on length samples (e.g., ELEFAN)
Met	Single Criteria	What time series of length composition data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Are data that are to be used within an assessment collected using a different gear than used by fishers?	Yes	Data may create biased results in this method. Reconsider using the data or determine a modification of the data to approximate the selectivity of the fishery.
Is the biological data (e.g., length or age compositions) differentiated by sex?	No	This method assumes that the biological parameters and length composition is of female fish only. If sex is unknown, the method would assume both sexes have the same growth curve and always caught in equal proportions. If there are sex-specific differences and data is of an unknown sex, results may be biased.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	This method currently assumes asymptotic (logistic), time-independent selectivity and estimates selectivity within this form. Thus the method is sensitive to selectivity mis-specification (need to know if selectivity is asymptotic or dome-shaped). However, the method has trouble with estimation of selectivity, or can yield unrealistic estimates of selectivity. (Theoretically one could fix the value of selectivity and therefore explore different values as a sensitivity analysis).
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	Temporal changes in the fishery could compromise the interpretation of fishery-dependent time series data, if time series are being interpreted. Assumes equilibrium biomass.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
Additional assessment requirement: Assumes age- and time-independent mortality.
Can explicitly quantify uncertainty
Assumes B0 (i.e., the initial condition of the stock) is constant.
Links readily to/lends itself for use with the decision rules: "Catch Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point" and "Effort Limit: according to assessment outcomes (feedback): ii) target based with F- or biomass-based reference point"
The method treats each year as an independent estimate. Changes in selectivity across years may indicate recruitment events (unless that change in selectivity actually occurred), which may lead to a bias in estimates of F and SPR in this method.
This method assumes selectivity is S-shaped (logistic, asymptotic). Other selectivity curves can cause biased results in the SPR. For example, if dome-shaped selectivity is the true selectivity pattern, LBSPR estimates of SPR will be biased low.
Assumes equilibrium conditions
This method assumes one length composition per time entry (e.g., year). If the overall fishing mortality comes from multiple fleets, the user will need to determine how to sample and combine compositions from multiple fleets into one composition.
This method assumes some value for the variability in length by age, which is often presented as the coefficient of variation at length (CVL). This value is often assumed to be 0.1, but generally ranges from 0.05 to 0.2.

Mean length mortality estimators

Assessment Category: Size/Age-Based

Section: Assessment

Assessment Output: Fishing Rate

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (3 of 3 met)

Description

To estimate total mortality (Z) for a fished stock, the original Beverton-Holt mortality estimator used the von Bertalanffy growth parameters (K and L), the length at first capture (Lc), and the mean length of the catch. However, this method was rightly criticized for its reliance on equilibrium conditions. This is because Z can change for a variety of reasons, such as in response to increased fishing pressure or environmental changes. In response to such criticism, Gedamke and Hoenig (2006) developed a new procedure for estimating Z reliably (and also, therefore, fishing mortality rate [F]) in non-equilibrium conditions (i.e., when the stock has experienced different Z values throughout its history). Users must specify how many times mortality is thought to have changed, initial guesses of the years during which mortality is thought to have changed, and the original von Bertalanffy parameters K, L, Lc, and mean length to estimates Z and F. From there, maximum likelihood estimation (MLE) is used to calculate variable values with an associated confidence interval, so uncertainty is partially accounted for.
The following link may serve as a useful resource for this assessment option: [http://www.datalimitedtoolkit.org/] (http://www.datalimitedtoolkit.org/)

Contacts

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References

References
Gedamke, T., & Hoenig, J. M. (2006). Estimating mortality from mean length data in nonequilibrium situations, with application to the assessment of goosefish. Transactions of the American Fisheries Society, 135, 476-487. [http://dx.doi.org/10.1577/T05-153.1] (http://dx.doi.org/10.1577/T05-153.1)

