Glossary of Analyses and Procedures for the EBFM Decision Support Tool

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Definitions, applications, and supporting references

SEDAR 103 working-paper companion | Draft for review

How to use this glossary

This glossary defines the analytical methods, diagnostic procedures, and management processes referenced in the decision tree. NOAA Fisheries definitions or guidance are used whenever an established NOAA usage is available. Terms marked **operational definition** are proposed specifically for this decision-support tool and should not be interpreted as formal NOAA, Council, SSC, or SEDAR terminology. Software-specific methods are defined from their original methodological literature or the PRIMER/PERMANOVA+ manuals.

Analytical and diagnostic terms

ANOSIM

Analysis of similarities (ANOSIM) is a nonparametric permutation test that evaluates whether ranked between-group dissimilarities are systematically greater than ranked within-group dissimilarities for groups defined a priori. Its R statistic generally ranges from −1 to 1: values near 0 indicate little group separation, whereas positive values approaching 1 indicate stronger separation. Because ANOSIM can respond to differences in group location and dispersion, results should be interpreted with ordination and multivariate-dispersion diagnostics (Clarke, 1993; Clarke et al., 2014).

PERMANOVA

Permutational multivariate analysis of variance (PERMANOVA) partitions variation in a resemblance matrix according to an ANOVA-style design and evaluates factors, interactions, and covariates using a pseudo-F statistic and permutations. It supports complex designs and user-selected distance or dissimilarity measures. Significant results should be evaluated alongside multivariate dispersion, because differences in group centroids and within-group dispersion can both affect interpretation (Anderson, 2001; Anderson et al., 2008).

Temporal ordering

Temporal ordering establishes whether a proposed driver changes before the response it is hypothesized to influence. Evaluation requires aligned observation periods, an a priori biologically or operationally plausible lag, and consideration of autocorrelation and sampling timing. Temporal precedence strengthens a causal interpretation but is not sufficient by itself; competing explanations and plausible mechanisms must also be evaluated (Grace, 2006; Shipley, 2016).

Collinearity diagnostics

Collinearity diagnostics evaluate whether predictor variables contain redundant information that can destabilize coefficients, obscure individual effects, and alter model selection. Common tools include correlation or draftsman plots, variance inflation factors, condition indices, and sensitivity to variable inclusion. Strongly collinear variables may be removed, combined, or represented by a justified proxy before DISTLM or structural equation modelling, with all decisions documented (Dormann et al., 2013; Anderson et al., 2008).

SIMPROF

Similarity profile analysis (SIMPROF) is a family of permutation tests for detecting nonrandom multivariate structure when groups are not specified a priori. With clustering, it tests whether samples within a dendrogram branch contain structure beyond that expected under a null model; inverse or Type 3 applications can identify groups of species that covary coherently. SIMPROF supports the interpretation of clusters but does not identify the causes of the observed pattern (Clarke et al., 2008; Somerfield and Clarke, 2013).

Clustering

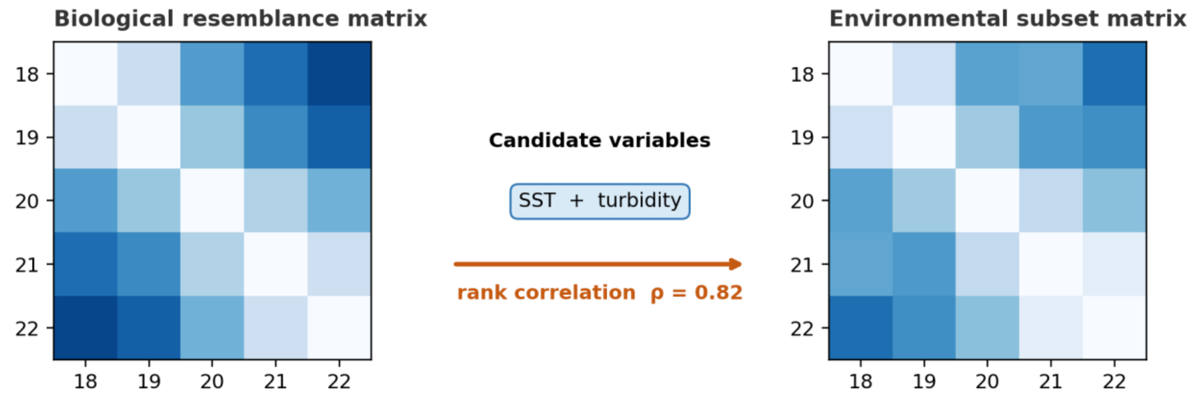
Cluster analysis groups samples or variables according to their resemblance, commonly using a hierarchical agglomerative algorithm applied to a distance or similarity matrix. The resulting dendrogram displays nested structure and possible groups, but results depend on data transformation, the resemblance measure, and the linkage method. SIMPROF can be used to test whether apparent groups contain structure beyond random variation (Clarke et al., 2014; Legendre and Legendre, 2012).

