FishSource Method for Evaluating Fishery Impact on the Environment

SFP Environment Risk Rating System

Version 2

2017

FishSource method for evaluating fishery impact on the environment; SFP Environment Risk Rating System (version 2)

Nicole Portley | Senior Scientist, SFP[1]

Pedro Sousa | Chief Scientist, SFP

Isidora Katara | Fisheries Data Analyst, SFP

CITATION

Portley, N., Sousa, P., and Katara, I., 2017. *FishSource Method for Evaluating Fishery Impact on the Environment; SFP Environment Risk Rating System (version 2)*. Sustainable Fisheries Partnership Foundation.

ACKNOWLEDGMENTS

We are indebted to many SFP colleagues for their help. The FishSource team provided highly valuable comments regarding the inadequacies of version 1; in particular, we thank Susana Segurado, Alexia Morgan, Marina Mendes, Pedro Veiga, Patrícia Amorim, Christie Hendrich, Matt Cieri, and Mariana Bock for their input. Thanks to Megan Westmeyer for her insightful comments and Jessica Beels for editing the document. We are grateful to Jack Whalen for working closely with us on analyzing the external review of the FishSource method, providing a thorough response and storing key lessons learned. Robert Blyth-Skyrme worked closely with us on analyzing the limitations of version 1 of the method and identifying areas for improvement, and Dr. Kevin Stokes provided a valuable critique of the method. We are indebted to Merul Patel, who brought our vision to life through his programming wizardry. Finally, we would like to thank the external reviewers, Dr. Eric Gilman and Dr. Robin Pelc, for their guidance and useful feedback.

[1] 2010-2015

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

In 2010, SFP launched its first comprehensive fishery risk rating system (Sousa and Cannon, 2010). The developed algorithms generated two ratings for target stock health and fisheries governance based on five FishSource scores (Cannon, 2006). A separate set of algorithms yielded a third rating for the environmental impact of fishing. The input for these algorithms was a number of factors, hereafter referred to as *parameters*, Boolean responses to questions grouped under five sub-categories: ETP species, bycatch, habitat, marine protected areas (MPAs), and ecosystem.

The application of an approach using parameters, as defined in the first version of the fishery risk-rating system to evaluate the environmental impact of fisheries, proved difficult and inconsistent for four key reasons:

1. The Boolean nature of the *parameters* (allowing only yes or no as answers).
2. Circularity/dependence among *parameters*, rendering inconsistency at the outset and increased difficulty in detecting what real environmental factors determined any given risk-rating outcome.
3. Lack of comparability/alignment with state-of-the-art fisheries evaluation methodologies.
4. Vagueness of terms and/or lack of guidance for the use of the *parameters*.

Altogether, these and other limitations, along with an unorthodox way of populating FishSource fishery profiles, rendered the *parameters* inefficient and, in terms of analysis, time-consuming for the FishSource profile developers. Some of the limitations were detected early on, and a sub-contractor working with the FishSource team systematically proposed improvements to address the deficiencies (Ichthys Marine, 2012). This work gained momentum after an external review of the FishSource method and associated algorithms was conducted in late 2011 (Stokes, 2011) to which SFP responded with a detailed report (Sousa, 2011; Whalen, 2011) yielding valuable lessons for improvement of the method. Lack of dedicated funding, among other limitations, has prevented the implementation of any of those improvements, and although the *parameters* have for years generated the ratings visible to supply chain partners in the SFP Metrics system, they have never been made public on FishSource.

In late 2014, access to funding for development of a new, completely revised version of the FishSource website allowed the FishSource team to refocus efforts to address the limitations of the environmental method and rating system. This document presents version 2 of the method and guidance for application.

METHODOLOGY

The FishSource Environment Method, version 2, replaces version 1 (the *parameters*) and comprises 12 scores nested within three principles (bycatch, habitat, and ecosystem) and three criteria[2] (information, outcome, and management) (see Table 1). The principle-criteria structure of the method is based on the framework of ecological risk assessment (ERA) for fisheries (Fletcher, 2005; Hobday et al., 2011), a method widely accepted by policy makers and eco-labeling organizations, that works with a three-level hierarchy from qualitative to quantitative evaluations (CSIRO Australia, 2009). The three principles address the main areas in which fisheries impact the environment, excluding the target species (Garcia, 2003; Hobday et al., 2011). The three criteria assess the magnitude of the impact (outcome), the measures taken to mitigate the impacts (management), and uncertainty due to absence or low quality of available information (information) for each principle. Outcome and management criteria correspond, at least partially, to the Pressure-State-Response (PSR) Framework (FAO, 1997). The developed methodology aims to derive qualitative risk ratings and, as such, corresponds largely to level 1 ERA; attention is given to uncertainty and in agreement with ERA (level 2), higher risk is assumed when information for generating a low risk rating is not available (i.e., when uncertainty is high).

Each of the 12 scores has four or five guideposts (benchmarked at scores <6, ≥6, ≥8, 10, and, for some but not all scores, >10). From among these, the analyst chooses the one that corresponds best to a fishery on the basis of publicly available information. FishSource scores of ">10" are meant to indicate levels of performance that exceed the maximum cut-off guideposts set by comparable state-of-the art fisheries evaluation systems. A set of rules takes the 12 scores entered by the analyst and generates three ratings at the principle level: one each for bycatch, habitat, and ecosystem. The three ratings for the principles are combined to generate a single environmental rating for the fishery that is reported in SFP Metrics. The three principles are weighted equally due to lack of evidence that one is more important than the other (Caveen et al., 2017). Below, we provide the guideposts for each of the 12 scores, the rules by which the 12 scores are transformed first into three ratings at the principle level and then into one rating in Metrics, and guidance (both in pop-up definitions and in a separate **Error! Reference source not found.**) that define all phrases marked in bold font in the guidepost descriptions (Table 2, Table 3, and Table 4).

FishSource profiles are structured based on a tree of assessment units (species/stock assessment unit/fishery, etc.). Scores might, and in some cases are expected to, differ depending on the assessment unit. For example, the US Gulf of Mexico lobster fishery has adverse impact on right whales, an endangered species, and is thus expected to receive a relatively low bycatch score. A small part of that

[2] From FAO (1997): A criterion is a "(c)ondition to achieve some development objective, defined through critical review of scientific information. (…) A set of criteria would provide a system of reference within which to assess or judge the state of the exploited system as reflected by indicators. (…) In fisheries, and according to the Law of the Sea, criteria would have to be based on 'the best scientific information available'."

fishery (inshore) that is MSC certified does not interact with right whales and would thus receive a better bycatch score.

Table 1. The 12 scores of the FishSource Environment Method, v2, organized by principle (bycatch, habitat, and ecosystem) and criterion (information, outcome, and management)

Principle	Criterion		
	Information (In)	Outcome (O)	Management (M)[3]
Bycatch (By)	**Bycatch_Info** Is available information sufficient to assess impact on bycatch species? (main AND ETP bycatch species)?	**Bycatch_Outcome_ETP** To what extent does the fishery impact ETP species? **Bycatch_Outcome_Main** To what extent does the fishery impact main bycatch species?	**Bycatch_Management** Are there measures in place aiming to reduce bycatch of main AND ETP species?
Habitat (Ha)	**Habitat_Info_Gear** Is available info sufficient to identify timing, location, and severity of impacts of gear on fishery habitats? **Habitat_Info_Map** Have fishery habitats, primarily priority habitats, been identified, mapped, & characterized?	**Habitat_Outcome** To what extent does the fishery impact habitats? (determined by a combination of two types of information: Habitat_Info_Gear and Habitat_Info_Map)	**Habitat_Management** Are there measures in place that aim to minimize the fishery's impact on habitats?
Ecosystem (Eco)	**Ecosystem_Info_Map** Is the ecosystem well described and is a reference state defined? **Ecosystem_Info_Impact** Is available information sufficient to identify if/how the fishery impacts the ecosystem?	**Ecosystem_Outcome** To what extent does the fishery impact the ecosystem? (determined by a combination of two types of information: Ecosystem_Info_Map and Ecosystem_Info_Impact)	**Ecosystem_Management** Are there measures in place that aim to minimize the fishery's impact on the ecosystem?

[3] The management criterion will only be assessed if the fishery negatively impacts the principle (see guidance for each principle below).

Generally, in comparison to version 1, the new method:

- Leaves more room for nuance (benchmarks rather than Boolean responses)
- Has fewer items to be scored (12 scores vs. 16 *parameters*)
- Accounts for the level of uncertainty in scientific understanding and data, in agreement with FAO guidelines for a *precautionary approach* to fisheries and relevant indicators (FAO, 1997). Data deficiency is also addressed by scoring information quality. Information scores should always be addressed first by the analyst. The information scores will define the upper limit for other scores within the same principle because if Information is poor, there cannot be certainty that Outcome or Management is good. Analysts also have the option of not awarding a score upon reviewing fishery performance and determining that there is insufficient information to make a decision. The information criterion can lead to a fishery receiving a "data deficient" rating for a principle when scores cannot not be attributed due to absence of information, or when low ratings (i.e., scores of "<6") are given. In many cases, specific rules are developed where, based on the information criteria, an outcome or management score either defaults to data deficient or a maximum possible score is set (Appendix C). Please note here that not scoring due to lack of information is different than using "Not Applicable" (NA) to management when management is not necessary (see score guidance below for details).
- Is more comprehensive and the rationale behind the scoring is expected to be informative for the development of recommendations for fishery improvements
- Solved issues with over-penalization (e.g., in the case of MPAs) and lack of consideration for certain impacts (e.g., impact on sea birds).

It is also important to acknowledge that there are no clear and defined boundaries among bycatch, habitat, and ecosystem impacts in fisheries, and some impacts fall into two or all three of these categories. However, our mission is to communicate the sustainability performance of a fishery as simply and clearly as possible, and **addressing the same issue in multiple places** in the method inevitably negatively impacts message clarity. Therefore, when faced with an issue that crosses the boundaries between principles, the analyst must examine the role of the species or ecosystem characteristic in the fishery and determine which principle is the most relevant, taking the issue into consideration only when attributing scores within that principle. For example, if a fishery has bycatch of endangered coral, this is clearly a bycatch issue; but it is also a habitat issue (bottom impacts to vulnerable habitats) and an ecosystem issue (impacts to a foundation, or habitat-forming, species, with associated impacts on other species). In this case, the analyst is recommended to weigh the different roles of coral in this particular fishery against each other, coming to the conclusion, for example, that bottom habitat provision is the most important role of the coral and subsequently only addressing the issue in the habitat scores. The analyst should make sure to record his/her rationale and decision for consistency between updates. If a decision is difficult, the analyst should follow the arbitrary rule that "ecosystem > habitat > bycatch," i.e., if confronted with the dilemma of scoring, ecosystem impacts supercede habitat or bycatch impacts, and habitat impacts supercede bycatch impacts.

This and other issues, such as consistency among profiles or fisheries with similar characteristics, could be solved with strict quality assurance and quality control for the development of FishSource profiles, including scoring for the environmental impact of the fishery, as described with the new method. For example, an analyst could flag a profile as a priority for quality control when environmental issues cross the boundaries between principles. Quality assurance and quality control processes for the development of FishSource profiles are currently being developed under a separate project. These processes foresee the constant improvement of methodologies as feedback is collected and unavoidable issues arise.

Guideposts for scoring

The following three sections give guidance for scoring for all the criteria of the three principles – bycatch, habitat, and ecosystem. Each section comprises a table of guideposts, additional guidance as necessary, and definitions of broad terms. Tables 2 (bycatch), 3 (habitat), and 4 (ecosystem) include bolded terms and phrases. Their definitions are available in the Guidance and Glossary of each section. The bolbed terms are in the Tables also revealed in a pop-up note when you hover your cursor over them (available only in the word doc form of the document).

Bycatch Scores

The term "bycatch," when used in the FishSource Environment Method, refers to both discarded and retained harvest of non-target species. Due to the desktop nature of analysis, the scope of the method with respect to bycatch is restricted to *main* bycatch species, (following the definition of MSC, 2014), as well as ETP species impacted by the fishery in any quantity.

.

Table 2. The four bycatch scores of the FishSource Environment Method, v2. Red font highlights the distinctions among guideposts and bold font highlights terms and phrases for which details and further guidance is given in the *Guidance and Glossary* for the principle.

Score Acronym	Guideposts				
	<6	**6**	**8**	**10**	**>10**
Bycatch_Info *Is available information sufficient to assess impact on bycatch species? (main AND ETP bycatch species)*	There is no reliable information on both the type and the amount of **bycatch** thus the amount cannot be inferred.	(a) Bycatch monitoring provides some reliable information on the type and/or amount of **bycatch**.	Bycatch monitoring provides substantial reliable information on both the type and the amount of **bycatch**.	Bycatch monitoring provides comprehensive reliable information with a low uncertainty on the type, amount, and mortality of **bycatch**.	(a)Bycatch monitoring provides comprehensive reliable information with a low uncertainty on the type, amount, and mortality of **bycatch**. AND (b)Bycatch monitoring provides substantial reliable information on the cumulative fishery impacts (type, amount, and mortality **bycatch**) upon **ETP** and **main species** affected by the fishery under evaluation.
Bycatch_Outcome_ETP *(To what extent does the fishery impact ETP species?)*	The fishery jeopardizes the viability or rebuilding of one or more **ETP** species**.**	The fishery interacts directly with ETP species but it does not jeopardize the viability or rebuilding of any **ETP** species.	(a) The probability that the fishery would jeopardize the viability or rebuilding of **ETP** species now or in the future is low. OR (b) Fishery catch does not include **ETP** species	Cumulative fishery impacts do not jeopardize the viability or rebuilding of **ETP** species.	
Bycatch_Outcome_Main *(To what extent does the fishery impact main bycatch species?)*	**Bycatch** mortality from the fishery jeopardizes the **main bycatch** species' viability or rebuilding.	**Bycatch** mortality from the fishery is substantial but it does not jeopardize the **main bycatch** species' viability or rebuilding.	(a) The probability that the fishery would jeopardize the viability or rebuilding of **main bycatch** species now or in the future is low. OR (b) Fishery catch does not include **main bycatch** species.	Cumulative fishery impacts do not jeopardize the viability or rebuilding of **main bycatch** species.	

Score Acronym	Guideposts				
	<6	**6**	**8**	**10**	**>10**
Bycatch_Management[4,5] *(Are there measures in place aiming to reduce bycatch of Main AND ETP species?)*	(a) No management measures are in place for the purpose of **bycatch** mitigation; OR (b) **Measures** are in place for the purposes of **bycatch** mitigation, but the measures are not enforced or complied with.	(a) Generic measures are in place for the purpose of **bycatch** mitigation; AND (b) the generic measures are enforced and compliance is not flagged as a problem	(a) **Measures** tailored to the characteristics of the fishery and local ecosystem are in place for the purpose of **bycatch** mitigation AND (b) Enforcement and compliance are monitored and is not flagged as a problem	(a) Bycatch assessment and management is an integral part of the fishery assessment, including set limits and reference points for main bycatch and ETP species; AND (b) An information system and monitoring are in place to inform management decisions.	a) Bycatch assessment and management is an integral part of the fishery assessment, including set limits and reference points for main bycatch and ETP species; AND (b) An information system and monitoring are in place to inform management decisions. AND (c) At least part of the fleet is actively involved in research and/or policy decisions to improve **bycatch** mitigation measures.

[4] There is a separate, offline worksheet for scoring Bycatch_Management for shrimp bottom trawl fisheries. See APPENDIX E. Scoring Bycatch_Management for Shrimp Bottom Trawl **Fisheries**).

[5] Measures adopted voluntarily by a fishery can be taken into consideration in scoring if the entire fleet is involved, resolution of information available about the measures' implementation is comprehensive, and the evidence of the measures' implementation by all fishers is conclusive.

Guidance and Glossary

If a fishery has multiple ETP and/or main bycatch species with differing status or management, the species with the poorest status should determine the score for bycatch outcome and the species with the poorest management should determine the score for bycatch management. Please note that we are trying to compare conservation status between species while ensuring that the "worst case" will determine the score.

Bycatch: The catch of non-target animals including retained (kept on board and landed) and discarded (dumped at sea, dead or alive) species. Discarded harvest of undersized, juvenile, or otherwise undesirable individuals of the target species are NOT considered here because these issues are considered by the FishSource scores on target stock health and management (Cannon, 2006). A multispecies fishery has multiple target species. However, profiles in FishSource are generally organized on a single-species or a single-species-group basis. Therefore, for the purposes of FishSource, only the species named in the profile name are considered the target. All other species harvested by the fishery are considered under the bycatch scores.

