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Ecological Risk Assessment for the Effects of Fishing

Final report for the Heard Island and McDonald Islands fishery: Demersal trawl sub-fishery 2010/11 to 2014/2015

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February 2018

Report for the Australian Fisheries Management Authority

CSIRO Oceans & Atmosphere

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Citation

Sporcic, M., Pethybridge, H., Bulman, C.M., Hobday, A., Fuller, M. (2018). Ecological Risk Assessment for the Effects of Fishing. Final Report for the Heard Island and McDonald Islands Fishery: Demersal trawl sub-fishery 2010/11 to 2014/15. Report for the Australian Fisheries Management Authority. 142 pp.

Notes to this document:

This fishery ERA Report document contains figures and tables with numbers that correspond to the full methodology document for the ERAEF method:

> Hobday, A. J., A. Smith, H. Webb, R. Daley, S. Wayte, C. Bulman, J. Dowdney, A. Williams, M. Sporcic, J. Dambacher, M. Fuller, T. Walker. (2007) Ecological Risk Assessment for the Effects of Fishing: Methodology. Report R04/1072 for the Australian Fisheries Management Authority, Canberra

Thus, table and figure numbers within the fishery ERA Report document are not sequential as not all are relevant to the fishery ERA Report results.

Additional details on the rationale and the background to the methods development are contained in the ERAEF Final Report:

> Smith, A., A. Hobday, H. Webb, R. Daley, S. Wayte, C. Bulman, J. Dowdney, A. Williams, M. Sporcic, J. Dambacher, M. Fuller, D. Furlani, T. Walker. (2007) Ecological Risk Assessment for the Effects of Fishing: Final Report R04/1072 for the Australian Fisheries Management Authority, Canberra.

This document also reflects some changes in methods that are detailed in AFMA's ERA guide (2016).

> Australian Fisheries Management Authority (2016). Draft Guide to AFMA's Ecological Risk Management. 130 pp. (Commonwealth of Australia, Canberra).

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Acknowledgments

Thanks to John Garvey (AFMA) and Selvy Coundjidapadam (AFMA) for providing summary statistics from AFMA logbook database which were subsequently used in this report. Thanks also to Tim Lamb (AAD) for providing summmaries of the HIMI Observer data that were incorporated in this report. Many thanks also to Jo Fisher (AFMA) and Natalie Rivero (AFMA) for providing initial species lists and information on HIMI management and fishery operations. Jo Fisher (AFMA), Gabrielle Nowara (AAD) and Industry representatives: Martin Exel and Rhys Arangio are also thanked for reviewing of this document.

Executive summary

The “Ecological Risk Assessment for Effect of Fishing” ERAEF was developed jointly by CSIRO Marine and Atmospheric Research and the Australian Fisheries Management Authority. This assessment of the ecological impacts of the Heard Island and McDonald Islands Fishery: demersal trawl sub-fishery was undertaken using the ERAEF method version 9.2, with some additional modifications currently in final stages of development with AFMA. This revised ERAEF provides a hierarchical framework for a comprehensive assessment of the ecological risks arising from fishing, with impacts assessed against five new ecological components –key commercial and secondary commercial species; byproduct and bycatch species; protected species; habitats; and (ecological) communities (ERM Guide; AFMA, 2016b).

ERAEF proceeds through four stages of analysis: scoping; an expert judgement based Level 1 analysis (SICA – Scale Intensity Consequence Analysis); an empirically based Level 2 analysis (PSA – Productivity Susceptibility Analysis); and a model-based Level 3 analysis. This hierarchical approach provides a cost-efficient way of screening hazards, with increasing time and attention paid only to those hazards that are not eliminated at lower levels in the analysis. Risk management responses may be identified at any level in the analysis.

Application of the ERAEF methods to a fishery represents a set of screening or prioritization steps that work towards a full quantitative ecological risk assessment. At the start of the process, all components are assumed to be at risk. Each step, or Level, potentially screens out issues that are of low concern. The Scoping stage screens out activities that do not occur in the specific fishery. Level 1 screens out activities that are judged to have low impact, and potentially screens out components with all low impact scores. Level 2 is a screening or prioritization process for individual species, habitats and communities at risk from direct impacts of fishing, using either PSA or SAFE. The Level 2 methods do not provide absolute measures of risk. Instead they combine information on productivity and exposure to fishing to assess potential risk – the term used at Level 2 is risk. Because of the precautionary approach to uncertainty, there will be more false positives than false negatives at Level 2, and the list of high risk species or habitats should not be interpreted as all being at high risk from fishing. Level 2 is a screening process to identify species or habitats that require further investigation. Some of these may require only a little further investigation to identify them as a false positive; for some of them managers and industry may decide to implement a management response; others will require further analysis using Level 3 methods, which do assess absolute levels of risk.

This 2010/11-2014/15 assessment of the Heard Island and McDonald Islands Fishery: Demersal trawl sub-fishery includes the following:

- Scoping
- Level 1 results for all components

Fishery Description

Gear:	Otter trawl
Area:	Heard Island and McDonald Islands Fishery
Depth range:	Commercial fishing: 262 – 886 m (targeting Patagonian toothfish; average: 533 m); 180 – 493 m (targeting mackerel icefish; average: 287 m). RSTS^: 230 – 976 m (targeting Patagonian toothfish; average: 607 m); 138 – 493 m (targeting mackerel icefish; average: 274m). ^ RSTS: Random Stratified Trawl Survey *cf.* 30 to 1300 m (2005)
Fleet size:	1-2 vessels *cf*. 2-3 vessels (2005)
Effort:	21.5 km^2 swept area targeting Patagonian toothfish and 9.9 km^2 swept area targeting mackerel icefish (AFMA, observer data). 259.8 hours, 265 shots (targeting Patagonian toothfish and mackerel icefish) in 2014/15 (AFMA logbook data). *cf.* 21,668 hours (targeting Patagonian toothfish); 6,363 hours (targeting mackerel icefish) in 2004/5.
Landings:	204.5 t Patagonian toothfish (2014/15); 9.9 t mackerel icefish (2014/15) (AFMA observer data). *cf.* 2744 t Patagonian toothfish (2004/5); 1851 t mackerel icefish (2004/5)
Discard rate:	34 t (2014/15, Observer data includes code – "mealed" and "dead overboard"). No offal or bycatch permitted to be discharged from fishing vessels within fishery area. *cf.* 256 t of byproduct/bycatch species retained and mealed onboard or discarded/released alive, ~1% of total catch (2001/04; AAD Observer database records).
Key commercial species:	Patagonian toothfish, mackerel icefish
Management:	Quota management system for two species/stocks. Catch limits for six bycatch species/groups
Observer program:	Observer program operating since beginning of fishery in 1997. Two observers present on all fishing trips. They each conduct 12 hour shifts and are present on all fishing operations. Each observer conducts 12 hour shifts, so that an observer is present on all fishing operations. Note: observers cannot observe 100% of all fishing operations.

Ecological Units Assessed

Table ES1.1. Ecological units assessed in 2016 and 2006.

Ecological component	Units assessed in 2016	Units assessed in 2006
Key/secondary commercial species	2	2
Byproduct and bycatch species	1 byproduct; 148 bycatch	77 byproduct; 8 bycatch
Protected species	22	82
Habitats	1 pelagic	-
Communities	9 (7 demersal, 2 pelagic)	12

- no habitat assessment was conducted in 2006

Level 1 Results

As a result of the SICA analysis, no ecological components are to be examined at Level 2 since all risk scores were ≤2 (Table ES1.2). Three ecological components (i.e., byproduct/bycatch, protected species and communities) were considerd to have a minor external impact by other fisheries. By contrast, the key/secondary commercial species component was considered to have a moderate external impact by other fisheries.

Benthic habitats were not assessed in this report because a previous assessment was conducted (Welsford et al. 2014). However, a Level 1 analysis was conducted for activities identified as leading to some form of impact on pelagic habitats. The impact of all five activities identified (i.e. four internal; one external) on the "Heard/McDonald Islands pelagic provinces-Plateau" habitat were negligible.

Summary

There have been updated management arrangements implemented in the HIMI fishery since the last ERAEF assessment was conducted for this sub-fishery. The assessment of this sub-fishery is better compared to the previous assessment since all ecological compoents did not trigger a Level 2 analysis (Table ES1.2). Patagonian toothfish was chosen as the most vulnerable key commercial species for the direct impact of capture by fishing activity. This did not trigger a Level 2 analysis since it is already assessed (Table ES1.3) under the revised ERAEF methodology.

The grey rockcod (*Lepidonotothen squamifrons*) was identified as the most vulnerable bycatch species (minor risk) in contrast to skates and rays in the previous assessment, based on greater quantities removed from this sub-fishery. The minor risk score was for the activity "direct impact of capture by fishing", since the total removals were below accepted annual bycatch limit (80 t; long-term yield). This work has recently been repeated incorporating updated estimated biological parameters and recent recruitment as part of an Honours thesis (Maschette, 2015; Maschette et al. 2015). The 2015 GYM-estimates which bycatch limits are based on are subject to uncertainty and have not yet been presented to CCAMLR.

Three ecological communities were chosen as the most vulnerable component (risk score 2). The communities were scored 2, given that only a small area of each community was fished and two of these communities were also within the Marine Reserve. However, even though the removal of Patagonian toothfish from communities has been considered in the precautionary TAC setting process, there is still further work to do to understand the fishery dynamics at a community level. A variety of ecosystem models e.g. size-based models, SEAPODYM, EwE and Atlantis, for the Kerguelen Axis which includes the HIMI region, are currently being developed and should enable exploration of the broader ecosystem effects of fishing in the near future.

Compared to the previous assessment, the threat of impact from IUU fishing has been significantly reduced with no reports during this assessment period. Results of this ERA assessment have been presented and discussed with stakeholders, an important step in the ERAEF process.

Table ES1.2. Outcomes of assessments for ecological components conducted or *triggered in 2016 and 2006.

Ecological component	Level attained in 2016	Level attained in 2006
Key/secondary commercial species	Level 1	Level 2
Byproduct and bycatch species	Level 1	Level 2
Protected species	Level 1	Level 1
Habitats	Level 1[#]	-
Communities	Level 1	Level 2*

[#]Partial assessment-pelagic only (Benthic habitat assessment previously conducted; Welsford et al. 2014)

- no habitat assessment was conducted in 2006

*triggered but due to lack of methodology available in 2006 and ecosystem modelling projects underway in 2016 this component was not assessed at L2 in the ERA process.

Table ES1.3. Stock and related assessments including status detail (where available) of key commercial and bycatch species in the HIMI fishery.

Role in fishery	Common name, scientific name	Stock status[1]	Year last assessed	Data included and/or Source
Key commercial	Patagonian toothfish, *Dissostichus eleginoides*	Not subject to overfishing. Not overfished.	2015	RSTS 2014/15; 2009-2014 fishery data. CCAMLR 2015b
	Mackerel icefish, *Champsocephalus gunnari*	Not subject to overfishing. Not overfished.	2015	RSTS 2014/2015; 2006-2014 fishery data. CCAMLR 2015a
Bycatch	Unicorn icefish, *Channichthys rhinoceratus*		2015	RSTS 2013/14 WG-FSA-15/50
	Grey rockcod, *Lepidonotothen squamifrons*		1998	SC-CAMLR-XVII, Annex 5, 4.204 to 4.206.
	Grey rockcod, *Lepidonotothen squamifrons*		2015	Maschette 2015; Maschette et al. 2015; Maschette et al. (in prep)
	Skates and rays		1997	SC-CAMLR-XVI, 5.119 to 5.122.
	Skates and rays		2017	Nowara et al. 2017
	Macrourus caml and *M. whitsoni*		2015	RSTS 2013/14 WG-FSA-15/50 and 15/63
	M. halotrachys and *M. carinatus*		2003	CCAMLR 2015a, 2015b

[1]Patterson and Skirtun 2015

Table ES1.4. Comparison of vulnerable analysis units for each ecological component which had a risk score >2 in 2016 and 2006. Numbers in parentheses represent consequence/confidence scores (e.g. (3/1)).

Year assessed	Fishing activity	Ecological component			
		Key/secondary commercial species	Byproduct/ Bycatch species	Protected species	Communities
2016	**Fishing with capture**	-	-	-	-
2006	**Fishing with capture**	Patagonian toothfish (3/2)	Skates and rays (3/2)	-	Eastern trough 500-1000 m; Outer Heard Plateau 100-500 m (3/2)

1 Overview

1.1 Ecological Risk Assessment for the Effects of Fishing (ERAEF) Framework

1.1.1 The Hierarchical Approach

The Ecological Risk Assessment for the Effects of Fishing (ERAEF) framework involves a hierarchical approach that moves from a comprehensive but largely qualitative analysis of risk at Level 1, through a more focused and semi-quantitative approach at Level 2, to a highly focused and fully quantitative "model-based" approach at Level 3 (Figure 1.1). This approach is efficient because many potential risks are screened out at Level 1, so that the more intensive and quantitative analyses at Level 2 (and ultimately at Level 3) are limited to a subset of the higher risk activities associated with fishing. It also leads to rapid identification of high-risk activities, which in turn can lead to immediate remedial action (risk management response). The ERAEF approach is also precautionary, in the sense that risks will be scored high in the absence of information, evidence or logical argument to the contrary.

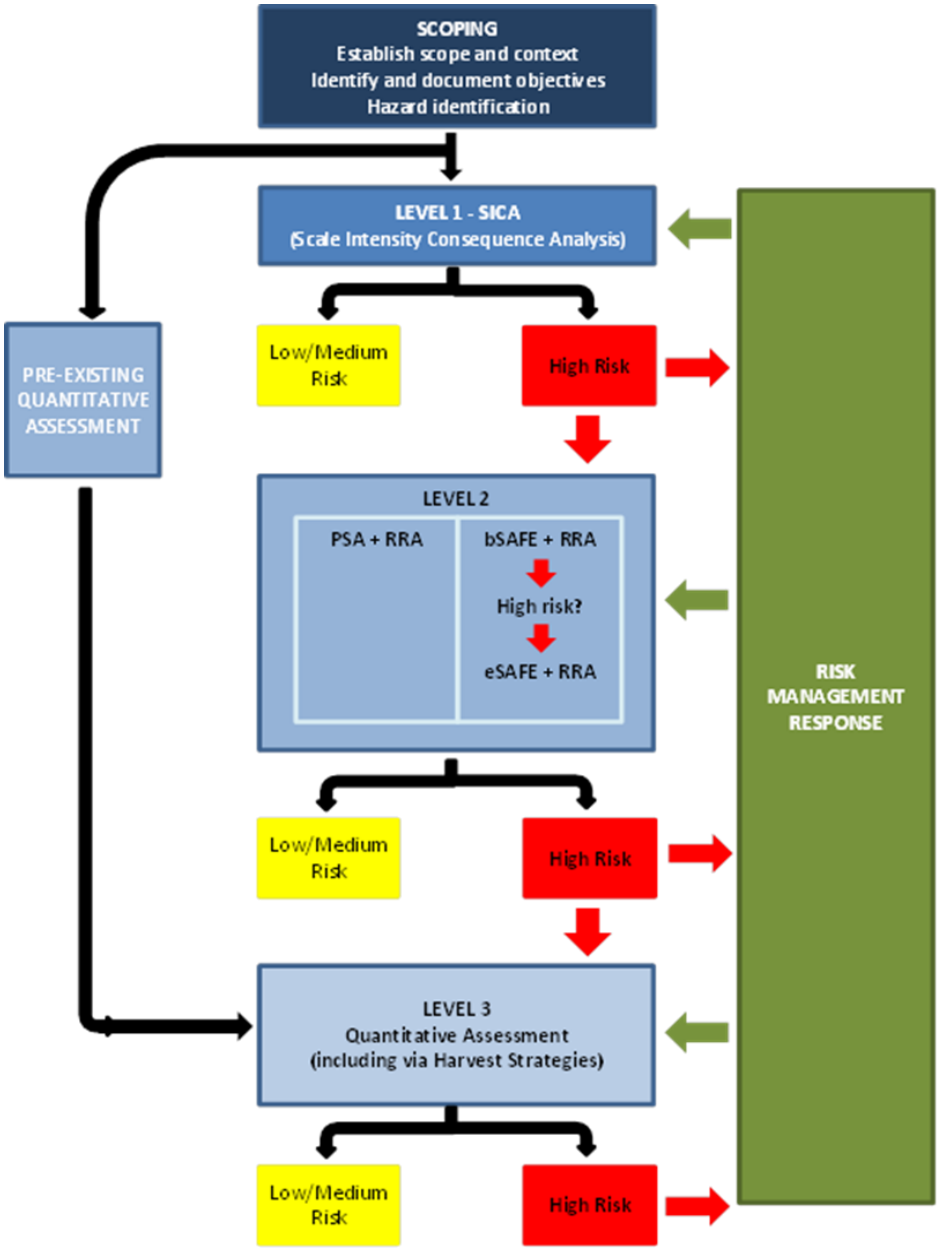


Figure 1.1. Structure of the 3 level hierarchical ERAEF methodology. SICA – Scale Intensity Consequence Analysis; PSA – Productivity Susceptibility Analysis; SAFE – Sustainability Assessment for Fishing Effects; RRA – Residual Risk Analysis. T1 – Tier 1. eSAFE may be used for species classified as high risk by bSAFE.

Conceptual Model

The approach makes use of a general conceptual model of how fishing impacts on ecological systems, which is used as the basis for the risk assessment evaluations at each level of analysis (Levels 1-3). For the ERAEF approach, five general ecological component are evaluated, corresponding to five areas of focus in evaluating impacts of

fishing for strategic assessment under EPBC legislation. The five revised *components* are:

- Key commercial species and secondary commercial species
- Byproduct and bycatch species
- protected[1] species (formerly referred to as threatened, endangered and Protected[2] species or TEPs)
- Habitats
- Ecological communities

This conceptual model (Figure 1.2) progresses from *fishery characteristics* of the fishery or sub-fishery, → *fishing activities* associated with fishing and *external activities*, which may impact the five ecological components (target, byproduct and bycatch species, protected species, habitats, and communities); → *effects of fishing and external activities* which are the direct impacts of fishing and external activities; → *natural processes and resources* that are affected by the impacts of fishing and external activities; → *sub-components* which are affected by impacts to natural processes and resources; → *components*, which are affected by impacts to the sub-components. Impacts to the sub-components and components in turn affect achievement of management objectives.

[1] The term "protected species" refers to species listed under [Part 13] of the EPBC Act (1999) and replaces the term "Threatened, endangered and protected species (TEPs)" commonly used in past Commonwealth (including AFMA) documents.

[2] Note "protected" (with small "p") refers to all species covered by the EPBC Act (1999) while "Protected" (capital P) refers only to those protected species that are threatened (vulnerable, endangered or critically endangered).

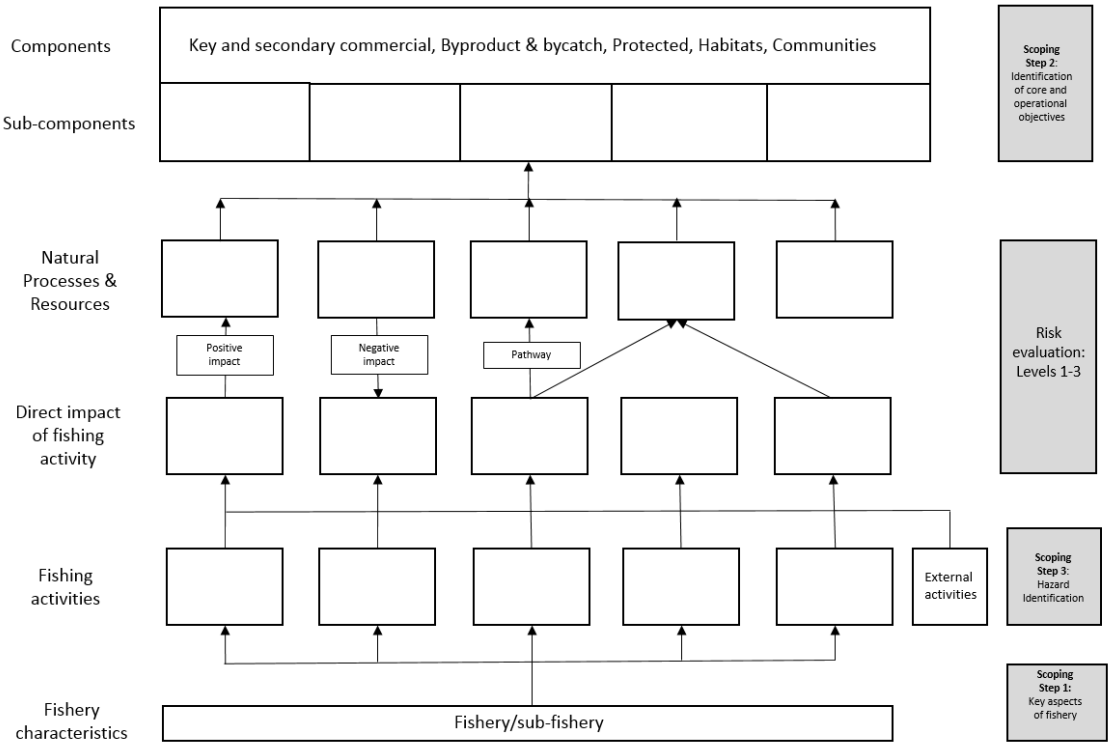


Figure 1.2. Generic conceptual model used in ERAEF.

The external activities that may impact the fishery objectives are also identified at the Scoping stage and evaluated at Level 1. This provides information on the additional impacts on the ecological components being evaluated, even though management of the external activities is outside the scope of management for that fishery.

The assessment of risk at each level takes into account current management strategies and arrangements. A crucial process in the risk assessment framework is to document the rationale behind assessments and decisions at each step in the analysis. The decision to proceed to subsequent levels depends on

- Estimated risk at the previous level
- Availability of data to proceed to the next level
- Management response (e.g. if the risk is high but immediate changes to management regulations or fishing practices will reduce the risk, then analysis at the next level may be unnecessary).

1.1.2 ERAEF stakeholder engagement process

A recognized part of conventional risk assessment is the involvement of stakeholders involved in the activities being assessed. Stakeholders can make an important contribution by providing expert judgment, fishery-specific and ecological knowledge, and process and outcome ownership. The ERAEF method also relies on stakeholder involvement at each stage in the process, as outlined below. Stakeholder interactions are recorded.

1.1.3 Scoping

In the first instance, scoping is based on review of existing documents and information, with much of it collected and completed to a draft stage prior to full stakeholder involvement. This provides all the stakeholders with information on the relevant background issues. Three key outputs are required from the scoping, each requiring stakeholder input.

1. Identification of units of analysis (species, habitats and communities) potentially impacted by fishery activities (Section 2.2.2; Scoping Documents S2A, S2B1, S2B2 and S2C1, S2C2).
2. Selection of objectives (Section 2.2.3; Scoping Document S3). The primary objective to be pursued for species assessed under ERAEF is that of ensuring populations are maintained at biomass levels above which recruitment failure is likely, as stated in Chapter 2 (ERM Guide; AFMA (2016b)). This is consistent with current legislation and fisheries policies and represents a change from when the ERAEF was first developed and there was less policy or legislation based guidance on sustainability objectives, with stakeholders able to choose from a range of “sustainability” objectives (e.g.: tables 5A-C in Hobday et al. 2007).
3. Selection of activities (hazards) (Section 2.2.4; Scoping Document S4) that occur in the sub-fishery is made using a checklist of potential activities provided. The checklist was developed following extensive review, and allows repeatability between fisheries. Additional activities raised by the stakeholders can be included in this checklist (and would feed back into the original checklist). The background information and consultation with the stakeholders is used to finalize the set of activities. Many activities will be self-evident (e.g. fishing, which obviously occurs), but for others, expert or anecdotal evidence may be required.

1.1.4 Level 1. SICA (Scale, Intensity, Consequence Analysis)

The SICA analysis evaluates the risk to ecological components resulting from the stakeholder-agreed set of activities. Evaluation of the temporal and spatial scale, intensity, sub-component, unit of analysis, and credible scenario (consequence for a sub-component) should be prepared by the draft fishery ERAEF report author and reviewed at an appropriate stakeholder meeting (e.g. Resource Assessment Group meeting). Due to the number of activities (up to 24) in each of five components (resulting in up to 120 SICA elements), preparation before involving the full set of stakeholders may allow time and attention to be focused on the uncertain or controversial or high risk elements. Documenting the rationale for each SICA element ahead of time for the straw-man scenarios is crucial to allow the workshop debate to focus on the right portions of the logical progression that resulted in the consequence score.

SICA elements are scored on a scale of 1 to 6 (negligible to extreme) using a "plausible worst case" approach (see ERAEF Methods Document for details; Smith et al. 2007). Level 1 analysis potentially result in the elimination of activities (hazards) and in some cases whole components. Any SICA element that scores 2 or less is documented, but not considered further for analysis or management response.

1.1.5 Level 2. PSA and SAFE (semi-quantitative and quantitative methods)

When the risk of an activity at Level 1 (SICA) on a species component is moderate or higher and no planned management interventions that would remove this risk are identified, an assessment is required at Level 2 (to determine if the risk is real and provide further information on the risk). The tools used to assess risk at Level 2 allow units (e.g. all individual species) within any of the ecological species components (e.g. key/secondary commercial, byproduct/bycatch, and protected species) to be effectively and comprehensively screened for risk. The analysis units are identified at the scoping stage. To date, Level 2 tools have been designed to measure risk from direct impacts of fishing only (i.e. risk of overfishing, leading to an overfished fishery), which in all assessments to date has been the hazard with the greatest risks identified at Level 1[3].

In the period since the first ERAEF was implemented across Commonwealth fisheries, much of the management focus has been on the assessment results associated with Level 2 and Level 2.5 or 3 risk assessment methods, which comprise semi-quantitative

[3] Future iterations of the methodology will include PSAs modified to measure the risk due to other activities, such as gear loss.

or rapid simple quantitative methods (e.g. PSA and SAFE). This level has been subject to the greatest level of change and improvement which are discussed in the following sections. Additional improvements are being developed for implementation in the near future (see Chapter 4.13 of AFMA ERM Guide, AFMA (2016b)).

