GoodFish: Australia's Sustainable Seafood Guide

Wild Capture Fisheries Assessment Criteria

Version 2021A

GoodFish

Australia's Sustainable Seafood Guide

Australian Marine Conservation Society

The GoodFish: Australia's Sustainable Seafood Guide is produced by the Australian Marine Conservation Society (AMCS) in order to provide the public, seafood retailers and restaurants with a robust, comprehensive and independent guide to the environmental sustainability of seafood choices available in Australia. The Goodfish Guide rates the environmental performance of fisheries that supply seafood to the Australian market against a set of criteria that have been developed by AMCS, based on international best practice in seafood ratings[1].

Key Principles

AMCS adheres to the following key principles of sustainability in our GoodFish Sustainable Seafood Guide:

1. Sustainable fisheries ensure their target stocks are at levels sufficient to maintain the long-term integrity and functioning of the marine ecosystem, particularly in the context of our increasingly warming climate.

2. Sustainable fisheries may have some threatened species bycatch, but not enough to cause a decline in populations or species, and do not target listed threatened, endangered or protected species.

3. Sustainable fisheries maintain the integrity and functionality of marine ecosystems, and do not cause lasting damage to vulnerable marine habitats.

4. Sustainable fisheries are managed using the best available science, prioritising environmental protection and ensuring regulations are effectively implemented and enforced.

These key principles are defined in further detail in the outline of our assessment criteria below.

Outline of assessment criteria

1. Stock impacts

Sustainable fisheries ensure that the status (abundance and age/size structure) of the target stock is sufficient to maintain the long-term structure and function of the ecosystem as well as support ecologically viable fisheries now and into the future. Sustainable fisheries consider the biological traits, conservation status and ecological importance of the target species applying the precautionary approach. Sustainable fisheries are proactive and responsive if there is evidence that fishery or environmental impacts are threatening the status of the stock.

[1] The Australian Marine Conservation Society is a member of the Global Seafood Ratings Alliance.

There are two assessment pathways, depending on whether the fishery is considered data rich or data poor (as defined in section 1a)

Criteria principles

A stock should only be harvested when:

- the status (abundance and age/size structure) of the target stock is sufficient to maintain the long-term integrity and functionality of the ecosystem as well as support ecologically viable fisheries now and into the future.
- the stock is not overfished or subject to overfishing
- the species is not listed as a threatened, endangered, protected or Conservation Dependent species as defined under Australian legislation (State, Territory and/or Commonwealth), international agreements (e.g. CMS, CITES) or is listed under a threatened category on the IUCN Red List of threatened species.
- Note: species with high vulnerability and low resilience to fishing pressure (based on age at maturity, maximum age, fecundity, intrinsic rate of increase 'r' and species range etc.) are at higher risk of overfishing and stock depletion than those with low vulnerability and high resilience to fishing pressure. Sufficiently precautionary management is necessary to ensure fishing pressure is not set too high (see Appendix 1).

Assessment subcriteria (data rich fisheries)

a. Stock status

The current status of the stock (e.g. based on its abundance/biomass/ size or age structure) is considered relative to its un-fished level. The assessment will also consider the quality of stock assessments, e.g. whether data is fishery independent or based on catch per unit effort (CPUE).

b. Fishing mortality

This criterion (i.e. "F" in the stock assessment model used) assesses whether the level of fishing is appropriate to the stock's status and biology.

c. Species biology – vulnerability and resilience to overfishing

Only evaluate if there are concerns about inadequate management (criteria 4) or if there are evidence-based concerns about the robustness of assessment in criteria 1a or 1b.

This criterion considers the vulnerability and resilience to fishing activities of the species under consideration. The criteria framework uses FishBase assessments as well as other parameters to estimate the vulnerability and resilience to fishing; for example, age at maturity, maximum age, fecundity, natural population fluctuations and species' range.

2. Bycatch, byproduct and discard concerns

Sustainable fisheries operate in a manner that does not cause declines or significantly hinder the recovery of TEP species that are likely to interact with the fishery. AMCS considers an environmentally conservative assessment of the impacts of fisheries on TEP species is appropriate. Sustainable fisheries minimize non-TEP bycatch and discarding, do not overfish stocks of any byproduct or discard species, and ensure that reliable and up to date information relating to bycatch, byproduct and discards is available.

Criteria Principles

- The fishery does not catch and kill or harm threatened, endangered or protected species to the point where this causes a population decline, or prevents recovery of a species. Threatened, endangered and protected species are defined as those listed under Australian legislation (State, Territory and/or Commonwealth and including species listed as Conservation Dependent), international agreements (e.g. CMS, CITES) or listed as Vulnerable, Endangered or Critically Endangered on the IUCN Red List of threatened species.
- Byproduct is minimised and byproduct species are not overfished or subject to overfishing.
- Discarding of unwanted species, size groups and over quota of target species catches is minimised by practices aimed at retaining more of the catch, choice of fishing gear and/or appropriate spatial and temporal closures and move-on rules.
- Assessment should consider all species impacted by the fishery, but rankings in these criteria are based on the most affected and/or most vulnerable bycatch, byproduct or discard stock or species.

Assessment subcriteria

a. Interactions with Threatened, Endangered or Protected (TEP) species

This subcriterion assesses the level of fishery impact on species listed as protected under national/state/territory legislation, or under international agreement/convention.

b. Impacts on byproduct and discard species

This subcriterion considers the levels of byproduct and discards taken in a fishery, whether these levels are changing over time, whether management measures exist to regulate/reduce byproduct/discard rates, whether these measures are appropriate, and whether the levels of take of byproduct or discards are negatively impacting a stock/species.

c. Bycatch, byproduct and discarding reporting

This subcriterion considers whether levels of independent observer coverage are adequate and credible, and whether fishery reporting (logbooks, data, etc.) is accurate.

3. Habitat and ecosystem impacts

Sustainable fisheries operate in a manner that does not significantly increase disturbance/alteration of habitats and ecosystems and in conjunction with

effective environmental management. The function and extent of habitats and ecosystems[2] affected by the fishery are well understood and fishery footprints are managed in a precautionary manner[3]. If a species caught in or impacted by the fishery is of exceptional ecological value (e.g. is a keystone predator), fishing is managed so as to maintain the ecological role of that species and ecosystem function. To the extent allowed by the current state of the science, ecological interactions affected by the fishery are understood and protected, and the structure and function of the ecosystem is maintained. It should be noted that in some geographies or jurisdictions ecosystem-based fisheries management has not yet been established[4].

Criteria principles

- The type of fishing gear used and/or the level of fishing pressure does not negatively impact physical or biotic habitat that has low resilience to disturbance, is not damaging to critical habitat of threatened species, the fishery does not impact stocks to a point where ecologically related species are negatively impacted.
- The fishery does not significantly alter natural ecosystem structure and functionality (trophic cascades, phase shifts, biodiversity impacts, impacts on species recruitment, etc.), or relationships between species (e.g. predator prey relationships).

Assessment subcriteria

a. Physical impacts

This is a measurement of the level of physical disturbance that the method of fishing is likely to cause

b. Spatial/temporal scale of impacts

This subcriterion is only applicable if the outcome of Sub criterion 3a (above) is amber or red, and assesses whether the spatial/temporal of impact is acceptable, accounts for the nature of the area impacted, including the location of any areas of significant importance, the level of detailed knowledge of impacted habitat and critical habitat impacts.

c. Ecological impacts of fishery

This subcriterion measures the indirect effects of fishing on ecologically related species and considers impacts on biodiversity. The position of the target species in the food chain, and its ecological function and importance is also accounted for. The intention is that this criterion enables ecosystem level analysis of the impacts of fishing.

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[2] When considering ecosystem impacts of fishing, consider maintenance of the food web and the ecological role of all species impacted by the fishery (target and non-target) as per GSRA core element definitions 2019.

[3] Examples include (consider fisheries that contact the bottom), representative areas of each habitat affected by the fishery are represented in MPAs or equivalent spatial protection according to CAR principles, and fishery footprints for high risk fishing methods (see criterion 3a) are prohibited from extending into habitats unimpacted by that method.

[4] As per GSRA core element definitions 2019.

4. Management and effectiveness of management measures

Sustainable fisheries have management frameworks in place that ensure a precautionary approach is applied to managing target stocks and environmental impacts, invest in science that addresses information gaps, and effectively and transparently enforce regulation.

Criteria principles

- The biology and life history of the target species or stock is well known, the stock assessment data are robust, with high levels of scientific certainty and the fishery exhibits a history of maintaining appropriate levels of biomass and effort.
- For smaller scale, data deficient fisheries, management prevents overfishing and maintains ecosystem function, and efforts are directed towards obtaining better data to inform fisheries management.
- The fishery is managed along ecosystem-based principles, management controls (input and output controls such as Total Allowable Catches and quotas, etc.) are precautionary and responsive to a dynamic fishery, the management unit is appropriate (one or more stocks, which are managed separately), expansion of effort and increasing quota of under-fished stocks are precautionary, and the fishing regime is such that the long-term productivity and functioning of the ecosystem is maintained.
- Management is responsive to changes in the fishery e.g. identification of over-fished stock or increases in fishing effort for a particular species with limited justification, and management measures are enacted accordingly.

Assessment subcriteria

a. Management of fishery compliance

This subcriterion relates to management of fishery compliance with regulation, and the comprehensiveness and effectiveness of environmental protection provided by fishery legislation as it relates to target species, bycatch, habitats and ecosystems.

b. Scientific uncertainty and how this is accounted for in management

This subcriterion considers management of harvest levels, bycatch and habitat ecosystem impacts in relation to any key information gaps and environmental externalities that affect the fishery.

c. Management approach to bycatch, byproduct and discards

This subcriterion considers whether there is accurate reporting of information related to bycatch (particularly TEP species), byproduct and discarding and the adequacy of management actions in addressing any issues identified.

d. Management approach to habitat and ecosystem impacts

This subcriterion considers whether management within and beyond direct fishery management provides adequate protection for habitats and ecosystems Final Scoring considerations

Instructions for Assessors

This document presents the criteria used to assess the environmental sustainability of wild capture fisheries, as well as providing guidance on how to apply those criteria to determine the sustainability ranking in the Guide.

Determining the appropriate unit of assessment is critical and should be established at the outset of the assessment. In general, assessment should be at a stock level within different fisheries. Where multiple stocks of the same species are targeted in the same fishery, it is important to assess the stock that provides the greatest proportion of the catch, as well as each stock that catches >50t/yr, considering how the fishery's stocks/source of origin are treated in the marketplace. Assess other, smaller stocks when considered significant, such as stocks that are recently (<10 years) closed to the fishery, are a developmental fishery, or are particularly important in the market.

Our assessments consider four criteria that encompass key aspects of fishery sustainability:

1. Stock impacts
2. Bycatch, byproduct and discard concerns
3. Habitat and ecosystem impacts
4. Management and effectiveness of management measures.

Each criteria is scored by assessing all available information against a series of subcriteria ranked in three categories of environmental performance – denoted as 'green', 'amber' or 'red', with red signifying most environmental concern.

The overall rankings for criteria 1,2,3 and 4 are used to determine the final ranking for the fishery, which is listed in GoodFish: Australia's Sustainable Seafood Guide. This is applied using weightings provided in the table in section 5. The following overarching rules also apply:

- If either criteria 1, 2 or 3 result in a red ranking after assessment of the subcriteria, the stock/species/species group under assessment results in an automatic red rating.
- If criteria 4 results in a red ranking, the stock/species/species group cannot achieve a green rating.

In scoring, use the statement/s associated with green, amber or red ranking that best fit the available evidence. A perfect fit may not be available; where there is uncertainty, or where the available information may fit multiple scoring statements within or between green, amber or red, the precautionary approach should be adopted, i.e. err on the side of caution. Ensure that this approach is consistently taken throughout the assessment process.