ETP species: Species recognized as endangered, threatened, or protected by national legislation and/or binding international agreements. Species listed under Appendix I of CITES shall be considered ETP species for the purposes of assessment unless it can be shown that the particular population of the CITES-listed species impacted by the fishery under assessment is not ETP. Species listed on the IUCN Red List as vulnerable, endangered, or critically endangered should be considered in the ETP category if the assessment is ten or fewer years old (IUCN, 2017) and relevant to the region in which the fishery occurs.

Main bycatch species: (a) Any non-ETP species whose catch by the fishery comprises 5% or more by weight of total fishery catch before discarding occurs, or (b) any non-ETP species of active management concern upon which the fishery causes substantial impact, for example has the fishery has the potential to decrease the population of the bycatch and threaten its viability under certain environmental circumstances or the species is a keystone species for the ecosystem as prey for large predators and even low bycatch can threaten the viability of its population.. The definition follows MSC (2014).

Bycatch_Info

- *Some reliable information*: Opportunistic data and research that are not part of a monitoring plan for bycatch assessment. They can include expert knowledge, local ecological knowledge, or generic knowledge on the impact of the fishing gear on bycatch species. Fisher surveys, risk assessments, or other types of qualitative information that yield an incomplete, broad understanding of the annual harvest volume ("amount") of main and ETP bycatch species ("type") also belong to this group. Species may be grouped in reporting. There may be an observer program in place generating information about bycatch, but coverage is low and its statistical and scientific soundness have not been proven.
- *Substantial reliable information*: Information should be collected in the area where the impact occurs and be part of a monitoring system. The fishery's annual harvests ("amounts") of the

main bycatch and ETP species ("types") are known, including cases where some species are reported as a group. This information may not be available for the entire fishery catch but has been extrapolated to generate a fishery-wide estimate. If an observer program is in place generating information about bycatch, coverage is reasonable, i.e., its statistical and scientific soundness have been proven. The uncertainty of estimates and knowledge gaps are known.

- *Comprehensive information with low uncertainty*: Complete and current (up-to-date) information generated by systematic monitoring or research. The annual harvest volume ("amount") for each main and ETP bycatch species is known for the entire fleet, and reporting is species-specific ("type"). Additional "mortality" of organisms that are not part of the bycatch but interact with the gear (e.g., pre-catch mortality, ghost fishing) has been estimated. If the fishery has both retained and discarded components of its bycatch, some information is available for both groups. The uncertainty of estimates is low and knowledge gaps are being addressed.

Bycatch type, amount, and mortality: "Type" refers to main or ETP species, "amount" to harvest volumes (in weight, numbers, percentages, etc.), and "mortality" to the rate at which the numbers in the bycaught population are decreasing due to direct impact of the fishery under assessment.

Cumulative fishery impacts: Impacts of both the fishery under assessment and other fisheries. For a score ">10" all types of information required for a score of "10" should be available for the fishery under assessment **and** for other fisheries that impact the same ETP and main bycatch species.

Bycatch_Outcome

Bycatch_Outcome_ETP and Bycatch_Outcome_Main

Only direct effects of fishing, including ghost fishing, should be accounted for here; indirect effects should be accounted for in the ecosystem principle.

Jeopardize/minimal impact:

- *Jeopardizes the viability or rebuilding of species*: The impact of the fishery is high and hinders the improvement of the bycatch species status. When reference limits for bycatch indicators have been set, the bycatch indicators are above the bycatch limits.
- *Does not jeopardize the viability or rebuilding of species*: The impact of the fishery is low enough that if the species is capable of improving its status, the fishery will not hinder that improvement. It does not require evidence that the status of the species is actually improving. Bycatch indicators fluctuate around set bycatch limits.
- *The probability of jeopardizing the viability or rebuilding of main bycatch species now or in the future is low*: Bycatch indicators have continuously been lower than precautionary bycatch limits. Stochastic events are taken into account when population viability is assessed.

Cumulative fishery impacts: Impacts of both the fishery under assessment and other fisheries. For a score ">10," the impact of the fishery under assessment **and** other fisheries that impact the same ETP or main bycatch species should be known and should not jeopardize any of the bycatch species.

Bycatch_Management

The bycatch management criterion (Bycatch_Management) should only be evaluated if the fishery impacts ETP or main species in absence of any management measures. If bycatch is minimal or nonexistent (e.g., when using gear with no bycatch, such as a harpoon) or none of the bycatch is ETP or main species, the management criterion is rendered inconsequential. In these cases, Bycatch_Management should be scored as "Not Applicable" (NA). Please note that NA is distinct from Not scored due to data deficiency.

Measures: Measures for bycatch mitigation can be encapsulated in five possible tactics (Hall, 1996): "(1) increasing the selectivity of the fishery by choices of gear, areas, or seasons; (2) modifying deployment conditions; (3) increasing the fraction released alive either from the gear, or (4) later, from the deck; or (5) increasing the utilization to make catches out of the incidental captures." Bycatch mitigation measures can be generic or specific to a fishery, a location, and/or a bycatch species.

Generic Measures: These can include best practices for bycatch mitigation. The effectiveness of generic mitigation **measures** has not been demonstrated for the assessed fishery, locality, or bycatch species. A list of generic best practices is given in Appendix B.

Limits and reference points: Reference points are values of indicators that describe a status (current, ideal, target, etc.) of the system. Limit reference points (LRPs) are thresholds to undesirable population or ecosystem states, offering a consistent, objective approach to management evaluation and prioritization. An example of a successful application to manage bycatch of marine megafauna is the use of Potential Biological Removal (PBR) under the US Marine Mammal Protection Act. Related indicators can include the maximum net productivity level (N_{MNP}) and related mortality (F_{MNP}), catch-based estimates and population trends (Curtis et al., 2015).

Information system: An organized system for the collection, organization, storage, and communication of information on stock and ecosystem performance, used to inform ecosystem-based management decisions.

Habitat Scores

With respect to the four habitat scores, "habitat" refers to the physical habitat (including its biogenic and chemical characteristics) where the fishery takes place. Habitat is certainly part of the *ecosystem* and the services it provides, as well as the diversity of and trophic relationships among species it maintains. However, these aspects of habitat are not considered here, but rather in the ecosystem scores.

.

Table 3. The four habitat scores of the FishSource Environment Method, v2. Red font highlights the distinctions among guideposts and bold font highlights terms and phrases for which details and further guidance is given in the *Guidance and Glossary* for the principle.

Score Acronym	Guideposts				
	<6	**6**	**8**	**10**	**>10**
Ha_Info_Gear Is available information sufficient to identify timing, location and severity of impacts of gear on fishery habitats?	There is no reliable information on the **timing, location, and severity** of the impacts of the fishery on priority habitats.	There is some reliable information on the **timing, location, and severity** of the impacts of the fishery on some **priority habitats**.	(a) There is substantial reliable information with low uncertainty on the **timing, location, and severity** of the impacts of the fishery on some **priority habitats**. AND (b) There is substantial reliable information on the **timing, location, and severity** of the impacts of the fishery on the entire habitat.	There is substantial reliable information with low uncertainty on the **timing, location, and severity** of the impacts of the fishery on the entire habitat.	There is substantial reliable information on the cumulative impact of the fishery and other ocean uses on **priority habitats**.
Habitat_Info_Map Have fishery habitats, primarily priority habitats, been identified, mapped, and characterized?	Priority habitats have not been identified and there is no reliable Information on their **location and status**.	Some priority habitats have been identified and there is some reliable information on their **location and status.**	(a) Substantial reliable information with low uncertainty allows for **identification and mapping,** of all priority habitats. AND (b) Some reliable information allows for **identification and mapping** of the entire habitat.	Substantial reliable information with low uncertainty allows for **identification and mapping,** of the entire habitat.	
Habitat_Outcome To what extent does the fishery impact habitats? (determined by a combination of two types of info: Habitat_Info_Gear and Habitat_Info_Map)	The fishery reduces the **structure and function** of priority habitats to a point where there would be **serious or irreversible harm**.	The fishery does not reduce **structure and function** of priority habitats to a point where there would be **serious or irreversible harm**.	(a) The probability that the fishery would reduce structure and function of habitats or **jeopardize habitat recovery** now or in the future is low. OR (b) The impact of the	(a) The cumulative impact of the fishery and other ocean or coastal uses does not reduce the structure and function of the habitat to a point where there would be **serious or irreversible harm**.	

Score Acronym	Guideposts				
	<6	6	8	10	>10
			fishery on habitats is minimal/negligible.	AND (b) The cumulative impact of the fishery and other ocean or coastal uses does not jeopardize habitat recovery	
Habitat_Management Are there measures in place that aim to minimize the fishery's impact on habitats?	(a) No measures are in place to manage the potential impacts of the fishery on priority habitats. OR (b) Some measures are in place to manage the potential impacts of the fishery on priority habitats, but the measures are not enforced or complied with.	(a) Some measures are in place to manage the potential impacts of the fishery on **priority habitats**. AND (b) Enforcement and compliance are not flagged as a problem.	(a) A management strategy is in place to protect priority habitats from fishery impacts and to promote the recovery of degraded habitats. AND (b) Enforcement and compliance are not flagged as a problem.	(a) An integrated management strategy is in place to protect habitats from the cumulative impact of the fishery and other ocean uses and to promote the recovery of degraded habitats. AND (b) The strategy is enforced and the fleet complies with the management measures.	

Guidance and Glossary

Habitat: The biophysical and chemical environment, including biogenic structures, where fishing takes place.

Priority habitats "cover a wide range of semi-natural habitat types, and are those that were identified as being the most threatened and requiring conservation action" (JNCC, last update 2016). They include Essential Fish Habitats such as wetlands, coral reefs, seagrasses, rivers, defined by NOAA as locations "where fish spawn, breed, feed, or grow to maturity. These habitats are 'essential' because, without these prime locations, fish would not be able to survive." Priority habitats are not always strictly protected by wildlife laws. However, they can be sensitive to human activity and both national and local priority habitats should be considered when determining planning applications (e.g., marine spatial planning). In general priority habitats support major ecological functions; they are sensitive, stressed from human activity, and rare. The criteria for priority habitats identification might differ on a case by case basis. Similarly, priority habitats can be referred to as Habitat Areas of Particular Concern, Biodiversity Hotspots, vulnerable habitats, vulnerable marine ecosystems, protected habitats, critical habitats, etc. Examples can be found in the EU Habitats Directive, the UK Biodiversity Framework, Habitat Conservation Plans, Biodiversity Scotland, and Washington Department of Fish and Wildlife (WDFW).

Entire habitat: The entire area where fishing takes place; includes all types of habitats (priority or not) where fishing takes place.

Cumulative impact: Apart from fishing, changes to coastal and ocean habitats are also induced by environmental change, development (ranging from port expansions to offshore energy development), climate, and other pressures. Cumulative impacts include the aforementioned pressures and their combined effect on habitats.

Habitat_Information_Gear

- *Some reliable information*: Opportunistic data and research that are **not** part of a plan for assessing the impact of fisheries on habitats. They can include expert knowledge, local ecological knowledge, or generic knowledge on the impact of the fishing gear on habitats. Qualitative information that yields an incomplete, broad understanding of the timing, location, and severity of the impacts of the fishery also belong to this group. If there is a monitoring program of fishing effort and its distribution (e.g., VMS and logbook data), the coverage is low (i.e., only a small percentage of vessels have VMS) or the data quality has been flagged as low (e.g., VMS data used in coastal fisheries). There is generic knowledge on the impact of the fishing gear type on priority habitats.
- *Substantial reliable information*: Information should be collected in the area where the impact occurs and be part of a monitoring system (e.g., vessel tracking data, fisher surveys) that records the timing, location, and severity of the impacts of the fishery. The information should include fishing effort temporal and spatial distribution. If there is a monitoring program of fishing effort and its distribution (e.g., VMS and logbook data), the coverage is adequate to allow for

interpolating the data to estimate fishing effort distribution throughout the area where the fishery takes place. The impact of the specific gear type used in the fishery has been studied for all habitat types that occur in the area. The uncertainty of estimates and knowledge gaps are known.

- ❖ *Substantial reliable information with low uncertainty*: Complete and current (up-to-date) information generated by systematic monitoring or research. The temporal and spatial distribution of fishing effort is known for the whole fleet and habitat changes (fragmentation, coverage, structure) where fishing occurs are monitored throughout the extent of the fishery. Disturbance of the habitat by fishing has been studied at the scale of the fishery.

Impacts of the fishery:

- Timing: When the fishery disrupts a habitat because of seasonal changes in the distribution of fishing effort.
- Location: Where the fishery disrupts a habitat because of the overlap between fishing effort and habitat types that are impacted by the gear used.
- Severity: The magnitude of the fishery's impact on different habitats, largely depending on the gear, the timing and location of fishing, and gear modifications to avoid or reduce impact.

Habitat_Information_Map

- ❖ *Some reliable information*: Opportunistic data and research on the presence of priority habitats. The criteria used to identify priority habitats are not part of a peer-reviewed framework. Data can include expert knowledge, local ecological knowledge, or generic knowledge on the presence and location of habitats. Qualitative information that yields an incomplete, broad understanding of the distribution and status of habitats. This category includes qualitative information on the presence and characterization of habitat types in an area, especially priority habitats.
- ❖ *Reliable information*: Maps of habitats throughout the fishery at scales and resolution consistent with the scale of the fishery. Data may not be available at the scale of the entire fishery catch, but the coverage allows for generation of fishery-wide maps of habitat types and their distribution. Maps can be developed using geostatistical techniques (e.g., kriging) or habitat modelling (e.g., MaxEnt). Priority habitats and their status are documented. Major uncertainties are identified and documented. Modelling used to understand habitat function and its changes through time, such as dynamic system models (e.g., Johnstone, 2006), involve assumptions and uncertainty, and should thus fall under this information category.
- ❖ *Substantial reliable information with low uncertainty*: Complete and current (up-to-date) information generated by systematic monitoring or research. The distribution and status of habitats is known for the entire area where the fleet operates. The distribution maps should be the result of surveys throughout the fishing area; the surveys should be conducted at an appropriate scale to provide distribution estimates of low uncertainty. Changes in habitat distribution and status are monitored and causal relationships have been discerned between the observed habitat changes and human activity/environmental change. The uncertainty of estimates is low and knowledge gaps are being addressed.

Entire fishery habitat refers to the entire area where fishing takes place/the fleet operates.

Location and status (of habitats): Location refers to the distribution of different habitat types. This can be presented in maps of various resolutions ranging from opportunistic points where a habitat is known to be present, coarse polygon maps of habitats and substrates, presence/absence maps, or maps of probability of habitat occurrence. Status refers to the conservation status and health of a habitat, whether it is fragmented or decreased in size, if it has lost key components of its structure, or if it supports its main functions.

Identification and mapping (of habitats): Habitat identification is performed based on certain criteria and key features that are important to a type of habitat. Identification includes efforts to identify priority and critical habitat, but mainly involves the characterization of the habitat as one of the known types of habitats (for examples see benthic Mediterranean habitat types, coral reefs and hard-bottom communities, transitional waters/ecosystems). After habitats have been characterized and a specific habitat type has been attributed to each location of the study area, a habitat map can be built showing the distribution of the different habitat types. The types of information needed for an assessment can be found in BOX 1.

BOX 1. Information on Habitats

What Is a Habitat Assessment?