Multivariate dispersion

Multivariate dispersion is the spread of observations around a group centroid or spatial median in the space defined by a resemblance measure. PERMDISP tests whether average within-group dispersion differs among groups and is a multivariate analogue of a test for homogeneity of variances. It helps distinguish a shift in group composition or centroid from a change in variability, which is important when interpreting ANOSIM or PERMANOVA (Anderson, 2006; Anderson et al., 2008).

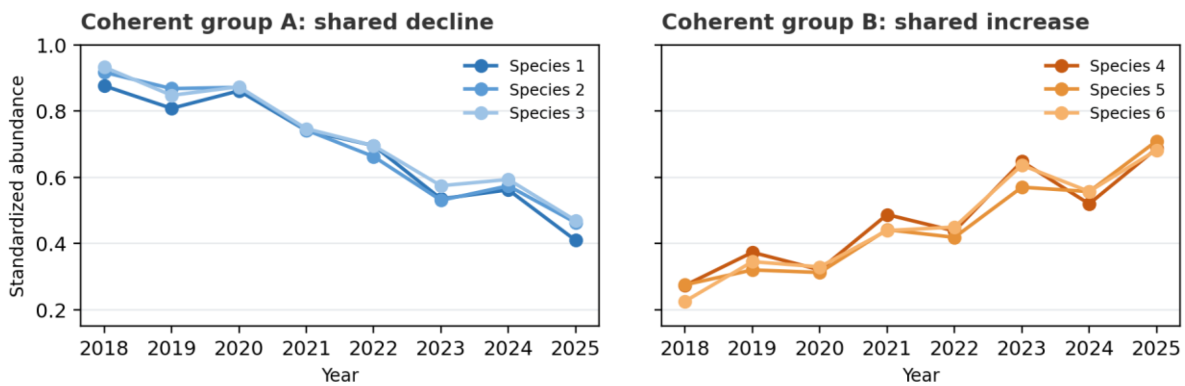
BIOENV

A nonparametric matching procedure that searches combinations of explanatory variables to identify the subset whose resemblance matrix has the highest rank correlation with the biological resemblance matrix. BIOENV identifies statistical correspondence, not causation, and should be interpreted alongside ecological knowledge, temporal ordering, and collinearity diagnostics. In this decision tree it is used to screen for environmental, habitat, or socioeconomic variables that may correspond with assemblage or landings change (Clarke and Ainsworth, 1993; Clarke et al., 2014).



Coherent-species analysis

An inverse multivariate procedure that groups species exhibiting statistically coherent patterns across samples, usually using Type 3 SIMPROF and clustering, and displays their standardized trajectories as coherent curves. It helps replace a long list of species-specific responses with interpretable groups of species that covary through time or space. The result describes shared response patterns; it does not by itself establish a common causal mechanism (Somerfield and Clarke, 2013; Clarke et al., 2014).