Justification should be provided in assessment reports for how the available information supports a particular statement/s associated with the applied ranking, along with the particular ranking statement that is applied.

Some criteria and subcriteria interact and/or overlap with others, and where this occurs, both criteria should be assessed together. For example, 2c considers the level of bycatch compliance monitoring, which is connected to criterion 4.

When finalising species/stock rankings, consider which fishery/jurisdiction produces the main catch volume. The overall ranking will reflect this, possibly accompanied by additional notes for other fisheries.

Information used to inform assessments against these criteria is of varying quality and quantity across all eight jurisdictions that manage fisheries under different management regimes and legislation around Australia, and it is rarely possible to assess all aspects of fishery sustainability using quantitative, up to date information. As a result, a degree of expert judgement may be required. In order to minimize subjectivity in assessments, the best publicly available supporting evidence should always be cited in the assessment and verified where possible. Assessments are subject to internal review by AMCS, and external peer reviewers where deemed necessary. All assessment conclusions are able to be reviewed and revised at any time if found in error as a result of incomplete or updated information. As a general principle, all publicly available data evidence directly relating to the unit of assessment should be applied, along with any data supplied by industry, managers or other stakeholders. Information that is of direct relevance to the unit of assessment will take precedence over information that is indirectly applicable, wherever it is available.

AMCS will provide, upon request, information required to enable an individual fishery or management to improve on any ranking or understand the ranking that is applied. Final rating determinations remain the responsibility of AMCS.

1. Stock impacts

Sustainable fisheries ensure that the status (abundance and age/size structure) of the target stock is sufficient to maintain the long-term structure and function of the ecosystem as well as support ecologically viable fisheries now and into the future. Sustainable fisheries consider the biological traits, conservation status and ecological importance of the target species using the precautionary approach. Sustainable fisheries are proactive and responsive if there is evidence that fishery or environmental impacts are threatening the status of the stock.

There are two assessment pathways, requiring a different assessment approach for **data-rich** and **data-poor** stocks. If the fishery does not meet the following definition of data rich, it should be assessed as data-poor:

Fisheries that are data-rich have scientifically rigorous, recent [5] stock assessments containing reliable estimates of biomass or spawning stock biomass at Maximum Sustainable Yield (MSY) or an equivalent proxy. MSY is the largest average catch that can be fished continuously under constant environmental conditions. Data rich fisheries have corresponding biological reference points that describe stock health, providing estimates of whether a stock is above a target level of biomass, below a biomass target but above a biomass limit, or below a biomass limit/overfished.

AMCS considers it best practice that fisheries are managed with biomass level around Maximum Economic Yield (MEY), which is the sustainable catch level for a commercial fishery that allows net economic returns to be maximized. This yields the best economic justification for extraction of a fishery resource and is under most conditions a more conservative catch level than Maximum Sustainable Yield (MSY) - the largest average catch that can be fished continuously under constant environmental conditions. Because the environment in which fisheries operate is dynamic, MSY is considered a minimum sustainable level of biomass for the purposes of this assessment.

The unit of assessment may vary. Assessment should generally be undertaken at a stock level within different fisheries. Where multiple stocks of the same species are targeted in the same fishery, assess the stock that provides the greatest proportion of the catch and each stock that catches >50t/yr, considering how the fishery's stocks/source of origin are treated in the marketplace. Assess other, smaller stocks where they are considered significant to the assessment[6].

[5] A 'recent' stock assessment is based on data ≤5 years old. If the stock assessment is very out of date - as a rule of thumb, data are >10 years old - the stock status should be considered unknown and rated accordingly. It may be considered unknown even when the assessment is less than 10 years old in circumstances where the stock was previously very close to reference points or is very dynamic.

[6] Such as stocks that are recently (<10 years previous) closed to the fishery or are developmental, or particularly important in the market.

Data rich assessment pathway

a. Stock status[7]

In this criterion the current status of the stock under assessment (e.g. based on its abundance/biomass/ size or age structure, etc.) is considered relative to its un-fished level or long-term trends. The assessment will also consider the quality of stock assessments, e.g. whether assessment is supported by fishery independent data or based on fishery dependent data, such as catch per unit effort (CPUE).

If it is necessary to assess at a fishery rather than a stock level, this should be identified in assessment reports.

See appendix one for guidance on determining appropriate reference points according to MBA Seafood Watch Fisheries Standard 4.0.

Specific ranking guidance: If the majority of statements (dot points) associated with a Green, Amber or Red rank apply, apply that rank. Otherwise, rank one level more conservatively. Always provide justification.

Green:

- Stock is not described as overfished based on parameters such as species/stock is around or above B_{MSY} or proxy (generally $1.2B_{MSY}$).
- Fishery-independent data supports determination of stock status.
- If a stock is shared spatially between jurisdictions[8], management is done collaboratively.
- Reference points are conservative and appropriate to the biology of the target species, and the precautionary principle has been applied for species at high risk/vulnerability to fishing.

Amber:

- Recovering from an overfished state, if the recovery has led to stock status approaching B_{MSY} (>75% of B_{MSY})[9].
- Species/stock is <75% of B_{MSY} (but above an appropriate Point of Recruitment Impairment[10]) AND management measures are likely to ensure stock will continue to rebuild within one generation[9].

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[7] For Commonwealth managed fisheries, use ABARES Fishery Status Reports and Status of Key Australian Fish Stocks Reports to inform the ranking. For State and Territory fisheries, use the relevant stock status report as initial guidance, and Status of Australian Fishery Stock reporting where relevant, although note different reports use different reference points to determine stock status – always use the most conservative measure. Account for quality of data upon which the reported stock status is based – e.g. the use of poor-quality data used to state that a stock status is healthy should result in a lower ranking, as long as adequate justification is provided. For imported species, use the stock status as defined by the country of production, but note some definitions are less conservative than Australia.

[8] For this subcriterion, collaborative management should occur between all jurisdictions that catch >5% of the total catch.

[9] Check mean generation time on Fishbase or Status of Australian Fish Stocks reporting. Generation time can be defined as 'the average time taken for an individual to replace itself within the population.'

[10] See Appendix 1 for further guidance on determining appropriate reference points.

- Stock is not considered overfished but there is evidence that localized depletion[11] has occurred AND management actions have been put in place to address the issue.
- Stock is not considered overfished, but reference points are likely inappropriate to the biology of the species (See Appendix 1) AND management measures are likely to ensure stock will rebuild to an appropriate level (at or around a biologically appropriate level indicating MSY) within one generation time.
- Stock is not considered overfished, but is spatially shared between jurisdictions that do not manage the stock collaboratively[8].
- Species/stock is assessed as environmentally limited AND harvest control rules have been adjusted accordingly.

Red:

- Species/stock is listed as overfished in fishery status reporting.
- Species/stock is listed as recovering from a currently overfished state but concern remains over the extent or timeframe of rebuilding[12].
- Species/stock is <75% of B_{MSY} AND is not recovering, or recovery to B_{MSY} is likely to exceed one generation time.
- Species/stock is assessed as environmentally limited AND harvest control rules have been not been adjusted accordingly.
- There is evidence of severe localized depletion (that could justifiably be at a level that would impair recruitment within the scale of the stock management unit)[11] , AND no management actions are in place to address the issue.
- Stock is not considered overfished but only because reference points in Harvest Strategies or management plans are likely inappropriate to the biology of the species (See Appendix 1) AND management measures are unlikely to ensure stock will rebuild to an appropriate level (at or around a biologically appropriate level indicating MSY) within one generation[9]
- Species/stock is assessed as environmentally limited AND harvest control rules have been not been adjusted accordingly.

b. Fishing mortality (F)

This criterion assesses whether the level of fishing (i.e. 'F' in the stock assessment model used) is appropriate to the stock's status.

Green:

- Stock is listed as not subject to overfishing in fishery status reporting, and there is confidence in the level of certainty in that reporting.
- Level of fishing mortality is below or around $F_{MEY/MSY}$ and is appropriate to the biology of the species/stock.

[11] While localized depletion can be difficult to define, consider this factor conservatively in all circumstances where stock assessments are multi-species, use proxy species or do not account for all stock structure or spatial population structure (such as species with very small home ranges, or highly limited within-stock population mixing and dispersal), and there is evidence localized fishing within a stock has created local impacts that would correspond to an amber or red ranking under criteria 1, 2 or 3 in combination with fishery/stock-wide impacts.

[12] For example, if recovery is expected to take >1 generation.

Amber:

- Fishing mortality is likely to be resulting in pushing the stock towards an overfished status, but management actions have been enacted in order to reduce fishing mortality.
- Fishing mortality is increasing and there is inadequate understanding of stock status.
- Stock is listed as not subject to overfishing in fishery status reporting, but there is a high degree of uncertainty in that determination AND there are concerns that overfishing could be occurring.

Red:

- Species/stock is classified as subject to overfishing or analogous classification in fishery status reporting.
- Fishing mortality is likely to be resulting in the stock trending towards an overfished status, AND management actions are inadequate to reduce pressure, OR management actions are justifiably unlikely to be effective.
- Stock has been overfished at previous assessment but is only considered not subject to overfishing due to change in assessment methodology rather than a demonstrated improvement in biomass through improved fishery dependent or independent data, AND a precautionary approach suggests significant risk to the stock if overfishing is continuing.

c. Species biology – vulnerability and resilience to overfishing[13]

This criterion analyses the vulnerability and resilience to fishing activities of the species under consideration. The criteria framework uses the scores recorded on FishBase as well as other parameters to decide upon the vulnerability and resilience to fishing pressure, e.g. age at maturity, maximum age, fecundity, intrinsic rate of increase 'r', natural population fluctuations and species' range.

Note: Only evaluate if there are concerns about inadequate management (criterion 4 ranks red overall) or if there are unknowns in criteria 1 a or b.

Green:

- FishBase vulnerability score[14] is Low to Moderate (0 – 0.35).

Amber:

- FishBase vulnerability score is Moderate to High Vulnerability (0.36 – 0.55).

Red:

- FishBase vulnerability score is High to Very High (0.56 – 1.0).

[13] Boundaries for FishBase Vulnerability score are sourced from Seafood Watch Criteria for Fisheries 2012.

[14] Froese, R. and D. Pauly. Editors. (2019) FishBase. World Wide Web electronic publication. www.fishbase.org, version .

In addition, or in cases where no FishBase score exists, assess species vulnerability based on the following parameters, if available:

Ranking:	Age at maturity:	Maximum age:	Average maximum size (cm):	Reproductive potential (individuals/ year):
Green	<5	<10	<100	>100
Amber	5-15	11-25	100-300	10-100
Red	>15	>25	>300	<10

If no information regarding target species biology is available, this criterion receives an automatic red ranking.

d. Criteria 1 overall ranking determination – data rich assessment pathway

If a species/stock is overfished, the species/stock receives an automatic red ranking, irrespective of assessment against other criteria. An automatic red ranking also applies if the species is a listed threatened species.

If assessment under subcriteria a and b results in one green and one amber outcome, rank as amber, unless mitigating circumstances exist (in which case justification must be provided).

<table>
<tr><th>Overall Ranking</th><th>Criterion 1, Subcriterion 1a</th><th>Criterion 1, Subcriterion 1b</th><th>Criterion 1, Subcriterion 1c</th></tr>
<tr><td>Green</td><td colspan="2">Green</td><td>N/A</td></tr>
<tr><td rowspan="3">Amber</td><td>Green</td><td>Amber</td><td>N/A</td></tr>
<tr><td>Amber</td><td>Green</td><td>N/A</td></tr>
<tr><td colspan="3">All Amber</td></tr>
<tr><td rowspan="2">Red</td><td colspan="2">Either Red</td><td>N/A</td></tr>
<tr><td colspan="2">Both Amber</td><td>Red</td></tr>
</table>

Data-poor assessment pathway

Fisheries with data-poor management are sustainable when what is known about the fishery gives confidence that fishing effort is highly likely to be appropriate based on catch history, biology of target species, and the presence of factors that effectively limit fishing mortality or protect biomass. These may include spatial factors, non-fishery environmental management (e.g. marine reserves), gear controls that limit catchability, or potentially economic factors.