Level 2 was originally designed to rely on a single risk assessment methodology, the Productivity-Susceptibility Analysis (PSA) (see Chapter 4.8.3 of AFMA ERM Guide, AFMA (2016b)), however a more quantitative method called the Sustainability Assessment for Fishing Effects (SAFE) (see Chapter 4.8.4 of AFMA ERM Guide, AFMA (2016b)) was developed early in the implementation of the ERAEF and classed as a Level 2.5 or Level 3 tool.

Under the revised ERAEF:

- bSAFE has now been reclassified as the preferred Level 2 method (over PSA) where sufficient spatial and biological data (to support bSAFE) are available. Typically this has been used for teleost and chondricthyan species.
- Species estimated to be at high risk under bSAFE may then be assessed under eSAFE which may provide reduced estimates of uncertainty pertaining to the actual risk.
- Where either the data or species biological characteristics are insufficient to support bSAFE analyses, it is recommended that PSA be applied instead. This will be the case for many protected species, invertebrate bycatch species and some other species.
- At Level 2, either PSA or SAFE methods should be applied to any given species, not both.
- For high risk species it is a management choice whether to progress to eSAFE, pursue a Level 3 fully quantitative stock assessment, or to take more immediate management action to reduce the risk. The types of considerations required in making that choice (ie: moving up the ERAEF assessment hierarchy or taking direct management action) are outlined in Chapter 5.5 of the AFMA ERM Guide (AFMA (2016b)).

It is also recognised that a number of additional tools, including some of the “data poor” assessment tools that are used to inform harvest strategies, could potentially be included within the Level 2 toolkit. They are distinguished from Level 3 quantitative tools (i.e. stock assessment models) that are more data rich and able to more precisely quantify uncertainty.

PSA (Productivity Susceptibility Analysis))

Details of the PSA method are described in the accompanying ERAEF Methods Document and also summarised in Section 4.8.3 of the AFMA ERM Guide (AFMA (2016b)). Stakeholders can provide input and suggestions on appropriate attributes,

including novel ones, for evaluating risk in the specific fishery. Attribute values for many of the units (e.g. age at maturity, depth range, mean trophic level) can be obtained from published literature and other resources (e.g. scientific experts) without initial stakeholder involvement. Stakeholder input is required after preliminary attribute values are obtained. In particular, where information is missing, expert opinion can be used to derive the most "reasonable" conservative estimate. For example, if species attribute values for annual fecundity have been categorized as low, medium or high on the set (<5, 5-500, >500), estimates for species with no data can still be made. Also, estimated fecundity of a broadcast-spawning fish species with unknown fecundity is still likely to be greater than the high fecundity category (>500). Susceptibility attribute estimates, such as "fraction alive when landed", can also be made based on input from experts such as scientific observers. Feedback to stakeholders regarding comments received during the preliminary PSA consultations is considered crucial. The final PSA is completed by scientists and results are presented to the relevant stakeholder group (e.g. RAG and/or MAC) before decisions regarding Level 3 analysis are considered. The stakeholder group may also decide on priorities for analysis at Level 3.

Residual Risk Analysis

There were several limitations due to the semi-quantitative nature of a Level 2 PSA assessment. For example, certain management arrangements which mitigate the risks posed by a fishery, as well as additional information concerning levels of direct mortality, may not be easily taken into account in assessments. To overcome this, Residual risk analyses (RRA) are used to consider additional information, particularly mitigating effects of management arrangements that were not explicitly included in the ERAs or introduced after the ERA process commenced. Priority for this process has typically been focused on those species attributed a high risk rating (those likely to be most at risk from fishing activities). It could in theory be used to also determine if some species have been incorrectly classified as low risk.

Recently revised Residual risk guidelines have been developed (see below) to assist in making accurate judgments of residual risk consistently across all fisheries. At the moment, they are applied to species and not applicable to habitats or communities.

These guidelines are not seen as a definitive guide on the determination of residual risk and it is expected they may not apply in a small number of cases. Care must also be taken when applying them to ensure residual risk results are appropriate in a practical sense. There are a number of conditions which underpin the residual risk guidelines and should be understood before the guidelines are applied:

- All assessments and management measures used within the residual risk assessment must be implemented prior to the assessment with sufficient data to demonstrate the effect. Any planned or proposed measures can be referred to in the assessment but cannot be used to revise the risk score.

- When applied, the guidelines generally result in changes to particular "attribute" scores for a particular species. Only after all of the guidelines have been applied to a particular species, should the overall risk category be re-calculated. This will ensure consistency, as well as facilitating the application of multiple guidelines.
- Unless there is clear and substantiated information to support applying an individual guideline, then the attribute and residual risk score should remain unchanged. All supporting information considered in applying these Guidelines must be clearly documented and referenced where applicable. This is consistent with the precautionary approach applied in ERAs, with residual risk remaining high unless there is evidence to the contrary ensuring a transparent process is applied.

The results (including supporting information and justifications) from residual risk analyses must be documented in “Residual Risk Reports” for each fishery (or can be integrated into the Level 2 risk assessment report). These will be publically available documents.

SAFE (Sustainability Assessment for Fishing Effects)

The SAFE method developed is split into two categories: base SAFE (bSAFE) and an enhanced SAFE (eSAFE). eSAFE has greater data processing requirements and is recommended to only be used to assess species estimated to be at high risk via the bSAFE. It is also able to more appropriately model spatial availability aspects when sufficient data are available.

bSAFE

Relative to the PSA approach, the bSAFE approach (Zhou and Griffiths, 2008; Zhou et al. 2011):

- is a more quantitative approach (analogous to stock assessment) that is able to provide absolute measures of risk by estimating fishing mortality rates relative to fishing mortality rate reference points (based on life history parameters);
- requires less productivity data than the PSA;
- is able to account for cumulative risk and
- potentially out performs PSA in several areas, including strength of relationship to Tier 1 assessment classifications (Zhou et al. 2016).

Like PSA, the bSAFE method is a transparent, relatively rapid and cost effective process for screening large numbers of species for risk, and is far less demanding of data and much simpler to apply than a typical quantitative stock assessment.

As such it is recommended that bSAFE be used as the preferred Level 2 assessment tool for all fish species and some invertebrates and reptiles (eg: some sea snakes) with sufficient data.

In estimating fishing mortality, bSAFE utilises much of the same information as the PSA, to estimate:

- Spatial overlap between species distribution and fishing effort distribution.
- Catchability resulting from the probability of encountering the gear and size-dependent selectivity. And;
- Post-capture mortality.

The fishing mortality is essentially the fraction of overlap between fished area and the species distribution area within the jurisdiction, adjusted by catchability and post-capture mortality. Uncertainty around the estimated fishing mortality is estimated by including variances in encounterability, selectivity, survival rate and fishing effort between years.

The three biological reference points are based on a simple surplus production model:

- **F_{MSY}** – instantaneous fishing mortality rate that corresponds to the maximum number of fish in the population that can be killed by fishing in the long term. The latter is the maximum sustainable fishing mortality (MSM) at B_{MSM}, similar to target species MSY.
- **F_{LIM}** – instantaneous fishing mortality rate that corresponds to the limit biomass B_{LIM} where B_{LIM} is a assumed to be half of the biomass that supports a maximum sustainable fishing mortality ($0.5B_{MSM}$)
- **F_{CRASH}** – minimum unsustainable instantaneous fishing mortality rate that, in theory, will lead to population extinction in the long term.

This methodology produces quantified indicators of performance against fishing mortality based reference points and as such does allow calibration with other stock assessment and risk assessment tools that measure fishing mortality. It allows the risk of overfishing to be determined, via the score relative to the reference line. Uncertainty (error bars) are related to the variation in the estimation of the scores for each axis.

It is recommended that species assessed as being potentially at high risk under bSAFE are then progressed to analysis by eSAFE which is able to narrow uncertainties around the risk (but is more time and resource intensive than bSAFE).

Assumptions and issues to be aware of:

- Comparisons of PSA and SAFE analyses for the same fisheries and species support the claim that the PSA method generally avoids false negatives but can result in many false positives. Limited testing of SAFE results against full

quantitative stock assessments suggest that there is less “bias” in the method, but that both false negatives and false positives can arise.

- SAFE analyses retain some of the key precautionary elements of the PSA method, including assumptions that fisheries are impacting local stocks (within the jurisdictional area of the fishery).
- Although the bSAFE analyses provide direct estimates of uncertainty in both the exploitation rate and associated reference points, they are less explicit about uncertainties arising from key assumptions in the method, including spatial distribution and movement of stocks.
- The method assumes there would be no local depletion effects from repeat trawls at the same location (ie: populations rapidly mix between fished and unfished areas). The fishing mortality will likely be overestimated if this assumption is not satisfied (ERA TWG 2015)[4].
- The method also assumes that the mean fish density does not vary between fished area and non-fished area within their distributional range. Hence, the level of risk would be over-estimated for species found primarily in non-fished habitat, while risk would be under-estimated for species that prefer fished habitat (ERA TWG 2015).
- The SAFE methodology makes greater assumptions than Tier 1 stock assessments in coming to its F estimates (due to a lack of the data relative to that used in a Tier 1 assessment) and it is not capable of measuring risk of a stock being already overfished (so the type of risk it measures relates only to overfishing, which may then lead to future overfished state). The limitations of SAFE with respect to measuring overfished risks are the same essentially as for PSA.

eSAFE

Enhanced SAFE (eSAFE) appears, based on calibration with Level 3 assessments, to provide improved estimates of fishing mortality relative to the base SAFE (bSAFE) method. The eSAFE requires more spatially explicit data and takes more analysis time than bSAFE, and so might only be used to further assess species that were identified as at high risk using bSAFE (and which have not had further direct management action taken). The eSAFE enhances the bSAFE method by estimating varying fish density across their distribution range as well as species- and gear-specific catch efficiency for each species.

[4] ERA Technical Working Group, September 2015

1.1.6 Level 3

This stage of the risk assessment is fully-quantitative and relies on in-depth scientific studies on the units identified as at medium or greater risk in the Level 2. It will be both time and data-intensive. Individual stakeholders are engaged as required in a more intensive and directed fashion. Results are presented to the stakeholder group and feedback incorporated, but live modification is not considered likely.

1.1.7 Conclusion and final risk assessment report

The conclusion of the stakeholder consultation process has resulted in a final risk assessment report for the individual fishery according to the ERAEF methods. It is envisaged that the completed assessment will be adopted by the fishery management group and used by AFMA for a range of management purposes, including to address the requirements of the EPBC Act as evaluated by Department of the Environment and Energy.

1.1.8 Subsequent risk assessment iterations for a fishery

The frequency at which each fishery must revise and update the risk assessment is not fully prescribed. As new information arises or management changes occur, the risks can be re-evaluated, and documented as before. The fishery management group or AFMA may take ownership of this process, or scientific consultants may be engaged. In any case the ERAEF should again be based on the input of the full set of stakeholders and reviewed by independent experts familiar with the process.

Fishery re-assessments for byproduct and bycatch species under the ERAEF will be undertaken every five years[5] or sooner if triggered by re-assessment triggers. The five year timeframe is based on a number of factors including:

- The time it takes to implement risk management measures; for populations to respond to those measures to a degree detectable by monitoring processes; and to collect sufficient data to determine the effectiveness of those measures.
- Alignment with other management and accreditation processes.
- The cost of re-assessments.
- The review period for Fisheries Management Strategy (FMS).

[5] Based on a recommendation by the ERA Technical Working Group, September 2015.

For byproduct and bycatch species, in the periods between scheduled five year ERA reviews[6], AFMA will develop and monitor a set of fishery indicators and triggers, on an annual basis, so as to detect any changes (increase or decrease) in the level of risk posed by the fishery to any species. Where indicators exceed specified trigger levels, AFMA will investigate the causes and provide opportunity for RAG comment/advice during that process. Pending outcomes of that review, and RAG advice, AFMA can if necessary, request a species specific or full fishery re-assessment (i.e. prior to the scheduled re-assessment dates).

The ERA TWG (September 2015) identified five key indicators upon which such triggers could be based, these being changes in:

- Gear type/use
- Mitigation measures (use or type)
- Area fished
- Catch or interaction rate
- Fishing effort

Where possible, the triggers should look to take into account additional sources of risk from interacting non-Commonwealth fisheries. In addition, if a major management change is planned for a fishery, such as a move from input to output controls, the fishery will need to be reassessed prior to that management change coming into effect. In considering each indicator and trigger level, the RAG should consider the following:

- The data upon which the indicator is based must be sufficiently representative of actual changes in catch, effort, area, gear or mitigation methods. Consideration should be given to the level of uncertainty associated with the data underpinning any prospective indicator.
- The trigger level chosen should not be overly sensitive to the normal inter-annual variance that is typical of the indicator and independent of fishing pressure, assuming such variance is unlikely to relate to a significant change in the risk posed by the fishery to any or all species.
- The trigger level should equate to the minimum level of change that the RAG (by its expert opinion) considers might potentially represent a significant change in the risk posed by the fishery.

[6] In contrast to key and secondary commercial species managed via catch/effort limits under Harvest Strategies, which depending on species and Harvest Strategy, can be re-assessed any time between 1 and 5 years.

- The trigger level could represent an absolute change (number/level) in an indicator or a percentage change in an indicator.
- The RAG should consider whether a "temporal" condition should be placed on the trigger (i.e. the trigger is breached 2 years in a row) to further reduce the likelihood of natural population variance or data errors triggering a re-assessment unnecessarily.

The final set of indicators and triggers will be developed for each fishery by AFMA in consultation with its fishery RAG (or for fisheries lacking a RAG, the ERA TWG), in association with the next planned re-assessment (see Table 8 in AFMA ERM Guide, AFMA (2016b)). A RAG may choose a subset of these indicators and triggers, or include an additional indicator/trigger(s), based on consideration of the availability and reliability of data upon which to base any of the above indicators/triggers, however justification of this must be provided.

Research is currently underway to develop specific guidance for RAG to aid in the selection of appropriate triggers, which will in the meantime be determined using RAG expert opinion. In the longer term it may be possible to refine indicators and triggers using the existing PSA and SAFE methods to test which attributes the end risk scores are most sensitive to (ERA TWG 2015)[7]. The RAG will record both the final set of indicators and triggers chosen, and a justification for those, in the RAG minutes. Once the final set of indicators and triggers is determined for a fishery, they will require implementation within the FMS and a monitoring and review process.

[7] ERA TWG recommendation, September 2015

2 Results

The focus of analysis is the fishery as identified by the responsible management authority. The assessment area is defined by the fishery management jurisdiction within the Australian Fisheries Zone (AFZ). The fishery may also be divided into sub-fisheries on the basis of fishing method and/or spatial coverage. These sub-fisheries should be clearly identified and described during the scoping stage. Portions of the scoping and analysis at Level 1 and beyond are specific to a particular sub-fishery. The fishery is a group of people carrying out certain activities as defined under a management plan. Depending on the jurisdiction, the fishery/sub-fishery may include any combination of commercial, recreational, and/or indigenous fishers.

The results presented below are for the demersal trawl sub-fishery of the Heard Island and McDonald Islands (HIMI) Fisheries. A full description of the ERAEF method is provided in the methodology document (Hobday et al. 2007; Hobday et al. 2011b). This fishery report contains figures and tables with numbers that correspond to this methodology document. Thus, table and figure numbers within this fishery ERAEF report are not sequential, as not all figures and tables are relevant to the fishery risk assessment results.

2.1 Stakeholder Engagement

Table 2.1. Summary Document SD1. Summary of stakeholder involvement for sub-fishery: Heard Island and McDonald Islands: demersal trawl sub-fishery.

Fishery ERA Report stage	Type of stakeholder interaction	Date of stakeholder interaction	Composition of stakeholder group (names or roles)	Summary of outcome
Scoping	Phone calls and emails	July/Aug. 2016	Jo Fisher (AFMA), Natalie Rivero (AFMA), Tim Lamb (AAD), Phillipe Ziegler (ADD), Industry	Discussion, information supplied and reports sent to ERA Team
Level 1 (SICA)	Phone calls and emails	July/Aug. 2016	AFMA contacts, Industry	Draft Level 1 completed
Draft report	Presenatation at SARAG meeting	8 Sep. 2016	SARAG members and invited participants	Comments on species lists, scoping and SICA
Draft report		13 Oct. 2016	Gabrielle Nowara (AAD)	Reviewed document
Draft report		26 Apr. 2017	Jo Fisher (AFMA), Martin Exel (Industry), Rhys Arangio (Industry)	Reviewed document
Draft final report		May 2017	Jo Fisher (AFMA), Industry	Reviewed document
Final report		Feb. 2018	Jo Fisher (AFMA); SARAG	Report submitted

2.2 Scoping

The aim in the Scoping stage is to develop a profile of the fishery being assessed. This provides information needed at stakeholder meetings and to complete Levels 1 and 2. The focus of analysis is the fishery, which may be divided into sub-fisheries on the basis of fishing method and/or spatial coverage. Scoping involves six steps:

Step 1. Document the general fishery characteristics
Step 2. Generating "unit of analysis" lists (species, habitat types, communities)
Step 3. Selection of objectives
Step 4. Hazard identification
Step 5. Bibliography
Step 6. Decision rules to move to Level 1

2.2.1 General Fishery Characteristics (Step 1).

The information used to complete this step came from a range of documents such as the Fishery's Management Plan, Assessment Reports, Bycatch Action Plans, and any other relevant background documents.

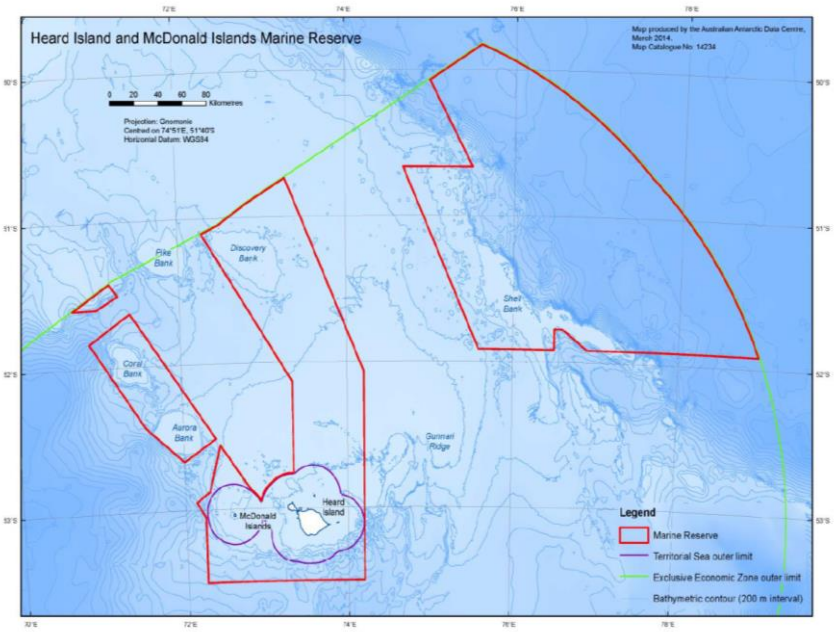
Scoping Document S1 General Fishery Characteristics

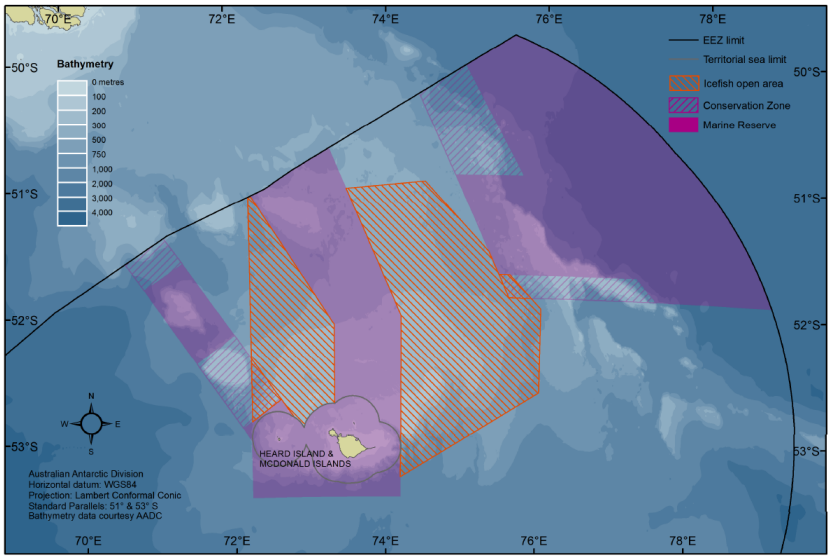
Fishery Name: Heard Island and McDonald Islands – Demersal Trawl
Assessment date: August 2016
Assessor: M. Sporcic (CSIRO)

Table 2.2. General fishery characteristics.

General Fishery Characteristics	
Fishery Name	Heard Island and McDonald Islands Fishery
Sub-fisheries	*Identify sub-fisheries on the basis of fishing method/area.* There are currently four sub-fisheries based on fishing methods, the first of which could be considered as two sub-fisheries because two species are targeted: 1. **Demersal otter board trawling** for Patagonian toothfish (*Dissostichus eleginoides*) and mackerel icefish (*Champsocephalus gunnari*). 2. **Midwater trawling** for mackerel icefish (C*. gunnari*). This method has had limited application over the past few years. 3. **Demersal longlining** for Patagonian toothfish (*D. eleginoides*) began in May 2003 season under scientific permits. 4. **Pot and trap fishing.** Although a permitted method in the HIMI Fishery, pot fishing has not been used recently and therefore hasn't been included in the current ERA process.

	The HIMI Fishery Direction which prohibited fishing methods other than trawling and longlining expired November 2010 and was not renewed. The SFR conditions for the fishery were amended to limit permitted fishing methods to trawl, longline and pot fishing.
Sub-fisheries assessed	This assessment only considers demersal otter board trawling sub-fishery but treats Patagonian toothfish and mackerel icefish separately where necessary.
Start date/ history	*Provide an indication of the length of time the fishery has been operating.* Fishing activity in the region had been sparse until recently. There are records of Soviet and Polish vessels fishing mackerel icefish (*Champsocephalus gunnari*) in the region in the 1970s and some research surveys were conducted by AAD in the early 1990s, before the establishment of the EEZs of Australia and France. The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) came into force in 1982, as part of the Antarctic Treaty System, with the aim of regulating exploitation rather than outright protection. CCAMLR was established at a time when commercial interests in krill were growing rapidly; it began to be truly effective as a management regime in 1991 when the first catch limits were set. From the outset CCAMLR was based on the principle that management of fisheries should include not just the target species but also dependent and associated species and their ecological relationships. CCAMLR and AFMA are committed to minimise impacts on the marine environment from fishing in the Heard Island and McDonald Islands area and strict environmental management measures have been in place since access to the fishery was first granted in 1995. These measures are incorporated in the Heard Island and McDonald Islands Fishery Management Plan 2002 (the HIMI Plan) and supporting legislative instruments, developed under the Fisheries Management Act 1991. Commercial fishing for *D. eleginoides* and *C. gunnari* by Australian operators commenced in March 1997 using demersal and midwater trawls in accordance with CCAMLR Conservation Measures 109/XV and 110/XV (1996) respectively (now CM 41-08 and 42-02). Subsequently, licensed Australian vessels have attempted to take the TAC set by CCAMLR each year but due to fluctuations in abundances, they have not always caught the icefish limit (Williams et al. 2002). A pot fishing trial was undertaken during the 2005/06, 2008/09, 2009/10, 2010/11 and 2012/13 seasons with low Patagonian toothfish catch (~35.9 t in 2010/11; 43.84 t in 2012/13). Pot fishing is very selective with very little bycatch (~4 t (mostly starfishes – unidentified in 2010/11) and 0.5 t (2012/13)) and there is less impact than demersal trawl on the benthic habitats. Since 2007, fishing methods in the HIMI Fishery has shifted from bottom trawling to longlining for Patagonian toothfish (Patterson & Skirtun 2012) with longlining catches exceeded trawl catches from 2010 onwards (SC-CAMLR 2012). The HIMI Fishery was the first Commonwealth fishery to be accredited for export approval/accreditation under the EPBC Act. The initial accreditation was granted in May 2002 for a period of five years. A further two 5 year exemption periods were granted which expired on 9 May 2017. More recently, a ten year exemption was granted with the current period expiring on 9 October 2026. Source: AFMA Annual Report 2014-2015 and Department of Enviromnet and Energy website The HIMI fishery was certified as sustainable in March 2012 by the Marine Stewardship Council both trawling and longlining Patagonian toothfish and has re-entered re-assessment in July 2016 (https://www.msc.org/track-a-fishery/fisheries-in-the-program/certified/southern-ocean/heard_island_and_mcdonald_islands_himi_toothfish). The HIMI Mackerel icefish fishery was certified in 2011. Illegal, unregulated or unreported (IUU) fishing is of concern because it has the potential to undermine attempts to manage fish stocks. In 1999, CCAMLR adopted a catch

	documentation scheme (CDS) which has helped prevent illegally caught fish entering the markets of CCAMLR nations. The CDS was implemented in 2000. No illegal foreign fishing vessels have been detected inside the Australian Fishing Zone of the HIMI area since 2007 (CCAMLR Fishery Report 2015c). There were 142 surveillance patrol days by Australian Government vessels in 2014-15 in the Southern Ocean (against a target of 172 days) (Australian Customs and Borders Protection Service 2015). There are cooperative arrangements with the French Government. Electronic surveillance methods and range of other approaches are also used to combating risks from IUU fishing in areas outside Australia's jurisdiction (SCS Global Services; https://www.msc.org/track-a-fishery/fisheries-in-the-program/certified/southern-ocean/heard_island_and_mcdonald_islands_himi_toothfish/assessment-downloads-1/20150901_SR_TOO227.pdf). Source: CCAMLR., 2015c; http://www.afma.gov.au/fisheries
Geographic extent of fishery	*The geographic extent of the managed area of the fishery. Maps of the managed area and distribution of fishing effort should be included in the detailed description below, or appended to the end of this table.* The fishery operates in sub-Antarctic waters adjacent to Heard Island and the McDonald Islands. Heard Island and McDonald Islands (HIMI) are external territories of Australia located in the Southern Indian Ocean about 4,000 km south-west of Perth. The islands lie south of the Polar Front. The Islands are listed on the Register of the National Estate as the only unmodified example of a sub-Antarctic island ecosystem. In addition, the Islands and the 12 nautical mile territorial sea around them are on the World Heritage List and form part of the current HIMI Marine Reserve (declared in 2014; Fig. 6 below). This Reserve was extended to include areas of an existing Conservation Zone (Fig. A below) and is categorised as an International Union for Conservation of Nature Category 1a: Strict Nature Reserve. It is managed by the Australian Antarctic Division (AAD), is closed to commercial fishing but limited scientific research and monitoring is permitted. In recognition of the Islands' importance, fishing is prohibited within 13 nautical miles of the Islands, providing a buffer zone of one nautical mile between the territorial sea and the area of the fishery. The fishery extends from 13 nautical miles offshore to the edge of the 200 nautical mile Australian Economic Exclusive Zone (EEZ) around the Islands and is managed by the Australian Fisheries Management Authority (AFMA). The fishery lies in CCAMLR Statistical Division 58.5.2.  **Figure 6: The HIMI Fishery including the Marine Reserve and Conservation Zones**