Decomposition of dissimilarities

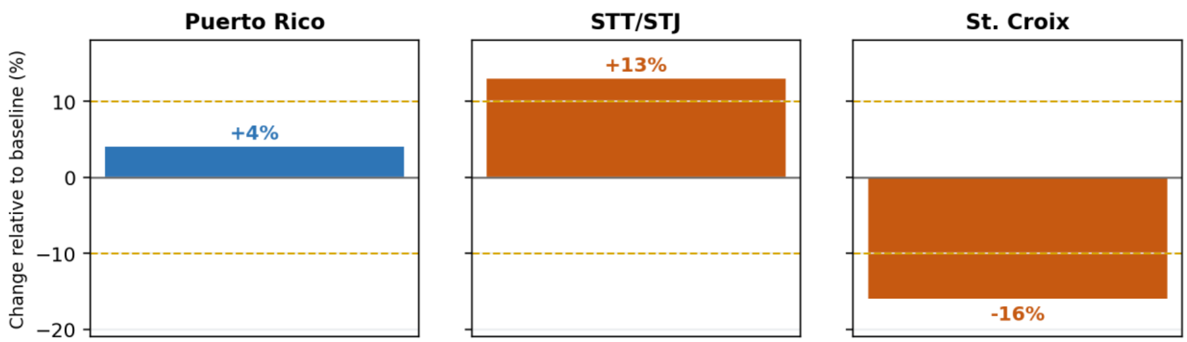
The partitioning of the average dissimilarity between samples or groups into contributions from individual species or variables. In PRIMER this is commonly implemented with SIMPER. The procedure helps identify which species or variables account for an observed multivariate change, but contributions can be influenced by abundance, variability, transformation, and correlations and should not be treated as formal tests of importance (Clarke, 1993; Clarke et al., 2014).

DISTLM — distance-based linear modelling

A regression framework that partitions variation in a multivariate response resemblance matrix among one or more predictor variables, with inference based on permutations. It can estimate marginal and sequential contributions, support model selection, and accommodate resemblance measures such as Bray–Curtis that are unsuitable for conventional multivariate regression. In the decision tree, DISTLM evaluates the amount of biological variation associated with environmental, habitat, fishery, or socioeconomic predictors; association should not be equated with causation (McArdle and Anderson, 2001; Anderson et al., 2008).

Evaluation of spatial heterogeneity

An assessment of whether the direction, magnitude, composition, or variability of change differs among management units, regions, habitats, depths, or survey domains. It can include stratified summaries, maps, interaction terms, multivariate dispersion, and region-specific analyses. Within the decision tree, it determines whether an apparent ecosystem signal is localized, widespread, or masked by spatial aggregation (Legendre and Legendre, 2012; Anderson et al., 2008).



Integrated diagnostic — operational definition

A structured synthesis undertaken when multiple programs or ecosystem components show change. It compares standardized rates and directions of change, evaluates temporal and spatial concordance, identifies the taxa or variables responsible, and develops competing explanations using all relevant biological, environmental, habitat, fishery, and socioeconomic evidence. Its purpose is to support an integrated management interpretation, consistent with NOAA's use of integrated ecosystem assessments, rather than to force all data into a single model (Levin et al., 2009; NOAA Fisheries, 2024a).

Methodological comparability

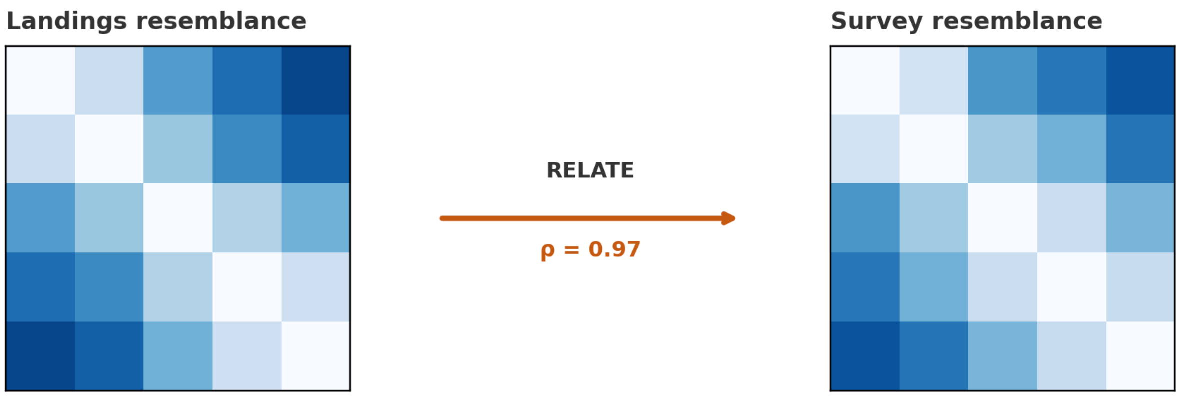
The degree to which estimates from different surveys, programs, years, or regions can be validly compared after considering sampling design, gear, effort, detectability, spatial and habitat coverage, season, taxonomic resolution, measurement units, transformations, and quality-control procedures. Comparable methods need not be identical, but differences must be documented and adjusted or explicitly carried as uncertainty before signals are combined (National Academies of Sciences, Engineering, and Medicine, 2017; Clarke et al., 2014).