"A habitat assessment is both the process and the products associated with consolidating, analyzing, and reporting the best available information on habitat characteristics relative to the population dynamics of fishery species and other living marine resources. The ultimate goal of a habitat assessment is to determine the function of habitats in relation to fishery production and ecosystems, thereby supporting management decisions … In a habitat assessment, spatial and temporal relationships of environmental data (e.g., ocean and climate properties, seafloor substratum types, water depth) with species by life stage are used to determine types, distribution, and amount of habitats … Evaluating the function of these habitats ultimately can include measures of habitat-specific vital rates such as growth, maturity, fecundity, and mortality, as well as patterns and rates of species movement among habitats. Important habitat components can be identified from these data and linked to sources of impacts and associated management options. The establishment of meaningful baseline conditions is critical to understand environmental impacts but can be difficult, largely due to lack of historic data. However, this should not forestall the advancement of habitat assessments. …outcome of an assessment is a gap analysis, by which research and data necessary to improve the assessment are identified and prioritized. The habitat research that improves assessments and the periodic review of assessments both lead to adaptive management." (NMFS, 2010)

What pieces of information are important as input to habitat management? (after the WDFW PHS Program)

- Identifying habitats and species determined to be priorities based on defensible criteria
- maps that provide a best understanding of the locations of Priority Habitats
- Maps that show where and when habitat change occurs and the cause of each change
- Science-based management recommendations for maintaining functioning Priority Habitats
- Consultation and guidance on fisheries issues affecting Priority Habitats
- Feedback to managers about the entire habitat and effectiveness of habitat conservation efforts

Habitat_Outcome

(Habitat) structure and function

- Habitat structure: The physical template underlying ecological patterns and processes (Byrne, 2007). Habitat structure is the physical arrangement of matter that supports plant and animal life (Grieve et al., 2014; 2015).
- Habitat function: Also referred to as habitat role, and defined as "the range of services provided to an organism or ecosystem, including, but not limited to, mediating trophic interactions between predator and prey and between predators, providing refugia, and influencing behavior of organisms" (Warfe and Barmuta, 2004; Grieve et al., 2015). Functions are a process or series of processes that take place within a habitat and include transformation of nutrients, growth of living matter, and biodiversity; they have value for the ecosystem itself, for surrounding ecosystems, and people.

Serious or irreversible harm: marine habitat loss and destruction. When habitat has been degraded to the point that the marine environment cannot support biodiversity and finally life. "Damage or destruction of habitats kills the plants and animals responsible for the habitat's ecological functions and, in some cases, its survival and regeneration" (Ocean Health Index). The habitat will not be able to provide ecosystem services. Indications of serious or irreversible harm include but are not limited to spreading of dead zones, loss of biodiversity, decreasing abundances of species, habitat fragmentation and decreasing habitat complexity (e.g., Airoldi et al., 2008; Diaz and Rosenberg, 2008; Fahrig, 2003; Hovel and Lipcius, 2001). For a definition of "harm" regarding habitats see BOX 2.

BOX 2. Defining harm (paraphrasing the definition of *adverse effects* on Essential Fish Habitat found in NOAA EFH regulatory guidelines at 50 CFR 600.920)
Harmful impact "may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and and other habitat components, if such modifications reduce the quality and/or quantity of the habitat. Harmful impact may result from actions occurring within the habitat or outside of the habitat and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

Jeopardized habitat recovery: When plans for habitat restoration are in place, they do not yield any results due to the impact of the fishery.

The probability (to cause serious harm) now or in the future is low: Indicators used to monitor habitat status are expected to be below precautionary reference points and their trends should be stable or decreasing.

Habitat_Management

The management criterion (Habitat_Management) should only be evaluated if the fishery impacts habitats by reducing their structure and function, in absence of any management measures. If the impact of the fishery is nonexistent or negligible, Habitat_Management should be scored as "Not Applicable" (NA).

Measures for habitat protection include:

- Fisheries Restricted Areas (FRAs): Geographical areas where fishing restrictions apply. They include seasonal closures to fishing and/or prohibiting the use of certain gears.
- Marine Protected Areas (MPAs): "A clearly defined geographical space in the marine environment that is recognized, dedicated, and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley, 2008).
- Modification of gear design or type to reduce impact, e.g., Bering Sea flatfish trawl gear.

Some measures refers, e.g., to opportunistic measures that are not part of a strategy, as this is defined below, or measures that deal with specific important issues of habitat loss and degradation (but not all the problems caused by the fishery).

Management strategy

Management strategies for habitat protection tend to have hierarchical goals. The preferred goal is avoidance of habitat loss or degradation followed by habitat recovery. The "no net loss" principle is often referred to as a target of habitat protection policies, i.e., if habitat loss is unavoidable, that habitat is created elsewhere to compensate (examples can be found in EU, Canada, US policies, etc.; Harper and Quigley, 2005). Box 3 lists some of the components of a habitat management strategy. Desirable attributes of habitat management include using data with clear criteria for data inclusion, stakeholder participation, application of decision support tools (preferably dynamically over time), selection of specific outcomes (such as preferred use scenarios), clearly defining success (using metrics of success with reference benchmarks), monitoring, incorporating monitoring results into management decisions (after Collie et al., 2013, on Marine Spatial Planning). BOX 3 describes the key components of habitat management.

BOX 3. Components of a Habitat Management Strategy (after DFO, 2001)

The Policy in terms of goals (in priority order)	**Integrated Planning for Habitat Management**	**Implementation Strategies**
Net Gain of Habitat Habitat Conservation No Net Loss Principle Habitat Restoration Habitat Development	Integration with other Resource Sector Objectives Integration of Habitat Needs with Fish Management Objectives	Protection and Compliance Integrated Resource Planning Scientific Research Public Consultation Public Information and Education Cooperative Action Habitat Improvement Habitat Monitoring

The need for an integrated management strategy arises due to "increased development pressures on the marine environment and the potential for multiple use conflicts, (...) a result of the current expansion of offshore wind energy, fishing and aquaculture, dredging, mineral extraction, shipping, and the need to meet (...) commitments to biodiversity conservation" (Douvere and Ehler, 2009). Emphasis here is on marine spatial planning, as the framework for an integrated management strategy for the protection of habitats and ecosystem-based management in general.

Ecosystem Scores

Table 4. The four ecosystem scores of the FishSource Environment Method, v2. The criteria used aim to account for a) the quality of the information available to describe the ecosystem and define its reference state, b) the quality of the information that allows for an assessment of the impact of the fishery on the ecosystem, c) the severity of the fishery's impact on the ecosystem, and d) the implementation of ecosystem-based fisheries management (EBFM). Red font highlights the distinctions among guideposts and bold font highlights terms and phrases for which details and further guidance is given in the *Guidance and Glossary* for the principle.

Score Acronym	Guideposts				
	<6	**6**	**8**	**10**	**>10**
Ecosystem_Info_Map *Is the ecosystem well described and is a reference state defined?*	There is no reliable information allowing for the characterization of the **ecosystem** and the definition of the **ecosystem reference state.**	There is some reliable information allowing for the characterization of the **ecosystem** and the definition of the **ecosystem reference state**.	There is substantial, reliable information allowing for the characterization of the **ecosystem** and the definition of the **ecosystem reference state.**	(a) There is comprehensive information with low uncertainty allowing for the characterization of the **ecosystem** and the definition of the **ecosystem reference state**. AND (b) Models have been developed to describe the **ecosystem dynamics**.	
Ecosystem_Info _Impacts *Is available information sufficient to identify if/how the fishery impacts the ecosystem?*	There is no reliable information to allow for assessment of the impacts of the fishery on **ecosystem structure and processes**.	There is some reliable information allowing for assessment of the main impacts of the fishery on **ecosystem structure and processes**.	There is substantial, reliable information allowing for assessment of the main impacts of the fishery on **ecosystem structure and processes.**	There is comprehensive, substantial reliable information with low uncertainty allowing for assessment of the main impacts of the fishery on **ecosystem structure and processes.**	(a) There is comprehensive, substantial reliable information with low uncertainty allowing for assessment of the main impacts of the fishery on **ecosystem structure and processes.** AND (b) Information is adequate to assess the cumulative impacts of anthropogenic and natural change on the **ecosystem**.

Score Acronym	Guideposts				
	<6	**6**	**8**	**10**	**>10**
Ecosystem_Outcome *To what extent does the fishery impact the ecosystem?*	The fishery disrupts **key elements** of **ecosystem structure and function** to a point that **serious or irreversible harm** is observed.	The fishery disrupts **key elements** of **ecosystem structure and function** but **serious or irreversible harm**.is not observed.	The fishery does not disrupt **key elements** of **ecosystem structure and function** either due to successful implementation of mitigation measures or due to the non-disruptive nature of the fishery.	The fishery does not disrupt **ecosystem structure and processes** to a point where **serious or irreversible harm** is probable now or in the future.	Cumulative fishery impacts do not cause **serious or irreversible harm** to **ecosystem structure and processes.**
Ecosystem_Management *Are there measures in place that aim to minimize the fishery's impact on the ecosystem?*	(a) No measures are in place to manage the potential impacts of the fishery on the **ecosystem**; OR (b) Some measures are in place to manage the potential impacts of the fishery on the **ecosystem**, but the measures are not enforced or complied with.	(a) Some measures are in place to manage the potential impacts of the fishery on the **ecosystem**; OR (b) **EBFM** is implemented and focuses on fish stocks with ecosystem considerations incorporated. AND c) Enforcement or compliance is not flagged as a problem.	(a) **EBFM** is implemented and focuses on the fisheries sector accounting for all fisheries and stocks AND (b) Enforcement or compliance is not flagged as a problem	(a) **EBFM** is implemented for a full set of ocean-use sectors impacting the ecosystem. AND (b) **EBFM** is enforced, and complied with.	(a) **EBFM** for a full set of ocean-use sectors is implemented, enforced, and complied with. AND (b) **EBFM** implementation includes stakeholder involvement, trade-off evaluation and incorporates environmental externalities**.**

Guidance and Glossary

Ecosystem_Info_Mapping

- *Some reliable information*: Research and data collected in an opportunistic manner, i.e., not as part of a monitoring system of an ecosystem management scheme. Information can include expert knowledge and local ecological knowledge.
- *Substantial reliable information*: Maps of the ecosystems and habitats throughout the fishery at scales of resolution consistent with the scale of the fishery. Major features and exceptions are documented (e.g., highly migratory species, oceanographic currents or features, boundary mismatches between taxa). Major uncertainties are identified and documented.
- *Comprehensive substantial reliable information with low uncertainty*: Complete, accurate, and realistic information that is generated by systematic monitoring or research and describes ecosystem connections (e.g., trophic levels), ecological integrity (e.g., community structure and ecological processes), and biodiversity. The information should be current (up to date) and in agreement with other sources of information.

Ecosystem: Features of the environment crucial to maintain the integrity of its structure and function, ensure resilience and productivity (including the ability to deliver ecosystem services), maintain biological diversity of the ecological community, and balance trophic relationships between species.

Ecosystem Reference State: A reference state or reference condition is a defined condition of a system against which another system (or the same system at another time) is being compared. It most commonly is a condition that is considered as normal or desirable (Jax, 2010). The reference state of a marine ecosystem impacted by a fishery can be described by variables relating to ecosystem functions and processes.

Ecosystem Dynamics: The dynamic nature of an ecosystem refers to changes in time relating to trophic relations, physical and biogeochemical processes, or exogenous (natural or anthropogenic) impacts.

Ecosystem_Info_Impacts

- *Some reliable information*: Examples include ecosystem or multispecies models that include fisheries impacts. These do not have to be part of a comprehensive ecosystem risk assessment. Information can include expert knowledge and local ecological knowledge.
- *Substantial, reliable information*: Examples include integrated ecosystem assessments or ecological risk assessments, as part of EBFM, including direct and indirect impact of fishing and evolutionary risk assessment.
- *Comprehensive, realistic information with low uncertainty*: Examples include integrated ecosystem assessments including risk evaluation, evaluation of alternative potential future management and environmental scenarios.

Ecosystem structure and processes: Productivity, trophic pyramids, biogeochemical cycles, spatial ecosystem dynamics, community structure and properties, meta-populations and dispersion, evolutionary processes, body-mass vs abundance distribution, interactions across space and time, energy flow mechanisms, etc.

Cumulative impacts: Cumulative fishery impacts that include those of both the fishery under assessment and other fisheries operating in the same or adjacent areas. Cumulative impacts from different sources of disturbance include all anthropogenic (fisheries, pollution, climate change, etc.) and natural (climatic cycles, geological events, etc.) impacts.

BOX 4. Ecosystem Models

Ecosystem models refer to an abstract, generally mathematical, representation of an ecosystem studied to gain understanding of the actual ecosystem. Examples of ecosystem model types include Lotka-Voltera equations, trophic cascades, Ecopath with Ecosim, and multispecies virtual population analysis (MSVPA – considered more informative for fisheries managers) (Larkin, 1996). For *comprehensive, realistic information* to be available, sufficiently vigorous modeling (i.e., with appropriate variables or accounting for spatial considerations) needs to have been undertaken in order to comprehensively describe the ecosystem. Furthermore, there should be evidence that information generated by modeling is available to managers rather than existing merely as an academic stand-alone product.

Ecosystem_Outcome

Key elements of ecosystem structure and function: The features of an ecosystem considered crucial to the ecosystem's nature and dynamics – its ecological integrity, resilience, and productivity. These can be keystone species, important trophic relationships, energy flows, spatial distribution, or temporal fluctuations of key species, etc.

Serious or irreversible harm…

- …to structure and function: In reference to impacts of the fishery that threaten the ecological integrity of the ecosystem, the disruption of features crucial to maintaining the ecosystem structure and functionality and that ensure ecosystem resilience and productivity. This includes, but is not limited to, inability to provide ecosystem services, disruption of trophic relationships, and fisheries-induced evolution of life history traits, decrease of biodiversity. When serious or irreversible harm is caused, ecosystem indicators are expected to be below the set limits of ecosystem reference points (ecosystem reference limits).
- …is not probable now or in the future: Ecosystem indicators are expected to be below precautionary ecosystem reference points and their trends should be stable or decreasing.

Ecosystem_Management

The management criterion (Ecosystem_Management) should only be evaluated if the fishery impacts the ecosystem in absence of any management measures. In these cases, the Ecosystem _Management should be scored as "Not Applicable" (NA).

Some measures: For example, opportunistic measures that are not part of EBFM, as this is defined below, or measures that deal with specific important ecological problems but not all the problems caused by the fishery.

Ecosystem-based fisheries management (EBFM): Also referred to as ecosystem-based management or ecosystem approach to fisheries management. Among the many possible definitions, here we refer to all frameworks that address the need to manage fisheries in an ecologically sensitive way (Pitzer et al., 2009). These frameworks involve the use of ecosystem indicators based on set goals and targets, the assessment of status and risk, and the development of an adaptive scheme that monitors ecosystem status and sets corrective or precautionary measures. For more information on EBFM and related challenges, also refer to Ruckelshaus et al. (2008), as well as Boxes 5 and 6.

Trade-off evaluation: Considered an integral part of EBFM, it aims to simultaneously deal with the cumulative impacts of both anthropogenic and natural pressures of key ecosystem components. This can lead to multiple objectives with various degrees of importance, some of which can be in conflict. Trade-offs are addressed across multiple objectives and based on importance and available resources.

Environmental externalities: These can include cross-boundary issues, the long-term dynamics of ecosystems, the full range of human uses, and aspirations for the ecosystems being managed.

BOX 5. Levels of Application of Ecosystem-Based Management (Link and Browman, 2014)

1. Solely on fish stocks
2. Focus on fish stocks with ecosystem considerations incorporated
3. Solely on the fisheries sector but for the full system of fisheries and stocks
4. On the full set of ocean-use sectors impacted by and impacting the fisheries sector and the ecosystem

BOX 6. Implementation Steps and Key Principles of Marine Ecosystem-Based Management

Implementation Steps (Pitcher et al., 2009):

- Identify stakeholder community
  Identify partners and their interests/ responsibilities
- Prepare a map of ecoregions and habitats
  Establish ecosystem values
  Determine major factors influencing ecosystem values
  Conduct ecological risk assessment
- Establish objectives and targets
  Establish strategies for achieving targets
- Design information system, including monitoring
  Establish research and information needs and priorities
- Design performance assessment and review processes
- Prepare education and training package for fishers

Key Principles (Long et al., 2015) that relate to one or more implementation steps:

Ecosystem Connections
Spatial and Temporal Scales
Adaptive Management
Based on Scientific Knowledge
Integrated Management
Stakeholder Involvement
Dynamic Nature of Ecosystems
Ecological integrity and Biodiversity
Sustainability
Coupled socio-ecological systems
Societal Choice
Distinct Boundaries
Interdisciplinary
Monitoring
Uncertainty
Cumulative Impacts
Precautionary Approach
Trade-offs across objectives

Definitions for Information Criteria

Current information:
Information regarding the status of bycatch species has optimally been generated within one generation cycle of the species in question. Meanwhile, information used in determining habitat and ecosystem scores was generated ideally no more than five years prior to scoring. If only older information is available (for either bycatch or other environment scores), the analyst must use best judgment in choosing between omitting a score due to data deficiency (if the situation has likely changed between the release of existing information and the present) or scoring on the basis of the information (if the situation has likely remained stable since the release of the information).