Use the following assessment matrix for data poor stocks, as substitution for criteria 1a-c. The colour denotes overall ranking for criteria 1. A data-poor stock can be defined as "stocks with no estimates of MSY or alternative equivalent reference points, no estimates of stock size, no estimates of fishing mortality from the fishery or cumulative fishing mortality from all fisheries and/or no quantitative estimates of data certainty. There may be information/trends or reference points for biomass but nothing known about fishing mortality, or vice versa. Whether a data limited assessment technique is appropriate depends on the life history characteristics of the species and the fishery. It should be noted that a data limited assessment is different from a data absent assessment, and in some geographies the majority of fisheries are data limited or data absent."[15]

Data limited indicators for Biomass (B) and fishing pressure (F) scenarios	No concern for F, no concern for B			*	*
	No concern for F, concern for B	*	*		
	Concern for F, no concern for B	*			
	Concern for F, Concern for B				
	Vulnerability**	0-0.24	0.25-0.49	0.5-0.74	0.75-1.0

*A green ranking can be made in this instance, if robust justification can be made that additional factors confer significant protection for the stock from fishing. This may include non-fishery environmental management, for example marine parks or other spatial closures in areas that are known to have been historically important to the fishery, or fisheries that are likely to have characteristics that highly constrain capacity to access the stock/species. Examples include TEP species management requirements, developmental fisheries that have low potential to expand in the forward scope of the assessment and are highly unlikely to be accessing the whole stock, or fisheries that have had gear restrictions imposed or adopted that have reduced most real or potential fishing pressure on the stock by from historic levels. Otherwise a conservative approach and amber ranking should be applied.

**Use criteria 1c to determine species vulnerability.

[15] Global Seafood Ratings Alliance core element definition 2019

Data poor assessment guidance[16]:

Consider the following guidance for considering level of concern for biomass (B):

Biomass can be evaluated based on the likelihood that management actions and characteristics of the fishery have prevented significant depletion of biomass. Biomass could be considered a low concern if:

- The fishery has a low likelihood of interacting with the stock under assessment due to low overlap between the species' range and the fishery
- A primary proportion of the stock's habitat is likely to be protected from fishing in MPAs (particularly no-take reserves)
- If historic factors (i.e. changed fishery economics, gear restrictions or fishery reforms) have substantially reduced the footprint of the fishery over a timescale that would be appropriate to what is known of the biology of the species.

Consider the quality of evidence available and apply a more conservative rank ('Concern') where significant shortcomings are identified. Consider recreational fishing effort where applicable, as recreational fishing is the major source of fishery mortality in a range of Australian fisheries.

No concern for B: Biomass is unknown in relation to reference points, declining but remaining at a high biomass level (likely near an unfished state), or stable at or above long-term average and biomass level is justifiably not of concern.

Concern for B: Biomass is unknown in relation to reference points, is stable at low levels or is declining below long-term average and there is concern for the biomass level, or no information available.

Consider the following guidance for considering level of concern for fishing mortality (F):

Fishing mortality can be evaluated based on the likelihood that management actions and characteristics of the fishery constrain fishing mortality to sustainable levels. For example, fishing mortality could be considered sustainable:

- due to low gear selectivity for the species;
- if there is a very low level of exploitation, as in an experimental emerging fishery;
- if fishing effort is low relative to historical levels (that were sustainable) due to changes in the fishery (i.e. spatial shifts or economic contractions in effort);
- if the species has characteristics that suggest low-very low vulnerability to fishing.

Consider the quality of evidence available and apply ranking from the matrix. Consider recreational fishing catch where applicable.

No concern for F: Fishing mortality is unknown in relation to reference points but catch trend is below long-term average or stable or increasing but at a

[16] Adapted from Marine Conservation Society (UK) Wild Capture Ratings Methodology June 2018.

low level, and fishing level is justifiably not of concern. This can be due to fishery externalities, such as robust evidence that the fishery is only accessing a small proportion of the stock because of historical changes in fishing through closures or conservation management (e.g. habitat protection, Marine Protected Area implementation).

Concern for F: Fishing mortality is unknown in relation to reference points but catch trend is stable or increasing but at a high level or increasing above long-term average, and there is concern for the fishing level or no information available. This can also be due to gear changes that may lead to increases in fishing power not explicitly accounted for in management, or externalities including significant increased access to new fishing grounds (e.g. reductions in habitat protection or Marine Protected Areas) likely to be a historical refuge for the stock.

2. Bycatch, byproduct and discard concerns

Sustainable fisheries operate in a manner that does not cause declines or significantly hinder the recovery of TEP species that are likely to interact with the fishery. AMCS considers an environmentally conservative assessment of the impacts of fisheries on TEP species is appropriate. Sustainable fisheries minimize non-TEP bycatch and discarding, do not overfish stocks of any byproduct or discard species, and ensure that reliable and up to date information relating to bycatch, byproduct and discards is available.

a. Interactions with Threatened, Endangered or Protected (TEP) species[17]

TEP species are defined as those listed under Australian legislation (State, Territory and/or Commonwealth), international agreements (CMS, CITES) or are listed as Vulnerable, Endangered or Critically Endangered on the IUCN Red List of threatened species. Species listed as Conservation Dependent should be considered TEP according to the status they would hold if not for Conservation Dependent Listing in conservation advice provided to the Threatened Species Scientific Committee at the time of listing[18].

As guidance, consider impacts on all TEP species impacted by the fishery (if any), and rank in an environmentally conservative manner based on the species most negatively impacted by the fishery, or most vulnerable to impacts related to the fishery.

Specific ranking guidance: Apply the ranking statement (dot points) associated with a Green, Amber or Red rank that best fits the Unit of Assessment. If statements from more than one ranking level apply equally, rank more conservatively. Always provide justification.

Green:

- The fishery does not catch TEP species.
- Fishery for the species/stock may catch limited numbers of TEP species, but there is a high level of confidence that no impact at a population level[19] is occurring AND mitigation measures are in place to reduce interactions, which are proven to be effective in this fishery or highly comparable contexts. This includes industry-developed codes of conduct that are considered highly likely to be effective, based on verifiable evidence or expertise.
- Interactions with TEP species are unknown, but risk that interactions occur can be considered minimal due to spatial separation of TEP species populations and the fishery, or fishing method.
- TEP bycatch data availability is inadequate, but fishing method is such that risk to likely encountered TEP species is minimal[20].

[17] There is often significant scientific uncertainty around byproduct and discards. Where levels of byproduct or discarding are unknown, rank conservatively.

[18] http://www.environment.gov.au/biodiversity/threatened/conservation-advices

[19] This can be verified by fishery independent data or independent expert opinion.

[20] Examples include hand gathering or trap fisheries (where TEP species are unlikely to be subject to entanglement, pre-release and post-release mortality such as barotrauma, handling related disease, depredation); fisheries that do not entangle catch (seine, haul seine, tunnel net) and use in-water sorting; and line fisheries that do not set hooks for a period

Amber:

- Fishery may catch significant[21] numbers of TEP species, but it is likely that the fishery is not preventing on-going recovery of a depleted population AND interaction rates are decreasing OR interaction rates are stable, and industry and fishery managers are actively pursuing mitigation measures that are proven to be effective.
- TEP species interactions are unknown, but there is a high likelihood of interaction with TEP species due to geographical overlap of the fishery and TEP species population AND these interactions are highly unlikely to have population level impacts.
- Fishery management of TEP species impacts is rudimentary, or has inadequate data available, but there is a high level of confidence that precautionary environmental management measures are highly robust and offer effective protection for TEP species at a population level (e.g. Comprehensive, Adequate and Representative marine reserves are in place throughout the extent of the fishery).

Red:

- TEP species interactions are likely to result in declines at a population level.
- TEP species interactions are likely preventing recovery at a population level.
- Fishery results in TEP species mortalities and interaction rate (interactions per unit effort) is increasing towards a level likely significant[21] at a population level.
- Fishery results in significant[21] TEP species interactions and is not actively pursuing implementation of mitigation measures that are proven to be effective in a comparable context.
- The fishery targets TEP species, defined as listed under State, or national environmental legislation (this includes 'Conservation Dependent' under the EPBC Act).
- Interactions with TEP species are unknown and the fishing method has the potential to interact with TEP species due to geographical overlap of the fishery and TEP species habitat AND these interactions are likely to be significant[21]
- Impacts at the population level are not disproven based on verifiable evidence AND size, distribution and genetic structure of TEP species population is not well understood AND/OR there is credible expert evidence[40] that the fishery poses a high risk to TEP species.

longer than air-breathing TEP species can survive. For sharks, consider whether species are physiologically robust to hooking/entanglement.

[21] A level of TEP interaction that can be considered 'significant' is where, in conjunction with other sources of mortality (because fishery mortality is typically a highly controllable source of mortality), catch in the fishery is likely to either prevent rebuilding of a depleted population, or cause a population to decline.

b. Impacts on byproduct and discard species[17]

Fisheries should optimize the use of all catch by being highly targeted, or be investing in achieving it. There should be an understanding of the impacts on the stock status of species that are byproducts or discards and the Unit of Assessment should not be overfishing, or preventing recovery, of a stock of any byproduct or discard species. Management and industry should seek continuous improvement in the reduction of discarding, where it occurs at significant levels, and fisheries should invest in retaining more of the total catch.

Post release and cryptic mortality is considered in assessments in an environmentally conservative manner. 100% mortality is assumed for discards unless there is robust data around discard survival, in which case the rate of total discarding can be modified by estimates of survival.

Consider efforts of industry to reduce discarding by investing in retaining and marketing catch that would otherwise be discarded.

As guidance, consider impacts on all TEP species impacted by the fishery (if any), and rank in a conservative manner based on the species most negatively impacted by the fishery, or most vulnerable to impacts related to the fishery.

Green:

- Quantity of byproduct/discards is low (<15% of catch by weight[22]) AND byproduct/ discards does not include overfished species.
- Quantity of byproduct/discards is significant (>15%) AND observer coverage/e-monitoring/reporting/data availability supports robust monitoring AND knowledge base for byproduct and discards species/stocks is good and current fishing mortality is not considered to be leading to overfishing and is not currently overfished.
- Available information on byproduct/discards is inadequate, but fishing method is such that risk to likely encountered species is minimal[23].
- Discarding is banned and monitored and enforced.
- Management of byproduct/discards is inadequate, but industry initiatives/fishing gear/ code of conducts ensure minimal risk to byproduct/discards.
- No byproduct/discard species stock is overfished or subject to overfishing.
- There is some catch of an overfished byproduct/discard species' stock, but not at levels that are likely to significantly hinder recovery.

[22] Low discards as defined by European Commission (2011) Studies in the Field of the Common Fisheries Policy and Maritime Affairs Lot 4: Impact Assessment Studies related to the CFP.

[23] Examples include hand gathering, trap fisheries (where discarded species are unlikely to be subject to post-release mortality (e.g. barotrauma, handling related disease, depredation) fisheries that do not entangle catch (e.g. seine, haul seine, tunnel net) and use in-water sorting, and line fisheries that do not set hooks for a period longer than air-breathing TEP species can survive. For sharks, consider species that can physiologically robust to hooking/entanglement.

Amber:

- There are significant byproduct/discards (15-60% of catch by weight[22]) BUT the level of take is not likely resulting in further decline of an overfished species.
- Catch rates of byproduct species exhibits decline not accountable to management/gear modifications designed to reduce catch, possibly indicating stock issues of byproduct/discarded species, AND this is being addressed by management.
- Byproduct/discard species catch rates are increasing BUT there are effective actions in place to reverse this trend.
- Any overfished byproduct/discard species/stock is subject to a credible rebuilding plan, and take in the fishery is not prohibiting the rebuilding of the overfished species within reasonable timeframes[12].
- There is some catch of an overfished byproduct/discard species, at levels likely to hinder recovery of the species at a stock level but not cause further declines.