Program-specific diagnostic — operational definition

A focused review initiated when only one monitoring program detects change. It checks data integrity, sampling effort, station and habitat coverage, field and laboratory methods, taxonomic consistency, detectability, extreme observations, and program-specific spatial or temporal patterns before the signal is given an ecosystem interpretation. The purpose is to distinguish a credible localized signal from a methodological or data-processing artifact.

RELATE

A PRIMER permutation test of the rank correlation between two resemblance matrices describing the same observations. It is commonly used to evaluate whether two multivariate patterns—for example, landings and survey assemblages—change in corresponding ways. RELATE tests overall pattern agreement; it does not identify the variables responsible or demonstrate a causal relationship (Clarke and Gorley, 2015; Clarke et al., 2014).



Retrospective analysis

An analysis that repeatedly removes recent observations or otherwise recreates what would have been known in earlier years to evaluate the stability of an indicator, model, threshold, or management conclusion. In this decision tree, retrospective analysis is used to examine false alarms, missed changes, sensitivity to the baseline period, and whether the proposed screening threshold would have produced consistent decisions through time (Mohn, 1999; ICES, 2021).

Sensitivity testing

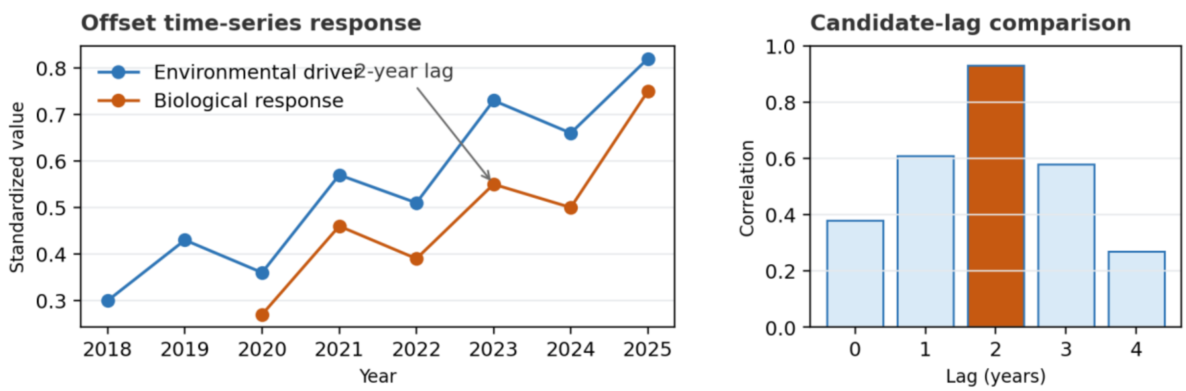
A systematic evaluation of how conclusions change when plausible analytical choices or assumptions varied. Relevant choices include the screening threshold, baseline period, transformation, standardization, resemblance measure, spatial scale, missing-data treatment, and survey inclusion rules. A robust decision signal should persist across a defensible range of choices; sensitivity is evidence of uncertainty that should be reported, not concealed (Saltelli et al., 2008; National Academies of Sciences, Engineering, and Medicine, 2017).

Structural equation modelling (SEM)

A family of models that represents hypothesized networks of direct and indirect relationships among observed or latent variables. SEM can compare alternative causal structures and estimate pathway strengths, but causal interpretation depends on a priori hypotheses, appropriate temporal and spatial design, adequate sample size, and model fit. In this tool it is a hypothesis-evaluation method for linked ecosystem components, not an automatic causal-discovery procedure (Grace, 2006; Shipley, 2016).