	Source : Figure 6: AFMA 2014 - HIMI Fishery Status Report 2014  **Figure A: HIMI Reserve before the newly declared (2014) HIMI Marine Reserve (i.e. Fig. 6 above).** Source: Welsford et al. 2014
Regions or Zones within the fishery	*Any regions or zones used within the fishery for management purposes and the reason for these zones if known.* The spatial distribution of trawling effort at HIMI is largely contained to five fishing grounds on the southern and bank slopes of the plateau, in depths between 400 m and 1000 m (Welsford et al. 2014). There are five main trawl grounds, which include the historical three grounds (A-C) for Patagonian toothfish that will not be identified further to retain confidentiality of the licensed operators of the fishery. Icefish are fished on the shallower parts of the Heard Island plateau particularly on the southeast slope and Gunnari Ridge between 450 m and 700 m deep (CCAMLR CM42-02, Meyer et al. 2000). Outside of the Heard Island Plateau there is a closure to mackerel icefish fishing (see figure). Until 1998 they were abundant on Shell Bank (Williams et al. 2002) but this area has been closed since then due to concern that it was not able to sustain a fishery and due to the potential for overlap between the icefish fishery and the foraging activities of icefish predators (Meyer et al. 2000). In contrast to the reports of the early 1970s, they are now found rarely on the other shallow banks i.e. Pike and Aurora, and other parts of the Plateau (Williams et al. 2002).
Fishing season	*What time of year does fishing in each sub-fishery occur?* The fishing season for both species using trawl is from 1 December to 30 November each year. Two observers are present on all HIMI fishing trips. Each observer conducts 12 hour shifts, so that an observer is present on all fishing trips.
Key/second-ary commercial species and stock status	*Species targeted and where known, stock status.* **Key commercial species** • Patagonian toothfish • Mackerel icefish **Patagonian toothfish (*Dissostichus eleginoides*)** The Patagonian toothfish is widely distributed across the entire Kerguelen Plateau. In Division 58.5.2, fish up to 175 cm long and older than 50 years of age have been found (Welsford et al. 2011; Welsford et al. 2014). They are a demersal species found at depths of 50-3000 metres, with younger fish, less than 500 mm TL, typically occurring in less than 500m. On maturation they migrate to spawning locations, with tagging studies showing

	occasional migration of more than 2500 km to deeper slopes around 1400-1800 m (Welsford et al. 2011). Older fish are generally solitary and relatively sedentary and move into depths >1000m where they are more usually caught by longline. Female fish reach reproductive maturity at about 9 years of age, have low fecundity, and spawn during winter at depths of about 1000 metres on the continental slope. Recent work has shown that toothfish spawn within the deep waters to the west and south of HIMI EEZ in addition to on the Kerguelen Plateau (Welsford et al. 2012). Existing research suggests that a metapopulation of *D. eleginoides* exists in the Indian Ocean sector (Williams et al. 2002; Appleyard et al. 2004). Genetic studies have shown that populations at HIMI are distinct from Macquarie Island and South Georgia but that there is no distinction between those at HIMI, Kerguelen, Crozet and Marion/Prince Edward Islands (CCAMLR 2015). Tagging studies suggest that a metapopulation exists in the Indian ocean sector of the Southern Ocean. Collaborative research on stock structure with French scientists is continuing to refine population models and improve management in the Kerguelen Plateau (Patterson and Savage 2016). The Harvest Strategy for HIMI Fishery (toothfish) is precautionary aiming to set TACS at a level that the probability of the spawning biomass falling below 20% of the pre-exploitation level over the 35 year projection period is not greater 0.1 and the median escapement for the Fishery of the spawning biomass is not be less than 50% over a 35 year projection. **Stock status:** The stock status of *D. eleginoides* is not overfished (Biomass) and not subject to overfishing based on current levels of fishing mortality (Patterson and Skirtun 2015 - HIMI Fishery Status Report 2015).The most updated stock assessment for *D. eleginoides* in Division 58.5.2 was presented in WG-FSA-15/52 with data until the end of July 2015 and tag data from 2012 to 2015. Compared to the last assessment in 2014, the assessment also updated fish growth parameters, changed the priors on survey catchability *q* (as recommended by WG-SAM-15), B_0 and year class strength (YCS), and split the trawl fishery into two periods of 1997–2004 and 2005–2015. The Working Group recommended that the catch limit for *D. eleginoides* in Division 58.5.2 should be set at 3405 t for 2015/16 and 2016/17. The assessment model led to an MCMC estimate of the virgin spawning stock biomass of 87077 t (95% CI: 78500–97547 t) and an estimated SSB status in 2015 of 0.64 (95% CI: 0.59–0.69)(CCAMLR 2015) **Mackerel icefish (*Champsocephalus gunnari*)** Mackerel icefish is found in the Atlantic and Indian sectors of the Southern Ocean. It is a semi-pelagic species confined to waters less than 500m, but is most abundant at depths of less than 350 m in shelf waters surrounding Heard Island (Williams et al. 2002). In this area they grow to a maximum length of around 45 cm and a maximum age of six years. Size at first maturity for females is 26.5 cm and for males is 28.5 cm total length (Williams et al. 2002). Older juveniles and adults form large aggregations predominantly in the demersal or midwater range of the water column. **Stock status:** Based on the 2015 survey and fixed model parameters, a short-term stock assessment was conducted for mackerel icefish producing a biomass estimate of 3048 t. The working group recommended a TAC of 482 t in 2015/16 to allow 75% escapement of biomass after two years. The stock status of mackerel icefish is not overfished (Biomass) and not subject to overfishing based on current levels of fishing mortality (Patterson and Skirtun 2015 - HIMI Fishery Status Report 2015).
Bait collection and usage	Not applicable.
Current entitlements	*The number of current entitlements in the fishery. Note latent entitlements. Licences/ permits/ boats and number active* Access to the fishery is limited and strict operating conditions are imposed to minimise negative effects on the environment, including effects on non-target species. The impact of

trawling on the benthic environment is limited to the depths and benthos that trawlers can operate in.

Only three trawl vessels can participate in the HIMI Fishery. Any trawl vessel with a minimum quota of 25.5% of the Statutory Fishing Rights (SFR) can participate. There are currently four SFR owners. There is no allocation between sectors in this fishery. SFR holders can choose to take their share of the TAC for toothfish by trawl, longline or potting fishing methods. Mackerel icefish can only be caught by trawl fishing methods.

Current and recent TACs, quota trends by method

Summary of the most recent catch quota levels in the fishery by fishing method (sub-fishery) in table form.

Total Allowable Catch (TAC) for Patagonian toothfish and mackerel icefish across all methods spanning fishing seasons 2010/11 – 2015/16. *: 30 t research/bycatch limit.

	PATAGONIAN TOOTHFISH	MACKEREL ICEFISH	
Fishing season	Agreed TAC (t)	Survey abundance estimates (t)	Agreed TAC (t)
2010/11	2550	5123	78
2011/12	2730	983	0*
2012/13	2730	3987	679
2013/14	2730	6098	1267
2014/15	4410	4861	309
2015/16	3405	Not available	482

TAC for Patagonian toothfish has remained relatively stable from 2550 t in 2010/11 to 2750 t in the following three fishing seasons. It increased to 4410 t in 2014/15 fishing season. By contrast, the TAC for mackerel icefish ranged from <30 t in 2011/12 to 1267 t for the 2013/14 season.

Bycatch limits for main bycatch species taken in the HIMI fishery.

Common name	Scientific name	Bycatch limit (t)	
		2014/15	2015/16
Unicorn icefish	*Channichthys rhinoceratus*	150	1663
Grey rockcod	*Lepidonotothen squamifrons*	80	80
Skates and rays	Skates and rays	120	120
Macrourus spp.	*Macrourus* spp.	360	
Macrourus spp.	*Macrourus caml* and *M. whitsoni*	-	409
Macrourus spp.	*M. halotrachys* and *M. carinatus*	-	360
Other species	Other species	50	50

Source: CCAMLR 2015/16 Schedule of Conservation Measures

Bycatch or byproduct is not considered a major issue in Antarctic fisheries. There are two observers on all trips to the regions, which has resulted in accurate catch and bycatch reporting. The major bycatch species are skates and rays, and macrourids**.** Catch limits are set for by-catch species groups (see TACs). No by-catch species was caught in quantities approaching the catch limit (CCAMLR 2015).

"A quantitative risk assessment of the Caml grenadier (*Macrourus caml*) was undertaken in 2015 and WG-FSA-15 recommended a catch limit of 409 tonnes for *M. caml* and Whitson's grenadier (*M. whitsoni*) combined based on the risk assessment in WG-FSA-15/63, and a catch limit of 360 tonnes for bigeye grenadier (*M. holotrachys*) and ridge-scaled grenadier (*M. carinatus*) combined based on the previous assessment from 2003. The current by-

catch limits for rajids (*Bathyraja* spp.) were set in 1997 (SC-CAMLR-XVI, paragraphs 5.119 to 5.122)" (CCAMLR 2015).

"An analysis of the by-catch species unicorn icefish (*Channichthys rhinoceratus*) and grey rockcod (*Lepidonotothen squamifrons*) indicated that both species are widespread over the plateau in depths of <1000 m (WG-FSA-15/50). Up to 2015, the catch limits of *C. rhinoceratus* and *L. squamifrons* were based on assessments carried out in 1998 (SC-CAMLR-XVII, Annex 5). Catches of each of these species were well below the limits set by CCAMLR since 2004. A quantitative risk assessment of *C. rhinoceratus* was undertaken in 2015 and WG-FSA-15 recommended a catch limit of 1 663 tonnes for *C. rhinoceratus*" (CCAMLR 2015).

Catch limits are set for three by-catch species groups (macrourids, rajids and grey rockcod and none approached their catch limits (CCAMLR 2015). Skates are also caught during the trawl surveys which has allowed for an ongoing program of collection of biological data (Nowara et al. 2014). Skate by-catch across both the HIMI and Kerguelen fisheries from the trawl fisheries is low and did not show any evidence of depletion in the main fishing although average size of *B eatoni* has decreased slightly (Nowara et al. 2017).

In the past, non-target fishes were retained for milling into meal which was sold ashore or dumped on return to port but this practice no longer occurs and bycatch is macerated and then discarded at sea outside the EEZ.

Bycatch limits have changed for the 2015/16 fishing season for macrourids, dividing them into two morphs, and increased for unicorn icefish (SouthMAC Nov 2015). Prior to this, these limits did not change for more than 10 years.

Source: CCAMLR 2015/16 Schedule of Conservation Measures (CCAMLR, 2015c).

The reported catch for skates and rays does not include animals that have been tagged or returned to the sea in a live and vigorous state, which is an approved CCAMLR protocol.

Current and recent fishery effort trends by method

Summary of the most recent effort levels in the fishery by fishing method (sub-fishery) in table form.

Total swept area (km^2) made during the fishing period in the demersal trawl fishery targeting either mackerel icefish (*Champsocephalus gunnari*), or Patagonian toothfish (*Dissostichus eleginoides*). Source: AFMA Observer data.

Fishing season	Patagonian toothfish swept area (km^2)	Mackerel icefish swept area (km^2)
2010/11	69.40	3.69
2011/12	78.39	3.32
2012/13	60.05	84.63
2013/14	12.36	134.38
2014/15	21.49	9.94

On average there was 48.34 km^{2}and 47.19 km^2 fished while targeting Patagonian toothfish and mackerel icefish, respectively, over the last five fishing seasons, based on Observer data.

Current and recent fishery catch trends by method

Summary of the most recent estimate of catch levels in the fishery by fishing method (sub-fishery). In table form.

Total catch (t) of mackerel icefish and Patagonian toothfish in the demersal trawl sub-fishery targeting Patagonian toothfish and mackerel icefish by fishing season (1 Dec – 30 Nov the following year). Source: AFMA Observer data.

Mackerel icefish catch (t)			
Target:	**Mackerel icefish**	**Patagonian toothfish**	
Fishing season			**Total (t)**
2010/11	0.617	0.050	0.668
2011/12	4.426	0.002	4.428
2012/13	673.84	0.022	673.872
2013/14	1067.546	0.013	1067.559
2014/15	9.810	0.045	9.855
Total:	1756.239	0.132	1756.382

Patagonian toothfish catch (t)			
Target:	**Mackerel icefish**	**Patagonian toothfish**	
Fishing season			**Total (t)**
2010/11	1.052	1112.014	1113.067
2011/12	1.262	1309.112	1310.374
2012/13	9.711	553.271	562.981
2013/14	26.891	80.639	107.531
2014/15	0.918	203.633	204.552
Total:	39.834	3258.669	3298.505

Overall, Patagonian toothfish demersal trawl catches have declined during the five year assessment period. Catches in 2010/11 and 2011/12 were reported to be higher compared to those in 2013/14 and 2014/15. Total mackerel icefish catch have ranged from 0.7 t in 2010/11 to a maximum of 1068 t in 2013/14. Total Patagonian toothfish demersal trawl catches are well below the TAC in all fishing seasons. Longline fishing accounts for the remaining caught component of the TAC.

Current and recent value of fishery ($)

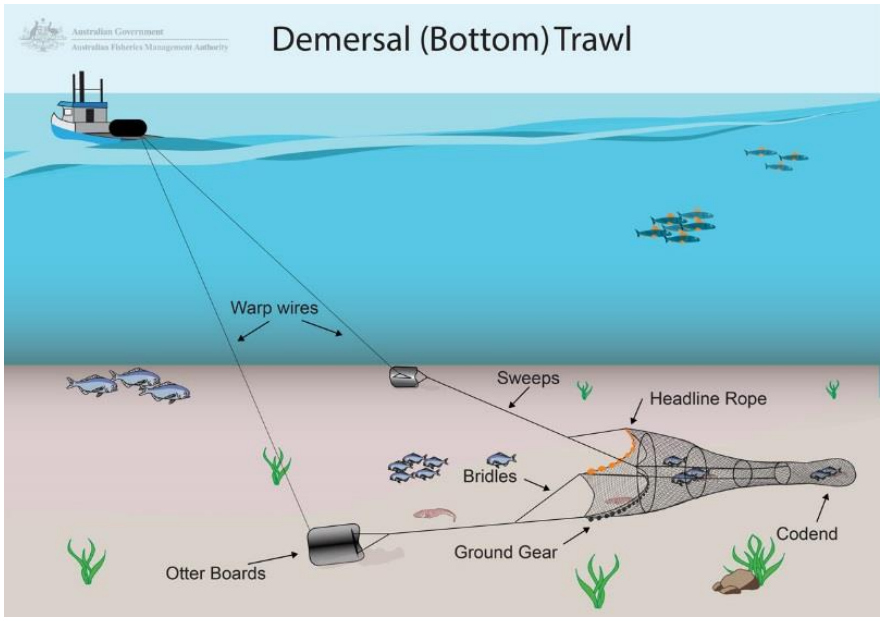
Note current and recent value trends by sub-fishery.

Patagonian toothfish: Conservative estimates of $2.04 million in 2014/15, $1.1 million in 2013/14, $5.6 million in 2012/13, $13.1 million in 2011/12, and $11.1 million in 2010/11 (assuming $10/kg as an average value ex-vessel presented in Lack and Sant (2001)). In order to maintain operator confidentiality, actual GVP estimates were unavailable to be released by AFMA and therefore not incorporated in this report. However, it is likely that more than $10 per kg is being achieved (AFMA).

Mackerel icefish: Conservative estimates of $19,710 in 2014/15, $2.1 million in 2013/14, $1.3 million in 2012/13, and <$10,000 in 2011/12 and 2010/11 (assuming $2/kg as an average value ex-vessel). In order to maintain operator confidentiality, actual GVP estimates were unavailable to be released by AFMA and therefore not incorporated in this report. However, it is likely that more than $2 per kg is being achieved (AFMA).

Source: Catarci, 2004; AFMA, http://www.afma.gov.au/fisheries/heard-island-mcdonald-island-fishery/

Relationship with other fisheries	*Commercial and recreational, state, national and international fisheries. List other fisheries operating in the same region any interactions* The Antarctic Fisheries (HIMI and Macquarie Island Toothfish Fishery (MITF)) are both managed within the context of the Australian Government's policy position within CCAMLR. Accordingly the HIMI fishery is more stringently managed than CCAMLR regulations. CCAMLR is the International Convention for the Conservation of Antarctic Marine Living Resources and Australia is one of the 25 member nations. CCAMLR is charged with ensuring the conservation and sustainable use of Antarctic living marine resources, with the exception of whales (ICRW) and seals (CCS). **IUU:** Illegal fishing has been a concern in the Patagonian toothfish fishery but not the icefish fishery. In the past, IUU fishing has targeted the northern and central part of the Kerguelen Plateau and the north-eastern part of the HIMI AFZ. Since 2005, no illegal foreign fishing vessels have been detected inside the Australian Fishing Zone of the HIMI area. However, remnants of IUU fishing for toothfish remain in high seas areas in the Southern Ocean. Australia is committed to combating illegal fishing in the EEZ around HIMI, and the region is the focus of growing national and international efforts to combat illegal fishing. There were no patrols by Australian Government vessels in 2012-13 but cooperative arrangements with the French Government remain and electronic surveillance methods continue to be used (ACBPS 2013). A range of other approaches are also used to assist in combating risks from IUU fishing in areas outside Australia's jurisdiction. A voluntary International Plan of Action for Illegal, Unreported and Unregulated (IUU) Fishing has been developed through the Food and Agriculture Organisation of the United Nations, within the framework of the Code of Conduct for Responsible Fisheries, and further measures may be adopted by the Commission for the Conservation of Antarctic Marine Living Resources. Source: Commonwealth of Australia, 2014; CCAMLR: http://ccamlr.org **Midwater sub-fishery:** The key commercial species is mackerel icefish. Fishing occurred only in the 2013/14 fishing season, with a total catch of 17.8 t over a depth range of 62-707 m. See also ERAEF-HIMI midwater trawl report, Sporcic et al. 2017. **Longline sub-fishery:** Demersal longlining operations began in 2002/3. Longlining operations generally occur on the deeper slope where larger fish occur. Longline fishing is thought to have less impact on benthic habitats than bottom trawling, although it may have greater impacts on the bycatch of some non-target species, such as skates (Rajiformes spp.) and rat-tails (*Macrourus* spp.), as well as bycatch of seabirds and mammals. See also ERAEF-HIMI longline report, Bulman et al. 2017. **Longline fisheries of other nations:** Adjacent to the HIMI fishery, longlining is conducted in the French EEZ around the Îles Kerguelen for Patagonian toothfish. Australian and French scientists are conducting joint research to determine the extent the toothfish stock is shared on the Kerguelen Plateau. Recent Patagonian Toothfish catches from the French zone around Kerguelen Island (CCAMLR Statistical Area 58.5.1), as reported by CCAMLR, are 5235 t (2010/11), 4897 t (2011/12) and 5341 t (2012/13). Source: http://ccamlr.org
Gear	
Fishing methods and gear	*Description of the methods and gear in the fishery, average number days at sea per trip.*

	Demersal otter board trawling is used in both the Patagonian toothfish and mackerel icefish fisheries. Trawls use rockhopper gear to minimize snagging of the footrope, which reduces the benthos entering the net.  Source: AFMA July 2016, http://www.afma.gov.au/portfolio-item/mackerel-icefish/
Fishing gear restrictions	*Any restrictions on gear* The HIMI Fishery Direction which prohibit fishing methods other than trawling and longlining expired November 2010 and was not renewed. However SFR conditions were amended to limit the fishery to longline, trawl and pot fishing. Trawl nets are shaped like a cone or funnel with a wide opening and a narrow closed off cod-end. These nets are limited to a mesh size of not less than 120 mm in every part of the net for Patagonian toothfish and not less than 90 mm when targeting mackerel icefish to enable juvenile fish to escape. This gear uses otter boards/ trawl boards to keep the mouth of the net open and at the bottom. These trawl nets have bobbins or rollers on the ground to allow the net to move over the sea floor without snagging and to minimise bottom contact. These bobbins must be at least 520 mm in diameter and rockhopper rubber discs must be at least 400 mm in diameter. Source: CCAMLR Schedule of Conservation Measures 2015/16 season (CCAMLR, 2015c)
Selectivity of fishing methods	*Description of the selectivity of the sub-fishery methods* Demersal trawl nets are limited to minimum mesh size of 120 mm when targeting Patagonian toothfish and 90 mm when targeting mackerel icefish to enable juvenile fish to escape the net. No other trawl net specifications were available.
Spatial gear zone set	*Description where gear set i.e continental shelf, shelf break, continental slope (range nautical miles from shore)* Demersal trawling is conducted on the continental slope of the Heard Island Plateau.
Depth range gear set	*Depth range gear set at in metres* When targeting Patagonian toothfish, gear is deployed in mid-upper slope depths. When targeting mackerel icefish, gear is deployed usually less than 400 m. **Fishing depth by species targeted over the 2010/11 – 2014/15 period in the HIMI demersal trawl sub-fishery. Source: AFMA Observer data. RSTS: Random Stratfied Trawl Survey** **Species targeted** / **Purpose** / **Minimum depth (m)** / **Maximum depth (m)** / **Mean depth (m)**

Patagonian toothfish	Commercial	262	886	533
Patagonian toothfish	RSTS	230	976	607
Mackerel icefish	Commercial	180	493	287
Mackerel icefish	RSTS	138	493	274

The mean depth fished in the HIMI region was 533 m 2010/11-2014/15 targeting Patagonian toothfish and 287 m targeting mackerel icefish based on commercial fishing records (AFMA Observer data). Also, the mean depth fished during annual RSTS was 607 m targeting Patagonian toothfish and 274 m targeting mackerel icefish.

How gear set

Description how set, pelagic in water column, benthic set (weighted) on seabed

Demersal trawlers tow a net along the ocean floor, in depths up to about 1000 metres. The net is towed behind the vessel by long wires (the warps) and is deployed and retrieved from the stern of the vessel by winches. The net opening (the mouth) is spread horizontally by the outward force acting on the otter boards as they are towed through the water. The bottom of the net opening, the footrope, is weighted bringing the net opening close to the bottom and has ground gear, principally bobbins commonly known as "rockhopper" gear, attached to enable the gear to be towed across the substrate with minimal hook-ups. The top of the mouth, the headline, is lifted vertically by floats. Vessels are generally equipped with electronic units to allow the proximity of the nets to the seabed to be monitored.

Demersal trawling relies on herding fish inward toward the path of the oncoming net mouth, rather than the speed of the tow. As the fish swim away from the warps and the net wings, they are enclosed and fall back towards the tapered body of the net. As the gear is hauled up toward the vessel the fish are contained in the end section of the net, the codend, which is fastened with a rope to release the catch into the vessel's fish pound.

Source: AFMA 2014, Fishery Status Report 2014

Area of gear impact per set or shot

Description of area impacted by gear per set (square metres)

Summary values for fishing effort and estimated effort footprints in the HIMI region 1997-2013 were given in Welsford et al. (2014). The total area fished for both demersal and midwater trawl sub-fisheries combined was 18726.3 km^2 (no overlap - pixel) and 2922.1 km^2 (with overlap - pixel) (Welsford et al. 2014).

An estimated 0.7% of the seafloor area within the EEZ at HIMI (410722 km^2; Welsford et al. 2014) is reported to have had some interaction with bottom fishing gear between 1997 and 2013. As trawling focuses on only a few relatively small fishing grounds, less than 1.5% of all biomass are estimated to be damaged or destroyed (Welsford et al. 2014). Most of the trawl fishing in the HIMI region is conducted primarily on the upper slopes of the banks and the plateau, with only a small proportion undertaken in deeper slope waters, and records of hauls apparently conducted at depths greater than 1000 m are unlikely to have maintained contact with the seafloor (Welsford et al. 2014).

Capacity of gear

Description number hooks per set, net size weight per trawl shot

Not available

Effort per annum all boats

Description effort per annum of all boats in fishery by shots or sets and hooks, for all boats

Total trawl hours and shots for the demersal trawl fishery by fishing season. Source: AFMA logbook data.

Fishing season	Trawl hours	Shots
2010/2011	627.48	652
2011/2012	715.13	859
2012/2013	969.8	617
2013/2014	977.12	540

2014/2015	259.82	265

The total trawl hours and shots varied from ~260 hours to ~977 hours over the last five years (above Table; source: AFMA logbook data). This corresponds to the 2014/15 and 2013/14 fishing seasons respectively.

Total swept area (km^2) made during the fishing period in the demersal trawl fishery targeting either Patagonian toothfish (*Dissostichus eleginoides*) or mackerel icefish, (*Champsocephalus gunnari*). Source: AFMA Observer data.

Fishing season	Patagonian toothfish swept area (km^2)	Mackerel icefish swept area (km^2)
2010/11	69.40	3.69
2011/12	78.39	3.32
2012/13	60.05	84.63
2013/14	12.36	134.38
2014/15	21.49	9.94

On average, there was 48.34 km^2 and 47.19 km^2 fished while targeting *D. eleginoides* and *C. gunnari*, respectively, over the last five fishing seasons based on Observer data.

Lost gear and ghost fishing

Description of how gear is lost, whether lost gear is retrieved, and what happens to gear that is not retrieved, and impacts of ghost fishing.

Lost trawl gear occurs rarely and operators are encouraged to attempt to retrieve it. Operators also recover previously lost illegal fishing gear (see Table below).

Lost and recovered gear for the 2011 – 2015 period. Source: SARAG minutes Sept 2015; AFMA.