Reliable information:
In order of decreasing reliability, the three tiers of information sources are:

- *First tier* – Anything peer-reviewed. Peer-reviewed science articles and government fishery management reports are the preferred sources of information for scoring. MSC and other certifications that are peer-reviewed are considered generally reliable.
- *Second tier* – Reports that have not been peer reviewed, such as reports from scientific projects or workshops.
- *Third tier* – In the absence of the first two types of sources, "gray literature" that has not been formally reviewed, such as NGO and industry reports (including reports from FIP implementers), can be used at the analyst's discretion. Sources for a particular fishery or region can be vetted with the Improvement team before making a pivotal rating decision based solely on these sources of information.

BOX 7. Uncertainty for FS scores **If there is no specific guidance to score availability and quality of information, please consider the following criteria. These guidelines are generic; more specific guidelines are generally given for FishSource scores. (*for internal use* see: Sharespace ticket 11988)**

• Reliability
  ○ High (e.g., government report)
  ○ Medium (e.g., NGO report)
  ○ Low (e.g., media coverage)
• Scale
  ○ Optimal (e.g., fishery level)
  ○ Medium (e.g., regional level)
  ○ Low (e.g. national level or broader)
• Age of data
  ○ Good (<= 2 yrs)
  ○ Medium (>2 to 5 yrs)
  ○ Low (>5 yrs)

Rules and Combinations

Generally, the lowest score attributed by the analyst to one of the four nested criteria is inherited as the overall principle score. However, there are some exceptions; for example, a “>10” rating is given to a principle when there are one or more “>10” scores among nested criteria, and all other scores are “10” (i.e., the lowest nested score is a “10,” but a principle score of “>10” is awarded). Other exceptions are indicated in the tables below.

In some cases, analysts cannot attribute a score to a criterion due to lack of information. If the information score indicates data deficiency, this is reflected in a principle rating of “data deficient.” Unscored criteria, “data deficient” principle scores, and “>10” principle scores add some complication to the overall rule of “lowest nested criterion score is inherited as the principle score.” To make things clear, tables 5–7 indicate how various scored and unscored criteria combine to yield principle scores. If a scenario is not included in one of the tables, it should be assumed that the lowest criterion score is inherited as the principle score. APPENDIX C. Rules and Combinations in Code Formatdescribes the algorithms in code format. An exhaustive list of all possible combinations and the score they generate for each principle is given in Appendix F.

Table 5. Rules for generating the score for the bycatch principle based on the four scores for the bycatch criteria (information, outcome, management)

Bycatch_Info	Bycatch_Outcome_ETP	Bycatch_Outcome_Main	Bycatch_Management	Principle	
>=6	At least one is <6			<6	1
<6	Not scored (default, conditional to Bycatch_Info)		<6 (allowed values <=6 or not scored, conditional to Bycatch_Info)	< 6	2
>=6	One criterion is not scored, the other <6		<=8 (max value set conditional to the outcome criteria) OR not scored	<6	3
>=6	<6		<=8 (max value set conditional to the outcome criteria)	<6	4
<6	Not scored (default, conditional to Bycatch_Info)		6 or not scored (allowed values <=6 or not scored, conditional to Bycatch_Info)	DD	5
>=6	One criterion is not scored, the other >= 6 (both not scored is not allowed given that the information criterion is >= 6)		Not scored	DD	6
>=6	>= 6		Not scored	6	7
>=6	One criterion is not scored, the other >= 6 (both not scored is not allowed given that the information criterion is >= 6)		>=6	6	8
All ≥ 6; with at least one criterion = 6				6	9
All≥ 8; with at least one criterion = 8				8	10
All≥ 8; with at least one criterion = 8			Not applicable	8	11
All 10				10	12
All 10			Not applicable	10	13
All 10, with at least one criterion >10				>10	14
All 10, with at least one criterion >10			Not applicable	>10	15

Notes:

"Not scored" denotes cases where an analyst could not attribute a score to a particular criterion. Information criteria are not allowed to be "not scored" because these are the first criteria the analyst scores and they indicate information availability and quality issues.

"Default" denotes cases where a score defaults to a value conditional to the score given to the information criterion: a score of "<6" for Bycatch_Info defaults to "not scored" for the two outcome criteria. The range of values allowed as valid scores for a given criterion can be conditional to the values given to other criteria (e.g., Bycatch_Management can only be <= 6 or "not scored" if Bycatch_Info is <6 or "not scored").

"DD" stands for "data deficient."

Table 6. Rules for generating the score for the habitat principle based on the four scores for the habitat criteria (information, outcome, and management)

Habitat_Info_Gear	Habitat_Info_Map	Habitat_Outcome	Habitat_Management	Principle	
>=6		At least one is <6		<6	1
<6	>=6	Not scored (default, conditional to Habitat_Info_Gear<6)	<6	<6	2
>= 6	<6	<=6 (max value set conditional to Habitat_Info_Map<6)	Not scored OR <=6 (conditional to Habitat_Info_Map<6)	<6	3
>= 6	<6	Not scored	<6	<6	4
<6		Not scored (default, conditional to info < 6)		DD	5
<6	>=6	Not scored (default, conditional to Habitat_Info_Gear<6)	Not scored OR 6 (max value set conditional to Habitat_Info_Gear<6)	DD	6
>=6	<6	Not scored	Not scored OR 6 (max value set conditional to Habitat_Info_Map)	DD	7
6		6 (max value set conditional to Ha_Info; Not scored not allowed conditional to Ha_Info >= 6)	Not scored OR >= 6	6	8
8		8 (max value set conditional to Ha_Info)	Not scored	6	9
All ≥ 6; with at least one criterion = 6 (if both Information criteria = 6, Habitat_Outcome defaults to a 6)				6	10
>= 6 (max value Habitat_Outcome = Habitat_Info_Gear, set conditional to Ha_Info; not scored not allowed conditional to Ha_Info >=6)			Not scored	6	11
All ≥ 8; with at least one criterion = 8 (if both Information criteria = 8, Habitat_Outcome defaults to an 8)				8	12
All ≥ 8; with at least one criterion = 8 (if both Information criteria = 8, Habitat_Outcome defaults to an 8)			Not applicable	8	13
All 10				10	14
All 10			Not applicable	10	15
All 10, with at least one criteria >10				>10	16
All 10, with at least one criteria >10			Not applicable	>10	17

Notes:

"Not scored" denotes cases where an analyst could not attribute a score to a particular criterion. Information criteria are not allowed to be "not scored" because these are the first criteria the analyst scores and they indicate information availability and quality issues.

"Default" denotes cases where a default is set a to a value conditional to the score given to the information criterion: if one or both of the information criteria is scored <6 the outcome criterion defaults to "not scored"; if both of the information criteria are scored <6 the management criterion defaults to "not scored." The range of values allowed as

valid scores for a given criterion can be conditional to the values given to other criteria, (e.g., Habitat_Outcome can only be lower or equal to the minimum score given to the two information criteria).

Table 7. Rules for generating the score for the ecosystem principle based on the four scores for the ecosystem criteria (information, outcome, and management)

Ecosystem_Info_Impact	Ecosystem_Info_Map	Ecosystem_Outcome	Ecosystem_Management	Principle	
>=6		At least one is <6		<6	1
<6	>=6	Not scored (default, conditional to Ecosystem_Info_Impact<6)	< 6	<6	2
>= 6	<6	<=6 (max value set conditional to Ecosystem_Info_Map<6)	Not scored OR <=6 (conditional to Ecosystem_Info_Map<6)	<6	3
>= 6	<6	Not scored	<6	<6	4
<6		Not scored (default, conditional to info < 6)		DD	5
<6	>=6	Not scored (default, conditional to Ecosystem_Info_Impact<6)	Not scored OR 6 (max value set conditional to Ecosystem_Info_Impact<6)	DD	6
>=6	<6	Not scored	Not scored OR 6 (max value set conditional to Ecosystem_Info_Map)	DD	7
6		6 (max value set conditional to Eco_In; not scored not allowed conditional to Eco_In = 6)	Not scored OR >= 6	6	8
8		8 (max conditional to Eco_In)	Not scored	6	9
All ≥ 6; with at least one criterion = 6 (if both Information criteria = 6, Ecosystem_Outcome defaults to a 6)				6	10
>= 6 (max value Ecosystem_Outcome = Ecosystem_Info_Impact, set conditional to Eco_In; not scored not allowed conditional to Eco_In >=6)			Not scored	6	11
All ≥ 8; with at least one criterion = 8 (if both Information criteria = 8, Ecosystem_Outcome defaults to an 8)				8	12
All ≥ 8; with at least one criterion = 8 (if both Information criteria = 8, Ecosystem_Outcome defaults to an 8)			Not applicable	8	13
All 10				10	14
All 10			Not applicable	10	15
All 10, with at least one criteria >10				>10	16
All 10, with at least one criteria >10			Not applicable	>10	17

Notes:

"Not scored" denotes cases where an analyst could not attribute a score to a particular criterion. Information criteria are not allowed to be "not scored" because these are the first criteria the analyst scores and they indicate information availability and quality issues.

"Default" denotes cases where a default is set a to a value conditional to the score given to the information criterion: if one or both of the information criteria is <6 the outcome criterion defaults to "not scored"; if both of the information criteria are <6 the management criterion defaults to "not scored." The range of values allowed as valid scores for a

given criterion can be conditional to the values given to other criteria (e.g., Ecosystem_Outcome can only be lower or equal to the minimum score given to the two information criteria and it cannot be “not scored” if Ecosystem_Info_Impact >=6).

Table 8 indicates how the three scores for the principles are combined to generate a single rating on environmental impact visible to industry partners in SFP's Metrics database.

Table 8. Rules for generating the Metrics environmental impact outcome from the scores for the three principles

Principle			Metrics Environmental Impact Outcome
Bycatch	**Habitat**	**Ecosystem**	
At least one of the three principles is <6			High Risk
At least 2 principles are DD			DD
One principle is DD and the other are ≥6'			Medium Risk
All principles are >= 6, with at least one principle = 6			Medium Risk
Between 8 and >10			Low Risk

Terminology

Additional terms that an analyst might need to know.

Baseline (levels of bycatch): The total amount of bycatch generated by the fishery before bycatch reduction measures were implemented. If an estimate for the entire fishery is unavailable, information for individual species or information from trials of bycatch reduction gear later implemented throughout the fishery can be used as proxies.

Exceptional species: Species that have been determined to play essential roles in maintaining the integrity, resilience, and productivity of the ecosystem, e.g., critical forage (i.e., in wasp-waist ecosystems) and other basal prey species, keystone species, foundation species (habitat-forming species, e.g., oyster beds), and top predators.

Ghost fishing: Continued fishing by gear (generally static gears such as gillnets, trammel nets, traps, etc.) that has been lost or abandoned. Reliable evidence on impacts of ghost fishing should be taken into account for bycatch outcome scores (main and PET).

Key ecosystem elements: The features of an ecosystem considered most crucial to the ecosystem's characteristic nature and dynamics, the integrity of its structure and functions, and its resilience and productivity.

Overfished: Depleted by excessive fishing. The stock may remain overfished for some time even if fishing mortality has been reduced (ecosystem overfishing).

Vulnerable Marine Ecosystem (VME): A marine habitat that is a) unique or rare, b) functionally significant, c) fragile, d) structurally complex, and/or e) home to species that are slow to recover. More information on these five FAO criteria for identification of VMEs can be found in FAO (2009. VMEs are typically related with deep sea fisheries in the high seas.

REFERENCES

Airoldi, L., Balata, D., and Beck, M.W., 2008. The gray zone: relationships between habitat loss and marine diversity and their applications in conservation. J. Exp. Mar. Biol. Ecol. 366, 8–15.

Byrne, L. B., 2007. Habitat structure: a fundamental concept and framework for urban soil ecology. Urban Ecosystems, 10(3):255–274.

Cannon, J., 2006. FishSource Scores, how they're calculated and what they represent, v.1. Sustainable Fisheries Partnership. 20 pp.

Caveen, A.J., Lart, W., Duggan, H., and Pickerell, T., 2017. The Risk Assessment for Sourcing Seafood (RASS): Empowering businesses to buy responsibly. Mar. Policy 75, 1–10. doi:10.1016/j.marpol.2016.10.005

Collie, J.S., Beck, M.W., Craig, B., Essington, T.E., Fluharty, D., Rice, J., Sanchirico, J.N., others, 2013. Marine spatial planning in practice. Estuar. Coast. Shelf Sci. 117, 1–11.

CSIRO Australia, 2009. Fishery Impact Test Developed. ScienceDaily, 29 October 2009. [https://www.sciencedaily.com/releases/2009/10/091027101411.htm]

Curtis, K.A., Moore, J.E., Boyd, C., Dillingham, P.W., Lewison, R.L., Taylor, B.L., and James, K.C., 2015. Managing catch of marine megafauna: Guidelines for setting limit reference points. Mar. Policy 61, 249–263. doi:10.1016/j.marpol.2015.07.002

DFO (Department of Fisheries and Oceans, Canada), 2001. Policy for the management of fish habitat. Commun. Dir. Dep. Fish. Oceans. Ottawa, Ontario. [http://www.dfo-mpo.gc.ca/Library/23654.pdf]

Diaz, R.J., and Rosenberg, R., 2008. Spreading dead zones and consequences for marine ecosystems. science 321, 926–929.

Douvere, F., and Ehler, C.N., 2009. New perspectives on sea use management: initial findings from European experience with marine spatial planning. J. Environ. Manage. 90, 77–88.

Dudley, N. (ed.), 2008. Guidelines for Applying Protected Area Management Categories. Gland, Switzerland: IUCN. 86 pp.

Fahrig, L., 2003. Effects of habitat fragmentation on biodiversity. Annu. Rev. Ecol. Evol. Syst. 34, 487–515.

FAO (Food and Agriculture Organization of the United Nations), 1997. Land Quality Indicators and Their Use in Sustainable Agriculture and Rural Development (Proceedings of the Workshop organized by the Land and Water Development Division FAO Agriculture Department and the Research, Extension and Training Division FAO Sustainable Development Department). Rome.

FAO, 2009. International guidelines for the management of deep-sea fisheries in the high seas. Rome, FAO. 73 pp.

Fletcher, W., 2005. The application of qualitative risk assessment methodology to prioritize issues for fisheries management. ICES J. Mar. Sci. J. Cons. 62:1576–1587.

Garcia, S.M., 2003. The ecosystem approach to fisheries: issues, terminology, principles, institutional foundations, implementation and outlook. FAO Technical Paper 443. Rome, FAO. 71 pp.

Grieve, C., Brady, D., and Polet, H., 2014. Best practices for managing, measuring and mitigating the benthic impacts of fishing–Part 1. Mar. Steward. Counc. Sci. Ser. 2, 18–88.

Grieve, C., Brady, D., and Polet, H., 2015. Best practices for managing, measuring and mitigating the benthic impacts of fishing. Mar. Steward. Counc. Sci. Ser. 3, 81–120.Hall, M.A., 1996. On bycatches. Rev. Fish Biol. Fish. 6, 319–352.

Harper, D.J., and Quigley, J.T., 2005. No Net Loss of Fish Habitat: A Review and Analysis of Habitat Compensation in Canada. Environ. Manage. 36, 343–355. doi:10.1007/s00267-004-0114-x

Hobday, A., Smith, A., Stobutzki, I., Bulman, C., Daley, R., Dambacher, J., Deng, R., Dowdney, J., Fuller, M., Furlani, D., others, 2011. Ecological risk assessment for the effects of fishing. Fish. Res. 108, 372–384.

Hovel, K.A., and Lipcius, R.N., 2001. Habitat fragmentation in a seagrass landscape: patch size and complexity control blue crab survival. Ecology 82, 1814–1829.

Ichthys Marine, 2012. Reviewing and updating the FishSource scoring system. 79 pp. [https://sharespace.sustainablefish.org/issues/7798]

Jax, K., 2010. Ecosystem functioning. Cambridge University Press.

Johnstone, R.W., 2006. Benthic habitat function: Understanding benthic community metabolism using dynamic system models. Cooperative Research Centre for Coastal Zone, Estuary, and Waterway Management.

Larkin, P.A., 1996. Concepts and issues in marine ecosystem management. Reviews in Fish Biology and Fisheries, 6(2):139–164.