Red:

- Quantity of byproduct/discards is high (>60%[22]) AND there is concern that this level of take is preventing overfished species recovery OR causing declines in stocks (consider how long species have been defined as overfished, whether there is a recovery plan in place, life history of overfished species and whether byproduct TAC accounts for scientific advice, e.g. whether byproduct TAC is set at a point that allows overfishing).
- Catch rates of byproduct/discards are increasing over time and are of significant concern with no effective management efforts to reduce catch.
- An overfished byproduct/discard species has rebuilt to the Limit Reference Point (20% of virgin biomass under Commonwealth policy, and use as a guide for other fisheries), but catch has been set to a level where rebuilding is not likely to continue, or rebuilding timeframes are too slow (more than twice the time estimated to occur in the absence of commercial fishing[24]).
- Catches of an overfished byproduct/discard species are occurring at levels likely to cause a further decline in that species at a stock level.

c. Bycatch, byproduct and discarding reporting[17]

Bycatch, byproduct and discards should be accounted for in a transparent manner. Fisher reporting should be consistent with observer data and there should be a level of independent observer coverage[25] appropriate to the fishery. If there is a very high level of confidence that a fishery has no or a

[24] As per Australian Commonwealth Harvest Strategy Policy: Australian Government (2018): Commonwealth Fisheries Harvest Strategy Policy: Framework for applying an evidence-based approach to setting harvest levels in Commonwealth fisheries, Department of Agriculture and Water Resources, Second Edition.

[25] This includes independent human observers and video monitoring systems. Treat Crew Member Observer coverage with caution, as this data requires independent verification.

very low level of discards and there is minimal risk to TEP species[20,26], a green ranking in this criteria may be appropriate even if reporting is rudimentary.

Green:

- Fisher reporting of bycatch, byproduct and/or discard levels is reliable and corroborated by observer data.
- Observer coverage is appropriate to the level of risk of the fishing method or vulnerability of affected bycatch species OR observer/bycatch study has occurred recently (≤5yrs prior to assessment).
- Observer coverage is inadequate but there is a high level of confidence that fisher reporting of bycatch, byproduct and discards is accurate[27].
- Fishing practices are employed that ensure very high survival of discard species (e.g. in-water sorting/release of discards with minimal disturbance) such that there is negligible risk to bycatch species[20].

Amber:

- There is moderate confidence in reporting of bycatch, byproduct and/or discard levels e.g. data is available, but observer coverage is inadequate AND/OR observer/bycatch study data is dated (>5 years prior to assessment), AND there are minor discrepancies between fisher and independent observer reporting.
- There is evidence of under-reporting of TEP interactions BUT actual TEP interaction rates are not likely to result in a red ranking under a (above)
- There are concerns that underreporting of byproduct or discards is occurring but high confidence that underreported catch is not leading to declines of discarded species.
- There are concerns that the level of observer coverage is low or not appropriate BUT it is highly unlikely the fishery would result in a red ranking for a and b (above).

Red:

- There is low confidence in reporting of bycatch, byproduct and/or discard levels (for example, there is historical/current evidence of under-reporting and observer coverage is inadequate) AND there is not high confidence that underreported catch is not leading to declines of discarded species..
- There is no independent observer coverage AND there is evidence/past history of TEP species interaction in the fishery.
- There is evidence of under-reporting of TEP interactions and TEP interaction rates are likely to result in an amber or red ranking under 2a (above).

[26] The scale of the fishery can be considered here, in that risk can be considered mitigated if the fishery is operating at a scale that is highly unlikely to add significant additional impact to any TEP species (at a population level), byproduct or discard species.

[27] For example, when fisher reporting is consistent (±20%) with periodic observer study data over a corresponding time period.

d. Criteria 2 Overall ranking determination

Green:

- If a is green, and either b or c are amber with the other being green, overall ranking is green (NB none of the rankings are red).

Amber:

- All amber
- If a is amber and b and c are green or amber, ranking is amber.
- If a is green, but b and c are amber, the overall criteria ranking is amber.
- If a is green, b is green or amber and c is red, overall criteria ranking is amber.
- If a is green, c is green or amber, and b is red (as long as the byproduct/discarded species is not overfished) then the overall ranking is amber.

Red:

- All red.
- a red, ranking is red.
- b and c red, ranking is red.
- If a is amber and b and c are red or amber, ranking is red.

Overall Ranking	Criterion 2, Subcriterion 2a	Criterion 2, Subcriterion 2b	Criterion 2, Subcriterion 2c
Green	All Green		
	Green	Green	Amber
	Green	Amber	Green
	Amber	Green	Green
Amber	More than one amber, no red		
Red	Any Red		

3. Habitat and ecosystem impacts

Sustainable fisheries operate in a manner that do not significantly increase disturbance/alteration of habitats and ecosystems and in conjunction with effective environmental management. The function and extent of habitats and ecosystems[2] affected by the fishery are well understood and fishery footprints are managed in a precautionary manner[3]. If a target species is of exceptional ecological value (e.g. a keystone predator), fishing is managed so as to maintain the ecological role of that species and ecosystem function. To the extent allowed by the current state of the science; ecological interactions affected by the fishery are understood and protected, and the structure and function of the ecosystem is maintained. It should be noted that in some geographies ecosystem-based fisheries management has not yet been established[4].

This criterion considers the impacts of the fishing method and the removal of target, byproduct and discard species on physical habitats and ecosystem function of the marine environment.

Assessors should consider recovery time of habitats and ecosystems in a context that assumes fishing will be an ongoing activity, rather than in regard to what might occur if fishing should cease. Further, AMCS considers the spatial significance of fishery impacts according to the fishery's operational footprint, rather than the scale of its operation within a management area.

Specific ranking guidance: Follow the table provided for subcriterion 3a. For 3b-c, apply the ranking statement (dot point) associated with a Green, Amber or Red rank that best fits the Unit of Assessment. If statements from more than one ranking level apply equally, rank more conservatively. Always provide justification.

a. Physical impacts of fishing gear on the seafloor

For guidance on the impact of different types of fishing gear refer to Monterey Bay Aquarium's scoring system for fisheries impacts[28] (adapted for AMCS usage). Use the following table to determine ranking under this criterion, considering whether gear modifications have reduced impact on the seafloor. Where multiple habitats are encountered by the fishery, assess according to the most sensitive habitat likely to be impacted.

Category:	Description:	Rank:
Negligible	Gear does not contact bottom, or uses hand gathering[29]	Green
Very low	Vertical line fished in contact with the bottom; **or** Vertical line used to fish for a benthic/demersal or reef-associated species	
Low	Bottom gillnet, trap, bottom longline except on rocky reef/boulder and corals; **or** Bottom seine (on mud/sand only); **or** Midwater trawl that is known to contact bottom *occasionally* (<25% of the time); **or** Purse seine known to commonly contact bottom	
Moderate	Scallop dredge on mud and sand; **or** Bottom gillnet, trap, bottom longline on boulder or coral reef; **or** Known trampling of coral reef habitat occurs; **or** Bottom seine (except on mud/sand); **or** Bottom trawl (mud and sand, or shallow gravel) (includes midwater trawl known to commonly contact bottom)	Amber
High	Hydraulic clam dredge; **or** Scallop dredge on gravel, cobble or boulder; **or** Trawl on cobble or boulder, or low energy (>60 m) gravel; **or** Bottom trawl or dredge used primarily on mud/sand (or to catch a species that associates with mud/sand habitat), but information is limited and there is the potential for the gear to contact sensitive habitat[31]	Red
Severe	Dredge or trawl on deep-sea corals or other biogenic habitat (such as seagrass, eelgrass and maerl)	

[28] Adapted from Seafood Watch Standard for Fisheries, Version F4.0 April 2020.

[29] If significant trampling of sensitive habitats is involved, a higher risk ranking may be justified.

b. Spatial/temporal scale of impacts

Assessment under this criterion is only necessary if the outcome of Section a (above) is amber or red.

Green:

- The area impacted has a short and biologically insignificant recovery time (though account for if an area is allowed to recover or whether fishing activity continues regardless) AND low vulnerability to fishing activity, based on nature of benthic environment and related biotic component (e.g. some sandy habitats).
- Fishing method risk would rank as amber or red, but knowledge of the area impacted is extensive, with robust habitat mapping in place and explicit and effective controls on fishery impact on individual habitats (e.g. footprint limitations).
- Fishery or non-fishery spatial closures (such as CAR marine reserves) effectively protect habitats and ecosystems from impacts of the fishery in biologically similar and geographically near areas of habitat.

Amber:

- The area impacted has an ecologically significant[30] recovery time (though account for if an area is allowed to recover or whether fishing activity continues regardless) AND moderate vulnerability to fishing activity (e.g. mud habitats), but it is unclear as to whether the spatial/temporal scale is having lasting habitat or ecosystem impacts.
- There is some information available on the nature of the impacted environment (e.g. habitat mapping is available), but not at a scale appropriate to fishing activity.
- There are controls on the fishery footprint that likely reduce fishery impacts but these are not based on robust and appropriate environmental data OR There are marine reserves or spatial closures in the fishing area that likely provide some mitigation of fishery impacts but these are not implemented in accordance with CAR principles.
- The fishery has high impacts in criteria 3a but these impacts are be substantially mitigated by management of spatial and temporal scale of fishery operation AND there is a high level of confidence that highly sensitive/vulnerable habitats[31] are protected from fishing.

Red:

- The timescales of recovery from fishing are highly likely to be significant given levels of fishing pressure, the habitat is sensitive or contains slow growing organisms and no/inadequate similar (biologically or geographically close) areas are protected in marine reserves or spatial closures.
- The fishery impacts habitats known to have high vulnerability to, and slow recovery from, fishing activity (e.g. coral, deep-water habitats)

[30] An ecologically significant recovery time for habitats can be considered to be a time likely to be impacted by fishing again before primary habitat function is restored.

[31] Consider any habitats composed of substrates other than mud, silt, sand or gravel (or with any biogenic component) vulnerable or sensitive for the purposes of assessment. Further, consider any habitats or sites of particular significance (e.g. EPBC Act designated sites, Marine Protected Areas or World Heritage Areas) as sensitive.

- Fishing is impacting on an area of significant importance (e.g. EPBC Act designated sites, Marine Protected Areas or World Heritage Areas) and fishery management does not adequately incorporate this significance.
- The nature of the area impacted by fishing is unknown and the fishery is classified as moderate-severe risk under criteria 3a.

c. Ecological impacts of fishery

The indirect effects of fishing are difficult to identify, measure and quantify, and there is generally little published information on these impacts. With this in mind, assessments need to take a weight of evidence approach in assessing the ecological impacts of fishing activities.

Green:

- There is no evidence or low likelihood of biological impacts[32] as a result of this, or comparable[33], fishing activity.
- Target species is not of exceptional ecological significance (e.g. keystone species, forage species, top predator). If target species is of high ecological value, this factor is explicitly accounted for in harvest control rules.
- Marine reserves or fishery closures are demonstrably effectively supporting maintenance of ecosystem function.

Amber:

- There is a likelihood of biological impacts[32] because of target species position in food chain (e.g. top predator) or functional status (e.g. keystone species), and harvest control rules are not proven effective in managing the impacts, BUT there is no evidence or high likelihood of a breakdown in natural ecosystem functioning and processes.
- Significant alteration of average size/age of fish present as a result of fishing for a particular size/age class has occurred, but evidence does not suggest this is resulting in declines to overall stock status or ecosystem function.
- Marine reserves or fishery closures are potentially supporting maintenance of ecosystem function, but are likely inadequate in conjunction with fishery management.