Lost	Recovered
34 floats	two complete trawl nets lost in 2010 and 2012
trawl cable (2 m)	demersal trawl rig recovered in 2011 which was lost in 2007
fire hose (30 m)	
3 paravenes	
4 steel bobbins	
20 rubber spacers	

Issues

Key/second-ary commercial species issues and Interactions

List any issues, including biological information such as spawning season and spawning location, major uncertainties about biology or management, interactions etc.

There are some uncertainties concerning both Patagonian toothfish and mackerel icefish particularly in relation to prey-predator interactions and extended ecological risk related to the fishery such as corresponding alteration of food webs. Drawing on results elsewhere (e.g. Baum and Worm 2009), effects on top predators from fishing may come from competition for and reduced availability of preferred prey species, and altered ecosystem structure and functions, with concomitant cascading effects of reduced top predator species.

There is also a need to better understand the effects of bycatch removals on ecosystem dynamics and population dynamics of key commercial species. There is still a need for more information about the population structure of toothfish, particularly as new vessels start exploring new fishing grounds (WG-FSA-15/55). Better estimates of key biological characteristics including growth, mortality and reproduction rates for both target species are needed, in addition to population dynamics and stock structure. For both species, there is

	also a need to understand any potential effects of habitat change brought about by climate change and ocean acidification. Genetic studies have shown that populations at HIMI are distinct from Macquarie Island and South Georgia but that there is no distinction between those at HIMI, Kerguelen, Crozet or Marion/Prince Edward Islands. Tagging studies suggest that a metapopulation exists in the Indian ocean sector. Collaborative research on stock structure with French scientists is continuing to refine population models and improve management in the Kerguelen Plateau (CCAMLR Fishery Report 2015, Patterson and Savage 2016) . In regards to icefish, there were no future research requirements recommended at the WG-FSA-15.
Byproduct and bycatch issues and interactions	*List any issues, as for the target species above* **Fishing season bycatch^ (kg) of the main species (>100kg) caught in the demersal trawl sub-fishery targeting Patagonian toothfish. ^: all bycatch must be disposed outside the fishery area. Source: AFMA Observer data**

Fishing season	Species name	Common name	Bycatch (kg)
2010/11	*Bathyraja eatonii*	Eaton's Skate	1909.51
	Bathyraja irrasa	Sandpaper Skate	318.65
	Bathyraja murrayi	Murray's Skate	480.07
	Channichthys rhinoceratus	Unicorn icefish	5125.72
	Dissostichus eleginoides	Patagonian toothfish	247.64
	Lepidonotothen squamifrons	Grey rockcod	26694.53
	Macrourus sp.	Rat tails, Grenadiers	195.72
	Macrourus whitsoni	Whitson's grenadier	3838.76
	Medusae	Jellyfish	270.37
	Somniosus antarcticus	Antarctic sleeper shark	1346
		Rocks	463.79
2011/12	Anemones	Anemones	441.69
	Asteroidea	Sea stars	401.71
	Bathyraja eatonii	Eaton's Skate	1939.41
	Bathyraja irrasa	Sandpaper Skate	192.47
	Bathyraja murrayi	Murray's Skate	446.84
	Channichthys rhinoceratus	Unicorn icefish	39715.28
	Dissostichus eleginoides	Patagonian toothfish	434.51
	Lepidonotothen squamifrons	Grey rockcod	35778.54
	Macrourus sp.	Rat tails, Grenadiers	1652.49
	Macrourus whitsoni	Whitson's grenadier	331.52
	Medusae	Jellyfish	1270.79
	Octopodidae	Octopus	124.96
	Porifera	Sponge	324.34
		Rocks	745.17
2012/13	Anemones	Anemones	172.53
	Asteroidea	Sea stars	516.23
	Bathyraja eatonii	Eaton's Skate	1400.75
	Bathyraja irrasa	Sandpaper Skate	154.16
	Bathyraja murrayi	Murray's Skate	521.80
	Channichthys rhinoceratus	Unicorn icefish	7346.38
	Gorgonians	Gorgonians	211.12

	Jellyfish	Jellyfish	2036.77
	Lepidonotothen squamifrons	Grey rockcod	44344.79
	Macrourus carinatus	Ridgescale grenadier	1048.56
	Macrourus whitsoni	Whitson's grenadier	2704.36
	Medusae	Jellyfish	154.32
	Porifera	Sponge	151.12
	Somniosus antarcticus	Antarctic Sleeper Shark	930.00
		Rocks	1094.58
2013/14	Anemones	Anemones	275.23
	Asteroidea	Sea stars	161.63
	Bathyraja eatonii	Eaton's Skate	157.01
	Channichthys rhinoceratus	Unicorn icefish	160.96
	Lepidonotothen squamifrons	Grey rockcod	2018.36
	Macrourus whitsoni	Whitson's grenadier	1392.33
	Medusae	Jellyfish	325.63
	Porifera	Sponge	256.69
		Rocks	260.21
2014/15	Anemones	Anemones	367.78
	Asteroidea	Sea stars	254.73
	Bathyraja eatonii	Eaton's Skate	3732.03
	Bathyraja irrasa	Sandpaper Skate	681.41
	Bathyraja murrayi	Murray's Skate	321.84
	Channichthys rhinoceratus	Unicorn icefish	1270.20
	Dissostichus eleginoides	Patagonian toothfish	108.30
	Jellyfish	Jellyfish	683.15
	Lepidonotothen squamifrons	Grey rockcod	2409.06
	Macrourus caml	Caml Grenadier	2227.27
	Macrourus sp.	Rat tails, Grenadiers	2431.84
	Porifera	Sponge	872.32
		Rocks	884.02

Fishing season bycatch^ (kg) of the main species (>100kg) caught in the demersal trawl sub-fishery targeting mackerel icefish. ^: all bycatch must be disposed outside the fishery area. Source: AFMA Observer data

Fishing season	Species name	Common name	Bycatch (kg)
2010/11	*Antimora rostrata*	Violet cod	182.51
	Channichthys rhinoceratus	Unicorn icefish	1442.73
	Lepidonotothen squamifrons	Grey rockcod	1090.53
	Zanclorhynchus spinifer	Spiny horsefish	160.72
2011/12	Anemones	Anemones	370.21
	Asteroidea	Sea stars	296.21
	Channichthys rhinoceratus	Unicorn icefish	2007.40
	Gobionotothen acuta	Triangular rockcod	235.11
	Invertebrata	Invertebrates	378.26
	Lepidonotothen squamifrons	Grey rockcod	199.61
	Macrourus sp.	Rat tails, Grenadiers	1156.48

		Medusae	Jellyfish	306.88
		Porifera	Sponge	706.20
	2012/13	Anemones	Anemones	5673.07
		Ascidian	Sea squirt	425.97
		Asteroidea	Sea stars	3910.90
		Bathyraja eatonii	Eaton's Skate	22449.15
		Bathyraja irrasa	Sandpaper Skate	1181.34
		Bathyraja murrayi	Murray's Skate	1449.81
		Channichthys rhinoceratus	Unicorn icefish	67284.08
		Dissostichus mawsoni	Antarctic toothfish	88.38
		Gobionotothen acuta	Triangular rockcod	1450.78
		Jellyfish	Jellyfish	1650.98
		Lepidonotothen squamifrons	Grey rockcod	2102.44
		Medusae	Jellyfish	7485.72
		Notothenia rossii	Marbled rockcod	215.76
		Porifera	Sponge	2151.67
		Squid Indet	Squids	193.43
	2013/14	Anemones	Anemones	3787.42
		Ascidian	Sea squirt	153.63
		Asteroidea	Sea stars	473.78
		Bathyraja eatonii	Eaton's Skate	6207.79
		Bathyraja irrasa	Sandpaper Skate	687.20
		Bathyraja murrayi	Murray's Skate	1922.50
		Bryozoa	Bryozoan	165.39
		Channichthys rhinoceratus	Unicorn icefish	143300.79
		Gobionotothen acuta	Triangular rockcod	3561.42
		Gorgonians	Gorgonians	107.27
		Holothurian	Sea Cucumber	176.75
		Lepidonotothen squamifrons	Grey rockcod	4988.17
		Macrourus whitsoni	Whitson's grenadier	99.60
		Medusae	Jellyfish	397.24
		Notothenia rossii	Marbled rockcod	256.09
		Porifera	Sponge	1074.08
	2014/15	Anemones	Anemones	642.59
		Asteroidea	Sea stars	363.51
		Bathyraja eatonii	Eaton's Skate	563.43
		Bathyraja irrasa	Sandpaper Skate	105.40
		Bathyraja murrayi	Murray's Skate	127.09
		Channichthys rhinoceratus	Unicorn icefish	11145.28
		Gobionotothen acuta	Triangular rockcod	481.58
		Jellyfish	Jellyfish	2140.25
		Lepidonotothen squamifrons	Grey rockcod	178.54
		Macrourus sp.	Rat tails, Grenadiers	178.84

	Porifera	Sponge	660.82

Based on AFMA Observer data, the principal bycatch species caught in the demersal trawl sub-fishery targeting both mackerel icefish and Patagonian toothfish are grey rockcod (*Lepidonotothen squamifrons*), unicorn icefish (*Channichthys rhinoceratus*), Eaton's skate (*Bathyraja eatonii*), Macrourus species, Murray's skate (*Bathyraja murrayi*) and Sandpaper skate (*Bathyraja irrasa*). Jellyfish, sponges, anemones and asteroidean are also caught (>100 kg) in most fishing seasons. These estimates are based on both commercial and research surveys (i.e. Random Stratified Trawl Surveys (RSTS) conducted annually since 1997). Approximately 84% grey rockcod bycatch are from commercial fishing operations during this assessment period (see Table below).

Grey rockcod (*Lepidonotothen squamifrons*) bycatch^ (kg) by Commercial fishing and Random Stratified Trawl Surveys for 2010/11 - 2014/15 fishing season. ^: all bycatch must be disposed outside the fishery area. Source: Observer data.

Fishing season	Target species	Commercial Bycatch (kg)	RSTS* Bycatch (kg)	Total (kg)	Commercial bycatch (%)
2010/11	Mackerel icefish	1.87	1088.66	1090.53	0.17
	Patagonian toothfish	25201.03	1493.50	26694.53	94.41
2011/12	Mackerel icefish	0	199.61	199.61	0.00
	Patagonian toothfish	27717.53	8061.01	35778.54	77.47
2012/13	Mackerel icefish	1098.82	1003.62	2102.44	52.26
	Patagonian toothfish	43649.07	695.72	44344.79	98.43
2013/14	Mackerel icefish	2301.52	2686.65	4988.17	46.14
	Patagonian toothfish	18.88	1999.48	2018.36	0.94
2014/15	Mackerel icefish	60.01	118.53	178.54	33.61
	Patagonian toothfish	709.98	1699.08	2409.06	29.47
Total		100758.71	19045.86	119804.57	84.10

*RSTS: Random Stratified Trawl Survey

Protected species issues and interactions

List any issues. This section should consider all protected species groups: marine mammals, chondrichthyans (sharks, rays etc.), marine reptiles, seabirds, teleosts (bony fishes), include any key spawning/breeding/aggregation locations that might overlap with the fishery/sub-fishery.

Protected species interactions in the HIMI demnersal trawl sub-fishery by species targeted (Patagonian toothfish (PT); mackerel icefish (MI)) over the 2010-2015 period. PIN: Pinniped; MB: Marine bird, CHN: Chondrichthyan. Life status: No damage: no apparent damage; Minor injury: possible minor injury; Major injury: possible major injury; Dead: dead; unknown: UnK. Source: AFMA Observer data.

Species targeted	Fishing season	Taxa	Common name	Life status: No damage	Minor injury	Major injury	Dead	UnK	Total
MI	2012/13	MB	Southern Black browed albatross				1		1
MI	2012/13	PIN	Seals				1	1	2
MI	2012/13	CHN	Porbeagle shark#				1	1*	2
MI	2013/14	PIN	Seals			1	1		2

MI	2013/14	CHN	Porbeagle shark[#]				2	8*	10
PT	2010/11	PIN	Antarctic fur seal	4					4
PT	2010/11	MB	Blue petrel	1					1
PT	2010/11	MB	Cape petrel	3			1	1	5
PT	2010/11	MB	Prion		1				1
PT	2010/11	MB	Southern Black browed albatross	1					1
PT	2010/11	MB	Storm petrel	1					1
PT	2010/11	MB	White chinned petrel	1			1		2
PT	2010/11	MB	Wilsons Storm Petrel			1			1
PT	2011/12	PIN	Antarctic fur seal	1					1
PT	2011/12	MB	Cape petrel	4	1				5
PT	2011/12	MB	Diving petrel		1				1
PT	2011/12	MB	Giant-petrels	1					1
PT	2011/12	MB	Prion					1	1
PT	2011/12	PIN	Seals	1					1
PT	2011/12	MB	Southern Black browed albatross	2	1				3
PT	2011/12	MB	White chinned petrel	2					2
PT	2012/13	MB	Cape petrel	2			1		3
PT	2014/15	MB	Cape petrel				1		1
			Total:	26	4	2	10	15	52

[#] Porbeagle shark data: from Observer bycatch data

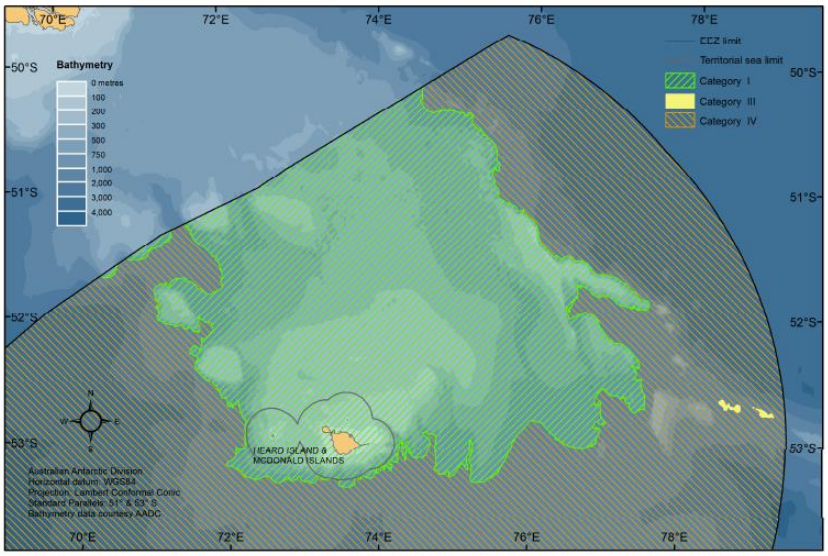
* does not specify the state of the animal, only that it was released.

Marine mammals:

Six pinnipeds have interacted with the demersal trawl gear while targeting Patagonian toothfish (uninjured: five Antarctic fur seals; 1 seal (species undifferentiated)) over the 2010/11-2014/15 period. There were four pinnipeds (seals; 2 dead; 1 uninjured; 1 major injury) that interacted with the demersal trawl gear while targeting mackerel icefish.

There have been 58 sightings (wildlife observations) of seals (36 Antarctic fur seal; 22 species undifferentiated) when targeting the Patagonian toothfish and no seal observations when targeting mackerel icefish over the last 5 years in the demersal trawl sub-fishery. There have been few whale sightings recorded by observers between 2010/11 to 2014/15 with only four killer whales sighted when targeting mackerel icefish in the 2013/14 fishing season.

	Chondrichthyans There have been 12 interactions in the demersal trawl fishery over the last five fishing seasons all reported when targeting mackerel icefish. These include: 1 dead overboard (DOB) and 1 released (REL) in 2012/13; 2 DOB and 8 REL in 2013/14 (source: Observer bycatch data). Porbeagle shark, *Lamna nasus*, is listed as a migratory species (EPBC Act). One of the six strategies developed under the Antarctic Fisheries Bycatch Action Plan 2003 (AFMA 2003) is to "minimise the bycatch of non-target species, including sharks, skates and rays". **Seabirds** There have been 29 seabird interactions while targeting Patagonian toothfish, over the 2010/11 – 2014/15 period, based on AFMA Observer data. These species consisted of Cape petrels, White chinned petrel, Southern black browed albatross, Diving petrel, Giant-petrels, Blue petrels and Prions. One seabird (Southern black browed albatross; 1 dead) interacted with the demersal trawl gear targeting mackerel icefish during the 2010/11 – 2014/15 period. There have been 190,206 sightings (wildlife observations) of 30 taxa of seabirds when targeting Patagonian toothfish in this sub-fishery. There has been 59,031 sightings of 24 taxa of seabirds when targeting mackerel icefish in this sub-fishery. For all demersal trawls the five most common species observed were: Southern black browed albatross, white chinned petrel, Cape petrel, storm petrel and prions.
Habitat issues and interactions	*List any issues for any of the habitat units identified in **Scoping Document S1.2**. This should include reference to any protected, threatened or listed habitats* **Benthic damage by trawl gear** A comprehensive assessment of the vulnerability of benthic habitats to impact by demersal fishing gear has been undertaken in the HIMI and surrounding Southern Ocean (Welsford et al. 2014). The approach was to combine data on the fishing footprint with estimates of taxa-specific vulnerability to different gear types and modelled distributions of habitats and taxa. The development of underwater camera equipment, which can be attached to the fishing gear (trawl, longline and pot), has enabled assessments of interactions on the benthic environment by the different gear types. A risk categorisation framework was then applied that allowed the seascape around HIMI to be categorised and the level of protection afforded by the Marine Reserve to be quantified. The majority of vulnerable organisms live on the seafloor in depths less than 1200 m, which overlaps with the trawl fishery. As trawling focuses on only a few relatively small fishing grounds, less than 1.5% of all biomass are estimated to be damaged or destroyed. An estimated 0.7% of the seafloor area within the EEZ at HIMI has had interaction with bottom fishing gear between 1997 and 2013. A small area of Category III risk to the east of Heard Island near the boundary of the EEZ was identified (see figure below; source: Welsford et al. 2014). The scientific assessment recommended that 6200 km^2 of the Conservation Zone be added to the Reserve on the basis that its waters were of high conservation value. The boundaries of the Reserve were expanded (by 6200 km^2) on 28 March 2014 and the Reserve's area increased to 71,200 km^2 (AAD 2014). The assessment found that the majority of vulnerable benthic organisms occurred in depths less than 1200 m, the depths in which the trawl fishery operates (400-1200m). However, on average more than half the biomass of the vulnerable structure-forming biota is protected by the current Marine Reserve (based on Table 17; Welsford *et al.* 2014). Furthermore, demersal trawling effort focused on only a few relatively small fishing grounds and less than 1.5% of all biomass was estimated to be damaged or destroyed by demersal trawl between 1997 and 2013. The assessment found that the risk that fishing will cause significant impacts to seafloor biodiversity at HIMI is likely to be low over the medium term. The assessment recommended that risk assessments for the fishery be updated regularly, to evaluate the likely performance of the current management approach in the long term.



Categorisation of the seascape within the EEZ at HIMI according to the distribution of vulnerable benthic taxa (source: Welsford et al. 2014)

There are a number of Conservation Measures implemented by CCAMLR to mitigate the impact of bottom fishing in the Southern Ocean, many of which were implemented in 2008-2009 (CM 22-05, 22-06, 22-07, and 22-08)(CCAMLR 2015c).

Habitat Protection

The Heard Island and McDonald Islands Marine Reserve was as established in 2003 with the boundaries expanded in March 2014 following scientific assessment of a Conservation Zone adjoining the Reserve. The scientific assessment recommended that 6200 square kilometres of the Conservation Zone be added to the Reserve on the basis that its waters were of high conservation value. The Reserve's area subsequently increased to 71,000 square kilometres. The Reserve is a declared IUCN Category 1a Strict Nature Reserve meaning that all fishing activities are prohibited unless for scientific research or management purposes in accordance with the Reserve Management Plan 2014-2024. It is thought that 40% of the biomass of potentially vulnerable benthic organisms are within the Marine Reserve (Welsford et al. 2014).

Source: https://www.legislation.gov.au/Details/F2014L01346/Html/Volume_2

Pollution and invasive species

Marine and terrestrial species that inhabit the HIMI fishery area are susceptible to marine pollution events (HIMI Marine Reserve Management Plan 2014-2024). Fishing operations (including for commercial, tourism, scientific reasons) in and around the HIMI are a key source of plastic debris in the Southern Ocean that can entangle or be consumed by wildlife (Woehler et al. 2014). Shipping operations can also disturb wildlife. Marine debris has been identified as a problem in the HIMI Fishery and the surrounding sub-Antarctic island basin (Eriksson et al. 2013). After a series of surveys over a five year period, most of the 6389 items collected at Heard and Macquarie Islands were plastic (94% at Heard) and discarded or lost fishing gear comprised 22% of those plastic items. Impacts upon fauna, including waste ingestion or entanglement and disease introduction, are of key concern that are as yet unknown for the Southern Ocean (Woehler et al. 2014). Anti-fouling toxins applied on ship hulls may also have adverse effects on marine species and ecosystems. All efforts are made not to dispose of rubbish at sea in the demersal trawl sub-fishery. MARPOL regulations are strongly adhered to (Observer data records).

	There is a plastic packaging ban which prohibits the use of plastic packaging bands, unless the bands are an essential part of the boat's gear, to avoid injury or death, through ingestion or entanglement, of wildlife. There is also a prohibition on the disposal of poultry products and vegetable scraps to minimise the possibility of the introduction of disease or pests on the Islands. Source(s): Woehler et al. 2014; HIMI Marine Reserve Management Plan 2014-2024 (Commonwealth of Australia, 2014). ***Climate change*** Climate change has emerged as a key issue for biodiversity and environmental management. The effects of climate change are apparent in the HIMI Reserve. Increased warming has led to glacial retreat (Thost and Truffer 2007), changes in weather patterns (Thost and Allison 2005) and the formation of lagoons and freshwater lakes. The Reserve's ecosystems and landscape are vulnerable to further climate change impacts, including: sea level rise; changes to ocean water chemistry; increases in sea surface temperature; and the arrival and establishment of invasive species (Chown et al. 2007). If such changes occur this will affect regional biodiversity. If change is detected or is of concern, a decision will be made on further monitoring requirements, and whether protective, rehabilitation or adaptation measures are feasible. Source: (Commonwealth of Australia, 2014).
Community issues and interactions	*List any issues for any of the community units identified in* ***Scoping Document S1.2****.* No specific issues identified. Aside from Intermittent visits by Australian Government personnel, scientists and tourists, the Territory is devoid of human habitation. A low number of private yachts and commercial tourist vessels have visited Heard Island, although few successful landings have been made due to poor weather. The importance of the Antarctic community is recognised by the CCAMLR approach to ecosystem-based management. AFMA has recognised and incorporated this approach in their management strategies for the HIMI fishery. To enable formulation of management strategies for the HIMI region, ongoing assessments of the ecosystem are needed. Two recent initiatives are being undertaken by the SCAR community: ICED is organising a conference in 2018 (www.MEASO2018.aq) with a principle focus on assessing the status and trends of habitats, species and foodwebs in the Southern Ocean; and SOOS is designing the biological component of its observing system to be complementary to the CCAMLR Ecosystem Monitoring Program and is in the process of developing an initiative to undertake a circumpolar benchmarking of the Southern Ocean ecosystem. These initiatives are been undertaken within a project in the AAD Science Program Stream 3.1 Marine Ecosystem Change. This project aims "to develop a quantitative framework for assessing change in ecosystems (habitats, species and foodwebs) and, in conjunction with the international program Integrating Climate and Ecosystem Dynamics of the Southern Ocean, undertake the first assessment within that framework, focussing on the Indian Sector " https://secure3.aad.gov.au/public/projects/report_project_public.cfm?project_no=4343&season=1415. Also providing fundamental information into this stream, is an ensemble of ecosystem models – together with a set of targeted models for particular ecological processes – that are currently being developed for the region. These include and implementation of the Atlantis model (as part of Australian Antarctic Science project #4347 (https://secure3.aad.gov.au/public/projects/report_project_public.cfm?project_no=4347&season=1516), an implementation of the SEAPODYM model (a stage-based model for fish-based ecosystems (Lehodey 2005) development of size-based models (AAS project #4366: https://secure3.aad.gov.au/public/projects/report_project_public.cfm?project_no=4366&season=1415) and implementations of Ecopath with Ecosim. Process modelling for the region includes individual-based modelling for predator species (http://soki.aq/x/EYArAQ), and larval transport modelling for Patagonian Toothfish (Mori *et al.* 2016). This suite of research will be

	important for assessing current and future status and trends of the ecosystem in the Kerguelen region. A recent MSC certification audit (SCS 2015) found it "highly unlikely that current catch levels will have any adverse effect on the impacts of the fishery on, or the status of, retained species, bycatch, ETP species, or trophic function." In addition, the (i) management of the HIMI as a Marine Reserve by the AAD; (ii) prohibition on fishing within 13 nautical miles of the islands; (iii) establishment of the HIMI Marine Reserve in 2002 (revised in 2014) and (iv) continued monitoring of top predators both in terms of diet, reproductive rates and overall abundance are seen as key actions in the preservation of community ecosystems. A specific allowance is made for predator needs by adopting a limit reference point for the icefish fishery of not less than 75% median escapement from the estimated lower 95% confidence interval of spawning biomass over a two year projection. However, this assumes that the biomass is known and that it does not fall below a sustainable level.
Discarding	*Summary of discarding practices by sub-fishery, including bycatch, juveniles of target species, high-grading, processing at sea.* Under the Antarctic Bycatch Plan and HIMI Fishery Management Plan, AFMA requires that all bycatch is retained (with some exceptions) in order to limit possible interactions with marine mammals and seabirds. All retained bycatch is discarded outside of the HIMI EEZ. Skates, sharks, jellyfish, sponges, crabs and coral are released upon capture to the ocean as these species either have a high chance of survival, do not attract seabirds and marine mammals when discarded. Source: AFMA, HIMI Fishery Status Report 2014
Management: planned and those implemented	
Manage-ment objectives	*The management objectives from the most recent management plan* The objectives of the *Heard Island and McDonald Islands Fishery Management Plan 2002* (amended in May 2016) assessed under the Environmental Protection and Biodiversity Act 1999 are to: a) manage the Fishery efficiently and cost effectively for the Commonwealth, b) ensure that the exploitation of the resources of the Fishery and the carrying on of any related activities are conducted in a manner consistent with the principles of ecologically sustainable development and the exercise of the precautionary principle, and in particular, the need to have regard to the impact of fishing activities on non-target species and the long-term sustainability of the marine environment, c) maximise economic efficiency in the exploitation of the resources of the Fishery, d) ensure AFMA's accountability to the fishing industry and to the Australian community in management of the resources of the Fishery, e) reach Government targets for the recovery of the costs of AFMA in relation to the Fishery, f) ensure, through proper conservation and management, that the living resources of the Australian Fishing Zone (AFZ) are not endangered by over-exploitation, g) achieve the best use of the living resources of the AFZ, and h) ensure that conservation and management measures in the Fishery implement Australia's obligations under international agreements that deal with fish stocks, and other relevant international agreements. Source : https://www.legislation.gov.au/Details/F2005B02477 The *Heard Island and McDonald Islands Marine Reserve Management Plan for 2014-2024,* signed October 2014, is the second management plan for the Reserve established in October 2002 under the EPBC Act 1999. The reserve is 71,000 km2 in area, possesses an incredibly dynamic natural environment, and is an important breeding and foraging ground for many bird and mammal species, some listed as threatened or migratory species under the EPBC