Link, J.S., and Browman, H.I., 2014. Integrating what? Levels of marine ecosystem-based assessment and management. ICES J. Mar. Sci. 71, 1170–1173. doi:10.1093/icesjms/fsu026

Long, R.D., Charles, A., and Stephenson, R.L., 2015. Key principles of marine ecosystem-based management. Mar. Policy 57, 53–60. doi:10.1016/j.marpol.2015.01.013

MSC (Marine Stewardship Council), 2014. Fisheries certification requirements and guidance, version 2.0. 527 pp.

Monterey Bay Aquarium Seafood Watch, 2015. Seafood Watch Criteria for Fisheries. June 24, 2015. Version for public comment period 2. 95 pp.

NMFS (National Marine Fisheries Service), 2010. Marine fisheries habitat assessment improvement plan, 115. NOAA Technical Memorandum NMFS-F/SPO-108. [https://www.st.nmfs.noaa.gov/st4/documents/habitatAssessmentImprovementPlan_052110.pdf]

Ocean Health Index. [http://www.oceanhealthindex.org/]

Pitcher, T.J., Kalikoski, D., Short, K., Varkey, D., and Pramod, G., 2009. An evaluation of progress in implementing ecosystem-based management of fisheries in 33 countries. Mar. Policy 33, 223–232.

Ruckelshaus, M., Klinger, T., Knowlton, N., and DeMaster, D.P., 2008. Marine Ecosystem-based Management in Practice: Scientific and Governance Challenges. BioScience 58, 53–63. doi:10.1641/B580110

Sousa, P., 2011. SFP Review of "Review. Robustness and Credibility of FishSource and Sustainable Fisheries Partnership (SFP) Generic Metrics System (GMS)" by Stokes, K. 21 pp. [https://sharespace.sustainablefish.org/issues/2909]

Sousa, P., and J. Cannon, 2010. The SFP Generic Metrics System, version 1. Sustainable Fisheries Partnership. 8 pp.

Stokes, K., 2011. Review. Robustness and Credibility of FishSource and Sustainable Fisheries Partnership (SFP) Generic Metrics System (GMS). Prepared for: Woolworths Limited, 6 November 2011. 14 pp. [https://sharespace.sustainablefish.org/issues/2909; https://sharespace.sustainablefish.org/issues/3221]

Warfe, D.M., and Barmuta, L.A., 2004. Habitat structural complexity mediates the foraging success of multiple predator species. Oecologia 141, 171–178.

Whalen, J., 2011. Summary response to Dr. Stokes' review ("Robustness and Credibility of FishSource and Sustainable Fisheries Partnership (SFP) Generic Metrics System (GMS)"). Sustainable Fisheries Partnership. 3 pp. [https://sharespace.sustainablefish.org/issues/2909]

APPENDIX A. Summary of current MSC standards for Principle 2

Appendix A summarizes the current MSC standards for Principle 2, Environmental Impact of Fishing, capturing the most important aspects and concepts.

2.1.1 Primary Species Outcomes
1. Are main primary species above the point where recruitment would be impaired?
2. If a main primary species is below the point where recruitment is impaired, does the fishery impair its recovery?
3. If a minor primary species is below the point where recruitment is impaired, does the fishery impair its recovery?

2.1.2 Primary Species Management
4. Is there a management strategy in place that is expected to maintain or to not hinder rebuilding of primary species?
5. Does the fishery regularly review the management strategy and deem it likely to work?
6. Is the management strategy being implemented successfully?
7. Is it likely that shark finning is not taking place?
8. Is there a regular review of the effectiveness and practicality of alternative measures to minimize fishery-related mortality of unwanted catch of main primary species?

2.1.3 Primary Species Information
9. Is information adequate to estimate the impact of the fishery on the main primary species with respect to status?
10. Is information adequate to estimate productivity and susceptibility attributes for main primary species?
11. Is information adequate to estimate the impact of the fishery on minor primary species with respect to status?
12. Is information adequate to support a strategy to manage primary species?

2.2.1 – 2.2.3 Secondary Species Outcomes, Management Information
13. – 24. Same as 1–12, but for secondary species

2.3.1 ETP Species Outcomes
25. Are effects of the fishery on population/stocks within national or international limits, where applicable?
26. Are known direct effects of the fishery likely to not hinder recovery of ETP species?
27. Are there no significant detrimental indirect effects of the fishery on ETP species?

2.3.2 ETP Species Management
28. Are there measures in place that minimize the mortality of ETP species?
29. Are there measures in place that achieve national and international requirements for the protection of ETP species?
30. Are there measures in place that ensure that the fishery does not hinder the recovery of ETP species?
31. Is the management strategy for ETP species likely to work?
32. Is the management strategy for ETP species being implemented successfully?
33. Is there a regular review of the effectiveness and practicality of alternative measures to minimize fishery-related mortality of unwanted catch of ETP species?

2.3.3 ETP Species Information
34. Is information adequate to estimate the impact of the fishery on the ETP species with respect to status?
35. Is information adequate to estimate productivity and susceptibility attributes for ETP species?
36. Is information adequate to estimate the impact of the fishery on ETP with respect to status?

37. Is information adequate to support a strategy to manage ETP species?

2.4.1 Habitats Outcomes
38. Is the fishery unlikely to reduce structure and function of the commonly encountered habitats to a point where there would be serious or irreversible harm?
39. Is the fishery unlikely to reduce structure and function of VME habitats to a point where there would be serious or irreversible harm?
40. Is the fishery unlikely to reduce structure and function of minor habitats to a point where there would be serious or irreversible harm?

2.4.2 Habitat Management
41. Are there measures in place that minimize fishery impact on habitat?
42. Is the management strategy for habitat likely to work?
43. Is the management strategy for habitat being implemented successfully?
44. Does the fishery comply with management requirements to protect VMEs?

2.4.3 Habitat Information
45. Are the nature, distribution, and vulnerability of the main habitats understood?
46. Is the distribution of all habitats known with particular attention to the occurrence of vulnerable habitats?
47. Is information adequate to understand the impacts of the gear on the main habitats?
48. Is there reliable information on the spatial extent of interaction and on the timing and location of use of the fishing gear?
49. Have the physical impacts of gear on all habitats been quantified fully?
50. Is adequate information collected to detect any increase in risk to the main habitats?
51. Are changes over time in all habitat distributions measured?

2.5.1 Ecosystem Outcomes
52. Is the fishery unlikely to disrupt the key elements of ecosystem structure and function?

2.5.2 Ecosystem Management
53. Are there measures in place that minimize fishery impact on ecosystems?
54. Is the management strategy for ecosystems likely to work?
55. Is the management strategy for ecosystems being implemented successfully?

2.5.3 Ecosystem Information
57. Is information adequate to identify and understand key elements of the ecosystem?
58. Are main impacts of the fishery on the ecosystem inferable from existing information?
59. Have main impacts of the fishery on the ecosystem been investigated in detail?
60. Are the main functions of ecosystem components known and understood?
61. Is adequate information available on the impacts of the fishery on ecosystem components to allow main consequences to be inferred?
62. Is adequate data collected to detect any increase in risk to ecosystems?

APPENDIX B. Best practices in bycatch mitigation

Table B-1 summarizes some practices that have proven successful in various fisheries and was adapted from the Monterey Bay Aquarium Seafood Watch Criteria for Fisheries. The table is provided for information only and not to be used as a rigid guide for scoring. Measures for bycatch mitigation are fishery and area specific, with various degrees of success for different fisheries or different areas. Defining best practices is specific to the fishery and species in question.

Table B-1. List of best practices in bycatch mitigation

Measure	Type	Notes
All Gear		
Compliance and associated monitoring	Primary	
Area and time closures	Supporting	The goal of these closures is to limit fisher access to bycatch species' high-value habitats, thereby reducing fishery impacts on bycatch species.
Bycatch caps / "real time" closures	Supporting	I.e., fishery closes when cap exceeded.
Transition to a lower impact gear, gear adaptations	Supporting	Gear adaptations: e.g., the use of circle hooks in longline fisheries, decreasing soaking time, minimum/maximum mesh sizes
Proper catch handling / safe release training	Supporting	
Landing prohibitions for some species	Supporting	
Pelagic longline fisheries		
Seabirds (albatrosses and petrels)		
Night setting	Primary in Southern hemisphere	Proven effective in Southern Hemisphere. Streamer lines and weighted lines should also be used when interacting with nocturnal birds/fishing during bright moon.

Streamer/scarer lines	Primary in Northern hemisphere	Proven to be effective in North Atlantic. Should be paired and/or weighted lines in North Pacific. Paired lines need more testing. Light configuration not recommended.
Weighted branch lines	Supporting	Must be combined with other measures.
Offal discharge management	Supporting	Not yet established but is thought to assist.
Sidesetting	Supporting	Effectiveness insufficiently researched.
Underwater setting chute, hook design, olfactory deterrents, blue-dyed bait, thawed bait	Supporting	Effectiveness insufficiently researched.
Shield deck lights, object cannons, towed objects, acoustic deterrents	Supporting	
Turtles		
Replacement of J and tuna hooks with circle hooks	Primary	Wide circle hook with </= 10 degree offset.
Bait change	Primary	Use of fish instead of squid.
Deep setting	Primary	Set gear deeper than turtle abundant depths (40–100m).
Fish bait hooking	Primary	Single hooking fish bait instead of threading hook through bait multiple times.
Temporal changes	Primary	Reduce soak time and haul during daylight.
Handling and release practices	Primary	To reduce mortality of caught turtles.
Lights on gear	Supporting	Use of intermittent flashing light sticks instead of continuous use non-luminous gear.
Sharks		
Bait change	Primary	Use fish instead of squid or vice-versa, depending on fishery, by catch type and location.
Prohibit wire leaders, use nylon leaders	Primary	
Deeper setting	Primary	Avoid surface waters.
Shark repellants	Supporting	Effectiveness insufficiently researched.
Circle, lanthanide, or large hooks (Hutchinson et al. 2012)	Supporting	
Avoid hotspots / change locations when shark bycatch is high	Supporting	

Reduce soak time	Supporting	
Marine mammals		
Weak hooks, deterrents, echolocation disruption	Supporting	Effectiveness insufficiently researched.
Reduce length of longline (Garrison 2007)	Supporting	
Shorter haulback (Kock et al. 2006)	Supporting	
Avoid hotspots	Supporting	
Fleet communication regarding mammal sightings	Supporting	
Other finfish (including juvenile targets)		
Circle hooks	Supporting	May help reduce mortality of billfish and tunas.
Bottom longline (Many measures similar to pelagic longline)		
Seabirds (albatrosses and petrels)		
Streamer/scarer lines	Primary	Effective, but must be used properly (streamers are positioned over sinking hooks). Better when combined with other measures, e.g., night setting, weighting, or offal control.
Underwater setting	Primary	Must be combined with other measures, especially streamers, offal control and/or night setting. Underwater setting is commonly deployed using chutes or weighted lines. Weighted lines have sometimes proven to be inadequate.
Night setting	Primary	Same as for pelagic longline fisheries (see above).
Haul curtain (reduce bird access when line is being hauled)	Supporting	Can be effective, but must use strategically as some birds become habituated. Must be used with other measures.
Offal discharge control (discharge homogenized offal at time of setting)	Supporting	Must be used in a combo, e.g., with streamers, weighting, or night setting.
Side setting	Supporting	Effectiveness insufficiently researched.

Hook design, olfactory deterrents, underwater setting chutes, blue-dyed bait, thawed bait, use of line setter	Supporting	Effectiveness insufficiently researched. Blue-dyed bait, thawed bait, and use of line setter not relevant in demersal gear.
Shield deck lights, object cannons, towed objects, acoustic deterrents	Supporting	
Turtles, sharks, mammals, other finfish: see pelagic longlines above		
Trawl		
Seabirds (albatrosses and petrels)		
Precautionary waste handling	Primary	No discharge of offal or discards during shooting and hauling.
Reduce cable strike through bird scaring wires or snatch block	Primary	Scarers recommended even when offal/discard management is in place. Snatch block recommended on theory.
Reduce net entanglement through net binding, net weights, net cleaning	Supporting	Recommended on theory.
Reduced mesh size, acoustic scarers, warp scarers, bird bafflers, cones on warp cables	Supporting	Effectiveness insufficiently researched.
Turtles		
Turtle excluder devices (TEDs)	Primary	
Sharks		
TEDs	Primary	
Marine mammals		
Turtle Excluder Devices (TEDs) or Bycatch Reduction Devices (BRDs)	Primary	Grids generally allow large animals to escape.
Other finfish		
BRDs	Primary	A BRD is any modification to gear to exclude bycatch species from trawl nets. Their principle focus is upon exclusion of finfish bycatch species.
BRD assist	Supporting	E.g., the cone. Stimulates fish to swim forward through escape hatches like the fisheye, square mesh window or radial escape section.

Coverless trawl	Supporting	Inclusion of increased mesh sizes in the upper wings and upper netting panel immediately behind the headrope crown, coupled with reduced headline height, encourages the escape of fish species such as haddock and whiting in and around the mouth of the trawl.
Rigging modification	Supporting	Triangular/diamond-shaped cut in the top of the codend (e.g., flapper), changes to ground chain settings, headline height reduction, a length of twine stretched between the otter boards to frighten fish, large mesh barrier across trawl mouth and large cuts in the top panel of the net ahead of the codend.
Semi-pelagic rigging	Supporting	Avoid contact with seabed.
Reduce trawling time	Supporting	
Trawl separator (Rhule trawl)	Supporting	Reduces cod catch in haddock trawls by separating catch and releasing cod from the net.
Shellfish		
TEDs	Supporting	TEDs generally allow large animals to escape (jellyfish). Downward facing TEDs may also allow benthic invertebrates to escape.
BRDs	Supporting	Possibly effective for jellyfish.
Rigging modification	Supporting	Longer sweeps between the otter board and trawl can reduce invertebrate bycatch.
Semi-pelagic rigging	Supporting	Avoid contact with seabed.
Other		
BRDs	Supporting	Seahorses, sea snakes in Australian prawn fisheries.
Gillnet		
Seabirds		
Visual and acoustic alerts	Supporting	Pingers may also reduce seabird bycatch.
Turtles		
Use lower profile nets	Primary	Reduces entanglement as the net is stiffer. Good for both demersal and drift nets.
Set nets perpendicular to shore	Supporting	Effectiveness insufficiently researched. May reduce interactions with nesting females.
Use deterrents	Supporting	Effectiveness insufficiently researched. Pingers, shark silhouettes, lights or chemicals.
Deep setting	Supporting	Effectiveness insufficiently researched. Avoid upper water column (above 40m).
Reducing soaking time	Supporting	
Marine mammals		
Pingers	Supporting	Acoustic devices to keep cetaceans (and possibly pinnipeds) away from nets. Effectiveness varies considerably depending on fishery and cetacean species.