Applications
Ault, Jerald S., Steven G. Smith, James A. Bohnsack, Jiangang Luo, Molly H. Stevens, Gerard T. DiNardo, Matthew W. Johnson, and David R. Bryan. 2018. Length-Based Risk Analysis for Assessing Sustainability of Data-Limited Tropical Reef Fisheries. ICES Journal of Marine Science. [https://doi.org/10.1093/icesjms/fsy123] (https://doi.org/10.1093/icesjms/fsy123) .
Gaertner, D. (2010). Estimates of historic changes in total mortality and selectivity for Eastern Atlantic skipjack (Katsuwonus pelamis) from length composition data. Aquatic Living Resources, 23(1), 3-11. [https://doi-org.proxy.library.ucsb.edu:9443/10.1051/alr/2009034] (https://doi-org.proxy.library.ucsb.edu:9443/10.1051/alr/2009034)

Hufnagl, M., Temming, A., Siegel, V., Tulp, I., & Bolle, L. (2010). Estimating total mortality and asymptotic length of Crangon crangon between 1955 and 2006. ICES Journal of Marine Science, 67(5), 875-884. [https://doi.org/10.1093/icesjms/fsq003] (https://doi.org/10.1093/icesjms/fsq003)
Huynh, Q. C., Cummings, N. J., & Hoenig, J. M. (2020). Comparisons of mean length-based mortality estimators and age-structured models for six southeastern US stocks. ICES Journal of Marine Science, 77(1), 162-173. [https://doi.org/10.1093/icesjms/fsz191] (https://doi.org/10.1093/icesjms/fsz191)
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Then, A. Y., Hoenig, J. M., & Huynh, Q. C. (2018). Estimating fishing and natural mortality rates, and catchability coefficient, from a series of observations on mean length and fishing effort. ICES Journal of Marine Science, 75(2), 610-620. [https://doi.org/10.1093/icesjms/fsx177] (https://doi.org/10.1093/icesjms/fsx177)

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (3 of 3 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or based only on length samples (e.g., ELEFAN)
Met	Multi A Met	What time series of length composition data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Met	Multi A Met	What time series of percentile length data (mean, median, x percentile) exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Are data that are to be used within an assessment collected using a different gear than used by fishers?	Yes	Data may create biased results in this method. Reconsider using the data or determine a modification of the data to approximate the selectivity of the fishery.

Yellow Caveats

Question	Answer	Caveat

Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output. This method does explicitly account for time-dependent selectivity.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Is the biological data (e.g., length or age compositions) differentiated by sex?	No	If there is a strong sexual differentiation in life history parameters resulting in mixed length compositions by sex, then you need to have some understanding of the sex composition of the sampling.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
The assessment has the ability to quantify output uncertainty.
Interpretation of results may be sensitive to major recruitment events.

Length-Only Integrated Model

Assessment Category: Size/Age-Based

Section: Assessment

Assessment Output: Stock Status

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (5 of 5 met)

Description

Length-Only Integrated models are a flexible age-based stock assessment method for fisheries with developing data collection programs and/or limited capacity for monitoring. These models expand on methods utilizing only length measurements by linking across years length samples and optionally incorporating recruitment, and thus variable fishing mortality. This approach reconciles multiple years of sampling length compositions removing the equilibrium assumption among years. Length-only integrated models require one year of length composition data (in which they behave more like LBSPR, but still can provide relative biomass, not just SPR, as an output) and assumptions about biological parameters. These are special cases of an general age-structure model, and thus further data (i.e., catch, indices or ages) could be included (and are reflected in other assessment options).

The following link may serve as useful resources for this assessment option:
Stock Synthesis - Length Only (SS-LO): [https://github.com/shcaba/SS-DL-tool] (https://github.com/shcaba/SS-DL-tool)
Length-based Integrated Mixed Effects (LIME): [https://github.com/merrillrudd/LIME] (https://github.com/merrillrudd/LIME)

Contacts

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Merrill Rudd: merrillrudd@gmail.com

References

References
Rudd, M. B., & Thorson, J. T. (2017). Accounting for variable recruitment and fishing mortality in length-based stock assessments for data-limited fisheries. Canadian Journal of Fisheries and Aquatic Sciences. [https://doi.org/10.1139/cjfas-2017-0143] (https://doi.org/10.1139/cjfas-2017-0143)