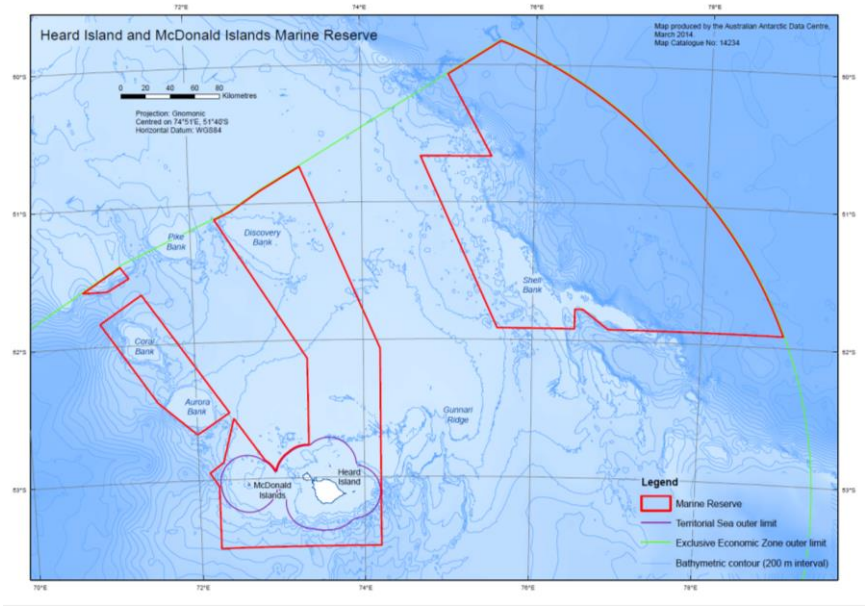
	Act. The reserve contains important benthic habitats and is part of Australia's National Representative System of Marine Protected Areas. Source: https://www.legislation.gov.au/Details/F2014L01346/Html/Volume_2 The consultative forums include the Sub-Antarctic Fisheries Management Advisory Committee (SouthMAC) and the Sub-Antarctic Resource Assessment Group (SARAG) which meet annually.
Fishery manage-ment plan	*Is there a fisheries management plan? Is it in the planning stage or implemented what are the key features* The HIMI fishery was first managed under the HIMI Exploratory Fishery Interim Management Policy November 1996 to August 1997. This was replaced by the HIMI Management Policy 1998 to 2000, which was extended to November 2001. Now the fishery is managed under the HIMI Fishery Management Plan 2002 (revised in May 2016) and supporting legislative instruments developed under the Fisheries Management Act 1991. The HIMI fishery falls within the area covered by CCAMLR and is managed by AFMA in close cooperation with the AAD in accordance with the Conservation Measures set by CCAMLR. **Seasonal and area closures:** There is a closure of the area outside of the Heard Island Plateau to mackerel icefish fishing (*Direction No. HIMIFD-10*) that was repealed in May 2014 by the *Heard Island and McDonald Islands Fishery (Closures) Direction No. 1 2014*. This states: (i) 6.1 No fishing is to be engaged in that targets mackerel icefish in the area of the fishery that is the outside of the Heard Island Plateau, as defined in Schedule 1. (ii) 6.2 Any incidental take of mackerel icefish in the area of the fishery referred to in clause 6.1 will be decremented from a person's quota holdings for that species in the same manner as it would be if mackerel icefish were a target species in that area. Source: https://www.legislation.gov.au/Series/F2009L01240 The fishery takes a precautionary approach to management which considers the effects of harvesting on target, dependent and associated species, and ecological relationships, to ensure sustainability of target species stocks and the broader marine environment. In November 2006, the HIMI mackerel icefish was the first fish in Australia to be certified as sustainable by the MSC and has passed certification re-assessments. Also, the HIMI Patagonian toothfish fishery also received MSC's sustainable status in March 2012.

Input controls	*Summary of any input controls in the fishery, e.g. limited entry, area restrictions (zoning), vessel size restrictions and gear restrictions. Primarily focused on target species as other species are addressed below.*
	
	HIMI Demersal Trawl Fishery is managed under a system of input and output controls designed to manage catches of the target and non-target species. The key input controls are:
	
	• Area closures defined under include:
	  - Heard Island Plateau to mackerel icefish fishing (CM 42-02)
	• 'move-on' provisions where vessels are required to move away from certain areas should a defined level of bycatch be taken in one fishing shot (CM 33-02);
	• gear restrictions for trawl, including:
	  - Bobbin diameter
	  - Mesh size is restricted to > 120 mm for Patagonian toothfish fishery and > 90 mm for mackerel icefish fishery (CM 22-02 and 22-01)
	• Limits on the number of trawlers than can operate to a maximum of three at any one time.
	
	Source: CCAMLR, 2015c; Patterson and Skirtun, 2015

There are also area closures to protect areas (i.e. HIMI Marine Reserve with a buffer zone of 1 nm; see below). The Reserve was declared by Proclamation for the purpose of '*protecting the conservation values of Heard Island and McDonald Islands and the adjacent unique and vulnerable marine ecosystems*'.

Heard Island and McDonald Islands Marine Reserve

In October 2002 the Heard Island and McDonald Islands (HIMI) Marine Reserve was declared under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). In 2014, the Reserve was expanded to cover 71 200 km^2 by proclamation after scientific assessment. It includes Heard Island and the McDonald Islands, the surrounding 12 nautical mile territorial sea, plus an extended marine area which extends in parts to the 200 nautical mile Exclusive Economic Zone (EEZ) boundary. The *Heard Island and McDonald Islands Marine Reserve management plan 2014–24*, provides the management regime for the reserve.



Source: July 2016, http://heardisland.antarctica.gov.au/about/maps

Classified as an IUCN Category 1a Strict nature reserve managed primarily for scientific research or environmental monitoring, the Reserve comprises the world's largest fully protected marine Reserve.

The management objectives for the Reserve outlined in the Reserve proposal were to:

- protect conservation values of Heard Island and McDonald Islands (HIMI), the territorial sea and the adjacent EEZ including:
    - World Heritage and cultural values of the HIMI Territory;
    - unique features of the benthic and pelagic environments;
    - representative portions of the different marine habitat types; and
    - marine areas used by land-based marine predators for local foraging activities.
- provide an effective conservation framework which will contribute to the integrated and ecologically sustainable management of the HIMI region as a whole;
- provide a scientific reference area for the study of ecosystem function within the HIMI region; and
- add representative examples of the HIMI EEZ to the National Representative System of Marine Protected Areas.

	Source: July 2016 http://heardisland.antarctica.gov.au/protection-and management/marine-reserve *Management of the HIMI Marine Reserve* Administration of the HIMI Marine Reserve is the responsibility of the Australian Antarctic Division (AAD). The EPBC Act requires that management must be based on IUCN category Ia reserve management principles, and be not inconsistent with Australian World Heritage management principles. The Management Plan for the HIMI Marine Reserve was enacted in 2005 and addresses a broad range of management issues. It includes a similarly broad range of measures to address these issues, such as from the cleaning of clothing and gear to prevent unwanted 'alien' species, to where and how visitors can go to the toilet. The new management plan replaces the previous Heard Island Wilderness Reserve Management Plan (PDF) in force for the HIMI Territory since 1996 under the Environment Protection and Management Ordinance 1987. (Source: http://www.heardisland.aq/protection/management_plan/index.html)
Output controls	*Summary of any output controls in the fishery, e.g. quotas. Effort days at sea. Primarily focused on target species as other species are addressed below.* Output controls are the primary means of controlling the level of catch, and are set as annual TACs or catch limits for target and bycatch species. The TACs for the target species are divided among SFR holders in proportion to their holdings for each species. The main output controls are: • annual review and setting of total allowable catches: (TAC) 2015/2016 and 2016/17 seasons for Patagonian toothfish is limited to 3405 t (Conservation Measure 41-08) and in the 2015/16 season for mackerel icefish is limited to 482 t (Conservation Measure 42-02). • move–on provisions if, in hauls larger than 100 kg of icefish, more than 10% of the fish are less than legal limits (240 mm) (Conservation Measure 42-02). • catch limits of bycatch species: fishing shall cease if bycatch of any species reaches its bycatch limit as specified in CM 33-02 (in CM 41-08 and 42-02). • if 50% of catch limit is reached for any non-target species, AFMA will review operating practices with SFR holders. Source: CCAMLR 2015/16 Schedule of Conservation Measures (CCAMLR, 2015c) A random stratified trawl survey and the results of an extensive tagging program are key inputs to the stock assessments. **Precautionary harvest strategies** are adopted for both target species: Patagonian toothfish – that the probability that spawning biomass will fall below 20% of the pre exploitation level over the 35 year projection period must not exceed 0.1 and the median escapement for the Fishery of the spawning biomass shall not be less than 50% over a 35 year projection. Mackerel icefish – that the probability that spawning biomass will fall below 20% of the pre exploitation level over the two year projection period must not exceed 0.1 and the median escapement for the Fishery of the spawning biomass shall not be less than 75% over a two year projection.
Technical measures	*Summary of any technical measures in the fishery, e.g. size limits, bans on females, closed areas or seasons. Gear mesh size, mitigation measures such as TEDs. Primarily focused on target species as other species are addressed below.* **Mesh size** (Conservation Measures 22-01 and 22-01, 2015)(CCAMLR 2015c) Under AFMA requirements the mesh-size of the trawl nets used must not be less than

	• 120 mm for targeting Patagonian toothfish and • 90 mm for targeting mackerel icefish. See also Conservation Measures in "Regulations" section below. Source: CCAMLR 2015/16 Schedule of Conservation Measures
Regulations	*Regulations regarding species (bycatch and by-product, protected species), habitat, and communities; MARPOL and pollution; rules regarding activities at sea such as discarding offal and/or processing at sea.* The Conservation Measures (CM) that apply to the HIMI Fishery are: 10-01 to 10-10 Compliance 22-01Regulation on mesh size measurements 22-02 Mesh size 23-02 Ten-day catch and effort reporting 23-04 Fine-scale catch and effort data 23-06 Fine-scale biological data 24-01 and 24-02 Research and Experiments 25-01 and 25-03 Minimisation of Incidental Mortality 26-01 General environmental protection during fishing 31-02 General measure for the closure of all fisheries 32-01 Fishing seasons 33-02 Limitation of bycatch in Division 58.5.2 41-08 Limits on the fishery for *Dissostichus eleginoides* in Division 58.5.2 42-02 Limits on the fishery for *Champsocephalus gunnari*in Statistical Division 58.5.2 Details of the three most pertinent conservation measures are given here: **Conservation measures 33-02** (CCAMLR 2015c) Limitation of bycatch in Statistical Division 58.5.2 in the 2015/16 season: 1. There shall be no directed fishing for any species other than *Dissostichus eleginoides* and *Champsocephalus gunnari*in Statistical Division 58.5.2 in the 2015/16 fishing season. 2. In directed fisheries in Statistical Division58.5.2 in the 2015/16 season, the bycatch of *Channichthys rhinoceratus* shall not exceed 1663 t, the bycatch of *Lepidonotothen squamifrons* shall not exceed 80 t, the bycatch of *Macrourus caml* and *Macrourus whitsoni* combined shall not exceed 409 t, the bycatch of *Macrourus holotrachys* and *Macrourus carinatus* combined shall not exceed 360 t, and the bycatch of skates and rays shall not exceed 120 t. For the purposes of this measure 'skates and rays' should be counted as a single species. 3. The bycatch of any fish species not mentioned in paragraph 2, and for which there is no other catch limit in force, shall not exceed 50 t in Statistical Division 58.5.2. 4. If, in the course of a directed fishery, the bycatch in any one haul is equal to, or greater than, 5 t for *Channichthys rhinoceratus*, 3 t for all *Macrourus* spp. combined, or 2 t for *Lepidonotothen squamifrons*, or 2 t of *Somniosus* spp., or 2 t of skates and rays, then the fishing vessel shall not fish using that method of fishing at any point within 5 nm of the location where the bycatch limit is exceeded for a period of at least five days. The location where the bycatch limit is exceeded is defined as the path followed by the fishing vessel. 5. If, in the course of a directed fishery, the bycatch in any one haul of any other bycatch species for which bycatch limitations apply under this conservation measure is equal to, or greater than 1 t, then the fishing vessel shall not fish using that method of fishing at any point within 5 nm of the location where the bycatch exceeded 1 t for a period of at least five days. The location where the bycatch exceeded 1 t is defined as the path followed by the fishing vessel. **Conservation measures 41-08** (2015) Limits on the fishery for *Dissostichus eleginoides* in Statistical Division 58.5.2 in the 2015/16 and 2016/17 seasons and Annex 41-08/A:

	1. Access. The fishery for *Dissostichus eleginoides* in Statistical Division 58.5.2 shall be conducted by vessels using trawls, pots or longlines only. 2. Catch limit. The total catch of *Dissostichus eleginoides* in Statistical Division 58.5.2 in the 2015/16 and 2016/17 seasons shall be limited to 3405 t in each season west of 79°20'E. 3. Season. For the purpose of the trawl and pot fisheries for *Dissostichus eleginoides* in Statistical Division 58.5.2, the 2015/16 and 2016/17 seasons are defined as the period from 1 December to 30 November in each season, or until the catch limit is reached, whichever is sooner. For the purpose of the longline fishery for *Dissostichus eleginoides* in Statistical Division 58.5.2, the 2015/16 and 2016/17 seasons are defined as the period from 1 May to 14 September in each season, or until the catch limit is reached, whichever is sooner. The season for longline fishing operations may be extended from 1 April to 30 April and 15 September to 30 November for any vessel which has demonstrated full compliance with Conservation Measure 25-02 in the previous season. These extensions to the season will also be subject to a total catch limit of three (3) seabirds per vessel. If three (3) seabirds are caught during the season extension, fishing throughout the season extensions shall cease immediately for that vessel for the remainder of that fishing season. 4. Bycatch. Fishing shall cease if the bycatch of any species reaches its bycatch limit as set out in Conservation Measure 33-02. 5. Mitigation. The operation of the trawl fishery shall be carried out in accordance with Conservation Measure 25-03 so as to minimise the incidental mortality of seabirds and mammals through the course of fishing. The operation of the longline fishery shall be carried out in accordance with Conservation Measure 25-02.During the periods 1 April to 30 April in the 2015/16 and 2016/17 seasons, vessels shall use IWL gear in conjunction with paired streamer lines. 6. Observers. Each vessel participating in this fishery shall have at least one scientific observer, and may include one appointedin accordance with the CCAMLR Scheme of International Scientific Observation, on board throughout all fishing activities within the fishing period, with the exception of the period 1 April to 30 April when two scientific observers shall be carried. 7. Data: catch/effort. For the purpose of implementing this conservation measure, the following shall apply: (i) the Ten-day Catch and Effort Reporting System set out in Annex 41-08/A; (ii) the Monthly Fine-scale Catch and Effort Reporting System set out in Annex 41-08/A. Fine-scale data shall be submitted on a haul-by-haul basis. 8. For the purpose of Annex 41-08/A, the target species is *Dissostichus eleginoides* and bycatch species are defined as any species other than *Dissostichus eleginoides*. 9. The total number and weight of *Dissostichus eleginoides* discarded, including those with the 'jellymeat' condition, shall be reported. These fish will count towards the total allowable catch. 10. Data: biological. Fine-scale biological data, as required under Annex 41-08/A, shall be collected and recorded. Such data shall be reported in accordance with the CCAMLR Scheme of International Scientific Observation. 11. Environmental protection. Conservation Measure 26-01 applies. **Conservation measures 42-02** (2015) Limits on the fishery for *Champsocephalus gunnari*in Statistical Division 58.5.2 in the 2015/16 season and Annex42-02/A and Annex42-02/B. 1. Access. The fishery for *Champsocephalus gunnari* in Statistical Division 58.5.2 shall be conducted by vessels using trawls only. 2. For the purpose of this fishery for *Champsocephalus gunnari*, the area open to the fishery is defined as that portion of Statistical Division58.5.2that lies within the area enclosed by a line: … 3. A chart illustrating the above definition is appended to this conservation measure (Annex 42-02/A). Areas in Statistical Division 58.5.2 outside that defined above shall be closed to directed fishing for *Champsocephalus gunnari*. 4. Catch limit. The total catch of *Champsocephalus gunnari* in Statistical Division 58.5.2 in the 2015/16 season shall be limited to 482 t. 5. Where any haul contains more than 100 kg of *Champsocephalus gunnari*, and more than 10% of *Champsocephalus gunnari* by number are smaller than the specified minimum legal total length, the fishing vessel shall move to another fishing location at least 5 nm

distant. The fishing vessel shall not return to any point within 5 nm of the location where the catch of small *Champsocephalus gunnari* exceeded 10% for a period of at least five days. The location where the catch of small *Champsocephalus gunnari* exceeded 10% is defined as the path followed by the fishing vessel from the point at which the fishing gear was first deployed from the fishing vessel to the point at which the fishing gear was retrieved by the fishing vessel. The minimum legal total length shall be 240 mm.

6. Season. For the purpose of the trawl fishery for *Champsocephalus gunnari* in Statistical Division 58.5.2, the 2015/16 season is defined as the period from 1 December 2015 to 30 November 2016, or until the catch limit is reached, whichever is sooner.
7. Bycatch. Fishing shall cease if the bycatch of any species reaches its bycatch limit as set out in CM 33-02.
8. Mitigation. The operation of this fishery shall be carried out in accordance with CM 25-03 so as to minimise the incidental mortality of seabirds in the course of fishing.
9. Observers. Each vessel participating in this fishery shall have at least one scientific observer, and may include one appointed in accordance with the CCAMLR Scheme of International Scientific Observation, on board throughout all fishing activities within the fishing period.
10. Data: catch/effort. For the purpose of implementing this conservation measure in the 2015/16 season, the following shall apply: (i) the Ten-day Catch and Effort Reporting System set out in Annex 42-02/B; (ii) the Monthly Fine-scale Catch and Effort Reporting System set out in Annex 42-02/B. Fine-scale data shall be submitted on a haul-by-haul basis.
11. For the purpose of Annex 42-02/B, the target species is *Champsocephalus gunnari* and 'bycatch species' are defined as any species other than *Champsocephalus gunnari*.
12. Data: biological. Fine-scale biological data, as required under Annex 42-02/B, shall be collected and recorded. Such data shall be reported in accordance with the CCAMLR Scheme of International Scientific Observation.
13. Environmental protection13.Conservation Measure 26-01 applies.

Source: CCAMLR Conservation Measures 2015/16 (CCAMLR., 2015c); https://www.ccamlr.org/en/data/data-forms

Under the EPBC Act 1999, interactions with a protected species must be reported within seven days of the incident occurring to the Department of Environment. A Memorandum of Understanding between AFMA and the Department for the Reporting of Fisheries Interactions with Protected Species (Reporting MOU) streamlines those reporting requirements (http://www.afma.gov.au/wp-content/uploads/2010/06/mou.pdf). AFMA reports its protected species interactions to the Department on a quarterly basis.

Amendments to the **International Maritime Organisation's International Convention for the Prevention of Pollution from Ships (MARPOL)** Annex V which came into force on 1 January 2013 prohibit the discharge of all garbage, from all ships, into the sea (except as provided otherwise, under specific circumstances). Garbage is all kinds of food wastes including brassicas, domestic wastes and operational wastes, all plastics, cargos residues, incinerator ashes, cooking oil, fishing gear, and animal carcasses generated during the normal operation of the ship and liable to be disposed of continuously or periodically except those substances which are defined or listed in other Annexes to the present Convention but not fish as a results of fishing or aquaculture activities. https://www.amsa.gov.au/environment/regulations/garbage-management-plans/sample.asp. Fishing gear is included in the definition of 'garbage' for the Convention (http://www.environment.gov.au/system/files/resources/d945695b-a3b9-4010-91b4-914efcdbae2f/files/tap-review-marine-debris.pdf.) Vessels of over 100 gross tonnage or which carries over 15 persons must have a Garbage Management Plan. Compliance by fishing vessels with the requirements of MARPOL Annex V and domestic marine pollution legislation on Commonwealth-licensed Australian fishing boats is monitored through the observer program (AFMA). Fishers must record loss of gear in vessel logbooks under the management of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR).

Initiatives, strategies and incentives	*BAPs;TEDs;Industry codes of conduct* The objective of the ***Antarctic Fisheries Bycatch Action Plan 2003*** is: To ensure that the impacts of the fishery's bycatch on the ecosystem are sustainable and consistent with legislative requirements. Six strategies have been developed to achieve this objective: 1 Develop and review non-target species catch limits to ensure catches are within sustainable limits 2 Minimise the bycatch of non-target species, including sharks, skates and rays, 3 Evaluate any fishing impacts on seabirds and marine mammals 4 Develop mitigation measures to minimise seabird and marine mammal catches in the longline fishery 5 Develop mitigation measures to minimise seabird and marine mammal interaction in the trawl fishery 6 Assess the benthic/ecological impacts of fishing on habitats. Source: AFMA Antarctic Fisheries Bycatch Action Plan 2003 (AFMA 2003). Also, the **Catch Documentation Scheme** (CDR) implemented in 2000 by CCAMLR tracks catches of toothfish sold in participating countries and is used to estimate IUU catch. **FAO *Code of Conduct*** *for Responsible Fisheries* (adopted in 1995) sets out principles and international standards of behaviour for responsible fishing practices to enable effective conservation and management of living aquatic organisms, whilst considering impacts on the ecosystem and biodiversity. International Plans of Actions (IPOAs) are voluntary instruments elaborated within the framework of the Code with four currently developed: • IPOA to prevent, deter and eliminate illegal, unreported and unregulated (IUU) fishing • IPOA for Reducing Incidental Catch of Seabirds in Longline Fisheries • IPOA for the Conservation and Management of Sharks, and • IPOA for the Management of Fishing Capacity Source: http://www.agriculture.gov.au/fisheries/legal-arrangements/code-conduct In addition to the previous controls and regulations, further conditions accompany the statutory fishing rights: • Boat eligibility • Personal consumption and jellymeat (in the toothfish fishery) • VMS requirements • Boat marking • Transhipping and carrying • Product labelling • Notification requirements • CCAMLR inspection • Carriage of observers • Data collection officers • Safety assessment • Contingency arrangements for breakdown of the meal plant and disposal of fish meal Source: MSC Assessment Report HIMI Mackerel icefish 2006
Enabling processes	*Monitoring, logbooks, observer data, scientific surveys); assessment stock assessments); performance indicators (decision rules, processes, compliance; education; consultation process.*