Red:

- There is evidence or high likelihood of biological impacts[32] from the fishery that cause a significant alteration or loss of function in natural ecosystem functioning and processes.
- There is evidence or high likelihood of significant indirect impacts of the fishery on ecologically related TEP species, through removal of prey/predator species or habitat-forming species.
- The target species is a keystone species, with evidence or a high likelihood of negative impacts to ecosystem functioning as a result of fishing activity.
- Significant alteration of average age of fish has occurred as a result of fishing for a particular size/age class, and evidence suggests this is resulting in declines to overall stock status or ecosystem function.

[32] Biological impacts include trophic cascades, phase shifts, biodiversity impacts or other ecosystem state changes.

[33] 'Comparable' might include a fishery in another domestic jurisdiction for the same species.

d. Criteria 3 Overall ranking determination

Green:

- If any two subcriteria are green and the third is amber, the overall ranking is green.

Amber:

- If a is red, b and c are amber or green, overall ranking is amber.
- If b is red and a and c are amber or green, overall ranking is amber.
- If two criteria are amber and one is green, overall ranking is amber.
- If c is amber and a is green or amber, overall ranking is amber.

Red:

- 2 red rankings of any subcriteria result in a red ranking.
- If c is red, the overall ranking is red.

Overall Ranking	Criterion 3, Subcriterion 3a	Criterion 3, Subcriterion 3b	Criterion 3, Subcriterion 3c
Green	All Green		
	Green		Amber
	Green	Amber	Green
	Amber	Green	
Amber	Green	Amber	
	Amber	Green	Amber
	Amber		Green
	Red	Green and/ or Amber	
	Green or Amber	Red	Green or Amber
Red	Green and/ or Amber		Red
	Red		Any

4. Management and effectiveness of management measures

Sustainable fisheries have management frameworks in place that ensure a precautionary approach is applied to managing target stocks and environmental impacts, invest in science that addresses information gaps, and effectively and transparently enforce regulation.

As the first three criteria capture biological and ecological information available from a fishery, this section provides an opportunity to highlight any management deficiencies or positives that come up during the assessment. The benefits of good management are instrumental to the environmental performance of a fishery and as such are somewhat accounted for in earlier criteria. Therefore, assessment under this criterion is an opportunity to provide information on management that supports the overall outcome for the fishery's rating.

Consider management over a time scale of 10 years prior to assessment, noting any serious environmental impacts that have occurred that are linked to inadequacies in management, and the extent to which they have been addressed by review and reform of management practice.

In assessing the effectiveness of management, prioritise the environmental outcome of whatever management framework is in place, and the role of management in delivering a particular aspect of the environmental status of the fishery. It is also important to consider the level of environmental risk posed by the various parameters of the fishery's operation. From AMCS' perspective, the quality of management process is only as good as the quality of environmental outcome. For this reason, rudimentary management frameworks should not necessarily be deleterious to the ranking of 4a-e if they are achieving an intended environmental outcome of effectively preventing environmental harm. For example, fishing methods that innately cause low or no disturbance to habitats do not necessarily require sophisticated management frameworks, and vice-versa.

Specific ranking guidance: Apply the ranking statement (dot points) associated with a Green, Amber or Red rank that best fits the Unit of Assessment. If statements from more than one ranking level apply equally, rank more conservatively. Always provide justification.

a. Management of fishery compliance

This subcriterion relates to management of fishery compliance with regulation, and the comprehensiveness and effectiveness of environmental protection provided by fishery legislation as it relates to target species, bycatch, habitats and ecosystems. Note that fully quantitative measures of fishery compliance outcomes are generally lacking[34], and that the extent or impacts of non-compliance are unlikely to be fully accounted for in management reporting. For this reason a weight-of-evidence approach should be used here.

Green:

- There are legislative and policy frameworks in place to mitigate risk to all aspects of fishery-related environmental impacts from non-compliance and there are no serious concerns over their effectiveness[35].
- Legislation and policy are adhered to in an open and transparent manner.
- There is no evidence of impact[36] resulting from non-compliance to fishery regulation or policy on the target stock, TEP, byproduct and discard species, or habitats and ecosystems at a level that would result in an amber or red ranking in any of Criteria 1, 2 or 3.
- Management of compliance is rudimentary or inadequate, but the nature of the fishery is likely to ensure minimal environmental risk posed by non-compliance[37].

Amber:

- There are legislative and policy frameworks in place to mitigate risks but there is concern over their effectiveness or they do not effectively address all aspects of fishery-related environmental impacts from non-compliance[35]
- There are concerns regarding the transparency and use of legislation and policy
- There is evidence of impact[36] resulting from non-compliance on the target stock, TEP, byproduct and discard species, or habitats and ecosystems at a level that would result in an amber (but not red) ranking in any of Criteria 1, 2 or 3.

Red:

- There are legislative and policy frameworks in place to mitigate environmental risks from fishery non-compliance but it is not effectively enforced
- Legislation and policy are not enacted in an open and transparent manner

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[34] E. Price, R. Melville-Smith, D. King, T. Green, W. Dixon, S. Lambert, T. Spencer (2016), Measurement of Fisheries Compliance Outcomes: A preliminary National Study. Perth, Australia, October 2016.

[35] Including target stocks, bycatch/byproduct/discard species, and habitats and ecosystems.

[36] Treat any impacts as a result of fishery non-compliance as additional to those occurring as a result of compliant fishery operations.

[37] Such a fishery may use practices that pose minimal risk to TEP, byproduct and discard species, and habitats and ecosystems. This may be a result of the gear used, industry practices, or the degree of spatial and temporal separation from them. Consider also whether there is likely to be significant 'black market', poaching or other illegal fishing, which tends to be more apparent in high-value fisheries.

- Appropriate legal and policy frameworks are not in place
- Legislation and policy are inappropriate, insufficient or ineffective
- There is evidence of impact[36] resulting from non-compliance on the target stock, TEP, byproduct and discard species, or habitats and ecosystems at a level that would result in a red ranking in any of Criteria 1, 2 or 3

b. Scientific uncertainty and how this is accounted for in management

This subcriterion considers management of harvest levels, bycatch and habitat ecosystem impacts in relation to any key information gaps and environmental externalities that affect the fishery.

Green:

- Management controls are precautionary and appropriate in relation to all aspects of fishery-related environmental impacts
- The management system is adaptive to changing fishery/environmental conditions that may affect target species, bycatch/byproduct and the wider ecosystem
- There is good knowledge of species biology OR where there is uncertainty in stock assessments and/or species biology, this is effectively accounted for in management controls
- There are no significant concerns regarding quality of scientific data used to manage environmental performance in the fishery

Amber:

- There is some concern regarding quality of scientific data used to support management of fishery-related environmental impacts BUT there is evidence that management measures are responsive to any negative trends in fishery or environmental status.
- Where there is uncertainty in stock assessments and/or species biology, this is partially accounted for in management measures AND there is no evidence of significant fishery or environmental impacts.
- Robust stock assessments are performed, but are outdated or inappropriately infrequent in relation to target species' biology[5].
- Environmental change impacts on target species, bycatch/byproduct and the wider ecosystem is inadequately accounted for in fishery management, but there is likely to be low resultant environmental risk.
- Scientific data used to manage fishery-related environmental impacts are inadequate, but these inadequacies apply to aspects of the fishery that can be considered low risk.

Red:

- There is minimal or no management of key fishery-related environmental impacts.
- Management is inappropriate to the target species' biology
- Poor knowledge of stock status or species biology is not accounted for in management measures.
- Management actively excludes or does not incorporate credible fishery independent data, where it exists.
- Environmental change impacts on target species, bycatch/byproduct and the wider ecosystem is inadequately accounted for in fishery management, and there is evidence of significant resultant impacts.

- There are inadequacies regarding quality of scientific data used to manage environmental performance in the fishery, that apply to aspects of the fishery that can be considered primary environmental risks AND there is evidence of significant environmental impact caused by the fishery.

c. Management of bycatch, byproduct and discards

(Related to Criterion 2- bycatch, byproduct and discards)

This criterion considers whether there is accurate reporting of information related to bycatch (particularly TEP species), byproduct and discarding and the adequacy of management actions in addressing any issues identified.

Green:

- Management actions are in place to address bycatch, byproduct and discards, and those actions are appropriate, measurable and achievable – as indicated by decreasing or stable temporal bycatch/discard trends or interaction levels that are demonstrably not causing declines at the appropriate level (i.e. at the population level for TEP species; or at the stock level for byproduct or discard species approaching or in an overfished state).
- Management ensures adequate monitoring and reliability of reporting if the fishery has significant TEP species bycatch AND reporting is publicly available.
- Management of bycatch, byproduct and discards is rudimentary but is appropriate to the scale/impacts of the fishery[38] OR effective protection is afforded by other environmental (non-fishery) management (e.g. MPAs and other spatial, Ramsar sites, World Heritage Areas).

Amber:

- Management actions are in place to address bycatch, byproduct and discards, but there are concerns regarding quality and/or effectiveness.
- There are significant inadequacies in management of TEP species interactions[39], but there is low likelihood of impacts at the population level.
- Bycatch/byproduct/discard data is available but is dated (>10yrs), or there is not high confidence in its reliability.
- There have been high levels of bycatch/discards but best-practice mitigation, shown to be effective in other fisheries, has been applied since the last assessment of the fishery.
- Management actions in place that require the use of best-practice mitigation measures and continuous improvement, BUT EITHER There is credible[40] concern or uncertainty around the effectiveness of mitigation

[38] For example, the fishery has little overlap with TEP species habitat or populations; or is highly targeted, being ranked green in criterion 2a.

[39] Adequate management of TEP species must not accept fishery-driven decline in any TEP species' population, and must not accept any serious fishery-driven prevention of or delay in recovery of any TEP species' population.

[40] For example, supported by data or opinion from an acknowledged expert source. An acknowledged expert source might be a person or organization that has an extensive research body in the subject area and/or whose work has been cited/applied in fishery or environment management.

measures OR management has not been in place long enough to demonstrate effective reductions in TEP bycatch.

Red:

- The management decision making process and/or rules is/are not transparent, not appropriate to the scale of the fishery[41], and are not likely to be effective.
- TEP species interaction management is inadequate[39], and likely increases risk of TEP species declines at the population level.
- Information on TEP bycatch is not publicly available or is dated (>10yrs old, or less if a significant change to the operation of the fishery has occurred).
- There is significant bycatch/discards in the fishery, and demonstrably effective bycatch mitigation management that is used in other comparable Australian fisheries is not required, or is not implemented.

d. Management approach to habitat and ecosystem impacts

(Related to Criterion 3) Consider whether management within and beyond direct fishery management provides adequate protection for habitats and ecosystems (for example, whether MPAs are designed in accordance with CAR principles and/or protect an adequate proportion of each habitat affected by the fishery, and are they likely to be effectively managed). Consider also whether managing authorities have invested in mapping, understanding, monitoring and mitigating negative impacts on habitats and ecosystems affected by the fishery.

Green:

- Management actions are in place to address habitat and ecosystem impacts, and those actions are appropriate, measurable and achievable.
- Habitats affected by the fishery have been mapped, AND there is some fishery independent monitoring of habitats and ecosystems (including by fishery managers or environmental management).
- Management of habitat and ecosystem impacts is rudimentary but the fishing method is assessed as posing low-very or low risk.
- A target or byproduct species known to have a key ecosystem role (e.g. as a keystone predator or ecosystem engineer) and this role is comprehensively accounted for in management actions.

Amber:

- Management actions are in place to address environmental impacts, but these actions are not comprehensive and there are concerns about their effectiveness.
- Habitats affected by the fishery have not been mapped, but the fishery is unlikely to have geographical overlap with highly sensitive habitats.