Shellfish		
Weak buoy lines	Supporting	
Precautionary mesh size regulations	Supporting	
Purse Seine		
Turtles		
Avoid turtles	Primary	Avoid encircling turtles. Restrict setting on FADs, logs and other debris.
Use of modified FAD designs	Supporting	Effectiveness insufficiently researched.
Sharks		
Avoid sharks	Primary	Avoid restrict setting on FADs, logs, other debris and whales. Avoid hotspots.
Shark repellants	-	For deployment on FADs. Effectiveness insufficiently researched.
Marine mammals		
Backdown maneuver, Medina panel, deploy rescuers	Primary	
Avoid mammals	Primary	Restrict setting on mammals.
Other finfish		
Avoid finfish	Primary	Restrict setting on FADs.
Sorting grids	Supporting	Effectiveness insufficiently researched.
Pots and traps		
Turtles		
BRDs	Primary	E.g., diamondback terrapins in the Floridian blue crab pot fishery.
Marine mammals		
Weak lines	Primary	E.g., northern right whales, NE lobster fishery.
Sea Lion Excluder Devices	Primary	
Finfish, invertebrates		
BRDs	Primary	

APPENDIX C. Rules and Combinations in Code Format

Principle: Bycatch

#0 = "not scored", 1 = "<6", 11 = ">10",-1=”Not Applicable”
#!=: does not equal
#the numbers before each clause refer to the line number in the rules and combinations table for the principle

#1
IF (BY_IN >=6 AND BY_O_ETP == 1) BY = "<6"
IF (BY_IN >=6 AND BY_O_MAIN == 1) BY = "<6"
IF (BY_IN >=6 AND BY_O_M == 1) BY = "<6"
#2
IF (BY_IN == 1 AND BY_O_ETP == 0 AND BY_O_MAIN == 0 AND BY_O_M == 1) BY = "<6"
IF (BY_IN == 1 AND BY_O_ETP != 0) BY = "ERROR TOO LITTLE INFO TO SCORE"
IF (BY_IN == 1 AND BY_O_MAIN != 0) BY = "ERROR TOO LITTLE INFO TO SCORE"
IF (BY_IN == 1 AND BY_O_M >= 6) BY = "ERROR VALUE NOT ALLOWED GIVEN LOW INFO CRITERION"
#3
IF (BY_IN >=6 AND BY_O_ETP == 0 AND BY_O_MAIN == 1 AND BY_O_M <= 8) BY = "<6"
IF (BY_IN >=6 AND BY_O_ETP == 0 AND BY_O_MAIN == 1 AND BY_O_M > 8) BY = "ERROR MAX VALUE FOR MANAGEMENT IS 8, GIVEN THE LOW OUTCOME SCORES"
IF (BY_IN >=6 AND BY_O_ETP == 1 AND BY_O_MAIN == 0 AND BY_O_M <= 8) BY = "<6"
IF (BY_IN >=6 AND BY_O_ETP == 1 AND BY_O_MAIN == 0 AND BY_O_M > 8) BY = "ERROR MAX VALUE FOR MANAGEMENT IS 8, GIVEN THE LOW OUTCOME SCORES"
#4
IF (BY_IN >=6 AND BY_O_ETP < 6 AND BY_O_MAIN < 6 AND BY_O_M <= 8) BY = "<6"
IF (BY_IN >=6 AND BY_O_ETP < 6 AND BY_O_MAIN < 6 AND BY_O_M > 8) BY = "ERROR THE OUTCOME SCORES ARE TOO LOW AND DO NOT ALLOW FOR A HIGH MANAGEMENT SCORE. USE VALUES <= 8"
#5
IF (BY_IN <6 AND BY_O_ETP == 0 AND BY_O_MAIN == 0 AND BY_O_M == 6) BY = "DD"
IF (BY_IN <6 AND BY_O_ETP == 0 AND BY_O_MAIN == 0 AND BY_O_M == 0) BY = "DD"
IF (BY_IN <6 AND BY_O_ETP != 0) BY = "ERROR THE LOW INFORMATION SCORE DOES NOT ALLOW FOR ANY OUTCOME SCORES OR A HIGH MANAGEMENT SCORE, BY_O_M <= 6"
IF (BY_IN <6 AND BY_O_MAIN != 0) BY = "ERROR THE LOW INFORMATION SCORE DOES NOT ALLOW FOR ANY OUTCOME SCORES OR A HIGH MANAGEMENT SCORE, BY_O_M <= 6"
IF (BY_IN <6 AND BY_O_M > 6) BY = "ERROR THE LOW INFORMATION SCORE DOES NOT ALLOW FOR ANY OUTCOME SCORES OR A HIGH MANAGEMENT SCORE, BY_O_M <= 6"
#6
IF (BY_IN >=6 AND BY_O_ETP == 0 AND BY_O_MAIN == 0) BY = "ERROR AT LEAST ONE OUTCOME CRITERION SHOULD BE SCORED GIVEN THE HIGH INFO CRITERION"
IF (BY_IN >=6 AND BY_O_MAIN == 0 AND BY_O_ETP >= 6 AND BY_O_M == 0) BY = "DD"
IF (BY_IN >=6 AND BY_O_MAIN >= 6 AND BY_O_ETP == 0 AND BY_O_M == 0) BY = "DD"
IF (BY_IN >=6 AND BY_O_ETP >= 6 AND BY_O_MAIN >= 6 AND BY_O_M == 0) BY = "DD"

#7
IF (BY_IN >=6 AND BY_O_ETP >= 6 AND BY_O_MAIN >= 6 AND BY_O_M == 0) BY = "6"
#8
IF (BY_IN >=6 AND BY_O_ETP == 0 AND BY_O_MAIN >= 6 AND BY_O_M >=6) BY = "6"
IF (BY_IN >=6 AND BY_O_ETP >= 6 AND BY_O_MAIN == 0 AND BY_O_M >= 6) BY = "6"
IF (BY_IN >=6 AND BY_O_ETP == 0 AND BY_O_MAIN == 0) BY = "ERROR AT LEAST ONE OUTCOME CRITERION SHOULD BE SCORED GIVEN THE HIGH INFO CRITERION"
#9
IF (BY_IN >=6 AND BY_O_ETP >=6 AND BY_O_MAIN >=6 AND BY_O_M >=6) BY = 6 #ONE SCORE IN OUTCOME AND MANAGEMENT == 6
#10
IF (BY_IN >=8 AND BY_O_ETP >=8 AND BY_O_MAIN >=8 AND BY_O_M >=8) BY = 8 #ONE SCORE IN OUTCOME AND MANAGEMENT == 8
#11
IF (BY_IN >=8 AND BY_O_ETP >=8 AND BY_O_MAIN >=8 AND BY_O_M == -1) BY = 8
#12
IF (BY_IN == 10 AND BY_O_ETP == 10 AND BY_O_MAIN== 10 AND BY_O_M == 10) BY = 10 #ONE SCORE IN OUTCOME AND MANAGEMENT == 10
#13
IF (BY_IN == 10 AND BY_O_ETP == 10 AND BY_O_MAIN== 10 AND BY_O_M == -1) BY = 10
#14
IF (BY_IN >= 10 AND BY_O_ETP >= 10 AND BY_O_MAIN>= 10 AND BY_O_M >= 10 AND
BY_IN + BY_O_ETP + BY_O_MAIN+ BY_O_M>40) BY = 11
#15
IF (BY_IN >= 10 AND BY_O_ETP >= 10 AND BY_O_MAIN>= 10 AND BY_O_M == -1 AND
BY_IN + BY_O_ETP + BY_O_MAIN > 30) BY = 11

# DO NOT ALLOW NOT APPLICABLE FOR MANAGEMENT IF ANY OTHER SCORE IS < 8
IF (BY_IN < 8 AND BY_O_M == -1) BY = "ERROR NOT APPLICABLE FOR MANAGEMENT IS NOT ALLOWED IF ANY OTHER SCORE IS < 8"
IF (BY_O_ETP<8 AND BY_O_M == -1) BY = "ERROR NOT APPLICABLE FOR MANAGEMENT IS NOT ALLOWED IF ANY OTHER SCORE IS < 8"
IF (BY_O_MAIN< 8 AND BY_O_M == -1) BY = "ERROR NOT APPLICABLE FOR MANAGEMENT IS NOT ALLOWED IF ANY OTHER SCORE IS < 8"
# DO NOT ALLOW CRITERIA OTHER THAN MANAGEMENT TO BE NOT APPLICABLE
IF (BY_IN == -1 OR BY_O_ETP == -1 OR BY_O_MAIN == -1) BY = "ERROR ONLY THE MANAGEMENT CRITERION CAN BE NOT APPLICABLE"
#DO NOT ALLOW OUTCOME TO BE > 10
IF (BY_O_ETP == 11 OR BY_O_MAIN == 11) BY = "ERROR NEITHER OUTCOME CRITERION CAN BE >10"
# DO NOT ALLOW FOR INFO AS NOT SCORED
IF (BY_IN == 0) BY = "ERROR PLEASE SCORE THE INFORMATION CRITERION FIRST"

Principle: Habitat

#0 = "not scored", 1 = "<6", 11 = ">10", -1=”Not Applicable”
#!=: does not equal

#the numbers before each clause refer to the line number in the rules and combinations table for the principle

#1
IF (HA_IN_GEAR >=6 AND HA_IN_ME >=6 AND HA_O == 1) HA = "<6"
IF (HA_IN_GEAR >=6 AND HA_IN_ME >=6 AND HA_M == 1) HA = "<6"
#2
IF (HA_IN_GEAR == 1 AND HA_IN_ME >=6 AND HA_O == 0 AND HA_M == 1) HA = "<6"
IF (HA_IN_GEAR == 1 AND HA_IN_ME >=6 AND HA_O != 0) HA = "ERROR INFO FOR GEAR IMPACT IS NOT ADEQUATE TO SCORE OUTCOME"
#3
IF (HA_IN_GEAR >=6 AND HA_IN_ME == 1 AND HA_O <= 6 AND HA_O != 0 AND HA_M <= 6) HA = "<6"
IF (HA_IN_GEAR >=6 AND HA_IN_ME == 1 AND HA_O <= 6 AND HA_O != 0 AND HA_M > 6) HA = "ERROR MAX MANAGEMENT SCORE ALLOWED IS 6, DUE TO LOW HA_IN_ME"
IF (HA_IN_GEAR >=6 AND HA_IN_ME == 1 AND HA_O > 6) HA = "ERROR TOO LITTLE INFO TO GIVE A HIGH OUTCOME SCORE"
IF (HA_IN_GEAR >=6 AND HA_IN_ME == 1 AND HA_M > 6) HA = "ERROR TOO LITTLE INFO TO GIVE A HIGH MANAGEMENT SCORE"
#4
IF (HA_IN_GEAR >=6 AND HA_IN_ME == 1 AND HA_O == 0 AND HA_M == 1) HA = "<6"
#5
IF (HA_IN_GEAR ==1 AND HA_IN_ME == 1 AND HA_O == 0 AND HA_M==0) HA = "DD"
IF (HA_IN_GEAR == 1 AND HA_IN_ME == 1 AND HA_O != 0) HA = "ERROR LOW INFORMATION SCORES SHOULD DEFAULT TO DD HA_O AND HA_M"
IF (HA_IN_GEAR == 1 AND HA_IN_ME == 1 AND HA_M!=0) HA = "ERROR LOW INFORMATION SCORES SHOULD DEFAULT TO DD HA_O AND HA_M"
#6
IF (HA_IN_GEAR == 1 AND HA_IN_ME >= 6 AND HA_O == 0 AND HA_M== 6) HA = "DD"
IF (HA_IN_GEAR == 1 AND HA_IN_ME >= 6 AND HA_O == 0 AND HA_M == 0) HA = "DD"
IF (HA_IN_GEAR == 1 AND HA_IN_ME >= 6 AND HA_O != 0) HA = "ERROR THE COMBINATION OF INFORMATION SCORES SHOULD DEFAULT TO DD FOR HA_O AND HA_M <= 6 OR DD"
IF (HA_IN_GEAR == 1 AND HA_IN_ME >= 6 AND HA_M > 6) HA = "ERROR THE COMBINATION OF INFORMATION SCORES SHOULD DEFAULT TO DD FOR HA_O AND HA_M <= 6 OR DD"
#7
IF (HA_IN_GEAR >= 6 AND HA_IN_ME == 1 AND HA_O == 0 AND HA_M== 6) HA = "DD"
IF (HA_IN_GEAR >= 6 AND HA_IN_ME == 1 AND HA_O == 0 AND HA_M== 0) HA = "DD"
IF (HA_IN_GEAR >= 6 AND HA_IN_ME == 1 AND HA_O > 6) HA = "ERROR THE COMBINATION OF INFORMATION SCORES DOES NOT FOR HA_O > 6 AND HA_M > 6"
IF (HA_IN_GEAR >= 6 AND HA_IN_ME == 1 AND HA_M > 6) HA = "ERROR THE COMBINATION OF INFORMATION SCORES DOES NOT FOR HA_O > 6 AND HA_M > 6"
#8
IF (HA_IN_GEAR == 6 AND HA_IN_ME == 6 AND HA_O == 6 AND HA_M== 0) HA = 6
IF (HA_IN_GEAR == 6 AND HA_IN_ME == 6 AND HA_O == 6 AND HA_M>= 6) HA = 6
IF (HA_IN_GEAR == 6 AND HA_IN_ME == 6 AND HA_O > 6) HA = "ERROR THE SCORE OF THE OUTCOME CANNOT EXCEED THE SCORE OF THE INFORMATION CRITERIA"

```
 IF (HA_IN_GEAR >= 6 AND HA_IN_ME >= 6 AND HA_O == 0) HA = "ERROR THERE IS ENOUGH
INFORMATION TO SCORE THE OUTCOME CRITERION"
 #9
 IF (HA_IN_GEAR == 8 AND HA_IN_ME == 8 AND HA_O == 8 AND HA_M== 0 ) HA = 6
 IF (HA_IN_GEAR == 8 AND HA_IN_ME == 8 AND HA_O > 8 ) HA = "ERROR THE SCORE OF THE
OUTCOME CANNOT EXCEED THE SCORE OF THE INFORMATION CRITERIA"
 #10
 IF (HA_IN_GEAR == 6 AND HA_IN_ME >= 6 AND HA_O >= 6 AND HA_M >= 6 ) HA = 6
 IF (HA_IN_GEAR >= 6 AND HA_IN_ME == 6 AND HA_O >= 6 AND HA_M >= 6 ) HA = 6
 IF (HA_IN_GEAR >= 6 AND HA_IN_ME >= 6 AND HA_O == 6 AND HA_M >= 6 ) HA = 6
 IF (HA_IN_GEAR >= 6 AND HA_IN_ME >= 6 AND HA_O >= 6 AND HA_M == 6 ) HA = 6
 IF (HA_IN_GEAR == 6 AND HA_IN_ME == 6 AND HA_O > 6 ) HA = "ERROR THE SCORE OF THE
OUTCOME CANNOT EXCEED THE SCORE OF THE INFORMATION CRITERIA"
 #11
 IF (HA_IN_GEAR >= 6 AND HA_IN_ME >= 6 AND HA_O >= 6 AND HA_M == 0) HA = 6
 IF (HA_IN_GEAR >= 6 AND HA_IN_ME >= 6 AND HA_M == 0 AND HA_O == 0) HA = "ERROR HA_O
NEEDS TO BE SCORED. THE INFO SCORES SCHOW THERE IS ENOUGH INFO"
 IF (HA_IN_GEAR >= 6 AND HA_IN_ME >= 6 AND HA_M == 0 AND HA_O > HA_IN_GEAR) HA =
"ERROR HA_O NEEDS TO BE <= HA_IN_GEAR"
 #12
 IF (HA_IN_ME >= 8 AND HA_O >= 8 AND HA_M >= 8 AND HA_IN_GEAR == 8 ) HA = 8
 IF (HA_IN_GEAR >= 8 AND HA_O >= 8 AND HA_M >= 8 AND HA_IN_ME == 8 ) HA = 8
 IF (HA_IN_GEAR >= 8 AND HA_IN_ME >= 8 AND HA_M >= 8 AND HA_O== 8 ) HA = 8
 IF (HA_IN_GEAR >= 8 AND HA_IN_ME >= 8 AND HA_O>= 8 AND HA_M == 8 ) HA = 8
 IF (HA_IN_GEAR == 8 AND HA_IN_ME == 8 AND HA_O > 8 ) HA = "ERROR THE SCORE OF THE
OUTCOME CANNOT EXCEED THE SCORE OF THE INFORMATION CRITERIA"
#13
 IF (HA_IN_GEAR >= 8 AND HA_IN_ME >= 8 AND HA_O== 8 AND HA_M == -1) HA = 8
 IF (HA_IN_GEAR >= 8 AND HA_IN_ME == 8 AND HA_O>= 8 AND HA_M == -1) HA = 8
 IF (HA_IN_GEAR == 8 AND HA_IN_ME >= 8 AND HA_O>= 8 AND HA_M == -1) HA = 8
 IF (HA_IN_GEAR == 8 AND HA_IN_ME == 8 AND HA_O > 8 ) HA = "ERROR THE SCORE OF THE
OUTCOME CANNOT EXCEED THE SCORE OF THE INFORMATION CRITERIA"
#14
 IF (HA_IN_GEAR == 10 AND HA_IN_ME == 10 AND HA_O== 10 AND HA_M == 10 ) HA = 10
 #15
 IF (HA_IN_GEAR == 10 AND HA_IN_ME == 10 AND HA_O== 10 AND HA_M == -1 ) HA = 10
 #16
 IF (HA_IN_GEAR >= 10 AND HA_IN_ME >= 10 AND HA_O>= 10 AND HA_M >= 10 AND
    HA_IN_GEAR+ HA_IN_ME + HA_O+ HA_M > 40 ) HA = 11
 #17
 IF (HA_IN_GEAR >= 10 AND HA_IN_ME >= 10 AND HA_O>= 10 AND HA_M == -1 AND
    HA_IN_GEAR+ HA_IN_ME + HA_O> 30 ) HA = 11

 # DO NOT ALLOW NOT APPLICABLE FOR MANAGEMENT IF ANY OTHER SCORE IS < 8
 IF (HA_IN_GEAR < 8 AND HA_M == -1 ) HA = "ERROR NOT APPLICABLE FOR MANAGEMENT IS NOT
ALLOWED IF ANY OTHER SCORE IS < 8"
```

```
 IF (HA_IN_ME<8 AND HA_M == -1 ) HA = "ERROR NOT APPLICABLE FOR MANAGEMENT IS NOT
ALLOWED IF ANY OTHER SCORE IS < 8"
 IF (HA_O< 8 AND HA_M == -1 ) HA = "ERROR NOT APPLICABLE FOR MANAGEMENT IS NOT
ALLOWED IF ANY OTHER SCORE IS < 8"
 # DO NOT ALLOW CRITERIA OTHER THAN MANAGEMENT TO BE NOT APPLICABLE
 IF (HA_IN_GEAR == -1 OR HA_IN_ME == -1 OR HA_O == -1) HA = "ERROR ONLY THE
MANAGEMENT CRITERION CAN BE NOT APPLICABLE"
 #DO NOT ALLOW "HA_IN_ME" ,"HA_O" , "HA_M" TO BE > 10
 IF (HA_IN_ME == 11 OR HA_O == 11 OR HA_M == 11) HA = "ERROR HA_IN_ME ,HA_O ,HA_M
CANNOT BE >10"
 # DO NOT ALLOW FOR INFO AS NOT SCORED
 IF (HA_IN_GEAR == 0 OR HA_IN_ME == 0) HA = "ERROR PLEASE SCORE THE INFORMATION
CRITERIA FIRST"
```