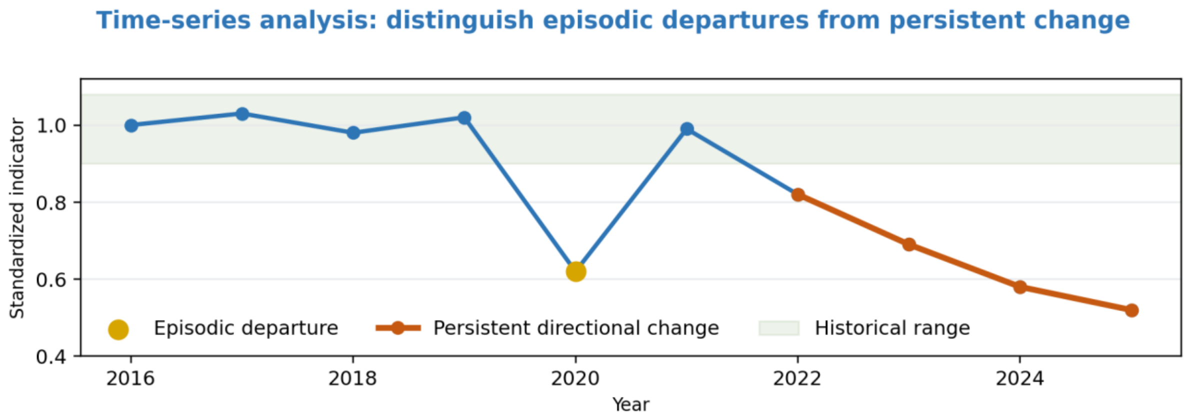
Temporal lag

A delay between a change in one component and a detectable response in another, such as a habitat or environmental change preceding recruitment, survey abundance, landings, or socioeconomic effects. Lag analysis evaluates whether relationships strengthen when one time series is shifted relative to another. Plausible lags should be specified from life history, survey timing, and fishery processes; unrestricted searching across many lags can produce spurious correlations (Legendre and Legendre, 2012).



Time-series analysis

The analysis of observations ordered through time to describe trend, seasonality, cycles, abrupt changes, persistence, autocorrelation, and forecast uncertainty. Because adjacent years are often not independent, methods should account for temporal dependence and changes in observation processes. In the decision tree, time-series analysis determines the direction, magnitude, duration, and persistence of component-specific changes (Hyndman and Athanasopoulos, 2021).



Ecological and management procedures

Adaptive management

An iterative, structured approach in which management objectives and actions are specified, outcomes are monitored, results are evaluated, and decisions are reconsidered as new information becomes available. NOAA Fisheries describes EBFM as an adaptive process in which science and management are updated, improved, and iterated. In this decision-support tool, repeated screening cycles provide the feedback needed to determine whether detected signals persist, whether proposed explanations remain supported, and whether management responses remain appropriate. Adaptive management does not bypass Council, SSC, statutory, or regulatory procedures; it requires explicit objectives, indicators, monitoring, review intervals, decision criteria, documentation, and a process for revising actions when warranted (NOAA Fisheries, 2024a, 2026e).

Biodiversity and functional indicators

Quantitative measures summarizing biological variety or ecosystem roles. Biodiversity indicators may represent richness, evenness, composition, or turnover; functional indicators may represent traits, trophic groups, size structure, functional diversity, or key ecological processes. NOAA uses suites of ecosystem indicators to describe ecosystem status and trends; no single indicator should be assumed to represent overall ecosystem condition (Shin et al., 2010; NOAA Fisheries, 2024b).

Buffering / precautionary buffer — operational definition

A temporary, explicitly justified increase in management precaution when exposure, vulnerability, or uncertainty is high—for example, a downward adjustment to a catch target or additional distance between a limit and an operational target. NOAA's catch-setting process similarly uses reductions from the overfishing limit to account for scientific uncertainty and may set annual catch targets below annual catch limits to account for management uncertainty. Any buffer proposed here would require the appropriate Council, SSC, and legal process and should specify its basis, duration, and removal criteria (NOAA Fisheries, 2026a).

Ecosystem-level indicators

Measures selected to track the state, pressure, or response of the broader social–ecological system rather than a single stock. Examples include community composition, trophic structure, habitat condition, climate exposure, fishery diversity, and community dependence. NOAA presents ecosystem indicators as status-and-trend information and uses them in ecosystem assessments and EBFM; their management role and trigger logic must be stated explicitly (Link, 2005; NOAA Fisheries, 2024a, 2024b).