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (5 of 5 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available
Met	Single Criteria	Do you have an estimate of recruitment compensation (i.e., termed "steepness" in some stock-recruit relationships) for the species? Select the answer that best describes the source and uncertainty.	3: Yes, species-specific value with low to moderate uncertainty	1: Yes, expert opinion or non-species-specific value
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or based only on length samples (e.g., ELEFAN)
Met	Single Criteria	What time series of length composition data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Are data that are to be used within an assessment collected using a different gear than used by fishers?	Yes	Data may create biased results in this method. Reconsider using the data or determine a modification of the data to approximate the selectivity of the fishery.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.

Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	Temporal changes in the fishery could compromise the interpretation of fishery-dependent time series data, if time series are being interpreted.
Is the biological data (e.g., length or age compositions) differentiated by sex?	No	If there is a strong sexual differentiation in life history parameters resulting in mixed length compositions by sex, then you need to have some understanding of the sex composition of the sampling.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
Assumes B0 (i.e., the initial condition of the stock) is constant.
Life history values are fixed in these models, and therefore uncertainty about these values is underestimated. Sensitivity scenarios using different life history values should be used gauge how much model output changes given changes in life history inputs.
This method assumes some value for the variability in length by age, which is often presented as the coefficient of variation at length (CVL). This value is often assumed to be 0.1, but generally ranges from 0.05 to 0.2.

Length-based Bayesian Biomass Estimation (LBB)

Assessment Category: Size/Age-Based

Section: Assessment

Assessment Output: Stock Status

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option meets all criteria (4 of 4 met)

Description

The length-based Bayesian biomass estimation method (LBB) estimates relative abundance (i.e., stock status) using only length frequency data compiled from catches. To accomplish this, LBB uses Bayesian methods to estimate or set a prior on several life history traits typically provided as inputs. These estimated values can then be used in standard fishery models to estimate the spawning potential ratio. One should be aware of the assumed priors being used before applying this method. For further discussion into the technical nuances and assumptions, see the comment by Hordyk et al and response by Froese et al listed below.
The following link may serve as a useful resource for this assessment option:
[https://oceanrep.geomar.de/43182/] (https://oceanrep.geomar.de/43182/)
[https://oceanrep.geomar.de/44832/] (https://oceanrep.geomar.de/44832/)

Contacts

rfroese@geomar.de

References

Froese, R, et al. "A new approach for estimating stock status from length frequency data." ICES Journal of Marine Science 75.6 (2018): 2004-2015;
Hordyk, A.R., Prince, J.D., Carruthers, T.R., Walters, C.J., Comment on "A new approach for estimating stock status from length frequency data" by Froese et al. (2018). ICES J Mar Sci. https://doi.org/10.1093/icesjms/fsy168
Froese, R., Winker, H., Coro, G., Demirel, N., Tsikliras, A.C., Dimarchopoulou, D., Scarcella, G., Probst, W.N., Dureuil, M., Pauly, D., n.d. On the pile-up effect and priors for Linf and M/K: response to a comment by Hordyk et al. on "A new approach for estimating stock status from length frequency data." ICES J Mar Sci. https://doi.org/10.1093/icesjms/fsy199

Applications
See supplemental materials of Froese et al. 2018

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option meets all the criteria for your fishery. (4 of 4 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	3: Yes, estimated with low to moderate uncertainty
Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	3: Yes, estimated with low to moderate uncertainty (e.g., good sample size, up to date, covers the spatial range of the species)
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	3: Yes, estimated from age and length data with low to moderate uncertainty
Met	Single Criteria	What time series of length composition data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	4: Bias and imprecision are minimal. There are few, if any, flaws in time series data representativeness and sampling, and bias and imprecision are not a major concern. Examples: time series that cover recognized major removal histories, fleets and areas, as well as high resolution in species reporting and sufficient sample sizes to minimize imprecision.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Are data that are to be used within an assessment collected using a different gear than used by fishers?	Yes	Data may create biased results in this method. Reconsider using the data or determine a modification of the data to approximate the selectivity of the fishery.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.

Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	Temporal changes in the fishery could compromise the interpretation of fishery-dependent time series data, if time series are being interpreted. Assumes equilibrium biomass; beware changes in selectivity
Is the biological data (e.g., length or age compositions) differentiated by sex?	No	If there is a strong sexual differentiation in life history parameters resulting in mixed length compositions by sex, then you need to have some understanding of the sex composition of the sampling.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific
Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Assumes equilibrium conditions
The method treats each year as an independent estimate. Changes in selectivity across years may indicate recruitment events (unless that change in selectivity actually occurred), which may lead to a bias in estimates of F and B/B0 in this method.
This method assumes one length composition per time entry (e.g., year). If the overall fishing mortality comes from multiple fleets, the user will need to determine how to sample and combine compositions from multiple fleets into one composition.
This method assumes some value for the variability in length by age, which is often presented as the coefficient of variation at length (CVL). This value is often assumed to be 0.1, but generally ranges from 0.05 to 0.2.

Catch Curve Stock-Reduction Analysis (CC-SRA)

Assessment Category: Size/Age-Based

Section: Assessment

Assessment Output: Stock Status

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (5 of 6 met)

Description

CC-SRA combines a catch curve analysis (see this assessment method for more details) and a stock-reduction analysis (see this assessment method for more details) to estimate fishing mortality and sustainable catch. The use of age frequency data theoretically allows one to bypass the requirement for a stock status estimate as an input or prior, which is a typical requirement of many catch-based assessment methods.
The following link may serve as a useful resource for this assessment option:
[https://github.com/James-Thorson/CCSRA] (https://github.com/James-Thorson/CCSRA)

Contacts

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References

Thorson, J and J.M. Cope. 2015. Catch curve stock-reduction analysis: An alternative solution to the catch equations. Fisheries Research 171: 33-41.

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (5 of 6 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	**Single Criteria**	**What time series of total removal data exists?**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.**	**3: Moderate to low bias, but high imprecision in time series. Moderate flaws that don't significantly bias time series data representativeness, but do create significant imprecision. Examples: "partial" time series that reflect only most major years of removals and major fleets/metiers; sampling that covers most of the temporal-spatial extent of the fishery, and is generally reported at species level (low bias), but sample sizes may be low (high imprecision).**
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	3: Yes, estimated with low to moderate uncertainty
Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	3: Yes, estimated with low to moderate uncertainty (e.g., good sample size, up to date, covers the spatial range of the species)
Met	Single Criteria	Do you have a length-weight relationship for the species? Select the answer that best describes the source and uncertainty.	3: Yes, species-specific value with low to moderate uncertainty	1: Yes, expert opinion or non-species-specific value

Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	3: Yes, estimated from age and length data with low to moderate uncertainty
Met	Single Criteria	What time series of length composition data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Are data that are to be used within an assessment collected using a different gear than used by fishers?	Yes	Data may create biased results in this method. Reconsider using the data or determine a modification of the data to approximate the selectivity of the fishery.

Yellow Caveats

Question	Answer	Caveat
Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	Temporal changes in the fishery could compromise the interpretation of fishery-dependent time series data. Be sure to track these changes in the input data and model parameterization.
Is the biological data (e.g., length or age compositions) differentiated by sex?	No	If there is a strong sexual differentiation in life history parameters resulting in mixed length compositions by sex, then you need to have some understanding of the sex composition of the sampling.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific

Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
If only 1 year of data, assumes equilibrium conditions.