	There are detailed management plans for Patagonian toothfish and mackerel icefish. Catches and landings are monitored by logbooks and observer data. This includes the: • Ten-day Catch and Effort Reporting System set out in Annex 42-02/B; • Monthly Fine-scale Catch and Effort Reporting System set out in Annex 42-02/B. Fine-scale data shall be submitted on a haul-by-haul basis. Stock assessments on target (icefish: annual; toothfish: bi-annual) and some non-target species are conducted less frequently by SAFAG. The Bycatch Action Plan is reviewed biannually and outcomes are reported against performance indicators. Random stratified trawl surveys are conducted annually to ensure that reliable stock assessments can be made for each target species and for monitoring the direct impact of the fishery on non-target species and ecosystem. Australia, through its work in CCAMLR, has undertaken assessments on potentially commercial bycatch species (i.e. grey rockcod (*Lepidonotothen squamifrons*) and unicorn icefish (*Channichthys rhinoceratus)*) based on the results of random stratified trawl surveys. Based on these assessments, bycatch limits have been set even though they are presently non-target species. CCAMLR has also agreed to apply a general precautionary catch limit for other non-target species for which no assessment has been undertaken. The status and management of the fisheries is reviewed annually by the Scientific Committee and its specialist working groups using the best available science and information, including detailed data from the fisheries and fishery surveys, and the CCAMLR Scheme of International Scientific Observation.
Other initatives or agreements	*State, national or international conventions or agreements that impact on the management of the fishery/sub-fishery being evaluated.* The declaration and ongoing management of the Heard Island and McDonald Islands (HIMI) Marine Reserve contributes to the implementation of several international conservation agreements, including: • World Heritage Convention • Ramsar Wetlands Convention • Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) • China/Australia Migratory Birds Agreement (CAMBA) • Japan/Australia Migratory Birds Agreement (JAMBA) • Australia/France Treaty on Maritime Cooperation • France/Australia Agreement on Cooperative Enforcement Laws • Convention on Biological Diversity • Agreement on the Conservation of Albatrosses and Petrels (ACAP) • Convention on the Conservation of Antarctic Marine Living Resources • International Convention for the Prevention of Pollution from Ships (MARPOL) • Convention on the International Trade in Endangered Species (CITES) • International Convention for the Regulation of Whaling • United Nations Convention on the Law of the Sea (UNCLOS) Source: HIMI Marine Reserve Management Plan 2014-2024 (Commonwealth of Australia, 2014)
Data	
Logbook data	*Verified logbook data; data summaries describe programme* All Australian operators are required to complete electronic shot by shot catch and effort logbooks with total coverage, including details of interactions with marine mammals and seabirds. The vessel's master is required to record an estimated weight of each species

	caught in each fishing operation. Data verified through Observer program and catch documentation scheme (CDS). Under the Fisheries Management Act 1991, the General Conditions 2014/15 require that the SFR holder to complete: • CCAMLR data form C1v2015b: electronic fine-scale catch and effort data for trawl fisheries. • CCAMLR data form CEv2014b: daily, 5-day, 10-day, monthly catch and effort report • ANT04-VG (electronic logbook Antartic waters and for trawl vessels and gear details log) • ANT02-LF: Antarctic waters length frequency log. CCAMLR publish catch statistics for all Antarctic fisheries in their jurisdiction annually in the Statistical Bulletin series. Source: Heard Island and McDonald Islands Management Plan 2002 (AFMA 2016a)
Observer data	*Objective observer programme; describe parameters, how many years run; coverage – random or full coverage; comments on interactions with species; observer training, species identification, and length of service; data summaries* The purpose of the Observer Program is to "provide fisheries managers, research organizations, environmental agencies, the fishing industry and the wider community with independent, reliable, verified and accurate information on the fishing catch, effort and practice of a wide range of boats operating inside, and periodically outside, the Australian Fishing Zone" (AFMA http://www.afma.gov.au/fisheries-services/observer-services/: accessed 29 June 2016). AFMA observers are highly experienced in fishery observer work in Australia. They: • collect data on independent boat activity and catch data (not recorded in official logbooks) • collect data and samples for research programs, supporting marine management and other issues relevant to environmental awareness and fisheries management and • monitor compliance of the boat with its fishing concession. Observer data is collated in AFMA's centralised database and data have been made available outside AFMA in the form of observer trip reports and as raw data. There are two observers present on all fishing trips to HIMI. Each observer carries out 12 hour shifts, so that an observer is on shift during all fishing operations. All wildlife interactions are also monitored. Observer data are maintained by AAD and a copy held by AFMA.
Other data	**Surveys:** Random Stratified Trawl Surveys (RSTS) have been conducted annually since 1998 to assess the juvenile stocks of Patagonian Toothfish and mackerel icefish in the HIMI Fishery. The information collected on the population structure and abundance of Patagonian toothfish and mackerel icefish during these surveys is a critical input to stock assessments of these species, the last one being in 2016. Fishing vessels participated in the 8-year benthic camera project for the AAD. This now completed project was designed to assess if fishing operations are negatively impacting the seabed (Welsford et al. 2014). Both the HIMI Mackerel icefish and Patagonian toothfish fisheries are certified by the Marine Stewardship Council (MSC). As part of this certification, a consulting company (SCSglobal) undertakes annual surveillance audits to check if both target species continues to comply with the MSC Requirements for Continued Certification. Annual reports are made available to the public and summarise the current status of the fishery based on recent documentation received. **Ageing programs (AAD):** The ageing program at AAD has produced an additional 2559 estimates of age, for fish captured during the 2014 and 2015 Random Stratified Trawl survey,

	commercial fishing in 2013/14. These samples have detected toothfish as old as 51 years, increasing the previous maximum age estimate of 42 years (WG-FSA-15/55). These data are used to develop age length keys and a revised growth function for inclusion in revised stock assessments. **Tagging programs (AAD):** Fishing vessels participate in toothfish tag and release programs that were established in 1998. This program now requires 2 tags per t of toothfish which is equivalent to around 7,000 toothfish per year. Information gathered in these tags and analysed by AAD include growth rates and the spatial movement of the particular fish. Natural mortality rates are a direct estimate based on tracking tagged cohorts in the HIMI Fishery (Candy et al, 2011). To date 15,795 skates/rays have also been tagged and released (including 7,127 in trawl operations, 8,664 in longline operations and 4 in potting operations) have been tagged with 160 recaptures from within the HIMI Fishery (AFMA HIMI Fishing Status Report 2014). **International scientific collaborations:** Australian and French scientists have been closely cooperating on complementary research on Kerguelen Plateau including on toothfish. There is a formal data sharing agreement between Australia and France signed in 2013. A joint meeting of scientists from Australia and France was held in May 2008, with a follow up workshop in May 2009, a symposium in April 2010 which focussed on marine ecosystems and fisheries, and a further workshop in June 2011 aimed at progressing work on toothfish and on Marine Protected Areas. The 2010 symposium resulted in a published document: The Kerguelen Plateau Marine Ecosystems and Fisheries, edited by Guy Duhamel and Dirk Welsford. Cooperative work has continued between Australia and France with a focus on improving toothfish assessments and other aspects of the fisheries and ecosystem in the Kerguelen region. A collaborative four year research program (Developing robust assessment methods for spatially complex, multi-jurisdictional toothfish fisheries in the Southern Ocean, FRDC project 2013/13) commenced in November 2013. The final report for the project is expected to be available in June 2018.

2.2.2 Unit of Analysis Lists (Step 2)

The units of analysis for the sub-fishery are listed by component:

- Species Components (key commercial and secondary commercial; byproduct/discards and protected species components). [Scoping document S2A Species]
- Habitat Component: habitat types. [Scoping document S2B1 and S2B2 Habitats]
- Community Component: community types. [Scoping document S2C1 and S2C2 Communities]

Ecological Units Assessed

Key commercial and secondary species:	2 key commercial species
Byproduct and bycatch species:	1 byproduct; 148 bycatch
Protected species:	22
Habitats:	1 pelagic
Communities:	9 (7 demersal, 2 pelagic)

Scoping Document S2A. Species

Each species identified during the scoping is added to the ERAEF database used to run the Level 2 analyses. A CAAB code (Code for Australian Aquatic Biota) is required to input the information. The CAAB codes for each species may be found at http://www.marine.csiro.au/caab/

Key commercial/secondary commercial species for the Heard Island and McDonald Islands demersal trawl sub-fishery

- *Key commercial species* – defined in the Harvest Strategy Policy (HSP) Guidelines as a species that is, or has been, specifically targeted and is, or has been, a significant component of a fishery.
- *Secondary commercial species* – commercial species that, while not specifically targeted, are commonly caught and generally retained, and comprise a significant component of a fishery's catch and economic return. These can include quota species in some fisheries.

Table 2.3. Key commercial (C1) and secondary commercial (C2) species list for the HIMI demersal trawl sub-fishery.

ERA species ID	Taxa name	Role in fishery	Family name	CAAB code	Scientific name	Common name	Source
	Teleost	C1	Notothenіidae	37404792	*Dissostichus eleginoides*	Patagonian toothfish	AFMA, Logbook, Observer
	Teleost	C1	Channichthyidae	37407791	*Champsocephalus gunnari*	Mackerel icefish	AFMA, Logbook, Observer

Byproduct species for the Heard Island and McDonald Islands demersal trawl sub-fishery

List the byproduct species of the sub-fishery. Byproduct species refers to any species that are retained for sale but comprise a minor component of the fishery catch and economic return. Byproduct are considered to be commercial species under the CPFB 2000. This list is obtained by reviewing all available fishery literature, including logbooks, observer reports and discussions with stakeholders.

Table 2.4. Byproduct (BP) species list for the HIMI demersal trawl sub-fishery.

ERA species ID	Role in fishery	Taxa name	Family name	CAAB code	Scientific name	Common name	Source
	BP	Teleost	Nototheniidae	37404795	*Dissostichus mawsoni*	Antarctic toothfish	AFMA; Observer

Bycatch (discard) species for the Heard Island and McDonald Islands demersal trawl sub-fishery

Bycatch species are species that are not retained (i.e. are discarded, and includes catch that does not reach the deck of the vessel but which nonetheless is killed (or effected) as a result of the interaction with the fishing gear) and as such make no contribution to the value of the fishery. The term bycatch does *not* include discards of commercial species. Bycatch species are divided, for management purposes, into:

- *General bycatch species* (i.e. species of fish, sharks, invertebrates, etc. that are never retained for sale).

In sub-Antarctic fisheries, discarding is generally not permitted in the fishery and the terms bycatch and byproduct have specific meaning which differ to some other fisheries (see Glossary). The bycatch species list was obtained directly from AFMA logbook and Observer data verfied by AAD, and observer reports. Protected species were excluded. The invertebrate bycatch comprised only 1.5% of total catch the majority being sea anemones, seastars, medusae (jellyfish) and sponges. This bycatch list includes sessile or sedentary structure-forming invertebrates that constitute the habitat component but are not further expanded here. Only motile groups (defined in Table A3.1, Welsford et al. (2014)) were expanded from the species list from the Plateau Deep East (PDE) and Gunnari Ridge(GRI) habitat (Appendix 8,Welsford et al. 2014), if over 100 kg were caught during the assessment period. Identifications such as rocks, litter, unknown, unidentified, not entered, bycatch were excluded. Identifications recorded that were that were insufficently resolved taxonomically e.g. crustaceans, invertebrates unlisted fish species were also excluded.

Table 2.5. Bycatch (BC) species list for the HIMI demersal trawl sub-fishery. Logbook: Commonwealth logbook data; Observer: Commonwealth Observer data

ERA species ID	Role in fishery	Taxa name	Family name	CAAB code	Scientific name	Common name	Source
	BC	Annelid			Polychaeta	Marine worms	AFMA; Logbook; Observer
	BC	Arthropod			Pycnogonida	Sea spiders	AFMA; Logbook; Observer
	BC	Bivalvia			Bivalvia	Bivalve	Observer
	BC	Bryozoa			Bryozoa	Bryozoan	Observer
	BC	Chordata	Salpidae	35103000	Salpidae	Salps	AFMA; Logbook; Observer
	BC	Cnidaria	Anthoathecata		Anthoathecata	Hydroids	Observer
	BC	Cnidaria	Actiniaria	14410000	*Actiniaria spA*	Sea anemones	CSIRO, expanded from 'Actiniaria'(Obs); Listed in Appendix 8 (Welsford et al. 2014)
	BC	Cnidaria	Actiniaria	14410000	*Actiniaria spC*	Sea anemones	CSIRO, expanded from 'Actiniaria'(Obs); Listed in Appendix 8 (Welsford et al. 2014)
	BC	Cnidaria	Actiniaria	14410000	*Actiniaria spD*	Sea anemones	CSIRO, expanded from 'Actiniaria'(Obs); Listed in Appendix 8 (Welsford et al. 2014)
	BC	Cnidaria	Actiniaria	14410000	*Actiniaria spK*	Sea anemones	CSIRO, expanded from 'Actiniaria'(Obs); Listed in Appendix 8 (Welsford et al. 2014)
	BC	Cnidaria	Actiniidae	11232007	*Glyphoperidium bursa*	sea anemones	CSIRO expanded from 'Cnidaria - Actiniidae'(Obs); spp listed in Appendix 8 (Welsford et al. 2014)

ERA species ID	Role in fishery	Taxa name	Family name	CAAB code	Scientific name	Common name	Source
	BC	Cnidaria	Ceriantharia		*Ceriantharia spA*	Sea anemones	CSIRO expanded from 'Cnidaria - Actiniidae'(Obs); spp listed in Appendix 8 (Welsford et al. 2014)
	BC	Cnidaria	Ceriantharia		*Ceriantharia spB*	Sea anemones	CSIRO expanded from 'Cnidaria - Actiniidae'(Obs); spp listed in Appendix 8 (Welsford et al. 2014)
	BC	Cnidaria	*Hormathiidae*		*Hormathiidae spp*	*Sea anemones*	*CSIRO expanded from 'Cnidaria - Actiniidae'(Obs); spp listed in Appendix 8 (Welsford et al. 2014)*
	BC	Cnidaria	Liponematidae		*Liponema spp.*	Sea anemones	CSIRO expanded from 'Cnidaria - Actiniidae'(Obs); spp listed in Appendix 8 (Welsford et al. 2014)
	BC	Cnidaria	Periphyllidae	11128001	*Periphylla periphylla*	Jellyfish	Observer
	BC	Cnidaria	Rhizostomatidae	11141901	*Rhopilema* spp	Jellyfish	AFMA; -Logbook; Observer
	BC	Crustacea	Solenoceridae	28714027	*Solenocera pectinata*	Comb shrimp	AFMA; Logbook; Observer
	BC	Crustacea			Isopoda	Isopods	Observer
	BC	Crustacea			Natantia	Natantian decapods	AFMA; Logbook
	BC	Crustacea			*Pasiphaea sp.*	Prawn, carid shrimp	Observer
	BC	Echinodermata	Asterinidae	25140001	*Tremaster mirabilis*	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata	Benthopectinidae		*Cheiraster hirsutus*	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)

ERA species ID	Role in fishery	Taxa name	Family name	CAAB code	Scientific name	Common name	Source
	BC	Echinodermata	Echniasteridae		*Henricia spA*	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata	Ganeriidae		*Cycethra verrucosa*	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata	Goniasteridae	25122077	*Hippasteria falklandica*	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata	Gorgonocephalidae	25171026	*Astrotoma agassizii*	snakestar	CSIRO, expanded from 'Gorgonocephalidae' (Obs): listed in Appendix 8 (Welsford et al. 2014)
	BC	Echinodermata	Gorgonocephalidae	25171028	*Gorgonocephalus chilensis*	Gorgons head basket-stars	CSIRO, expanded from 'Gorgonocephalus spp' (Obs): listed in Appendix 8 (Welsford et al. 2014)
	BC	Echinodermata	Odontasteridae		*Acodontaster elongatus*	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata	Odontasteridae		*Odontaser meridionalis*	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata	Pterasteridae		*Hymenaster* sp. A	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata	Pterasteridae		*Pteraster rugatus*	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata	Pterasteridae		*Pteraster* sp B	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata	Solasteridae	25141006	*Cuenotaster involutus*	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata			Asteroidae spA	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata			Asteroidea spA	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)

ERA species ID	Role in fishery	Taxa name	Family name	CAAB code	Scientific name	Common name	Source
	BC	Echinodermata			Asteroidea spB	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata			Asteroidea spC	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata			Asteroidea spF	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata			Asteroidea spI	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata		25111024	*Bathybiaster loripes*	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in Appendix 8 (Welsford et al. 2014)
	BC	Echinodermata			Crinoids	Sea Lily, feather stars	Observer
	BC	Echinodermata			Echinoidea	Sea urchins, etc.	AFMA; Logbook; Observer
	BC	Echinodermata			Euryalidae	Basket stars and sea lillies	AFMA; Logbook; Observer
	BC	Echinodermata			Holothuroidea	Sea cucumbers	AFMA; Logbook; Observer
	BC	Echinodermata		25153003	*Labidiaster annulatus*	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Echinodermata		25111029	Leptychaster kerguelensis	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in Appendix 8 (Welsford et al. 2014)
	BC	Echinodermata		25160000	Ophiuroidea	Basket, brittle, snake stars	AFMA; Logbook; Observer
	BC	Echinodermata		25154902	*Smilasterias* spA	Seastar	CSIRO expanded from 'Asteroidea'(Obs); listed in HIMI (Welsford et al. 2014)
	BC	Mollusca			Gastropoda	Gastropods	AFMA; logbook; Observer

ERA species ID	Role in fishery	Taxa name	Family name	CAAB code	Scientific name	Common name	Source
	BC	Mollusca	Chiroteuthidae	23638004	*Chiroteuthis veranyi*	Verany's long-armed squid	CSIRO expanded from Chiroteuthidae (Obs); common squid in sub-antarctica (Cherel et al. 2004)
	BC	Mollusca	Enteroctopodidae	23659008	*Benthoctopus levis*	octopus	CSIRO expanded from Octopodidae (Obs); included in Welsford et al. (2014)
	BC	Mollusca	Octopodidae	23659010	*Graneledone antarctica*	octopus	CSIRO expanded from Octopodidae (Obs); included in Welsford et al. (2014)
	BC	Mollusca	Ommastrephidae	23636003	*Martialia hyadesi*	Flying squids	CSIRO expanded from Ommastrephidae squid (Obs)
	BC	Mollusca	Ommastrephidae		*Moroteuthis ingens*	Hooked squid	Observer
	BC	Mollusca	Ommastrephidae	23623011	*Moroteuthis knipovitchi*	smooth clubhook squid	CSIRO expanded from Ommastrephidae squid (Obs); common squid sp in the area (Cherel et al. 2004)
	BC	Mollusca		23301000	Bivalvia	Clams, etc.	AFMA; Logbook; Observer
	BC	Chondrichthyan	Etmopteridae	37020021	*Etmopterus baxteri (granulosus)*	Southern lanternshark (Lucifer)	AFMA; Logbook; Observer
	BC	Chondrichthyan	Rajidae		*Amblyraja taaf*	Thorny Skate	Observer
	BC	Chondrichthyan	Rajidae	37031750	*Bathyraja eatonii*	Eaton's skate	AFMA; Logbook; Observer
	BC	Chondrichthyan	Rajidae	37031000	*Bathyraja irrasa*	Kerguelen sandpaper skate	AFMA; Logbook;Observer
	BC	Chondrichthyan	Rajidae	37031048	*Bathyraja murrayi*	Murray's skate	AFMA; Logbook; Observer
	BC	Chondrichthyan	Rajidae	37031753	*Raja georgiana*	Antarctic starry skate	AFMA; Logbook; Observer

ERA species ID	Role in fishery	Taxa name	Family name	CAAB code	Scientific name	Common name	Source
	BC	Chondrichthyan	Somniosidae	37020036	*Somniosus antarcticus*	Antarctic Sleeper Shark	Observer data
	BC	Teleost	Achiropsettidae	37460076	*Mancopsetta maculata*	Spotted armless flounder	Observer
	BC	Teleost	Achiropsettidae	37460052	*Neoachiropsetta milfordi*	Largemouth armless flounder	Observer
	BC	Teleost	Alepisauridae		*Achiropsetta tricholepis*	Finless Flounder	Observer
	BC	Teleost	Alepisauridae	37128002	*Alepisaurus brevirostris*	Short snouted lancetfish	Observer
	BC	Teleost	Alepisauridae	37128002	*Alepisaurus brevirostris*	Lancertfish	CSIRO, expanded from 'Alepocephalus sp.'(Obs)
	BC	Teleost	Alepocephalidae	-	*Rouleina* sp.	Slickhead	Observer
	BC	Teleost	Anotopteridae	37129750	*Anotopterus pharao*	Daggertooth	Observer
	BC	Teleost	Astronesthidae	37108010	*Borostomias antarcticus*	Snaggletooth	AFMA; Logbook; Observer
	BC	Teleost	Balistidae	37465086	*Canthidermis maculata*	Rough triggerfish	AFMA; Logbook
	BC	Teleost	Bathydraconidae	37098002	*Bathydraco antarcticus*	Antarctic Deepsea Smelt	AFMA; Logbook; Observer
	BC	Teleost	Bothidae		*Arnoglossus elongatus*	Lefteye flounders	CSIRO, expanded from 'Bothidae'(Obs)
	BC	Teleost	Carapidae		*Echiodon cryomargarites*	Messmate, Pearlfish	Observer
	BC	Teleost	Centrolophidae	37445000	Centrolophidae	Ruffs, barrelfishes	AFMA; Logbook; Observer

ERA species ID	Role in fishery	Taxa name	Family name	CAAB code	Scientific name	Common name	Source
	BC	Teleost	Centrolophidae	37445015	*Icichthys australis*	Southern driftfish	AFMA; Logbook
	BC	Teleost	Ceratiidae	37220003	*Ceratias tentaculatus*	Sea Devil Anglerfish	Observer
	BC	Teleost	Ceratiidae			Anglerfish sp.	Observer
	BC	Teleost	Channichthyidae	37407792	*Channichthys rhinoceratus*	Unicorn icefish	AFMA; Logbook; Observer
	BC	Teleost	Channichthyidae	37407792	*Channichthys rhinoceratus*	Crocodile icefishes	CSIRO, expanded from 'Channichthyidae - crocodile icefish'(Obs) to Antarctic /sub-Antarctic speices listed in CAAB
	BC	Teleost	Channichthyidae	37407793	*Chionobathyscus dewiti*	Crocodile icefishes	CSIRO, expanded from 'Channichthyidae - crocodile icefish'(Obs) to Antarctic /sub-Antarctic speices listed in CAAB
	BC	Teleost	Channichthyidae	37407794	*Cryodraco antarcticus*	Crocodile icefishes	CSIRO, expanded from 'Channichthyidae - crocodile icefish'(Obs) to Antarctic/sub-Antarctic speices listed in CAAB
	BC	Teleost	Channichthyidae	38407795	*Cryodraco atkinsoni*	Crocodile icefishes	CSIRO, expanded from 'Channichthyidae - crocodile icefish'(Obs) to Antarctic/sub-Antarctic speices listed in CAAB
	BC	Teleost	Channichthyidae	39407796	*Cryodraco hamatus*	Crocodile icefishes	CSIRO, expanded from 'Channichthyidae - crocodile icefish'(Obs) to Antarctic/sub-Antarctic speices listed in CAAB
	BC	Teleost	Channichthyidae	40407797	*Cryodraco myersi*	Crocodile icefishes	CSIRO, expanded from 'Channichthyidae - crocodile icefish'(Obs) to Antarctic/sub-Antarctic speices listed in CAAB
	BC	Teleost	Channichthyidae	39407798	*Dacodraco hunteri*	Crocodile icefishes	CSIRO, expanded from 'Channichthyidae - crocodile icefish'(Obs) to Antarctic/sub-Antarctic speices listed in CAAB

ERA species ID	Role in fishery	Taxa name	Family name	CAAB code	Scientific name	Common name	Source
	BC	Teleost	Channichthyidae	39407799	*Neopagetopsis ionah*	Crocodile icefishes	CSIRO, expanded from 'Channichthyidae - crocodile icefish'(Obs) to Antarctic/sub-Antarctic speices listed in CAAB
	BC	Teleost	Channichthyidae	39407750	*Pagetopsis macropterus*	Crocodile icefishes	CSIRO, expanded from 'Channichthyidae - crocodile icefish'(Obs) to Antarctic/sub-Antarctic speices listed in CAAB
	BC	Teleost	Channichthyidae	40407751	*Pagetopsis maculatus*	Crocodile icefishes	CSIRO, expanded from 'Channichthyidae - crocodile icefish'(Obs) to Antarctic/sub-Antarctic speices listed in CAAB
	BC	Teleost	Congiopodidae		*Zanclorhynchus spinifer*	Spiny horsefish	Observer
	BC	Teleost	Embiotocidae		*Rhacochilus toxotes*	Rubberlip seaperch	AFMA; Logbook
	BC	Teleost	Gempylidae	37439005	*Paradiplospinus gracilis*	Slender escolar	AFMA; logbook; observer
	BC	Teleost	Lampridae	37268002	*Lampris immaculatus*	Southern opah	AFMA; Logbook
	BC	Teleost	Liparidae	37307758	*Paraliparis antarcticus*	Snailfish	CSIRO expanded from 'Paraliparis sp'(Obs) as a species occuring in Antarctic /sub-Antarctic zone (CAAB)
	BC	Teleost	Liparidae		*Paraliparis copei*	Blacksnout snailfish	Observer
	BC	Teleost	Liparidae	37307762	*Paraliparis rossi*	Snailfish	CSIRO expanded from 'Paraliparis sp'(Obs) as a species occuring in Antarctic /sub-Antarctic zone (CAAB)
	BC	Teleost	Macrouridae	37232750	*Coryphaenoides armatus*	Abyssal Grenadier	Observer
	BC	Teleost	Macrouridae	37232054	*Cynomacrurus piriei*	Dogtooth grenadier	AFMA; Logbook; Observer

ERA species ID	Role in fishery	Taxa name	Family name	CAAB code	Scientific name	Common name	Source
	BC	Teleost	Macrouridae		*Macrourus caml*	Caml grenadier	AFMA; Logbook; Observer
	BC	Teleost	Macrouridae	37232036	*Macrourus carinatus*	Ridge scaled rattail/grenadier	AFMA; Logbook; Observer
	BC	Teleost	Macrouridae		*Macrourus holotrachys*	Bigeye grenadier	AFMA; Logbook; Observer
	BC	Teleost	Macrouridae	37232753	*Macrourus whitsoni*	Whitson's grenadier	AFMA; Logbook; Observer
	BC	Teleost	Melamphaidae	37251004	*Poromitra atlantica*	Crested bigscale	Observer
	BC	Teleost	Melanonidae	37224015	*Melanonus gracilis*	Pelagic cod	Observer
	BC	Teleost	Melanostomiidae	-	*Melanostomias* sp.	Scaleless dragonfish	Observer
	BC	Teleost	Monodactylidae	37356002	*Monodactylus argenteus*	Silver moony	AFMA; Logbook
	BC	Teleost	Moridae	37224008	*Antimora rostrata*	Blue antimora	AFMA; logbook; observer
	BC	Teleost	Moridae	37224041	*Guttigadus kongi*	Austral cod	Observer
	BC	Teleost	Moridae	37224009	*Halargyreus johnsonii*	Johnson’s deepsea cod	Observer
	BC	Teleost	Moridae	37224750	*Lepidion* spp	Lepidion codlings	AFMA; Logbook
	BC	Teleost	Muraenolepididae	37223750	*Muraenolepis marmorata*	Moray cods	CSIRO, expanded from 'Muraenolepis spp'(Obs) as a Ant/sub- Antarctic spp in CAAB

ERA species ID	Role in fishery	Taxa name	Family name	CAAB code	Scientific name	Common name	Source
	BC	Teleost	Muraenolepididae	37223752	*Muraenolepis orangiensis*	Moray cods	CSIRO, expanded from 'Muraenolepis spp'(Obs) as a Ant/sub- Antarctic spp in CAAB
	BC	Teleost	Myctophidae	37122750	*Electrona antarctica*	lanternfish	CSIRO, expanded from 'Myctophidae'(Obs)
	BC	Teleost	Myctophidae	37122104	*Electrona carlsbergi*	Carlsberg's Lanternfish	CSIRO, expanded from 'Myctophidae'(Obs)
	BC	Teleost	Myctophidae	37122752	*Gymnoscopelus nicholsi*	lanternfish	CSIRO, expanded from 'Myctophidae'(Obs)
	BC	Teleost	Nemichthyidae	37076004	*Labichthys yanoi*	Yano's snipe eel	Observer
	BC	Teleost	Notacanthidae	37083002	*Notacanthus chemnitzii*	Cosmopolitan spineback	Observer
	BC	Teleost	Nototheniidae		*Gobionotothen acuta*	Triangular rockcod	Observer
	BC	Teleost	Nototheniidae		*Lepidonotothen mizops*	Toad Rockcod	Observer
	BC	Teleost	Nototheniidae	37404793	*Lepidonotothen squamifrons*	Grey rockcod	Observer
	BC	Teleost	Nototheniidae		*Notothenia acuta*	Triangular rockcod	AFMA; Logbook; Observer
	BC	Teleost	Nototheniidae	37404798	*Notothenia coriiceps*	Black rockcod	AFMA; Logbook; Observer
	BC	Teleost	Nototheniidae		*Notothenia kempi*	Striped-eyed rockcod	AFMA Logbook
	BC	Teleost	Nototheniidae		*Notothenia rossii*	Marbled rockcod	AFMA; Logbook; Observer
	BC	Teleost	Nototheniidae		*Nototheniops mizops*	Toad notie	AFMA; Logbook

ERA species ID	Role in fishery	Taxa name	Family name	CAAB code	Scientific name	Common name	Source
	BC	Teleost	Nototheniidae	37404909	*Trematomus* spp	Trematomus	AFMA; Logbook
	BC	Teleost	Oreosomatidae	37266003	*Pseudocyttus maculatus*	Smooth Oreo	Observer
	BC	Teleost	Oreosomatidae	37445015	*Pseudoicichthys australis*	Ruff, Southern driftfish	Observer
	BC	Teleost	Paralepididae	37126004	*Magnisudis prionosa*	Southern barracudina	Observer
	BC	Teleost	Petromyzontidae		*Muraenolepis microps*	Smalleye moray cod	AFMA; Logbook; Observer
	BC	Teleost	Scopelarchidae	37131750	*Benthalbella elongata*	Pearleye	Observer
	BC	Teleost	Scopelarchidae	37131751	*Benthalbella macropinna*	Longfin Pearleye	Observer
	BC	Teleost	Serranidae	37311116	*Pseudanthias fasciata*	rockcod	AFMA logbook
	BC	Teleost	Sparidae		*Pagellus acarne*	Axillary seabream	AFMA; Logbook
	BC	Teleost	Stomiidae	-	*Stomias* sp.	Dragonfishes	Observer
	BC	Teleost	Stomiidae	37109037	*Trigonolampa miriceps*	Threelight dragonfish	Observer
	BC	Teleost	Trichiuridae	37440002	*Lepidopus caudatus*	Frostfish	Observer
	BC	Teleost	Zoarcidae	37231751	*Lycodapus dearborni*	Eelpout	CSIRO expanded from 'Lycodapus sp'(Obs) as only sp listed in CAAB to occur in Ant/sub- Antarctic
	BC	Teleost	Zoarcidae	37231001	*Melanostigma gelatinosum*	Limp eelpout	Observer

ERA species ID	Role in fishery	Taxa name	Family name	CAAB code	Scientific name	Common name	Source
	BC	Teleost	Zoarcidae	37231001	*Melanostigma gelatinosum*	Gelatinous eel fish	CSIRO expanded from 'Melanostigma sp'(Obs) as only sp listed in CAAB to occur in Ant/sub- Antarctic
	BC	Cnidaria			Gorgoniidae	Gorgonians	AFMA; Logbook; Observer
	BC	Porifera		10000000	Porifera	Sponges	AFMA; Logbook; Observer
	BC	Annelida	Aphroditidae		*Aphrodite* sp.	Polychaete worms	Observer
	BC	Chordata		35000000	Ascidiacea	Sea squirts	AFMA; Logbook; Observer
	BC	Bryozoa			Scleractinia	Stony or Hard corals, madrepores	AFMA; Logbook; Observer
	BC	Teleost	Mordaciidae		*Mordacia lapicida*	Chilean lamprey	AFMA; Logbook. Outside HIMI area. However, *Geotria australis* is possible.