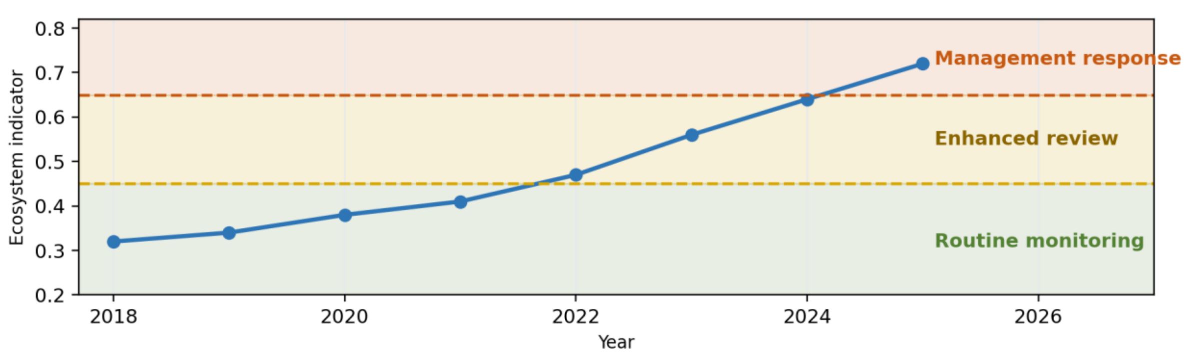
Ecosystem Status Report (ESR)

A recurring compilation and synthesis of ecosystem indicators relevant to marine resource management. NOAA Fisheries uses Ecosystem Status Reports to summarize status and trends in climate and ocean conditions, habitats, biological communities, fisheries, and human dimensions; in some regions, these reports are presented annually to fishery management councils. For the USCFE decision-support tool, an ESR could serve as the principal recurring product for each management unit, documenting screening results, component-specific and multi-component diagnostics, spatial patterns, uncertainties, management interpretations, and recommended follow-up actions. An ESR provides ecosystem context and supports adaptive management, but it is not a stock assessment, a formal stock-status determination, or a management decision by itself (NOAA Fisheries, 2024b, 2026e).

Ecosystem reference point (ERP) — operational definition

A predefined ecosystem indicator value, range, or condition used to place stock or fishery information in ecosystem context and support a specified management response. Unlike statutory stock-status reference points, an ERP is not automatically a legal determination of overfishing or overfished status. For this tool, any ERP should identify the indicator, baseline, direction of concern, uncertainty, decision consequence, review frequency, and governance process (Link, 2005; NOAA Fisheries, 2024a).

Ecosystem reference point: indicator zones are linked in advance to specified responses



Essential Fish Habitat (EFH) review

An evaluation of whether new information or detected habitat change affects the description, identification, mapping, or conservation of habitat necessary for federally managed fish to spawn, breed, feed, or grow to maturity. Under the Magnuson–Stevens Act, councils periodically review EFH information, and federal actions that may adversely affect EFH require consultation with NOAA Fisheries. In this tool, an EFH review may lead to updated habitat information, conservation recommendations, or coordination; it is not itself an automatic fishing restriction (NOAA Fisheries, 2025a, 2026b).

Examination of trophic or multispecies consequences

An evaluation of whether observed change may alter predator–prey relationships, competition, forage availability, mortality, energy flow, or the productivity of managed species. Approaches range from diet and functional-group indicators to multispecies and food-web models. NOAA treats such ecosystem models as decision-support tools that connect single-species advice to ecosystem context; results should be presented with model assumptions and uncertainty (NOAA Fisheries, 2023a; Link, 2010).

Precautionary review — operational definition

A structured, time-limited review initiated when a persistent, widespread, or biologically consequential signal is detected but the evidence is insufficient for a stock-status conclusion or immediate regulatory action. The review validates the signal, assesses exposure and vulnerability, examines alternative explanations, identifies information gaps, and determines whether enhanced monitoring, assessment prioritization, or interim precaution is warranted. It is an evidence-review step, not a formal NOAA stock-status determination (FAO, 1996; Link, 2005).

Risk assessment

A systematic process for identifying stressors or hazards, characterizing exposure and consequences, evaluating uncertainty, and ranking the likelihood or relative severity of adverse outcomes. NOAA describes ecosystem risk assessments as standardized, flexible, and transparent tools that integrate ecosystem information to identify science or management priorities. In this decision tree, a risk assessment provides context and prioritization; it does not by itself prescribe a management action (NOAA Fisheries, 2023b).