Catch and Length Integrated Model

Assessment Category: Size/Age-Based

Section: Assessment

Assessment Output: Stock Status

Assessment 'Tier': Mid-tier

Fishery: Smooth hammerhead shark, U.S. Atlantic and Gulf of Mexico

This option does NOT meet all criteria (8 of 9 met)

Description

Catch and length integrated models expand length-only integrated models by incorporating catch time series (see that option for more details). Combining catch and length into an integrated model has been shown to reduce bias and error of the results when compared to catch- or length-only models (Rudd et al. 2020). Similar to length-only integrated models, these models directly address and remove the need for the equilibrium assumption that is needed in length-only methods (e.g., LB-SPR). Catch and length integrated models require a catch time series, at least one year of length data, and assumptions about biological parameters. Abundance indices may be incorporated as well, but are not required.

The following link may serve as a useful resource for this assessment option:
Stock Synthesis - Length Only (SS-LO): [https://github.com/shcaba/SS-DL-tool] (https://github.com/shcaba/SS-DL-tool)
Length-based Integrated Mixed Effects (LIME): [https://github.com/merrillrudd/LIME] (https://github.com/merrillrudd/LIME)

Contacts

Jason Cope: jason.cope@noaa.gov

References

Pons, M., Cope, J. M., and Kell, L. T. (2020). Comparing performance of catch-based and length-based stock assessment methods in data-limited fisheries. Can. J. Fish. Aquat. Sci. 77, 1026-1037. doi: 10.1139/cjfas-2019-0276
Rudd, M. B., & Thorson, J. T. (2017). Accounting for variable recruitment and fishing mortality in length-based stock assessments for data-limited fisheries. Canadian Journal of Fisheries and Aquatic Sciences. [https://doi.org/10.1139/cjfas-2017-0143] (https://doi.org/10.1139/cjfas-2017-0143)
Rudd, M.B., Cope, J.M., Wetzel, C.R., Hastie, J., 2021. Catch and Length Models in the Stock Synthesis Framework: Expanded Application to Data-Moderate Stocks. Frontiers in Marine Science 8, 1119. [https://doi.org/10.3389/fmars.2021.663554] (https://doi.org/10.3389/fmars.2021.663554)

User Notes About This Option

No user notes were recorded at the time of report generation.

Criteria

This option does not meet the criteria for your fishery. (8 of 9 met)

Met/ Failed	Single or Multi?	Question	Answer	Minimum Criteria
Failed	**Single Criteria**	**What time series of total removal data exists?**	**2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.**	**3: Moderate to low bias, but high imprecision in time series. Moderate flaws that don't significantly bias time series data representativeness, but do create significant imprecision. Examples: "partial" time series that reflect only most major years of removals and major fleets/metiers; sampling that covers most of the temporal-spatial extent of the fishery, and is generally reported at species level (low bias), but sample sizes may be low (high imprecision).**
Met	Single Criteria	Do you have an estimate of the natural mortality (M) of the species? Select the answer that best describes the source and uncertainty.	3: Yes, estimated with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived
Met	Single Criteria	Do you have a maturity ogive (cumulative frequency graph) or a size-at-maturity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or when only one maturity metric (e.g., L50%) is available

Met	Single Criteria	Do you have a length-fecundity relationship for the species? Select the answer that best describes the source and uncertainty.	1: Use model default	1: Use model default
Met	Single Criteria	Do you have an estimate of recruitment compensation (i.e., termed "steepness" in some stock-recruit relationships) for the species? Select the answer that best describes the source and uncertainty.	3: Yes, species-specific value with low to moderate uncertainty	1: Yes, expert opinion or non-species-specific value
Met	Single Criteria	Do you have the level of recruitment variability (i.e., sigmaR) for the species? Select the answer that best describes the source and uncertainty.	1: Yes, expert opinion or non-species-specific value	1: Yes, expert opinion or non-species-specific value
Met	Single Criteria	Do you have a length-weight relationship for the species? Select the answer that best describes the source and uncertainty.	3: Yes, species-specific value with low to moderate uncertainty	1: Yes, expert opinion or non-species-specific value
Met	Single Criteria	Do you have estimates of the von Bertalanffy growth parameters? Select the answer that best describes the source and uncertainty.	3: Yes, estimated from age and length data with low to moderate uncertainty	1: Yes, taxonomically (i.e., nearest taxonomic neighbor) or empirically derived, or based only on length samples (e.g., ELEFAN)

Met	Single Criteria	What time series of length composition data exists?	2: Significant bias in time series. Major flaws that significantly bias time series data representativeness. Examples: missing years of major removals; missing catch contributions of major fleets/metiers; and, significant gaps in reporting, species identification, and/or spatial sampling of fisheries.	1: Snapshot (1-2 years of data only). Use caution when applying all snapshot data, but be especially careful with data that is poorly sampled or poorly representative.