[41] For example, where inappropriate spatial or temporal scales are applied by management – such as where management allows fisheries to seriously impact small and/or sensitive areas of a management area, but only considers impacts at the level of the entire management area. An inappropriate temporal scale might be when management fails to adequately consider highly seasonal environmental impacts, such as to migratory TEP species, or issues relating a fishery that primary operates on spawning aggregations of the target species.

- There is inadequate fishery independent monitoring of habitats and ecosystems but no evidence of impacts as a result of the fishery.
- A target or byproduct species is known to have a key ecosystem role (e.g. as a keystone predator or ecosystem engineer) and is inadequately accounted for in management actions BUT there is no evidence of ecosystem impacts as a result of the fishery.

Red:

- No management actions are in place to address fishery impacts on habitats and ecosystems.
- Management actions are in place but are not appropriate to the scale of the fishery[41] and are not likely to be effective.
- Management of habitat impacts is based on poorly supported assumptions/ecologically irrelevant spatial scales, or data that is likely compromised by its age AND it is likely that the fishery encounters sensitive habitats.
- A target or byproduct species is known to have a key ecosystem role (e.g. as a keystone predator or ecosystem engineer), and there is evidence of ecosystem impacts as a result of the fishery that are not accounted for in management actions.

e. Criteria 4 Overall ranking determination

Red rankings in this section should not lead to an automatic red ranking of the species/species grouping but will mean that if overall red in this category, the species/species group will not attain a green ranking.

Overall criteria ranking is as per lowest outcome, e.g. if a is amber and b is red, overall ranking is red

5. Final Ranking Determination

This determines the overall ranking for the Unit of Assessment that will appear in the GoodFish: Australia's Sustainable Seafood Guide, and is applied using the weightings provided in the table below. The following overarching rules also apply:

- If either Criteria 1, 2 or 3 result in a red ranking after assessment of the subcriteria, the stock/species/species group under assessment results in an automatic red rating.
- If Criteria 4 results in a red ranking, the stock/species/species group cannot achieve a green rating.

Overall Ranking	Criterion 1 Stock	Criterion 2 Bycatch	Criterion 3 Habitat	Criterion 4 Management
Green	Green			Green or Amber
Amber	Any one Amber			Green, Amber or Red
	Green			Red
Red	Any one Red			Green, Amber or Red

Appendix 1: Determining appropriate reference points[42]

Determination of the appropriateness of reference points depends on two questions:

1) *Is the goal appropriate?* Appropriate biomass reference points are designed with the goal of maintaining stock biomass at or above the point where yield is maximized (*target reference points*; *TRP*s) and safely above the point where recruitment is impaired (*limit reference points*; *LRP*s). Fishing mortality reference points should be designed with the goal of ensuring that catch does not exceed sustainable yield and has a very low likelihood of leading to depletion of the stock in the future.

2) *Is the calculation of the reference points credible?* There may be a concern if reference points have been lowered repeatedly or if there is scientific controversy regarding the reference points or the calculations of biomass and fishing mortality relative to reference points. See the guidance for each type of reference point below:

Target reference point: Reference points need to be evaluated on a case-by-case basis, but in general: Biomass target reference points (TRPs) below about B35% require strong scientific rationale. TRP values below about B35% may not be acceptable, as deterministic reference points may not be adequately precautionary accounting for stochasticity and environmental variability. See Appendix 2 for more details.

Limit reference point: The point where recruitment would be impaired. Reference points need to be evaluated on a case-by-case basis, but in general: Biomass limit reference points (LRPs) should be no less than ½ B_{MSY}, or ½ an appropriate target reference point such as $B_{40\%}$. LRPs below $B_{20\%}$ or ½ B_{MSY} require strong scientific rationale. Limit reference points set at 50% of B35% may not be acceptable, as deterministic reference points may not be adequately precautionary accounting for stochasticity and environmental variability. Where the LRP is not set at 50% of the TRP, it is important to consider the appropriateness of each RP when determining the appropriate score.

Spawning potential ratio/fraction of lifetime egg production (SPR/FLEP) reference point: The SPR/FLEP limit reference point should either be derived through scientific analysis to be at or above replacement %SPR for the species (the threshold level of SPR necessary for replacement) based on its productivity and S-R relationship[48], or should be set at about 35–40% of LEP. An exception can be made for species with very low inherent productivity (*e.g.*, rockfish, sharks), in which case a reference point of 50–60% of LEP is more appropriate[48,51,50,49].

[42] Adapted from MBA Fisheries Standard Version F4 (Apr. 2020).

Appropriate for the species:

Whether a reference point is appropriate for a species depends on its life history characteristics, its productivity dynamics and its role in the ecosystem.

In respect to forage species: Most modern assessments use a stock-recruitment curve that is described by stationary parameters, including virgin biomass or B_0 and are not appropriate for species with dynamic productivity that shifts in response to environmental conditions. While it is possible to calculate reference points based on dynamic virgin biomass (acknowledging that the carrying capacity of the environment for these species is different based on favourable to unfavourable environmental conditions), to date, none exist in practice for any species and the effectiveness of dynamic reference points is not well understood. While static reference points do not describe the shifts in productivity of forage species (instead, at best, they represent a long term average), they can be used effectively in management when 1) the harvest strategies based upon them account for volatility AND 2) when the harvest strategy outcomes have been tested using a proven, robust Management Strategy Evaluation framework, demonstrating that fishing mortality is set low enough to prevent collapse during periods of low stock productivity. Given these considerations, unless harvest strategies account for volatility and have been tested and proven to prevent stock collapse (i.e., in most situations), Seafood Watch considers forage stock biomass and fishing mortality to be highly uncertain.

Note that the best reference point to minimize the probability and severity of collapse for forage species depends on the specific attributes of the species[43].

Appendix 2: Further guidance on interpreting the health of stocks and fishing mortality[42]

The tremendous variability among fisheries makes it impossible to define specific appropriate reference points that would be applicable to all assessed fisheries. Instead, criteria are based on the commonly accepted management goal that target biomass should be at or above the point where yield is maximized, and management should ensure a high probability that biomass is at or above a limit reference point (where recruitment or productivity of the stock would be impaired). Common types of reference points are MSY-based and SPR-based reference points. However, other reference points may be used in some fisheries, and should be evaluated in accordance with the management goal articulated above.

Evaluating Abundance

MSY-based reference points

While the concept of MSY is far from perfect, MSY-based biomass and fishing mortality reference points are commonly used in some of the most well managed fisheries around the world. When applied appropriately, these reference points are an important tool for maintaining stock productivity in the long term. However, without properly accounting for scientific and

[43] Siple, M.C., T.E. Essington, and É. Plagányi. 2019. Forage fish fisheries management requires a tailored approach to balance trade-offs. Fish and Fisheries, 20(1): 110-124.

management uncertainty, maintaining a stock at B_{MSY} (the biomass corresponding to MSY) and harvesting at MSY runs a high risk of unknowingly either overshooting MSY or allowing biomass to drop below B_{MSY} without reducing harvest rates and thus inadvertently overharvesting[44,45]. The risk of impacts from inadvertent overharvesting increases with increased uncertainty and with increased inherent vulnerability of the targeted stock. To account for these interactions, the guidance provided for assessing stock health and fishing mortality is based on MSY reference points but requires high scientific confidence that biomass is above target levels and that fishing mortality is below MSY.

Proxies for B_{MSY} are acceptable if shown to be conservative relative to BMSY for that stock, or if they fit within the guidelines for appropriate target level (See Appendix 1). Where B_{MSY} or other appropriate reference points are not known or are not applicable, the stock/population health criteria can be interpreted using relevant indicators that are appropriate as targets and safe limits for abundance of the species (*e.g.*, escapement relative to escapement goals can be evaluated in lieu of biomass relative to limit reference points).

Proxies

For many fisheries, F_{MSY} and B_{MSY} are unknown, and proxies are often used. Most commonly, biomass proxies are based on the percent of unfished or virgin biomass (B_0). Fishing mortality proxies are often based on spawning potential ratio (SPR).

Commonly used and acceptable biomass reference points are typically 35–40% of B_0 for most stocks[46]. This target may vary according to stock productivity; however, justifications for lower target levels are often based on assumptions about "steepness[47]" that may be highly uncertain or poorly understood. It is now recognized that stock targets lower than approximately 30-40% of B_0 are increasingly difficult to justify. For these targets to be considered appropriate reference points, solid scientific justification is required. In addition, stocks reduced to this target level or below (equivalent to removing more than 60–70% of the stock's biomass) would be unlikely to achieve the ecosystem-based management goal of allowing a stock to fulfil its ecological role and should be scored accordingly.

Alternatively, when unfished biomass cannot be estimated, appropriate biomass reference points may be based on the equilibrium biomass achieved using appropriate fishing mortality reference points, as described below.

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[44] Roughgarden, J. and F. Smith. 1996. Why fisheries collapse and what to do about it. *Proceedings of the National Academies of Sciences* (USA) 93:5078-5083

[45] Froese, R., T.A. Branch, A. Proelß, M. Quaas, K. Sainsbury, and C. Zimmermann. 2010. Generic harvest control rules for European fisheries. Fish and Fisheries: doi:10.1111/j.1467-2979.2010.00387.x

[46] Clark, W.G. 1991. Groundfish exploitation rates based on life history parameters. *Canadian Journal of Fisheries and Aquatic Sciences* 48: 734-750.

[47] Steepness is a key parameter of the Beverton-Holt spawner-recruit model that is defined as the proportion of unfished recruitment produced by 20% of the unfished spawning biomass. Steepness is difficult to estimate, and the calculation of reference points is often very sensitive to estimates of steepness.

A large body of scientific literature addresses appropriate fishing mortality reference points based on spawner biomass per recruit (SPR). Ideally, these should be shown through scientific analysis to be at or above replacement %SPR (the threshold level of SPR necessary for replacement) for the species, based on its productivity and S-R relationship[48]. However, for many species this analysis will not be available mortality from other fisheries) are sustainable. When determining whether a fishery is a substantial contributor, err on the side of caution. Unknown or missing data are grounds for classification as a substantial contributor.

Reference points

Generally, species should be managed with reference points that fit the definition of a sustainable level of fishing mortality and/or an appropriate SPR or Fraction of Lifetime Egg Production (FLEP)-related reference point. Species that are not commercially fished or managed but make up non-target catch in the fishery will generally not have reference points defined. In lieu of reference points, these stocks should be evaluated relative to a level of mortality scientifically shown not to lead to depletion of the stock. For species with high vulnerability, the reference point must be demonstrated to be appropriate for that species' biology. As a rule of thumb, F40% is not precautionary enough for high vulnerability species; F50% or lower is more appropriate when using SPR-based proxies. In these cases, guidance is based on the conclusions of numerous analyses demonstrating that, in general, F35-40% (the fishing mortality rate that reduces the SPR to 35–40% of unfished levels) is appropriate for species with moderate vulnerability, while a more conservative fishing mortality rate of about F50-60% is needed for highly vulnerable species such as rockfish and sharks[48,49,50,51,52].

Evaluating Fishing Mortality

Evaluation of fishing mortality should reflect the mortality caused by the fishery, but in the context of whether cumulative impacts on the species (including

[48] Mace, P.M. and M.P. Sissenwine. 1993. How much spawning per recruit is enough? pp 101–118 in S.J. Smith, J.J. Hunt and D.Revered (eds.) Risk Evaluation and Biological Reference Points for Fisheries Management. Canadian Special Publication of Fisheries and Aquatic Sciences 120. National Research Council of Canada.

[49] Botsford, L. W., and A. M. Parma. 2005. Uncertainty in Marine Management. Pages 375-392 in E. A. Norse and L. B. Crowder, editors. *Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity.* Island Press, Washington, DC.

[50] Clark W. G. 2002. $F_{35\%}$ revisited ten years later. *North American Journal of Fisheries Management* 22.251-257.