Principle: Ecosystem

```
#0 = "not scored", 1 = "<6", 11 = ">10", -1=”Not Applicable”
#!=: does not equal
#the numbers before each clause refer to the line number in the rules and combinations table for
    the principle

 #1
 IF (ECO_IN_IMP >=6 AND ECO_IN_MAP >=6 AND ECO_O == 1) ECO = "<6"
 IF (ECO_IN_IMP >=6 AND ECO_IN_MAP >=6 AND ECO_M == 1) ECO = "<6"
 #2
 IF (ECO_IN_IMP == 1 AND ECO_IN_MAP >=6 AND ECO_O == 0 AND ECO_M == 1 ) ECO = "<6"
 IF (ECO_IN_IMP == 1 AND ECO_IN_MAP >=6 AND ECO_O != 0) ECO = "ERROR INFO FOR GEAR
    IMPACT IS NOT ADEQUATE TO SCORE OUTCOME"
 #3
 IF (ECO_IN_IMP >=6 AND ECO_IN_MAP == 1 AND ECO_O <= 6 AND ECO_O != 0 AND ECO_M <= 6
    ) ECO = "<6"
 IF (ECO_IN_IMP >=6 AND ECO_IN_MAP == 1 AND ECO_O <= 6 AND ECO_O != 0 AND ECO_M > 6)
    ECO = "ERROR MAX MANAGEMENT SCORE ALLOWED IS 6, DUE TO LOW ECO_IN_MAP"
 IF (ECO_IN_IMP >=6 AND ECO_IN_MAP == 1 AND ECO_O > 6) ECO = "ERROR TOO LITTLE INFO TO
    GIVE A HIGH OUTCOME SCORE"
 IF (ECO_IN_IMP >=6 AND ECO_IN_MAP == 1 AND ECO_M > 6) ECO = "ERROR TOO LITTLE INFO TO
    GIVE A HIGH MANAGEMENT SCORE"
 #4
 IF (ECO_IN_IMP >=6 AND ECO_IN_MAP == 1 AND ECO_O == 0 AND ECO_M == 1 ) ECO = "<6"
 #5
 IF (ECO_IN_IMP <=1 AND ECO_IN_MAP <= 1 AND ECO_O == 0 AND ECO_M==0 ) ECO = "DD"
 IF (ECO_IN_IMP <= 1 AND ECO_IN_MAP <= 1 AND ECO_O != 0 ) ECO = "ERROR LOW
    INFORMATION SCORES SHOULD DEFAULT TO DD ECO_O AND ECO_M"
 IF (ECO_IN_IMP <= 1 AND ECO_IN_MAP <= 1 AND ECO_M!=0) ECO = "ERROR LOW INFORMATION
    SCORES SHOULD DEFAULT TO DD ECO_O AND ECO_M"
 #6
```

IF (ECO_IN_IMP == 1 AND ECO_IN_MAP >= 6 AND ECO_O == 0 AND ECO_M== 6) ECO = "DD"
IF (ECO_IN_IMP == 1 AND ECO_IN_MAP >= 6 AND ECO_O == 0 AND ECO_M == 0) ECO = "DD"
IF (ECO_IN_IMP == 1 AND ECO_IN_MAP >= 6 AND ECO_O != 0) ECO = "ERROR THE COMBINATION OF INFORMATION SCORES SHOULD DEFAULT TO NOT SCORED FOR ECO_O AND ECO_M <= 6 OR DD"
IF (ECO_IN_IMP == 1 AND ECO_IN_MAP >= 6 AND ECO_M > 6) ECO = "ERROR THE COMBINATION OF INFORMATION SCORES SHOULD DEFAULT TO NOT SCORED FOR ECO_O AND ECO_M <= 6 OR NOT SCORED"
#7
IF (ECO_IN_IMP >= 6 AND ECO_IN_MAP == 1 AND ECO_O == 0 AND ECO_M== 6) ECO = "DD"
IF (ECO_IN_IMP >= 6 AND ECO_IN_MAP == 1 AND ECO_O == 0 AND ECO_M== 0) ECO = "DD"
IF (ECO_IN_IMP >= 6 AND ECO_IN_MAP == 1 AND ECO_O > 6) ECO = "ERROR THE COMBINATION OF INFORMATION SCORES DOES NOT ALLOW FOR ECO_O > 6 AND ECO_M > 6"
IF (ECO_IN_IMP >= 6 AND ECO_IN_MAP == 1 AND ECO_M > 6) ECO = "ERROR THE COMBINATION OF INFORMATION SCORES DOES NOT ALLOW FOR ECO_O > 6 AND ECO_M > 6"
#8
IF (ECO_IN_IMP == 6 AND ECO_IN_MAP == 6 AND ECO_O == 6 AND ECO_M== 0) ECO = 6
IF (ECO_IN_IMP == 6 AND ECO_IN_MAP == 6 AND ECO_O == 6 AND ECO_M>= 6) ECO = 6
IF (ECO_IN_IMP == 6 AND ECO_IN_MAP == 6 AND ECO_O > 6) ECO = "ERROR THE SCORE OF THE OUTCOME CANNOT EXCEED THE SCORE OF THE INFORMATION CRITERIA"
IF (ECO_IN_IMP >= 6 AND ECO_IN_MAP >= 6 AND ECO_O == 0) ECO = "ERROR THERE IS ENOUGH INFORMATION TO SCORE THE OUTCOME CRITERION"
#9
IF (ECO_IN_IMP == 8 AND ECO_IN_MAP == 8 AND ECO_O == 8 AND ECO_M== 0) ECO = 6
IF (ECO_IN_IMP == 8 AND ECO_IN_MAP == 8 AND ECO_O > 8) ECO = "ERROR THE SCORE OF THE OUTCOME CANNOT EXCEED THE SCORE OF THE INFORMATION CRITERIA"
#10
IF (ECO_IN_IMP == 6 AND ECO_IN_MAP >= 6 AND ECO_O >= 6 AND ECO_M >= 6) ECO = 6
IF (ECO_IN_IMP >= 6 AND ECO_IN_MAP == 6 AND ECO_O >= 6 AND ECO_M >= 6) ECO = 6
IF (ECO_IN_IMP >= 6 AND ECO_IN_MAP >= 6 AND ECO_O == 6 AND ECO_M >= 6) ECO = 6
IF (ECO_IN_IMP >= 6 AND ECO_IN_MAP >= 6 AND ECO_O >= 6 AND ECO_M == 6) ECO = 6
IF (ECO_IN_IMP == 6 AND ECO_IN_MAP == 6 AND ECO_O > 6) ECO = "ERROR THE SCORE OF THE OUTCOME CANNOT EXCEED THE SCORE OF THE INFORMATION CRITERIA"
#11
IF (ECO_IN_IMP >= 6 AND ECO_IN_MAP >= 6 AND ECO_O >= 6 AND ECO_M == 0 AND ECO_O<= ECO_IN_IMP) ECO = 6
IF (ECO_IN_IMP >= 6 AND ECO_IN_MAP >= 6 AND ECO_M == 0 AND ECO_O == 0) ECO = "ERROR ECO_O NEEDS TO BE SCORED. THE INFO SCORES SCHOW THERE IS ENOUGH INFO"
IF (ECO_IN_IMP >= 6 AND ECO_IN_MAP >= 6 AND ECO_M == 0 AND ECO_O > ECO_IN_IMP) ECO = "ERROR ECO_O NEEDS TO BE <= ECO_IN_IMP"
#12
IF (ECO_IN_MAP >= 8 AND ECO_O >= 8 AND ECO_M >= 8 AND ECO_IN_IMP == 8) ECO = 8
IF (ECO_IN_IMP >= 8 AND ECO_O >= 8 AND ECO_M >= 8 AND ECO_IN_MAP == 8) ECO = 8
IF (ECO_IN_IMP >= 8 AND ECO_IN_MAP >= 8 AND ECO_M >= 8 AND ECO_O== 8) ECO = 8
IF (ECO_IN_IMP >= 8 AND ECO_IN_MAP >= 8 AND ECO_O>= 8 AND ECO_M == 8) ECO = 8
IF (ECO_IN_IMP == 8 AND ECO_IN_MAP == 8 AND ECO_O > 8) ECO = "ERROR THE SCORE OF THE OUTCOME CANNOT EXCEED THE SCORE OF THE INFORMATION CRITERIA"

#13
IF (ECO_IN_IMP >= 8 AND ECO_IN_MAP >= 8 AND ECO_O== 8 AND ECO_M == -1) ECO = 8
IF (ECO_IN_IMP >= 8 AND ECO_IN_MAP == 8 AND ECO_O>= 8 AND ECO_M == -1) ECO = 8
IF (ECO_IN_IMP == 8 AND ECO_IN_MAP >= 8 AND ECO_O>= 8 AND ECO_M == -1) ECO = 8
IF (ECO_IN_IMP == 8 AND ECO_IN_MAP == 8 AND ECO_O > 8) ECO = "ERROR THE SCORE OF THE OUTCOME CANNOT EXCEED THE SCORE OF THE INFORMATION CRITERIA"
#14
IF (ECO_IN_IMP == 10 AND ECO_IN_MAP == 10 AND ECO_O== 10 AND ECO_M == 10) ECO = 10
#15
IF (ECO_IN_IMP == 10 AND ECO_IN_MAP == 10 AND ECO_O== 10 AND ECO_M == -1) ECO = 10
#16
IF (ECO_IN_IMP >= 10 AND ECO_IN_MAP >= 10 AND ECO_O>= 10 AND ECO_M >= 10 AND ECO_IN_IMP+ ECO_IN_MAP + ECO_O+ ECO_M > 40) ECO = 11
#17
IF (ECO_IN_IMP >= 10 AND ECO_IN_MAP >= 10 AND ECO_O>= 10 AND ECO_M == -1 AND ECO_IN_IMP+ ECO_IN_MAP + ECO_O> 30) ECO = 11

# DO NOT ALLOW 'NOT APPLICABLE' FOR MANAGEMENT IF ANY OTHER SCORE IS < 8
IF (ECO_IN_IMP < 8 AND ECO_M == -1) ECO = "ERROR 'NOT APPLICABLE' FOR MANAGEMENT IS NOT ALLOWED IF ANY OTHER SCORE IS < 8"
IF (ECO_IN_MAP<8 AND ECO_M == -1) ECO = "ERROR NOT APPLICABLE FOR MANAGEMENT IS NOT ALLOWED IF ANY OTHER SCORE IS < 8"
IF (ECO_O< 8 AND ECO_M == -1) ECO = "ERROR NOT APPLICABLE FOR MANAGEMENT IS NOT ALLOWED IF ANY OTHER SCORE IS < 8"
# DO NOT ALLOW CRITERIA OTHER THAN MANAGEMENT TO BE NOT APPLICABLE
IF (ECO_IN_IMP == -1 OR ECO_IN_MAP == -1 OR ECO_O == -1) ECO = "ERROR ONLY THE MANAGEMENT CRITERION CAN BE NOT APPLICABLE"
#DO NOT ALLOW "ECO_IN_MAP" TO BE > 10
IF (ECO_IN_MAP == 11) ECO = "ERROR ECO_IN_MAP CANNOT BE >10"
# DO NOT ALLOW FOR INFO AS NOT SCORED
IF (ECO_IN_IMP == 0 OR ECO_IN_MAP == 0) ECO = "ERROR PLEASE SCORE THE INFORMATION CRITERIA FIRST"

Metrics Environmental impact Outcome

#1
if (BY < 6 OR HA < 6 OR EC <6)EN = ”High Risk”
#2
if (BY == DD AND HA == DD AND EC == DD) EN = DD
if (BY != DD AND HA == DD AND EC == DD) EN = DD
if (BY == DD AND HA != DD AND EC == DD) EN = DD
if (BY == DD AND HA == DD AND EC != DD) EN = DD
#3
if (BY == DD AND HA >= 6 AND EC >= 6) EN = “Medium Risk”
if (BY >= 6 AND HA == DD AND EC >= 6) EN = “Medium Risk”
if (BY >= 6 AND HA >= 6 AND EC == DD) EN = “Medium Risk”
#4

if (BY >= 6 AND HA >= 6 AND EC >= 6 AND BY == 6 OR HA == 6 OR EC == 6) EN = “Medium Risk”
#5
if (BY >= 8 AND HA >= 8 AND EC >= 8) EN = “Low Risk”

APPENDIX D. Testing for Repeatability and Alignment

Introduction

Scoring fisheries on a public website and making recommendations to the supply chain based on those scores involves quality assurance and control. SFP needs to be confident that its method reflects best available science, sets reasonable benchmarks for performance, and that analyst can apply the method in a standardized way. FishSource's sustainability assessment method is applied through rapid desktop research and is not an independent standard. The rationale follows that of other assessment standards. Alignment/agreement with two well-known prominent assessment standards, the Marine Stewardship Council (MSC) and Seafood Watch (SFW) was tested, to verify that SFP's method is equivalent to MSC's or SFW's. Alignment would ensure an easy understanding of SFP's scoring by variable audiences and would enable SFP to communicate to its audience how its scores compare with those of MSC and SFW.

In the interest of actively pursuing quality, the FishSource team conducted a test of the new method in October 2015. We sought to test the method's *repeatability* (do two analysts attribute the same scores to the same fishery?) and *alignment* (does the method align with the MSC, Seafood Watch, and FishSource version 1 (FSv1) standards?). We were also interested in the following questions:

- Do data deficient fisheries receive "data deficient" scores?
- Can the method be applied efficiently in terms of time required to score the average fishery?
- Should there be interim benchmarks of "7" and "9" and/or should the algorithms for the three scores yield "7"s and "9"s in addition to the other, explicit options?

Methods

We included a group of twelve fisheries (Table D-1) in our test, selected because they met at least one of the following criteria:

- Recently (in the last two years) rated by MSC (nine of the fisheries), Seafood Watch (three of the fisheries, or FSv1 (four of the fisheries)
- Controversially failed (five fisheries) or just passed (four fisheries) for various environmental issues when assessed against the MSC, SFW, and/or FSv1 standards
- Scored very highly (>80, no conditions) for various environmental issues when assessed against the MSC standard, and might consequently earn ">10" scores when the new method is applied (three fisheries)

- Were assessed by MSC using the risk-based framework due to data deficiency, or data deficiency had otherwise been identified as a problem (two fisheries)
- Encompass a variety of gear types, target species, and geographies.