Caveats and Attributes

Red Caveats

Question	Answer	Caveat
Is the range of the fished population greater than the area in which fishing or sampling occurs, or the jurisdictional management boundary?	**Yes**	**If data are not representative of the stock as a whole, the information may not represent the unit you are trying to manage**

Orange Caveats

Question	Answer	Caveat
Is the species being actively and consistently targeted?	No	If there have been changes in targeting practices, time series of data may not be commensurate because of changes in catchability. Caution should be applied in interpreting temporal trends in indicators.
Are data that are to be used within an assessment collected using a different gear than used by fishers?	Yes	Data may create biased results in this method. Reconsider using the data or determine a modification of the data to approximate the selectivity of the fishery.

Yellow Caveats

Question	Answer	Caveat

Do you know the selectivity, or selectivities of the fleet(s) or gear type(s)? Select the answer that best applies.	1: Able to be inferred by expert opinion or very limited direct measurements (e.g., L50, L95), with some uncertainty in the exact shape	Need selectivity to at least be able to be inferred. If selectivity is unknown, you need to be more mindful of your uncertainty (e.g. undertake sensitivity analysis to alternate forms of selectivity). Selectivity is a very influential parameterisation - logistic vs dome-shaped can produce very different results. Particular care needs to be taken if the fishery has multiple fleets or gear types targeting or selecting different size ranges of the same species. Knowing every fishery isn't necessarily required, but understanding the predominant selectivity is important. Note that most methods cannot handle multiple selectivities, so an overall single estimate will be required in most cases. Interpret your results with a clear awareness of the selectivity assumptions.
Has the selectivity pattern changed over time?	Unknown	Time series data may not be commensurate if the selectivity has changed: changing selectivity may change your interpretation of the method's output.
Are data that are to be used in an assessment representative of the spatial extent of the fleet and fishers? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the spatial extent of the fleet, the information may not represent the unit you are trying to manage.
Has anything in the fishery changed over time that would impact your interpretation of the data?	Yes	Temporal changes in the fishery could compromise the interpretation of fishery-dependent time series data, if time series are being interpreted.
Is the biological data (e.g., length or age compositions) differentiated by sex?	No	If there is a strong sexual differentiation in life history parameters resulting in mixed length compositions by sex, then you need to have some understanding of the sex composition of the sampling.
Is the life history of the species sex-specific?	Yes	Be cautious regarding the interpretation of life-history parameters that may be sex-specific

Are data that are to be used in an assessment representative of the activities of the fleet and fisher characteristics? Select the answer that best applies.	Mostly, but with some representativeness issues in the data	If data are not representative of the activities of the fleet, the information may not represent the unit you are trying to manage.
Does the species change sex?	No	The treatment of life history information should be carefully considered when a species is a sequential hermaphrodite. Stock Synthesis can accommodate hermaphroditic life histories. This flexibility should be checked for non-SS frameworks.

Positive Attributes

There are no positive attributes.

Static Caveats

These caveats always apply to this option.

Static Caveat
Consider whether catchability varies in time or space (e.g. if environmental, oceanographic, weather, temperature conditions affect either fish availability or fishing gear effectiveness).
Assumes B0 (i.e., the initial condition of the stock) is constant.
This method assumes some value for the variability in length by age, which is often presented as the coefficient of variation at length (CVL). This value is often assumed to be 0.1, but generally ranges from 0.05 to 0.2.
Life history values are fixed in these models, and therefore uncertainty about these values is underestimated. Sensitivity scenarios using different life history values should be used gauge how much model output changes given changes in life history inputs.