[51] Myers R. A., K. G. Bowen and N. J. Barrowman. 1999. Maximum reproductive rate of fish at low population sizes. *Canadian Journal of Fisheries and Aquatic Sciences* 56.2404-2419

[52] Goodman, D., M. Mangel, G. Parkes, T. Quinn, V. Restrepo, T. Smith and K. Stokes. 2002. Scientific Review of The Harvest Strategy Currently Used in The BSAI and GOA Groundfish Fishery Management Plans, North Pacific Fishery Management Council, Anchorage, AK. 153 p.

Age of Assessment

If the stock assessment, or the data used within it, is greater than 10 years old then there is a high level of uncertainty associated with the result (with respect to how it reflects the current situation). In cases where $F<F_{MSY}$ (or appropriate reference point) and the data are greater than 10 years old, fishing mortality should be considered "unknown" or a moderate conservation concern. In all cases where $F>F_{MSY}$ (or appropriate reference point), regardless of the age of assessment, fishing mortality should be scored as a high conservation concern.

Glossary

This glossary of common terminology can be considered as definitions and guidance for assessors, and may also be used to support assessment reports. It is largely adapted from glossaries provided in the MBA Seafood Watch Fisheries Standard Version F4[28] and Australian ABARES Fishery status reports 2018.

B (biomass). Total weight or volume of a stock or a component of a stock.

B_0 (mean equilibrium unfished biomass). Average biomass level if fishing had not occurred.

B_{LIM} (biomass limit reference point). Point beyond which the risk to the stock is regarded as unacceptably high.

B_{MEY} (biomass at maximum economic yield). Average biomass that corresponds to maximum economic yield.

B_{MSY} (biomass at maximum sustainable yield). Average biomass that corresponds to maximum sustainable yield.

Benthic. Associated with the bottom of a water body.

Biodiversity. Biological diversity; variety among living organisms, including genetic diversity, diversity within and between species, and diversity within ecosystems.

Bycatch. A species that is incidentally (a) taken in a fishery and returned to the sea, or (b) killed or injured as a result of interacting with fishing equipment in the fishery, but not taken. Bycatch can include species listed under the *Environment Protection and Biodiversity Conservation Act 1999*.

Bycatch reduction device. A device that allows fish and other animals to escape immediately after being taken in or with fishing gear (for example, a trawl net).

Byproduct. Species/stocks that are not considered/managed as a target species/stock, but are none the less retained, either all the time or some of the time, as a result of some commercial value.

CAR (Comprehensive, Adequate, Representative). Scientific design principles that underpin best-practice Marine Protected Area Design for management of the environmental values of the marine environment. MPAs implemented using these principles will provide a high level of protection (principally through no-take zoning regulations) to replicated areas of sufficient size to be effective, across all known habitat types within a bioregion or area in question.

Catch. In relation to fishing, means capture, take or harvest.

Catchability. The extent to which a stock is susceptible to fishing.

Catch-per-unit-effort (CPUE). The number or weight of fish caught by a unit of fishing effort. Often used as a measure of fish abundance.

Catch rate. *See* Catch-per-unit-effort (CPUE).

Catchability. The extent to which a stock is susceptible to fishing; quantitatively, the proportion of the stock removed by one unit of fishing effort.

Conservation-dependent species. The *Environment Protection and Biodiversity Conservation Act 1999* dictates that a native species is eligible to be included in the conservation-dependent category at a particular time if, at that time, (a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered;

or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long-term survival in nature are maximised; (iii) the plan

of management is in force under a law of the Commonwealth or of a state or territory; and (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Conservative ranking. (or 'rank conservatively') A more environmentally precautionary ranking, such as *red* in place of *amber*, made in any assessment criterion or subcriterion, specifically called for where there are uncertainties or inadequacies in the data available to inform the assessment.

Critically endangered. An IUCN category for listing endangered species. A taxon is considered "critically endangered" (CE) when it faces an extremely high risk of extinction in the wild in the immediate future, as defined by any of the relevant IUCN criteria for "critically endangered" (FAO Glossary; IUCN).

Critical habitat. Habitats that, if impaired, would threaten the viability of a population, stock or any species affected or exploited by a fishery.

Data-poor fishery. A data-poor fishery can be defined as any stock with no estimates of MSY or alternative equivalent reference points, no estimates of stock size, no estimates of fishing mortality from the fishery or cumulative fishing mortality from all fisheries and/or no quantitative estimates of data

certainty. There may be information/ trends or reference points for biomass but nothing known about fishing mortality, or vice versa.

Data-rich. Refers to fisheries with reliable estimates of MSY-related quantities and current stock size. Stock assessments are sophisticated and account for uncertainty

Danish-seining. A trawling method used by relatively small vessels in shallow waters (up to about 200 m). Lengths of weighted ropes of up to 2,800 m are laid out on the sea floor in a diamond pattern, with the vessel at one end of the diamond and the net at the other. As the vessel moves forward, bringing in the net, the diamond becomes elongated, allowing the fish to be herded into the path of the net (c.f. Purse seining).

Demersal trawling. Trawling with gear designed to work on or near the seabed. Such gear is used to take demersal species of fish and prawns.

Discard/s. Species/stocks that are not retained in the catch, either as they are of no commercial value, are managed under quota but are undersized or of low grade and disposed of in order to catch individuals of higher commercial value or are discarded as quota allocation has been exceeded.

Driftnet. Gillnet suspended by floats so that it fishes the top few metres of the water column. *See also* Gillnet.

Dropline. Fishing line with one or more hooks, held vertically in the water column with weights.

E-monitoring. *See video monitoring.*

Ecological role. The natural trophic role of a stock within the ecosystem under consideration in an assessment

Ecosystem. A complex of plant, animal and microorganism communities that, together with the non-living components, interact to maintain a functional unit.

Effort. A measure of the resources used to harvest a fishery's stocks. The measure of effort appropriate for a fishery depends on the methods used and the management arrangements. Common measures include the number of vessels, the number of hooks set, and the number of fishing days or nights.

Effort restriction. Restriction of the permitted amount of fishing effort (for example, total number of hooks) in a fishery; used as a management tool.

Endangered/threatened. Taxa in danger of extinction and whose survival is unlikely if causal factors continue operating. Included are taxa whose numbers have been drastically reduced to a critical level or whose habitats have been so drastically impaired that they are deemed to be in immediate danger of extinction. This classification includes taxa listed as "endangered" or "critically endangered" by IUCN or "threatened", "endangered" or "critically endangered" by an international, national or state government body, as well as taxa listed under CITES Appendix I. This classification does not include species listed by the IUCN as "vulnerable" or "near threatened".

Environmentally limited. The productive capacity of a fish stock is limited by an environmental (non-fishing) impact on biomass, recruitment or mortality (eg severe weather events, marine heatwaves, drought) – typically leading to a state similar to that if overfishing had impacted the stock.

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The central piece of Commonwealth environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places—defined in the EPBC Act as matters of national environmental significance. Parts 10, 13 and 13A relate specifically to aspects of fisheries.

F (fishing mortality). The instantaneous rate of fish deaths due to fishing a designated component of the fish stock. F reference points may be applied to entire stocks or segments of stocks and should match the scale of management unit. Instantaneous fishing mortality rates of 0.1, 0.2 and 0.5 are equivalent to 10 per cent, 18 per cent and 39 per cent of deaths of a stock due to fishing.

F_{Curr}. Current level of fishing mortality.

F_{LIM} (fishing mortality limit reference point). Point above which the removal rate from the stock is too high.

F_{MEY} (fishing mortality at maximum economic yield). Fishing mortality rate that corresponds to maximum economic yield.

F_{MSY} (fishing mortality at maximum sustainable yield). Fishing mortality rate that achieves maximum sustainable yield.

F_{TARG} (fishing mortality target). Target fishing mortality rate.

Fecundity. Number of eggs an animal produces each reproductive cycle; the potential reproductive capacity of an organism or population.

Fisher reporting. Data recorded by fishers relating to catch and effort and bycatch.This data may be unreliable, unless corroborated by independent observer and/or video monitoring.

Fishery-independent data. Data used to support management of the stock that is collected independently of normal commercial or recreational fishing operations

Generation time. Average time taken for an individual animal to replace itself in a population.

Gillnet. Type of passive fishing gear consisting of panels of net held vertically in the water column, either in contact with the seabed or suspended from the sea surface, such that fish attempting to swim through the net are entangled. The mesh size of the net determines the size range of fish caught, because smaller fish can swim through the meshes and larger fish are not enmeshed. *See also* Driftnet.

Growth overfishing. Occurs when fish are harvested at an average size that is smaller than the size that would produce the maximum yield per recruit. This makes the total yield less than it would be if the fish were allowed to grow to an appropriate size. The annual yield is therefore smaller than the maximum sustainable yield.

Handline. Hand-held lines of various types used to catch fish.

Harvest control rules. Predetermined rules that control fishing activity according to the biological and economic conditions of the fishery (as defined

by monitoring or assessment). Also called 'decision rules' or 'control rules'. Harvest control rules are a key element of a harvest strategy.

Harvest strategy. Strategy outlining how the catch in a fishery will be adjusted from year to year depending on the size of the stock, the economic or social conditions of the fishery, conditions of other interdependent stocks or species, and uncertainty of biological knowledge. Well-managed fisheries have an unambiguous (explicit and quantitative) harvest strategy that is robust to the unpredictable biological fluctuations to which the stock may be subject.

Independent observer. An independent observer is someone (not an employee of the fishery) that observes part or all of a fishing activity, for the purposes of recording data such as catch composition/length/weight or quantifying bycatch. Independent observers are considered the most reliable source of information related to these data. E-monitoring/video monitoring (see *video monitoring*) can be considered another form of independent monitoring, though should not be considered an equivalent substitute in circumstances of high environmental risk unless supported by robust verification.

Limited entry fishery. Fishery in which the fishing effort is controlled by restricting the number of operators. Usually requires controlling the number and size of vessels, the transfer of fishing rights and the replacement of vessels (c.f. Open-access fishery).

Limit reference point: The point where recruitment would be impaired. Reference points need to be evaluated on a case-by-case basis, but in general: Biomass limit reference points (LRPs) should be no less than ½ BMSY, or ½ an appropriate target reference point such as $B_{40\%}$. LRPs below about $B_{20\%}$ or ½ BMSY require strong scientific rationale. Limit reference points set at 50% of deterministically calculated BMSY values below about B35% may not be acceptable, as deterministic reference points may not be adequately precautionary accounting for stochasticity and environmental variability.

Line fishing. Fishing methods that use fishing lines, including handlines, hand reels, powered reels, pole and line, droplines, longlines, trotlines and troll lines.

Listed threatened species. *See TEP species*

Logbook. Official record of catch-and-effort and/or bycatch and/or discard data completed by fishers. In many fisheries, a licence condition makes the return of logbooks mandatory.

Longline. Fishing gear in which short lines (branch lines, snoods or droppers) carrying hooks are attached to a longer mainline at regular intervals. Pelagic longlines are suspended horizontally at a predetermined depth with the help of surface floats. The mainlines can be 100 km long and have several thousand hooks. Droppers on demersal longlines (set at the seabed with weights) are usually more closely spaced.

Marine reserve/Marine park. *See MPA.*

MPA/Marine Protected Area. An area closure to some or all extractive activities, established for conservation (non-fishery management) management purposes. Often implemented in network form, the most effective MPAs are designed in accordance with Comprehensive, Adequate and Representative principles, with no-take zoning at its core. MPAs may provide meaningful protection and resilience additional to fishery and other

environmental management for target stocks, bycatch and protected species, and habitats and ecosystems if designed well.