Protected species for the Heard Island and McDonald Islands demersal trawl sub-fishery

A protected species[2] refers to all species listed/covered under the EPBC Act 1999, which include Protected[3] species (listed threatened species i.e. vulnerable, endangered or critically endangered), cetaceans, listed migratory species and listed marine species.

Protected species that occur in the area of the sub-fishery. Protected species are often poorly listed by fisheries due to low frequency of direct interaction. Both direct (capture) and indirect (e.g. food source captured) interaction are considered in the ERAEF approach. A list of protected species has been generated for this sub-fishery and included in the PSA workbook species list. This list has been generated using the Department of the Environment and Energy home page **http://www.environment.gov.au/** as well as by reviewing all available fishery literature. Species considered to have potential to interact with fishery (based on geographic range & proven/perceived susceptibility to the fishing gear/methods and examples from other similar fisheries across the globe) should also be included. Highlighted in red are protected species that have interacted in the HIMI.

Table 2.6. Protected species (PS) list for the HIMI demersal trawl sub-fishery. Obs-WI: Observer wildlife interactions; Obs-WO: Observer wildlife obseravtions.

ERA species ID	Role in fishery	Taxa	Family name	CAAB code	Scientific name	Common Name	Source(s)
	PS	Chondrichthyan	Lamnidae	37010004	*Lamna nasus*	Porbeagle shark	AFMA; logbook
	PS	Marine bird	Diomedeidae	40040003	*Thalassarche chlororhynchos*	Yellow-nosed albatross, Atlantic yellow- nosed albatross	Expanded from Albatrosses; Obs-WI
	PS	Marine bird	Diomedeidae	40040004	*Thalassarche chrysostoma*	Grey-headed albatross	Expanded from Albatrosses; Obs-WI
	PS	Marine bird	Diomedeidae	40040007	*Thalassarche melanophrys*	Black-browed albatross	AFMA; Obs-WI; Obs-WO
	PS	Marine bird	Diomedeidae	40040012	*Diomedea sanfordi*	Northern royal albatross	Expanded from Albatrosses; Obs-WI
	PS	Marine bird	Diomedeidae	40040014	*Thalassarche carteri*	Indian yellow-nosed albatross	Expanded from Albatrosses; Obs-WI

[2] The term "protected" species refers to species listed under [Part 13] the EPBC Act 1999 and replaces the term "Threatened, endangered and protected species (PS)" commonly used in past Commonwealth Government (including AFMA) documents.

[3] Note "protected" (with small "p") refers to all species covered by the EPBC Act 1999 while "Protected" (capital P) refers only to those protected species that are threatened (vulnerable, endangered or critically endangered).

ERA species ID	Role in fishery	Taxa	Family name	CAAB code	Scientific name	Common Name	Source(s)
	PS	Marine bird	Diomedeidae	40040018	*Diomedea amsterdamensis*	Amsterdam albatross	Expanded from Albatrosses; Obs-WI
	PS	Marine bird	Hydrobatidae	40042002	*Fregetta tropica*	Black-bellied storm-petrel	Expanded from Storm petrel; Obs-WI
	PS	Marine bird	Hydrobatidae	40042003	*Garrodia nereis*	Grey-backed storm petrel	Expanded from Storm petrel; Obs-WI
	PS	Marine bird	Hydrobatidae	40042004	*Oceanites oceanicus*	Wilson's storm petrel (subantarctic)	AFMA; Obs-WI; Obs-WO
	PS	Marine bird	Procellariidae	40041003	*Daption capense*	Cape petrel	AFMA; Obs-WI; Obs-WO
	PS	Marine bird	Procellariidae	40041005	*Halobaena caerulea*	Blue petrel	AFMA; Obs-WI; Obs-WO
	PS	Marine bird	Procellariidae	40041010	*Pachyptila* crassirostris	Fulmar prion	Expanded from Prion; Obs-WI
	PS	Marine bird	Procellariidae	40041011	*Pachyptila desolata*	Antarctic prion	Expanded from Prion; Obs-WI
	PS	Marine bird	Procellariidae	40041018	*Procellaria aequinoctialis*	White-chinned petrel	AFMA; Obs-WI; Obs-WO
	PS	Marine mammal	Otariidae	41131002	*Arctocephalus gazella*	Antarctic fur seal	AFMA; Obs-WI; Obs-WO
	PS	Marine mammal	Otariidae	41131004	*Arctocephalus tropicalis*	Subantarctic fur seal	Expanded from Seals; Obs-WI
	PS	Marine mammal	Phocidae	41136001	*Hydrurga leptonyx*	Leopard seal	Expanded from Seals; Obs-WI
	PS	Marine mammal	Phocidae	41136002	*Leptonychotes weddelli*	Weddell seal	Expanded from Seals; Obs-WI
	PS	Marine mammal	Phocidae	41136003	*Lobodon carcinophagus*	Crabeater seal	Expanded from Seals; Obs-WI
	PS	Marine mammal	Phocidae	41136004	*Mirounga leonina*	Elephant seal	Expanded from Seals; Obs-WI
	PS	Marine mammal	Phocidae	41136005	*Ommatophoca rossii*	Ross seal	Expanded from Seals; Obs-WI
Observed, not interacted							
	PS	Marine bird	Diomedeidae	40040001	*Thalassarche bulleri*	Buller's albatross	AFMA; Obs-WO
	PS	Marine bird	Diomedeidae	40040002	*Diomedia cauta*	Shy Albatross	AFMA; Obs-WO
	PS	Marine bird	Diomedeidae	40040004	*Thalassarche chrysostoma*	Grey-headed albatross	AFMA; Obs-WO
	PS	Marine bird	Diomedeidae	40040005	*Diomedea epomophora*	Southern royal albatross	AFMA; Obs-WO

ERA species ID	Role in fishery	Taxa	Family name	CAAB code	Scientific name	Common Name	Source(s)
	PS	Marine bird	Diomedeidae	40040006	*Diomedea exulans*	Wandering albatross	AFMA; Obs-WO
	PS	Marine bird	Diomedeidae	40040008	*Phoebetria fusca*	Sooty albatross	AFMA; Obs-WO
	PS	Marine bird	Diomedeidae	40040009	*Phoebetria palpebrata*	Light-mantled albatross	AFMA; Obs-WO
	PS	Marine bird	Laridae	40128012	*Larus dominicanus*	Kelp gull	AFMA; Obs-WO
	PS	Marine bird	Procellariidae	40041004	*Fulmarus glacialoides*	Southern fulmar	AFMA; Obs-WO
	PS	Marine bird	Procellariidae	40041006	*Lugensa brevirostris*	Kerguelen petrel	AFMA; Obs-WO
	PS	Marine bird	Procellariidae	40041007	*Macronectes giganteus*	Southern giant-petrel	AFMA; Obs-WO
	PS	Marine bird	Procellariidae	40041008	*Macronectes halli*	Northern giant-petrel	AFMA; Obs-WO
	PS	Marine bird	Procellariidae	40041011	*Pachyptila desolata*	Antarctic prion	AFMA; Obs-WO
	PS	Marine bird	Procellariidae	40041019	*Procellaria cinerea*	Grey petrel	AFMA; Obs-WO
	PS	Marine bird	Procellariidae	40041031	*Pterodroma macroptera*	Great-winged petrel	AFMA; Obs-WO
	PS	Marine bird	Procellariidae	40041042	*Puffinus griseus*	Sooty shearwater	AFMA; Obs-WO
	PS	Marine bird	Procellariidae	40041048	*Thalassoica antarctica*	Antarctic petrel	AFMA; Obs-WO
	PS	Marine mammal	Delphinidae	41116011	Orcinus orca	Killer whale	AFMA; Obs-WO

Scoping Document S2B1. Benthic Habitats

A comprehensive assessment of the vulnerability of benthic habitats to impact by demersal fishing gear has been undertaken in the HIMI and surrounding Southern Ocean (Welsford et al. 2014). Consequently, at SARAG's September 2016 meeting, it was agreed that to avoid duplication and benthic habitats will not be assessed further. There is no SICA for this component.

Table 2.7. Benthic habitats that occur within the jurisdictional boundary of the HIMI Fishery. Shading denotes habitats over which no effort occurs. Not assessed in this report.

ERAEF record No.	ERAEF Habitat Number	Sub-biome	Feature	Habitat type	Depth (m)

Scoping Document S2B2. Pelagic Habitats

Table 2.8. Pelagic habitats for the HIMI demersal trawl sub-fishery. Shading denotes habitats occurring within the jurisdictional boundary of the fishery that are not subject to effort from demersal trawl methods. Bolded text refers to pelagic habitats where fishing effort has has occurred.

ERAEF Pelagic Habitat No.	Pelagic Habitat type	Depth (m)	Comments	Source
P1	Eastern Pelagic Province - Coastal	0 – 200		ERA pelagic habitat database based on pelagic communities definitions
P2	Eastern Pelagic Province - Oceanic	0 – > 600	this is a compilation of the range covered by Oceanic Community (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions
P3	Heard/ McDonald Islands Pelagic Provinces - Oceanic	0 - >1000	this is a compilation of the range covered by Oceanic Community (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions

ERAEF Pelagic Habitat No.	Pelagic Habitat type	Depth (m)	Comments	Source
P4	North Eastern Pelagic Province - Oceanic	0 – > 600	this is a compilation of the range covered by Oceanic Community (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions
P5	Northern Pelagic Province - Coastal	0 – 200		ERA pelagic habitat database based on pelagic communities definitions
P6	North Western Pelagic Province - Oceanic	0 – > 800	this is a compilation of the range covered by Oceanic Community (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions
P7	Southern Pelagic Province - Coastal	0 – 200	this is a compilation of the range covered by Coastal pelagic Tas and GAB	ERA pelagic habitat database based on pelagic communities definitions
P8	Southern Pelagic Province - Oceanic	0 – > 600	this is a compilation of the range covered by Oceanic Communities (1, 2 and 3)	ERA pelagic habitat database based on pelagic communities definitions
P9	Southern Pelagic Province - Seamount Oceanic	0 – > 600	this is a compilation of the range covered by Seamount Oceanic Communities (1), (2), and (3)	ERA pelagic habitat database based on pelagic communities definitions
P10	Western Pelagic Province - Coastal	0 – 200		ERA pelagic habitat database based on pelagic communities definitions
P11	Western Pelagic Province - Oceanic	0 – > 400	this is a compilation of the range covered by Oceanic Community (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions
P12	Eastern Pelagic Province - Seamount Oceanic	0 – > 600	this is a compilation of the range covered by Seamount Oceanic Communities (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions
P13	Heard/ McDonald Islands Pelagic Provinces - Plateau	0 -1000	this is a the same as community Heard Plateau 0-1000m	ERA pelagic habitat database based on pelagic communities definitions
P14	North Eastern Pelagic Province - Coastal	0 – 200		ERA pelagic habitat database based on pelagic communities definitions

ERAEF Pelagic Habitat No.	Pelagic Habitat type	Depth (m)	Comments	Source
P15	North Eastern Pelagic Province - Plateau	0 – > 600	this is a compilation of the range covered by the Northeastern Seamount Oceanic (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions
P16	North Eastern Pelagic Province - Seamount Oceanic	0 – > 600		ERA pelagic habitat database based on pelagic communities definitions
P17	Macquarie Island Pelagic Province - Oceanic	0 – 250		ERA pelagic habitat database based on pelagic communities definitions
P18	Macquarie Island Pelagic Province - Coastal	0 - > 1500	this is a compilation of the range covered by Oceanic Community (1) and (2)	ERA pelagic habitat database based on pelagic communities definitions

Scoping Document S2C1. Demersal Communities

In ERAEF, communities are defined as the set of species assemblages that occupy the large scale provinces and biomes identified from national bioregionalisation studies. The biota includes mobile fauna, both vertebrate and invertebrate, but excludes sessile organisms such as corals that are largely structural and are used to identify benthic habitats. The same community lists are used for all fisheries, with those selected as relevant for a particular fishery being identified on the basis of spatial overlap with effort in the fishery. The spatial boundaries for demersal communities are based on IMCRA boundaries for the shelf, and on slope bioregionalisations for the slope (IMCRA 1998; Last et al. 2005). The spatial boundaries for the pelagic communities are based on pelagic bioregionalisations and on oceanography (Condie et al. 2003; Lyne and Hayes 2004). Fishery and region specific modifications to these boundaries are described in detail in Hobday et al. (2007) and briefly outlined in the footnotes to the community Tables below.

Table 2.9. Demersal communities that underlie the pelagic communities in which fishing activity can occur in the HIMI fishery (x). Shaded cells indicate all communities within the province. Bold crosses refer to communities that underlie where fishing occurred in the HIMI.

Demersal community	Cape	North Eastern Transition	North Eastern	Central Eastern Transition	Central Eastern	South Eastern Transition	Central Bass	Tasmanian	Western Tas Transition	Southern	South Western Transition	Central Western	Central Western Transition	North Western	North Western Transition	Timor	Timor Transition	Heard & McDonald Is	Macquarie Is
Inner Shelf 0 – 110m [1,2]																			
Outer Shelf 110 – 250m [1,2,]																			
Upper Slope 250 – 565m [3]																			
Mid–Upper Slope 565 – 820m[3]																			
Mid Slope 820 – 1100m[3]																			
Lower slope/ Abyssal > 1100m[6]																			
Reef 0 -110m[7, 8]																			
Reef 110-250m[8]																			
Seamount 0 – 110m																			
Seamount 110- 250m																			

Demersal community	Cape	North Eastern Transition	North Eastern	Central Eastern Transition	Central Eastern	South Eastern Transition	Central Bass	Tasmanian	Western Tas Transition	Southern	South Western Transition	Central Western	Central Western Transition	North Western	North Western Transition	Timor	Timor Transition	Heard & McDonald Is	Macquarie Is
Seamount 250 – 565m																			
Seamount 565 – 820m																			
Seamount 820 – 1100m																			
Seamount 1100 – 3000m																			
Plateau 0 – 110m																			
Plateau 110- 250m[4]																		X	
Plateau 250 – 565m[4]																			
Plateau 565 – 820m[5]																		X*	
Plateau 820 – 1100m[5]																			

[1] Four inner shelf communities occur in the Timor Transition (Arafura, Groote, Cape York and Gulf of Carpentaria) and three inner shelf communities occur in the Southern (Eyre, Eucla and South West Coast). At Macquarie Is: [2]inner & outer shelves (0-250m), and [3]upper and midslope communities combined (250-1100m). **At Heard/McDonald Is: [4]outer and upper slope plateau communities combined to form four communities: Shell Bank, inner and outer Heard Plateau (100-500m) and Western Banks (200-500m), [5]mid and upper plateau communities combined into 3 trough (Western, North Eastern and South Eastern), southern slope and North Eastern plateau communities (500-1000m), and [6] 3 groups at Heard Is: Deep Shell Bank (>1000m), Southern and North East Lower slope/abyssal**, [7]Great Barrier Reef in the North Eastern Province and Transition and [8] Rowley Shoals in North Western Transition.

X: Shell Bank, inner and outer Heard Plateau (100-500m) and Western Banks (200-500m)

X*: North Eastern Trough (500-1000 m); North Eastern Plateau (500-1000 m); South Eastern Trough

Scoping Document S2C2. Pelagic Communities

Table 2.10. Pelagic communities in which fishing activity occurs in the HIMI (black; x). Shaded cells indicate all communities that exist in the province.

Pelagic community	Northeastern	Eastern	Southern	Western	Northern	Northwestern	Heard and McDonald Is[2]	Macquarie Is
Coastal pelagic 0-200m[1,2]								
Oceanic (1) 0 – 600m								
Oceanic (2) >600m								
Seamount oceanic (1) 0 – 600m								
Seamount oceanic (2) 600–3000m								
Oceanic (1) 0 – 200m								
Oceanic (2) 200-600m								
Oceanic (3) >600m								
Seamount oceanic (1) 0 – 200m								
Seamount oceanic (2) 200 – 600m								
Seamount oceanic (3) 600–3000m								
Oceanic (1) 0-400m								
Oceanic (2) >400m								
Oceanic (1) 0-800m								
Oceanic (2) >800m								
Plateau (1) 0-600m								
Plateau (2) >600m								
Heard Plateau 0-1000m[3]							X	
Oceanic (1) 0-1000m							X	
Oceanic (2) >1000m								
Oceanic (1) 0-1600m								
Oceanic (2) >1600m								

[1] Northern Province has five coastal pelagic zones (NWS, Bonaparte, Arafura, Gulf and East Cape York) and Southern Province has two zones (Tas, GAB). [2] At Macquarie Is: coastal pelagic zone to 250m. [3] At Heard and McDonald Is: coastal pelagic zone broadened to cover entire plateau to maximum of 1000 m.

X: Pelagic community in which fishing activity occurred was the Heard Plateau (0-1000 m) and Oceanic 0-1000 m.

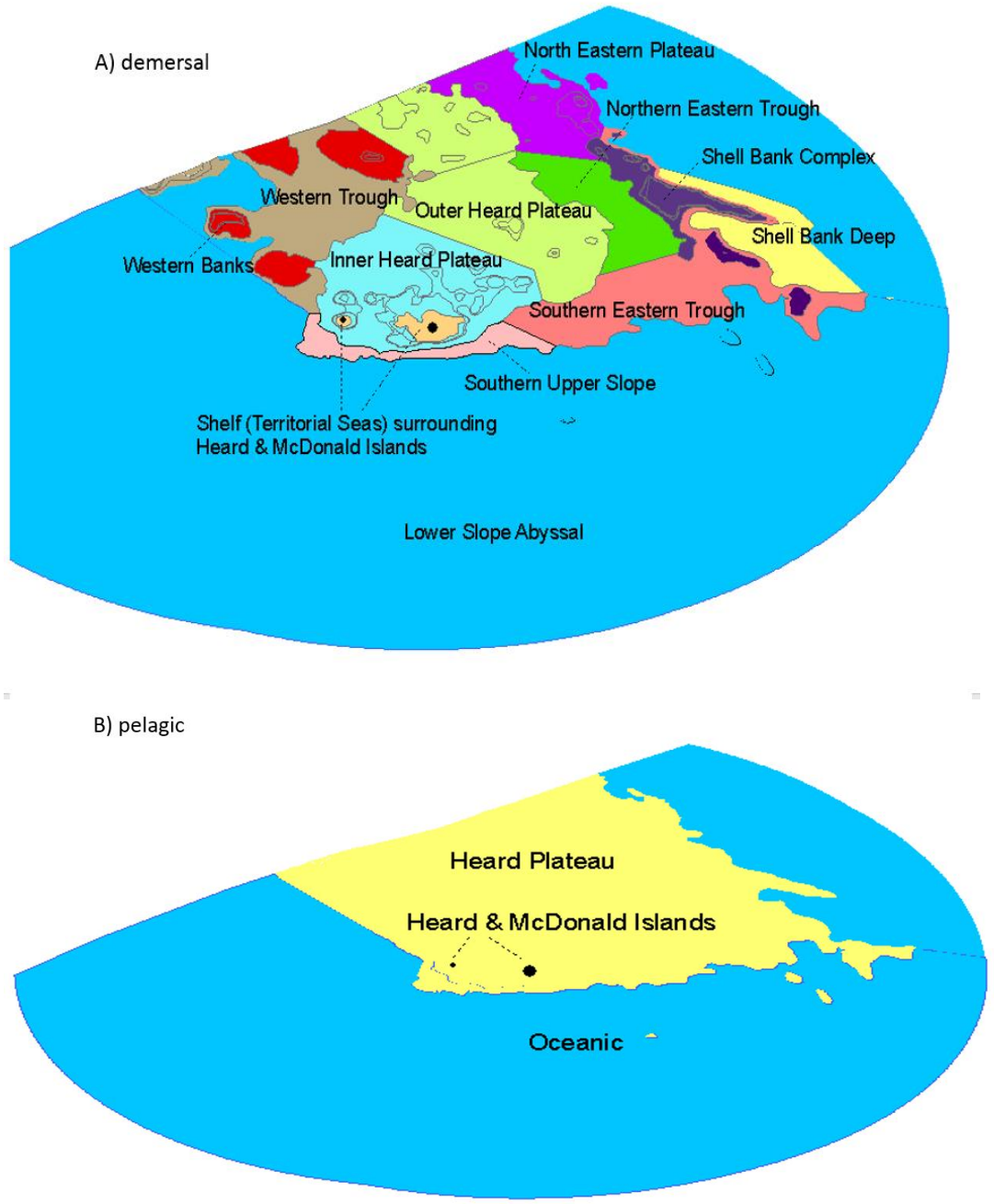


Figure 2.1 (a) Demersal and (b) pelagic communities in the Heard Island and McDonald Islands Fisheries.

2.2.3 Identification of objectives for components and sub-components (Step 3)

Objectives are identified for each sub-fishery for the five ecological components (target, bycatch/byproduct, protected species, habitats, and communities) and sub-components, and are clearly documented. It is important to identify objectives that managers, the fishing industry, and other stakeholders can agree on, and that scientists can quantify and assess. The criteria for selecting ecological operational objectives for risk assessment are that they:

- be biologically relevant;
- have an unambiguous operational definition;
- be accessible to prediction and measurement; and
- that the quantities they relate to be exposed to the hazards.

For fisheries that have completed Ecological Sustainable Development (ESD) reports, use can be made of the operational objectives stated in those reports.

Each 'operational objective' is matched to example indicators. **Scoping Document S3** provides suggested examples of operational objectives and indicators. Where operational objectives are already agreed for a fishery (Existing Management Objectives; EMOs), those should be used (e.g. Strategic Assessment Reports). The objectives need not be exactly specified, with regard to numbers or fractions of removal/impact, but should indicate that an impact in the sub-component is of concern/interest to the sub-fishery. The rationale for including or discarding an operational objective is a crucial part of the table and must explain why the particular objective has or has not been selected for in the (sub) fishery. Only the operational objectives selected for inclusion in the (sub) fishery are used for Level 1 analysis (**Level 1 SICA Document L1.1**).

Scoping Document S3. Components and sub-components identification of objectives

Table 2.11. Components and sub-components identification of operational objectives and rationale. Operational objectives that are eliminated are shaded out. EMO: Existing Management Objective; AMO: Existing AFMA Objective

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
	What is the general goal?		*"What you are specifically trying to achieve"?*	*"What you are going to use to measure performance?*	*Rationale flagged as 'EMO' where Existing Management Objective in place, or 'AMO' where there is an existing AFMA Management Objective in place for other Commonwealth fisheries (assumed that squid fishery will fall into line).*
Key Commercial and secondary commercial species	Avoid recruitment failure of the key/secondary commcercial species Avoid negative consequences for species or population sub-components	1. Population size	1.1 No trend in biomass 1.2 Maintain biomass above a specified level 1.3 Maintain catch at specified level 1.4 Species do not approach extinction or become extinct	Biomass, numbers, density, CPUE, yield	1.1 Increases in biomass of the key/secondary commcerical species would be acceptable. 1.2. To ensure that population at acceptable level by the assessment. 1.3. TAC levels are specified. 1.4. This is a general objective for all AFMA fisheries as per Fisheries Management Act 1991 (objective (b)). In general these objectives underlie the sustainable management of the Fishery, for both target bait and target species.
		2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across the known distribution range	2.1 Not currently monitored. No specific management objective based on the geographic range of key/secondary commercial species.
		3. Genetic structure	3.1 Genetic diversity does not change outside acceptable bounds	Frequency of genotypes in the population, effective population size (N_e), number of spawning units	3.1 Genetic studies have identified multiple stocks of striped marlin in Pacific Ocean. Stock assessment split by north and south Pacific Ocean.
		4. Age/size/sex structure	4.1 Age/size/sex structure does not change outside acceptable bounds (e.g. more than X% from	Biomass, numbers or relative proportion in age/size/sex classes Biomass of spawners	4.1 Covered in general by 1.2 EMO and AMO. The size range of Patagonian toothfish suggests that the fishery is not targeting recruitment or spawning grounds.