Table D-1. Fisheries included in test scoring. “x”s indicate recent past scoring of each fishery by MSC, SFW, or FishSource v1 or issues with data deficiency

No.	Stock	Gear	Data Deficient	MSC	SFW	FSv1	Note
1	Latvian E. Baltic cod	gillnet		X			failed MSC indicator for ETP outcome
2	Juan Fernandez Chile rock lobster	trap	X	X			just passed MSC (65) for ETP info indicator
3	Iceland saithe	bottom trawl		X		X	just passed MSC (60) for habitat outcome
4	US Atlantic scallop	dredge		X			just passed MSC (60) for ecosystem outcome
5	Patagonian toothfish	longline		X			just passed MSC (60) for bycatch outcome
6	Canadian swordfish	longline		X	X		SFW 'Avoid' for lack of bycatch management
7	Pacific hake	mw trawl		X		X	MSC 100s on the habitat indicators.
8	Olympic Antarctic krill	mw trawl		X		X	no P2 MSC conditions
9	Norwegian herring	purse seine		X			no P2 MSC conditions
10	NZ orange roughy	bottom trawl			X	X	SFW 'Avoid' for bycatch, habitat outcome
11	Upper Gulf of California blue shrimp	bottom trawl			X		SFW 'Avoid' due to bycatch outcome
12	Peruvian anchoveta	purse seine	X				FS profile of recent heavy focus, data deficient

For each of the twelve fisheries, two analysts (Nicole Portley and one other FishSource team member) attributed ratings for all twelve scores, accompanying each rating with a textual rationale and citations indicating the sources of information. Scores of “<6” were replaced with “4” and scores of “>10” with “12” in order to transform the scores to numeric values. Using the ratings and combinations tables in this document (tables 5–8 of the main document), the analysts determined the three scores at the principle level, as well as the overall Metrics rating for each fishery. Cumulatively, the trial gave 192 records: 144 scores at the criterion level, 36 principle-level scores, and 12 Metrics ratings.

If the fishery was also recently scored by the MSC, SFW, or the FishSource team using version 1 of our method, these other scores were compiled and placed alongside the analogous test scores in order to compare and assess alignment. Scores from MSC and SFW needed to be converted to a scale of 0–12 in order to compare with the FishSource scores. For this purpose, MSC scores were all divided by 10 (and MSC scores of "<60" were replaced with scores of "4"); meanwhile, SFW scores were converted using the formula y = 2x+1.6, where *x* is the SFW score and *y* the equivalent FishSource score (this formula was conceived using SFW's thresholds for red, <2.2, and yellow, 3.2, risk ratings, equivalent to <6 and <8 in the FishSource method, respectively). MSC has more indicators (15) in Principle 2, which deals with environmental impacts, than FishSource has scores (12)—therefore, some of the FishSource scores have multiple relevant MSC scores. In these cases, we used the lowest MSC score. Six out of the 12 FishSource scores have no equivalent in Seafood Watch, and consequently comparison of alignment between SFW and FS could only be done for the other six scores, as well as the three principle scores and the ratings. Finally, FishSource version 1, with its Boolean format, is difficult to convert to a 0 – >10 scale. Therefore, FSv1 and FSv2 were compared only at the rating level.

Cumulatively across all fisheries, there were 144 opportunities to test alignment with the MSC, 30 opportunities to test alignment with SFW, and four opportunities to test alignment with FSv1.
For the purposes of testing both repeatability and alignment, all scores (FSv2 scores, as well as those of MSC, SFW, and FSv1) were categorized into four groups: (1) <6; (2) 6–8; (3) >8; and (4) No Score or Data Deficient. If FS analysts assigned scores in the same category, this was considered a success in terms of repeatability. Analogously, if the FSv2 test scores attributed by at least one of the two analysts were in the same category as those of MSC, SFW, and FSv1, this was considered a success in terms of alignment. Results were examined using simple exploratory analysis (histograms) and the Wilcoxon test for paired samples. All analyses were applied in R statistical software (version 2.15.1).

Please note that for this analysis, FishSource analysts used the environmental methodology developed in 2015. Since then the methodology has been reviewed and the guideposts have changed, but changes were not substantial and the structure of the framework remains the same.

Results and Discussion

As indicated in Table D-2, below, the FishSource analysts attributed scores in the same category 68% of the time, including a 75% repeatability rate on Metrics ratings. As for alignment with other standards, FS analyst scoring corresponded with MSC scoring in 81% of cases, including 78% of Metrics ratings. Alignment with SFW was a little poorer, with only 60% correspondence, albeit with 100% correspondence at the ratings level. As for alignment with FishSource version 1, all ratings attributed in the testing using FishSource version 2 corresponded with ratings attributed by the old FishSource.

Table D-2. Summary of repeatability and alignment trial results

	Repeatability	MSC Alignment	SFW Alignment	FSv1 Alignment
# of tested responses	192	144	30	4
incl. criterion-scores	*144*	*117*	*21*	
excl. criterion-scores	*48*	*27*	*9*	
incl. Metric ratings	*12*	*9*	*3*	
# of complete matches	130	86	6	4
incl. criterion-scores	*99*	*70*	*4*	
excl. criterion-scores	*31*	*16*	*2*	
incl. Metric ratings	*9*	*5*	*1*	
# of partial matches	N/A	31	12	
incl. criterion-scores	*-*	*22*	*6*	
excl. criterion-scores	*-*	*9*	*6*	
incl. Metric ratings		*2*	*2*	
# of misses	62	27	12	
incl. criterion-scores	*45*	*16*	*8*	
excl. criterion-scores	*17*	*11*	*4*	
incl. Metric ratings	*3*	*2*	*0*	
Success rate: Overall	68%	81%	60%	100%
Criterion-Scores	69%	79%	48%	
Principle-Scores	65%	93%	89%	
Metrics Ratings	75%	78%	100%	100%

Notes: In the lefthand column, "complete matches" indicate instances where both FS analysts attributed scores in the same category (repeatability), as well as where both FS analysts attributed scores in the same category as MSC, SFW, or FSv1; "partial matches" refer to instances in which one of the two FS analysts attributed a score in the same category as MSC, SFW, or FSv1; "misses" refer to those cases in which neither FS analyst matched scores attributed by the other standards. Results are broken out by the type of scores (criterion-scores, principle-scores, Metrics ratings). Bottom rows summarize the findings, indicating success rates (proportion of matches, partial or complete).

In terms of repeatability, comparing Portley's scores with those of the other participating FishSource analysts revealed a similar distribution of the 192 scores among the four categories, with Portley assigning fewer "<6" scores than the other analysts (Figure D-1). As for alignment with MSC, analysis of the 178 scores with MSC analogs indicated very similar distributions among the FS analysts and MSC, with MSC attributing slightly fewer "<6" scores than the FS analysts (Figure D-2). Finally, regarding alignment with SFW, analysis of the 30 scores with SFW analogs indicated some variability in distribution of scores among the categories (Figure D-3). The Wilcoxon test showed consistency between analysts (Table D-3, raw data).

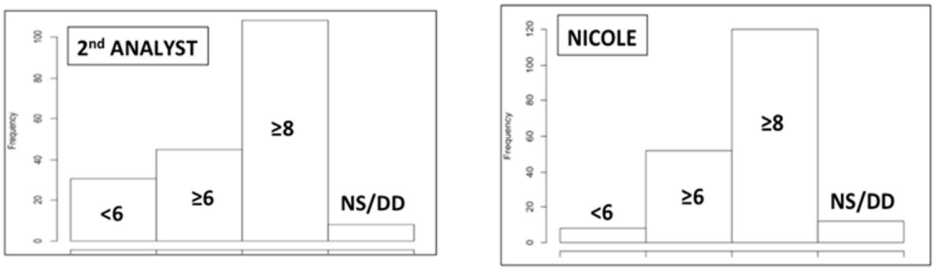

Figure D-1. Histograms indicating Nicole Portley's 192 fishery scores in the trial, as well as the 192 scores attributed by other participating FishSource analysts. Comparison of the two histograms indicates decent repeatability, with a similar distribution of ratings among the four categories between Nicole and the second analyst. Nicole attributed "<6" scores less often than the second analyst and did not score fisheries due to data deficiency more often.

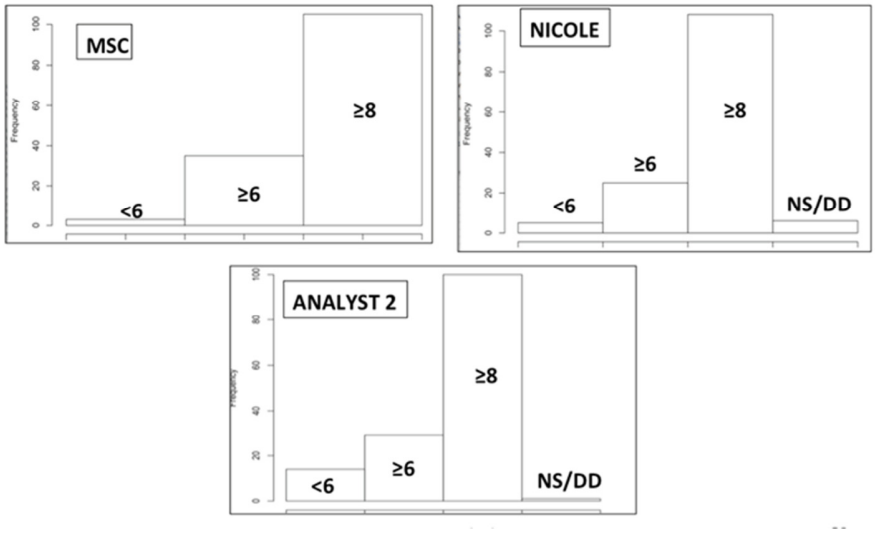

Figure D-2. Histograms indicating the scoring distribution of Nicole Portley, the team of other FS analysts, and the MSC for those 178 scores for which MSC ratings were available. Comparison of the three histograms indicates decent repeatability, with a similar distribution of ratings among the four categories for all three analysts. As with the repeatability test, the main difference among the histograms is the quantity of "<6" ratings that are attributed. Note: MSC analysts do not have the option of not scoring due to data deficiency.

Figure D-3. Histograms indicating the scoring distribution of Nicole Portley, the team of other FS analysts, and SFW for those 30 scores for which SFW ratings were available. Comparison of the three histograms indicates significant variability, with SFW generally scoring much more harshly than Nicole in terms of the quantity of "<6" scores. SFW matches the team of other FS analysts better in this respect, but is harsher than the FS analysts in terms of the number of "≥6" scores attributed vs. "≥8" scores.

Table D-3. comparison of paired scores between two groups using the Wilcoxon test (p-values). The table also shows the average difference of scores between the two groups and the average scoring of each group in []. The comparison between SFP analysts aims to assess consistency in scoring.

Group 1	Group 2	Difference [g1, g2]	P value
Raw Scores			
SFP control analyst	SFP second analysts	0.107 [6.23, 6.13]	0.5732
SFP control analyst	MSC	-2.097 [6.20, 8.30]	3.31e-12
SFP second analysts	MSC	-2.167 [6.13, 8.30]	< 2.2e-16
SFP control analyst	SFW	0.079 [6.13, 6.05]	0.6507
SFP second analysts	SFW	-0.521 [5.53, 6.05]	0.9344
Rescaled Scores			
SFP control analyst	SFP second analysts	0.224 [2.71, 2.48]	6.071e-05
SFP control analyst	MSC	0.084 [2.80, 2.71]	0.1264
SFP second analysts	MSC	-0.105 [2.61, 2.71]	0.0392
SFP control analyst	SFW	0.633 [2.30, 1.67]	0.001078
SFP second analysts	SFW	0.100 [2.75, 2.00]	0.5774

The consistency (repeatability) and alignment of our method with MSC and FSv1 is indicated by the trial results. We come to the conclusion that our method in its current iteration provides sufficiently detailed guidance to analysts and the likelihood of consistent scoring across multiple analysts is adequate. Our method is in reasonable alignment with MSC, and scores provide reasonable estimates of how fisheries would perform if assessed by MSC.

Alignment of the new method with SFW's standard was not strongly indicated by the current analysis, and is flagged as an area for further exploration. Results are considered inconclusive in this respect both because of the limited sample size and the fact that all of the fisheries scored by SFW and included in the trial were, with some controversy, rated "high risk" by SFW. Controversial cases of low performance where the analyst must choose between failing (a score of "<6") and just passing (a score of "6") a fishery, as well as considering the possibility of a "data deficient" rating, may result in greater variability between analysts using both the same standard and different standard. This hypothesis is supported by the repeatability trial results (Figure D-1), which indicate that the main difference among FS analysts lay with the number of "<6" and "data deficient" ratings awarded.

Other findings of the test scoring follow below:

- Analysts reported that scoring fisheries required 1–5 hours of work.
- Fisheries with known data deficiency issues did not always emerge with "data deficient" ratings. Reticence to use the option of not scoring, which is a new feature of FSv2 compared with FSv1, appears to be the main factor here. Additional guidance was added to this document in order to remind analysts of the existence of this option.
- Analysts expressed a preference for having the option of assigning interim scores at the criterion level (scores of "7" and "9") when fishery performance appears to lie between benchmarks. However, experimentation with the rules and combinations that yield scores at the principle level did not indicate that interim scores at the principle level would enhance alignment with MSC and/or SFW in a meaningful way.

APPENDIX E. Scoring Bycatch_Management for Shrimp Bottom Trawl Fisheries

Because bycatch is a particularly acute problem in bottom trawl shrimp fisheries, analysts are instructed to use a separate, offline scoring matrix for the bycatch management score (Bycatch_Management) when scoring them (Table E-1). The matrix is intended to ensure maximum scrutiny in the scoring of this very important issue. The score resulting from application of the matrix should be entered into FishSource by manual override. This method is work in progress and is not expected to be effective by the time SFP Environment Method, v2, is launched.

Score	Guideposts			
	<6	6	8	10
1. Is there an observer coverage plan in place?	No, there is no routine observer coverage in place.	Yes, there is an observer coverage program in place, but it is either inadequate or its statistical and scientific soundness has not been demonstrated.	Yes, there is a scientifically designed observer program in place with a demonstrated statistically robust coverage level.	(a) Yes, there is 100% observer coverage; OR (b) No, but bycatch is documented to be extremely low and observer coverage is not necessary.
2. Is there a plan in place to reduce bycatch and impacts upon ETP species?	No plan is in place to reduce bycatch and impacts on PET species, and fishery impacts on an individual PET species are likely considerable.	No plan is in place to reduce bycatch and impacts on PET species, but information available suggests that impacts on individual PET species are likely low.	Yes, a plan is in place to reduce bycatch and impacts on ETP species, but it does not mandate risk assessments for all main bycatch and ETP species.	(a) Yes, a plan is in place to reduce bycatch and impacts on ETP species, and it mandates risk assessments for all main bycatch and ETP species; OR (b) Scientific research has demonstrated that bycatch and ETP species impacts are low, and a plan is not needed.
3. Are BRDs (bycatch reduction devices) used in the fishery, and is their use mandated by law?	No, BRDs are not required in any portion of the fishery.	Yes, BRDs are required in part of the fishery.	Yes, 100% BRD use is mandated by law.	(a) Yes, 100% BRD use is mandated by law and scientific trials have demonstrated that approved BRDs effectively reduce bycatch; OR (b) Scientific research has demonstrated that bycatch is low and BRDs are not needed.
4. Are TEDs (turtle excluder devices) used in the fishery, and is their use mandated by law?	No, TEDs are not required in any portion of the fishery.	Yes, TEDs are required in part of the fishery.	Yes, 100% TED use is mandated by law.	(a) Yes, 100% TED use is mandated by law and scientific trials have demonstrated that approved TEDs effectively reduce sea turtle captures; OR (b) Scientific research has demonstrated that turtle interactions are low and TEDs are not needed.
5. Do fishers comply with mandatory use of BRDs, TEDs?	No, there is systematic non-compliance with BRD and TED regulations enabled by poor enforcement.	Compliance with and/or enforcement of BRD and TED regulations is below acceptable.	(a) Yes, compliance with and enforcement of BRD and TED regulations is generally good, but there are occasional violations; OR (b) BRD and TED use is not required in the fishery, but they are used voluntarily by a significant proportion of the fleet.	Yes, fishermen demonstrate full compliance with BRD and TED regulations.

Table E-1. Matrix for scoring Bycatch_Management for tropical bottom trawl shrimp fisheries. The analyst is instructed to review fishery performance and attribute ratings for each of the five scores. The lowest score among the five is taken as the fishery score for Bycatch_Management. If the fishery receives "10" for all five scores, a score of ">10" for Bycatch_Management is awarded. If two or more of the five scores cannot be determined due to data deficiency, Bycatch_Management is left unscored.

APPENDIX F. Spreadsheet of all possible criteria combinations and the score they generate for each principle

The attached Excel document is divided into three spreadsheets, one for each of the three principles evaluated in the SFP Environmental Method v2 (bycatch, habitat, and ecosystem). It includes all possible combinations of scores for all the criteria (information, outcome, and management) for each of the three principles.