Scenario development / scenario planning

A structured process for constructing multiple plausible—not necessarily predicted—future conditions and testing which strategies remain useful across them. NOAA defines scenario planning as a method for identifying uncertainties and determining options that can meet management goals across multiple possible future conditions. It is most useful when uncertainty is high and managers have limited control over future drivers (Frens and Morrison, 2020; NOAA Fisheries, 2025b).

Sentinel species

A species or taxonomic/functional group whose measurable response provides an early or informative signal of change in ecosystem conditions, pressures, or processes. Selection should be justified by responsiveness, ecological relevance, detectability, monitoring feasibility, and the reliability of the link to the condition of interest. A sentinel is an indicator, not necessarily the species most affected or the cause of change (NOAA Fisheries, 2025c).

Single-species assessment (SSA)

In this document, SSA refers to any analyses (including stock assessment) focused on one managed species or stock. NOAA defines a stock assessment as the collection and analysis of biological and statistical information used to determine changes in stock abundance in response to fishing and, where possible, predict future trends. Assessments provide the scientific basis for stock-status determinations and sustainable harvest advice; the exact model complexity depends on available data and management needs (NOAA Fisheries, 2025d).

Stock-assessment prioritization

An objective and transparent process for deciding which stocks should be assessed, at what analytical level, and how frequently, given management needs, data, risk, value, and limited assessment capacity. NOAA's national framework organizes stocks, develops prioritization scores, identifies target assessment levels and frequencies, and uses regional management weights to establish annual priorities. A decision-tree signal would inform this process rather than automatically require an SSA (NOAA Fisheries, 2021).

Vulnerability analysis

An evaluation of which species, habitats, fisheries, or communities are most susceptible to harm and why. NOAA climate vulnerability assessments generally combine exposure to projected environmental change with biological or social sensitivity and, where applicable, adaptive capacity. In this tool, vulnerability analysis helps identify priorities for monitoring, research, adaptation, and precaution; it does not measure current stock status (NOAA Fisheries, 2026c).

Human-dimensions and reporting terms

Economic impact analysis

An analysis of how a proposed action or external change affects economic activity, such as revenues, income, employment, costs, business activity, and regional economic contributions. Economic impacts are distinct from net economic benefits and costs, although both may be relevant to regulatory analysis. NOAA guidance calls for economic and social analyses to address the effects of management actions on fishery participants, neighboring fisheries, and fishing communities (NOAA Fisheries, 2024c).

Fishery Performance Report (FPR) — operational definition

A concise, recurring report that integrates quantitative fishery and socioeconomic indicators with stakeholder observations to describe recent fishery performance, emerging issues, data limitations, and management-relevant changes. In this decision tree the FPR is a communication and diagnostic product, not a stock assessment or a formal NOAA-required report. Its proposed content may include landings, effort, participation, prices, costs, access, infrastructure, community effects, compliance, and local ecological knowledge.

Local ecological knowledge (LEK)

Place-based knowledge developed through repeated observation and experience by fishers, resource users, and community members concerning species, habitats, environmental conditions, and fishery dynamics. LEK can help interpret survey signals, identify historical baselines and spatial patterns, and formulate hypotheses, especially in data-limited settings. It should be collected using transparent social-science methods and evaluated as a complementary evidence stream rather than treated as interchangeable with standardized monitoring data (McLean et al., 2022; Sjostrom et al., 2021).

Quantitative socioeconomic indicators

Numerical measures that track the condition or change of fishery participants and communities, including fishing engagement and reliance, employment, income, revenue, operating costs, participation, access, demographic conditions, infrastructure, and social vulnerability. NOAA's Community Social Vulnerability Indicators classify fishing dependence and describe social, economic, demographic, land-use, and sea-level-risk conditions. Indicator direction, scale, comparability, and affected population must be specified (NOAA Fisheries, 2026d).

Social impact analysis (SIA)

A systematic assessment of the likely social consequences of a proposed management action for fishery participants, fishing communities, neighboring fisheries, and relevant demographic or cultural groups. NOAA's fisheries SIA guidance emphasizes identifying affected groups, baseline conditions, distributional effects, community vulnerability, engagement, and uncertainty. An SIA evaluates management alternatives; it is distinct from monitoring a socioeconomic signal before an action is proposed (Clay and Colburn, 2020; NOAA Fisheries, 2024c).

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