Maximum economic yield (MEY). The sustainable catch level for a commercial fishery that allows net economic returns to be maximised. For most practical discount rates and fishing costs, MEY implies that the equilibrium stock of fish is larger than that associated with maximum sustainable yield (MSY). In this sense, MEY is more environmentally conservative than MSY and should, in principle, help to protect the fishery from unfavourable environmental impacts that could diminish the fish population.

Maximum sustainable yield (MSY). The maximum average annual catch that can be removed from a stock over an indefinite period under prevailing environmental conditions. MSY defined in this way makes no allowance for environmental variability, and studies have demonstrated that fishing at the level of MSY is often not sustainable.

No-take reserve. An MPA spatial closure that is closed to all extractive activities (ie all commercial and recreational fishing methods).

Non-target species. Species that is unintentionally taken by a fishery or not routinely assessed for fisheries management. *See also* Bycatch, Byproduct.

Not overfished. *See* Overfished.

Otter trawl. Demersal trawl operated by a single vessel in which the net is held open horizontally by angle-towed otter boards (large rectangular 'boards' of timber or steel), and vertically by a combination of floats on the headrope and weights on the ground line. Attached between the head and ground ropes and the towing warps, the otter boards are spread apart by the hydrodynamic forces acting on them when the net is towed.

Output controls. Management measures that place restraints on what is caught, including total allowable catch, quota, size limits and species limits.

Overfished. A fish stock with a biomass below a level at which recruitment would be impaired. This is often indicated by biomass being below the biomass limit reference point or below its specified indicator limit reference point.

Overfishing. A generic term used to refer to a level of fishing effort or fishing mortality such that a reduction of effort would, in the medium term, lead to an increase in the total catch; or, a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the maximum sustainable yield on a continuing basis. For long-lived species, overfishing (*i.e.,* using excessive effort) starts well before the stock becomes overfished. Overfishing can encompass biological or recruitment overfishing (but not necessarily economic or growth overfishing).

- *Biological overfishing*: Catching such a high proportion of one or all age classes in a fishery as to reduce yields and drive stock biomass and spawning potential below safe levels. In a surplus production model, biological overfishing occurs when fishing levels are higher than those required for extracting the Maximum Sustainable Yield (MSY) of a resource and recruitment starts to decrease.
- *Recruitment overfishing*: When the rate of fishing is (or has been) high enough to significant reduce the annual recruitment to the exploitable

stock. This situation is characterized by a greatly reduced spawning stock, a decreasing proportion of older fish in the catch and generally very low recruitment year after year. If prolonged, recruitment overfishing can lead to stock collapse, particularly under unfavorable environmental conditions.

- *Growth overfishing:* Occurs when too many small fish are being harvested too early through excessive fishing effort and poor selectivity (*e.g.*, excessively small mesh sizes), and the fish are not given enough time to grow to the size at which maximum yield-per-recruit would be obtained from the stock. Reduction of fishing mortality among juveniles, or their outright protection, would lead to an increase in yield from the fishery. Growth overfishing occurs when the fishing mortality rate is above F_{max} (in a yield-per-recruit model). This means that individual fish are caught before they have a chance to reach their maximum growth potential. Growth overfishing, by itself, does not affect the ability of a fish population to replace itself.
- Economic overfishing: Occurs when a fishery is generating no economic rent, primarily because an excessive level of fishing effort is applied in the fishery. This condition does not always imply biological overfishing.

Pelagic. Inhabiting surface waters rather than the sea floor. Usually applied to free-swimming species such as tunas and sharks (c.f. Demersal).

Phase shift. A change in ecosystem function driven in whole or in part by the effects of fishing.

Pole-and-line fishing (poling). Fishing method in which fishers attract schools
of fish to the vessel with live or dead bait, get them into a feeding frenzy with more bait and water sprayed onto the sea surface to simulate the behaviour of small baitfish, and then use poles with short, fixed lines and lures to 'pole' the fish aboard. Also called 'pole-and-live-bait fishing'.

Population structure. Composition of a population in terms of size, stock (genetic or regional), age class, sex and so on.

Precautionary approach. The precautionary approach involves the application of prudent foresight. Taking account of the uncertainties in fisheries systems and considering the need to take action with incomplete knowledge, the precautionary approach requires, inter alia: (i) consideration of the needs of future generations and avoidance of changes that are not potentially reversible; (ii) prior identification of undesirable outcomes and measures to avoid or correct them promptly; (iii) initiation of any necessary corrective measures without delay and on a timescale appropriate for the species' biology; (iv) conservation of the productive capacity of the resource where the likely impact of resource use is uncertain; (v) maintenance of harvesting and processing capacities commensurate with estimated sustainable levels of the resource and containment of these capacities when resource productivity is highly uncertain; (vi) adherence to authorized management and periodic review practices for all fishing activities; (viii) establishment of legal and institutional frameworks for fishery management within which plans are implemented to address the above points for each fishery, and (ix) appropriate placement of the burden of proof by adhering to the requirements above (modified from FAO 1996).

Productivity (biological). An indication of the birth, growth and death rates of a stock. A highly productive stock is characterised by high birth, growth and mortality rates, and can sustain high harvesting rates.

Purse seining. Harvesting of surface-schooling pelagic fish by surrounding the school with a net. A line that passes through rings on the bottom of the net can be tightened to close the net so that the fish cannot escape (c.f. Danish-seining).

Quota. Amount of catch allocated to a fishery (total allowable catch), or to an individual fisher or company (individual transferable quota).

Quota species. Species for which catch quotas have been allocated.

Rebuilding strategy. Strategy designed to rebuild a stock when a measure of its status (for example, its biomass) is below the biomass limit reference point (that is, the stock is assessed as overfished). Stock rebuilding strategies should include elements that define rebuilding targets, rebuilding time horizons and control rules related to the rate of progress.

Recent stock assessment. As a rule of thumb, stock assessments or updates conducted within the last five years are considered to be recent (a shorter period may be appropriate for species with very short-lived life histories or very dynamic biomass patterns). If an assessment showing the biomass is above target reference points is >5 years old, but <10 years old, it should be considered a low concern in most cases, but with consideration of trends and time series; *e.g.*, if the population has been stable and was well above the Target Reference Point in the last assessment, and the species is not one that fluctuates greatly in abundance, and the fishery hasn't changed dramatically in recent years, a very low concern may be justified. If the stock assessment is very out of date – as a rule of thumb, >10 years old – the stock status should be considered unknown and rated accordingly. It may be considered unknown even when the assessment is less than 10 years old in circumstances where the stock was previously very close to reference points or is very dynamic.

Recovery plan. Management process to rebuild a stock when a measure of its status (for example, its biomass) is outside a defined limit (that is, the stock is assessed as overfished). Recovery plans should include elements that define stock-specific management objectives, harvesting strategies specified by control rules, and recovery periods.

Recruit. Usually, a fish that has just become susceptible to the fishery. Sometimes used in relation to population components (for example, a recruit to the spawning stock).

Recruitment. The amount of fish added to the exploitable stock each year due to growth and/or migration into the fishing area. Also used to refer to the number of fish from a year-class reaching a certain age.

Recruitment overfishing. Fishing activity impacts the stock—either through reduced abundance, changes in size, sex or age distribution, or reduction of reproductive capacity at age—to a degree that will diminish the growth and/or reproduction of the population over the long-term (multiple generations); or, the stock is below an appropriate limit reference point, if one is defined. Excessive fishing effort or catch that reduces recruitment to the extent that the stock biomass falls below the predefined limit reference point.

Reference point. Specified level of an indicator (for example, fishing mortality, biomass) used as a benchmark for managing a fishery.

Regularly monitored. Fishery-independent surveys of stocks, or other reliable assessments of abundance, are conducted at least every three years.

Resilience. the capacity of a species/stock to respond to and absorb fishery-related disturbance while retaining essentially the same function, structure, and feedbacks.

Seasonal closure. Closure of a fishing ground for a defined period; used as a management tool, often to protect one component of the stock. See also Temporal closure.

Seines. Seine nets are usually long, flat nets like a fence that are used to encircle a school of fish, with the vessel driving around the fish in a circle. Purse-seine and Danish-seine nets are used in a range of fisheries.

Spawning potential ratio (SPR). The average fecundity of a recruit over its lifetime when the stock is fished divided by the average fecundity of a recruit over its lifetime when the stock is unfished.

Spatial closure. Closure of a given area or fishing ground. Used as a tool in the management of a fishery.

Stock. Functionally discrete population that is largely distinct from other populations of the same species and can be regarded as a separate entity for management or assessment purposes.

Stock–recruitment relationship. Relationship between the size of the parental biomass and the number of recruits it generates. Determination of this relationship is difficult, and involves studying the population's size–age composition, and growth and mortality rates.

Stock status. the current status of a stock relative to its un-fished level or long-term trends.

Target fishing (targeting). Fishing selectively for particular species or sizes of fish.

Target reference point: Reference points need to be evaluated on a case-by-case basis, but in general: Biomass target reference points (TRPs) should generally not be lower than BMSY or approximately B35–B40%. TRPs below about B35% require strong scientific rationale.

Target species. A species that a particular fishery intends to catch

TEP species. Threatened, endangered and protected species are defined as those listed under Australian legislation (State, Territory and/or Commonwealth), international agreements (e.g. CMS, CITES) or listed as Vulnerable, Endangered or Critically Endangered on the IUCN Red List of threatened species. TEP species typically have additional management considerations (eg reporting requirements and recovery plans) relative to other bycatch species.

Threat abatement plan. A plan formalised under endangered species legislation to reduce the effects of a process that threatens a species or taxon (eg seabirds).

Total allowable catch (TAC). For a fishery, a catch limit set as an output control on fishing (see also Output controls). Where resource-sharing arrangements are in place between commercial and recreational fishers, the

term total allowable commercial catch (TACC) will apply. The term 'global' is applied to TACs that cover fishing mortality from all fleets, including Commonwealth, state and territory fleets.

Total length. The length of a fish from the tip of the snout to the tip of the longer
lobe of the caudal fin, usually measured with the lobes compressed along the midline. It is a straight-line measure, not measured over the curve of the body.

Trap fishing. Fishing by means of traps, often designed to catch a particular species (for example, rock lobster pots).

Trawl fishing. Fishing method in which a large, bag-like net is drawn along behind a vessel to target either demersal or pelagic fish species. There are many variations.

Trigger catch limit. When catches reach this limit, management actions are triggered.

Trophic Cascade. An impact caused at a lower trophic level of an ecological community driven by the effects of a disturbance (eg removal of higher order predators by fishing) at a higher trophic level.

Trotline. A dropline of hooks suspended from a mainline.

Unit of Assessment. The definition of the boundaries within which a species or fishery is assessed. This is established using one or a combination of the biological and spatial stock structure of a fishery, spatial considerations (such as jurisdictional or bioregional boundaries) or market-based distinctions that are important to consumers (that may relate to gear type or location, for instance).

Vessel monitoring system. Electronic device that transmits the identity and location of a vessel.

Video monitoring/ The use of onboard video cameras to record all or a randomly selected proportion of fishing activity, primarily employed as a lower-cost alternative to independent observer monitoring for the purposes of recording data such as catch composition/length/weight or quantifying bycatch. E-monitoring/video monitoring (see *independent observer*) can be considered another form of independent monitoring, though should not be considered an equivalent substitute in circumstances of high environmental risk unless supported by robust verification.

Virgin biomass. Biomass of a stock that has not been fished (also called the 'unfished' or 'unexploited' biomass).

Vulnerability. The susceptibility of a species/stock to fishery-related depletion, either through physiological (eg life history, susceptibility to barotrauma), reproductive or behavioural traits, or other factors that affect likelihood of capture in the fishery ('catchability').

Vulnerable species. Species that will become endangered within 25 years unless mitigating action is taken. *See also* Endangered species. The *Environment Protection and Biodiversity Conservation Act 1999* dictates that a native species is eligible to be included in the vulnerable category at a particular time if, at that time, (a) it is not critically endangered or endangered, and (b) it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.