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
			reference structure)	Mean size, sex ratio	
		5. Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity) 2 Recruitment to the population does not change outside acceptable bounds	Egg production of population Abundance of recruits	5.1 Covered by 1.2 EMO and AMO. Reproductive capacity in terms of egg production may be easier to monitor via changes in Age/size/sex structure. 5.2 Covered by 1.2 EMO and AMO. May be easier to monitor via changes in Age/size/sex structure in the fishery.
		6. Behaviour /Movement	6.1 Behaviour and movement patterns of the population do not change outside acceptable bounds	Presence of population across space, movement patterns within the population (e.g. attraction to bait, lights)	6.1. Changes behavior that are deleterious to the species and populations are to be avoided. Covered by 1.2 EMO and AMO. However the possible links between the HIMI, Kerguelen and Crozet stocks and their respective degree of independence from each other require further investigation.
Byproduct and Bycatch	Avoid recruitment failure of the byproduct and bycatch species Avoid negative consequences for species or population sub-components	1. Population size	1.1 No trend in biomass 1.2 Species do not approach extinction or become extinct 1.3 Maintain biomass above a specified level 1.4 Maintain catch at specified level	Biomass, numbers, density, CPUE, yield	1.1 Increases in biomass of the key/secondary commcerical species would be acceptable. 1.2. To ensure that population at acceptable level by the assessment. Covered by EMO and AMO that ensures the fishery does not threaten bycatch species. 1.3. TAC levels are specified. EMO/AMO - annual reviews of all information on bycatch species with the aim of developing species specific bycatch limits. Use of 'move on provisions' to limit exploitation of bycatch stocks in localised areas. 1.4. This is a general objective for all AFMA fisheries as per Fisheries Management Act 1991 (objective (b)). Maintaining bycatch/byproduct levels not a specific objective. The protection of bycatch by TACs based on precautionary principles is the preferred method. "Move on provisions" are enforced if bycatch exceeds set limits.

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
		2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across space	2.1 Not currently monitored. No specific management objective based on the geographic range of byproduct/bycatch species. No specific management objective based on the geographic range of bycatch/byproduct species.
		3. Genetic structure	3.1 Genetic diversity does not change outside acceptable bounds	Frequency of genotypes in the population, effective population size (N_e), number of spawning units	3.1 Not currently monitored. No reference levels established. No specific management objective based on the genetic structure of bycatch species.
		4. Age/size/sex structure	4.1 Age/size/sex structure does not change outside acceptable bounds (e.g. more than X% from reference structure)	Biomass, numbers or relative proportion in age/size/sex classes Biomass of spawners Mean size, sex ratio	4.1 EMO – move on provisions require that if bycatch in any one haul exceeds set limits then the vessel must not use that fishing method within 5 nm of that site for at least 5 days.
		5 Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity) Recruitment to the population does not change outside acceptable bounds	Egg production of population Abundance of recruits	5.1 Beyond the generality of the EMO "Fishing is conducted in a manner that does not threaten stocks of byproduct / bycatch species", reproductive capacity is not currently measured for bycatch/byproduct species and is largely covered by other objectives.
		6. Behaviour /Movement	6.1 Behaviour and movement patterns of the population do not change outside acceptable bounds	Presence of population across space, movement patterns within the population (e.g. attraction to bait, lights)	6.1 Trawling does not appear to attract bycatch species or alter their behaviour and movement patterns, resulting in the attraction of species to fishing grounds.

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
Protected species	Avoid recruitment failure of protected species Avoid negative consequences for protected species or population sub-components Avoid negative impacts on the population from fishing	1. Population size	1.1 Species do not further approach extinction or become extinct 1.2 No trend in biomass 1.3 Maintain biomass above a specified level 1.4 Maintain catch at specified level	Biomass, numbers, density, CPUE, yield	1.1 EMO - The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species. 1.2 A positive trend in biomass is desirable for protected species. 1.3 Maintenance of protected species biomass above specified levels not currently a fishery operational objective. 1.4 The above EMO states '.must avoid mortality/injury to protected species.
		2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across space, i.e. the Southern Ocean	2.1 Change in geographic range of protected species may have serious consequences e.g. population fragmentation and/or forcing species into sub-optimal areas.
		3. Genetic structure	3.1 Genetic diversity does not change outside acceptable bounds	Frequency of genotypes in the population, effective population size (N_e), number of spawning units	3.1 Because population size of protected species is often small, protected species are sensitive to loss of genetic diversity. Genetic monitoring may be an effective approach to measure possible fishery impacts.
		4. Age/size/sex structure	4.1 Age/size/sex structure does not change outside acceptable bounds (e.g. more than X% from reference structure)	Biomass, numbers or relative proportion in age/size/sex classes Biomass of spawners Mean size, sex ratio	4.1 Monitoring the age/size/sex structure of protected species populations is a useful management tool allowing the identification of possible fishery impacts and that cross-section of the population most at risk.
		5. Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference	Egg production of population Abundance of recruits	5.1 The reproductive capacity of protected species is of concern to this fishery because potential fishery induced changes in reproductive ability (e.g. reduction in prey items may critically affect seabird brooding success) may have immediate impact on the population size of protected species.

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
			population fecundity) Recruitment to the population does not change outside acceptable bounds		
		6. Behaviour /Movement	6.1 Behaviour and movement patterns of the population do not change outside acceptable bounds	Presence of population across space, movement patterns within the population (e.g. attraction to bait, lights)	6.1 Trawling operations may attract protected species and alter behaviour and movement patterns, resulting in the habituation of protected species to fishing vessels. The overall effect may be to prevent juveniles from learning to fend for themselves therefore increasing the animals' reliance on fishing vessels. Subsequently this could substantially increase the risk of injury/mortality by collision, entrapment or entanglement with a vessel or fishing gear.
		7. Interactions with fishery	7.1 Survival after interactions is maximised 7.2 Interactions do not affect the viability of the population or its ability to recover	Survival rate of species after interactions Number of interactions, biomass or numbers in population	7.1, 7.2, EMO – The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species. Includes the prohibition on discarding offal (bycatch, fish processing waste, unwanted dead fish), gear restrictions and reduced lighting levels to minimise interactions and attraction of the vessel to protected species.
Habitats	Avoid negative impacts on quality of environment Avoid reduction in the amount and quality of habitat	1. Water quality	1.1 Water quality does not change outside acceptable bounds	Water chemistry, noise levels, debris levels, turbidity levels, pollutant concentrations, light pollution from artificial light	1.1 EMO control the discharge or discarding of waste (fish offal) and limit lighting on the vessels. MARPOL regulations prohibit discharge of oils, discarding of plastics.
		2. Air quality	2.1 Air quality does not change outside acceptable bounds	Air chemistry, noise levels, visual pollution, pollutant concentrations, light pollution from artificial light	2.1 Not currently perceived as an important habitat sub-component, trawling operations not believed to strongly influence air quality.
		3. Substrate quality	3.1 Sediment quality does not change outside acceptable bounds	Sediment chemistry, stability, particle size, debris, pollutant concentrations	3.1 EMO – The fishery is conducted, in a manner that minimises the impact of fishing operations on benthic habitat. Controls on bobbin and disc size requirements to minimise benthic impacts (EA Assessment 2002). The current MPA and conservation areas reserve large areas of the known habitat types from fishing disturbance.
		4. Habitat types	4.1 Relative abundance of habitat types does not vary	Extent and area of habitat types, % cover, spatial	4.1 Trawling activities may result in changes to the local habitat types on fishing grounds.

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
			outside acceptable bounds	pattern, landscape scale	The current MPA and conservation areas reserve large areas of the known habitat types from fishing disturbance.
		5. Habitat structure and function	5.1 Size, shape and condition of habitat types does not vary outside acceptable bounds	Size structure, species composition and morphology of biotic habitats	5.1 Trawling activities may result in local disruption to pelagic and benthic processes.
Communities	Avoid negative impacts on the composition/function/distribution/structure of the community	1. Species composition	1.1 Species composition of communities does not vary outside acceptable bounds	Species presence/absence, species numbers or biomass (relative or absolute) Richness Diversity indices Evenness indices	1.1 EMO – The fishery is conducted, in a manner that minimises the impact of fishing operations on the ecosystem generally. Assessments of benthic impacts by AFMA have been based on AAD trawl data and quantitative monitoring of benthic bycatch.
		2. Functional group composition	2.1 Functional group composition does not change outside acceptable bounds	Number of functional groups, species per functional group (e.g. autotrophs, filter feeders, herbivores, omnivores, carnivores)	2.1 The presence/abundance of 'functional group' members may fluctuate widely, however in terms of maintenance of ecosystem processes it is important that the aggregate effect of a functional group is maintained.
		3. Distribution of the community	3.1 Community range does not vary outside acceptable bounds	Geographic range of the community, continuity of range, patchiness	3.1 Demersal trawling operations have unknown impacts on the benthos in the fishing grounds. The current MPA and conservation areas reserve large areas of the known habitat types from fishing disturbance.
		4. Trophic/size structure	4.1 Community size spectra/trophic structure does not vary outside acceptable bounds	Size spectra of the community Number of octaves, Biomass/number in each size class Mean trophic level Number of trophic levels	4.1 Trawling activities for key/secondary commercial species have the potential to remove a significant component of the predator functional group. Increased abundance of the prey groups may then allow shifts in relative abundance of higher trophic level organisms.
		5. Bio- and geo-chemical cycles	5.1 Cycles do not vary outside acceptable bounds	Indicators of cycles, salinity, carbon, nitrogen, phosphorus flux	5.1 Trawling operations not perceived to have a detectable effect on bio and geochemical cycles.

2.2.4 Hazard Identification (Step 4)

Hazards are the activities undertaken in the process of fishing, and any external activities, which have the potential to lead to harm.

The effects of fishery/sub-fishery specific hazards are identified under the following categories:

- capture
- direct impact without capture
- addition/movement of biological material
- addition of non biological material
- disturbance of physical processes
- external hazards

These fishing and external activities are scored on a presence/absence basis for each fishery/sub-fishery. An activity is scored as a zero if it does not occur and as a one if it does occur. The rationale for the scoring is also documented in detail and must include if/how the activity occurs and how the hazard may impact on organisms/habitat.

Scoping Document S4. Hazard Identification Scoring Sheet

This table is completed once for each sub-fishery. See Table 2.13 provides a set of examples of fishing activities for the effects of fishing to be used as a guide to assist in scoring the hazards.

Fishery name: Heard Island and McDonald Islands (HIMI)
Sub-fishery name: Demersal trawl
Date completed: September 2016

Table 2.12. Hazard identification, score and rationale(s) for the HIMI demersal trawl sub-fishery.

Direct impact of Fishing	Fishing Activity	Score (0/1)	Documentation of Rationale
Capture	Bait collection	0	No baits used in trawl fishery
	Fishing	1	Occurs, resulting in capture of animals
	Incidental behaviour	0	No ports, no landings, no recreational fishing recorded.
Direct impact without capture	Bait collection	0	No baits used in trawl fishery
	Fishing	1	Trawling is likely to impact benthic habitats and animals as the gear contacts seafloor.
	Incidental behaviour	0	

Direct impact of Fishing	Fishing Activity	Score (0/1)	Documentation of Rationale
	Gear loss	1	Lost gear may interact with animals, including benthic species and habitats. Also, nets are towed on bottom and gear loss has been reported.
	Anchoring/ mooring	0	Not recorded
	Navigation/steaming	1	Occurs throughout the fishery grounds.
Addition/ movement of biological material	Translocation of species	1	Translocation of species via ballast water or as hull or organisms fouling sea water piping systems is a potential risk. Movement of species due to movement of boats between areas of the fishery is a possibility.
	On board processing	0	Fish processed on-board but discarding of offal and unwanted bycatch prohibited within fishery jurisdiction.
	Discarding catch	0	Target and byproduct species are occasionally discarded. Bycatch species are discarded outside the fishery area, as discarding is not permitted.
	Stock enhancement	0	Does not occur in this fishery
	Provisioning	0	No bait or berley used in fishery
	Organic waste disposal	0	Disposal of certain food scraps, brassicas and poultry products prohibited, other food scraps disposed of according to MARPOL regulations.
Addition of non-biological material	Debris	0	Debris from non-fishing activities e.g. Crew rubbish – discarding regulations, plastics must be retained under MARPOL Convention. Other items (e.g. poultry and brassicas are incinerated and ash stored in impermeable bags in a rubbish locker located on deck. All non-burnable rubblish is bagged and retained in rubber locker and locked on deck.
	Chemical pollution	0	Possible oil spills, detergents other cleaning agents or chemicals. However, regulated by MARPOL.
	Exhaust	1	Occurs through steaming and engine operations. Types of fuels being burnt e.g.: MDO (marine diesel oils) vs HFO (heavy fuel oil).
	Gear loss	1	Several instances of gear loss occurred within the last five years.
	Navigation/ steaming	1	Trawling operations involves navigating to and from fishing grounds. Navigation/steaming introduces noise to environment. Depth sounders/ acoustic net positioning systems have potential to disturb marine species.
	Activity/ presence on water	1	Noise and movement, visual stimuli may be a cue to some species attracting them to the vessel or a part of the fishing operation.

Direct impact of Fishing	Fishing Activity	Score (0/1)	Documentation of Rationale
Disturb physical processes	Bait collection	0	No bait used in trawl fishery.
	Fishing	1	Fishing gear may disturb benthos by nets.
	Boat launching	0	Vessels operate from ports.
	Anchoring/ mooring	0	No records of vessels anchoring in sub-Antarctic AFZ.
	Navigation/ steaming	1	Trawling operations involves navigating to and from fishing grounds. Due to depth benthos unlikely to be affected. Wake mixing of surface waters does occur.
External Hazards (specify the particular example within each activity area)	Other capture fishery methods	1	Longline fisheries for toothfish. Demersal trawl fishery for Patagonian toothfish and mackerel icefish. Area too remote for indigenous or recreational fishers.
	Aquaculture	0	None
	Coastal development	0	None
	Other extractive activities	0	Not known
	Other non-extractive activities	0	Not known
	Other anthropogenic activities	1	Tourist shipping and landings by tourists. Other scientific voyages.

Table 2.13. Examples of fishing activities (Modified from Fletcher et al. 2002).

Direct Impact of Fishing	Fishing Activity	Examples of Activities Include
Capture		Activities that result in the capture or removal of organisms. This includes cryptic mortality due to organisms being caught but dropping out prior to the gear's retrieval (i.e. They are caught but not landed)
	Bait collection	Capture of organisms due to bait gear deployment, retrieval and bait fishing. This includes organisms caught but not landed.
	Fishing	Capture of organisms due to gear deployment, retrieval and actual fishing. This includes organisms caught but not landed.
	Incidental behaviour	Capture of organisms due to crew behaviour incidental to primary fishing activities, possible in the crew's down time; e.g. crew may line or spear fish while anchored, or perform other harvesting activities, including any land-based harvesting that occurs when crew are camping in their down time.
Direct impact, without capture		This includes any activities that may result in direct impacts (damage or mortality) to organisms without actual capture.
	Bait collection	Direct impacts (damage or mortality) to organisms due to interactions (excluding capture) with bait gear during deployment, retrieval and bait fishing. This includes: damage/mortality to organisms through contact with the gear that doesn't result in capture, e.g. Damage/mortality to benthic species by gear moving over them, organisms that hit nets but aren't caught.
	Fishing	Direct impacts (damage or mortality) to organisms due to interactions (excluding capture) with fishing gear during deployment, retrieval and fishing. This includes: damage/mortality to organisms through contact with the gear that doesn't result in capture, e.g. Damage/mortality to benthic species by gear moving over them, organisms that hit nets but are not caught.
	Incidental behaviour	Direct impacts (damage or mortality) without capture, to organisms due to behaviour incidental to primary fishing activities, possibly in the crew's down time; e.g. the use of firearms on scavenging species, damage/mortality to organisms through contact with the gear that the crew use to fish during their down time. This does not include impacts on predator species of removing their prey through fishing.
	Gear loss	Direct impacts (damage or mortality), without capture on organisms due to gear that has been lost from the fishing boat. This includes damage/mortality to species when the lost gear contacts them or if species swallow the lost gear.

Direct Impact of Fishing	Fishing Activity	Examples of Activities Include
	Anchoring/ mooring	Direct impact (damage or mortality) that occurs and when anchoring or mooring. This includes damage/mortality due to physical contact of the anchor, chain or rope with organisms, e.g. An anchor damaging live coral.
	Navigation/ steaming	Direct impact (damage or mortality) without capture may occur while vessels are navigating or steaming. This includes collisions with marine organisms or birds.
Addition/ movement of biological material		Any activities that result in the addition or movement of biological material to the ecosystem of the fishery.
	Translocation of species (boat movements, reballasting)	The translocation and introduction of species to the area of the fishery, through transportation of any life stage. This transport can occur through movement on boat hulls or in ballast water as boats move throughout the fishery or from outside areas into the fishery.
	On board processing	The discarding of unwanted sections of target after on board processing introduces or moves biological material, e.g. heading and gutting, retaining fins but discarding trunks.
	Discarding catch	The discarding of unwanted organisms from the catch can introduce or move biological material. This includes individuals of target and byproduct species due to damage (e.g. shark or marine mammal predation), size, high grading and catch limits. Also includes discarding of all non-retained bycatch species. This also includes discarding of catch resulting from incidental fishing by the crew. The discards could be alive or dead.
	Stock enhancement	The addition of larvae, juveniles or adults to the fishery or ecosystem to increase the stock or catches.
	Provisioning	The use of bait or berley in the fishery.
	Organic waste disposal	The disposal of organic wastes (e.g. food scraps, sewage) from the boats.
Addition of non-biological material		Any activities that result in non-biological material being added to the ecosystem of the fishery, this includes physical debris, chemicals (in the air and water), lost gear, noise and visual stimuli.

Direct Impact of Fishing	Fishing Activity	Examples of Activities Include
	Debris	Non-biological material may be introduced in the form of debris from fishing vessels or mother ships. This includes debris from the fishing process: e.g. cardboard thrown over from bait boxes, straps and netting bags lost. Debris from non-fishing activities can also contribute to this e.g. Crew rubbish – discarding or food scraps, plastics or other rubbish. Discarding at sea is regulated by MARPOL, which forbids the discarding of plastics.
	Chemical pollution	Chemicals can be introduced to water, sediment and atmosphere through: oil spills, detergents other cleaning agents, any chemicals used during processing or fishing activities.
	Exhaust	Exhaust can be introduced to the atmosphere and water through operation of fishing vessels
	Gear loss	The loss of gear will result in the addition of non-biological material, this includes hooks, line, sinkers, nets, otter boards, light sticks, buoys etc.
	Navigation /steaming	The navigation and steaming of vessels will introduce noise and visual stimuli into the environment. Boat collisions and/or sinking of vessels. Echo-sounding may introduce noise that may disrupt some species (e.g. whales, orange roughy)
	Activity /presence on water	The activity or presence of fishing vessels on the water will noise and visual stimuli into the environment.
Disturb physical processes		Any activities that will disturb physical processes, particularly processes related to water movement or sediment and hard substrate (e.g. boulders, rocky reef) processes.
	Bait collection	Bait collection may disturb physical processes if the gear contacts seafloor-disturbing sediment, or if the gear disrupts water flow patterns.
	Fishing	Fishing activities may disturb physical processes if the gear contacts seafloor-disturbing sediment, or if the gear disrupts water flow patterns.
	Boat launching	Boat launching may disturb physical processes, particularly in the intertidal regions, if dredging is required, or the boats are dragged across substrate. This would also include foreshore impacts where fishers drive along beaches to reach fishing locations and launch boats.

Direct Impact of Fishing	Fishing Activity	Examples of Activities Include
		Impacts of boat launching that occurs within established marinas are outside the scope of this assessment.
	Anchoring /mooring	Anchoring/mooring may affect the physical processes in the area that anchors and anchor chains contact the seafloor.
	Navigation /steaming	Navigation /steaming may affect the physical processes on the benthos and the pelagic by turbulent action of propellers or wake formation.
External hazards		Any outside activities that will result in an impact on the component in the same location and period that the fishery operates. The particular activity as well as the mechanism for external hazards should be specified.
	Other capture fishery methods	Take or habitat impact by other commercial, indigenous or recreational fisheries operating in the same region as the fishery under examination
	Aquaculture	Capture of feed species for aquaculture. Impacts of cages on the benthos in the region
	Coastal development	Sewage discharge, ocean dumping, agricultural runoff
	Other extractive activities	Oil and gas pipelines, drilling, seismic activity
	Other non-extractive activities	Defense, shipping lanes, dumping of munitions, submarine cables
	Other anthropogenic activities	Recreational activities, such as scuba diving leading to coral damage, power boats colliding with whales, dugongs, turtles. Shipping, oil spills

2.2.5 Bibliography (Step 5)

All references used in the scoping assessment are included in the References section.

Key documents can be found on the AFMA web page at www.afma.gov.au and include the following:

- HIMI Status Assessment Report 2013
- HIMI Fishery Management Plan 2002 (amended 04/05/2016)
- HIMI Fishery Regulations 2002
- Management Plan and Regulation Guidelines
- AFMA At a glance web page http://www.afma.gov.au/fisheries/heard-island-mcdonald-island-fishery/
- Bycatch Action Plans
- Data Summary Reports (logbook and observer)

Other publications that may have provided information include

- ABARES Fishery Status Reports
- Strategic Plans

2.2.6 Decision rules to move to Level 1 (Step 6)

Any hazards that are identified at Step 4 Hazard Identification as occurring in the fishery are carried forward for analysis at Level 1.

In this case, 11 out of 26 possible internal activities were identified as occurring in this sub-fishery. Two out of six external scenarios were also identified. Thus, a total of 13 activity-component scenarios will be considered at Level 1. This results in 39 total scenarios (of 160 possible) to be developed and evaluated using the unit lists (byproduct/bycatch, protected species, communities).

2.3 Level 1 Scale, Intensity and Consequence Analysis (SICA)

Level 1 aims to identify which hazards lead to a significant impact on any species, habitat or community. Analysis at Level 1 is for whole components (key/secondary commercial; bycatch and byproduct; protected species; habitat; and communities), not individual sub-components. Since Level 1 is used mainly as a rapid screening tool, a "worst case" approach is used to ensure that elements screened out as low risk (either activities or components) are genuinely low risk. Analysis at Level 1 for each component is accomplished by considering the most vulnerable sub-component and the most vulnerable unit of analysis (e.g. most vulnerable species, habitat type or community). This is known as credible scenario evaluation (Richard Stocklosa e-systems Pty Ltd (March 2003) Review of CSIRO Risk Assessment Methodology: ecological risk assessment for the effects of fishing) in conventional risk assessment. In addition, where judgments about risk are uncertain, the highest level of risk that is still regarded as plausible is chosen. For this reason, the measures of risk produced at Level 1 cannot be regarded as absolute.

At Level 1 each fishery/sub-fishery is assessed using a scale, intensity and consequence analysis (SICA). SICA is applied to the component as a whole by choosing the most vulnerable sub-component (linked to an operational objective) and most vulnerable unit of analysis. The rationale for these choices must be documented in detail. These steps are outlined below. Scale, intensity, and consequence analysis (SICA) consists of thirteen steps. The first ten steps are performed for each activity and component, and correspond to the columns of the SICA table. The final three steps summarise the results for each component.

Step1: Record the hazard identification score (absence (0) presence (1) scores) identified at Step 3 at the scoping level (Scoping Document S3) onto the SICA table
Step 2: Score spatial scale of the activity
Step 3: Score temporal scale of the activity
Step 4: Choose the sub-component most likely to be affected by activity
Step 5: Choose the most vulnerable unit of analysis for the component e.g. species, habitat type or community assemblage
Step 6: Select the most appropriate operational objective
Step 7: Score the intensity of the activity for that sub-component
Step 8: Score the consequence resulting from the intensity for that sub component
Step 9: Record confidence/uncertainty for the consequence scores
Step 10: Document rationale for each of the above steps
Step 11: Summary of SICA results
Step 12: Evaluation/discussion of Level 1
Step 13: Components to be examined at Level 2

2.3.1 Record the hazard identification score (absence (0) presence (1) scores) identified at step 3 in the scoping level onto the SICA Document (Step 1)

Record the hazard identification score absence (0) presence (1) identified at Step 3 at the scoping level onto the SICA sheet. A separate sheet will be required for each component (key/secondary commercial, bycatch and byproduct, and protected species, habitat and communities). Only those activities that scored a 1 (presence) will be analysed at Level 1.

2.3.2 Score spatial scale of activity (Step 2)

The greatest spatial extent must be used for determining the spatial scale score for each identified hazard. For example, if fishing (e.g. capture by longline) takes place within an area of 200 nm by 300 nm, then the spatial scale is scored as 4. The score is then recorded onto the SICA Document and the rationale documented.

Table 2.14. Spatial scale score of activity.

<1 nm:	1-10 nm:	10-100 nm:	100-500 nm:	500-1000 nm:	>1000 nm:
1	2	3	4	5	6

Maps and graphs may be used to supplement the information (e.g. sketches of the distribution of the activity relative to the distribution of the component) and additional notes describing the nature of the activity should be provided. The spatial scale score at Step 2 is not used directly, but the analysis is used in making judgments about level of intensity at Step 7. Obviously, two activities can score the same with regard to spatial scale, but the intensity of each can differ vastly. The reasons for the score are recorded in the rationale column of the SICA spreadsheet.

2.3.3 Score temporal scale of activity (Step 3)

The highest frequency must be used for determining the temporal scale score for each identified hazard. If the fishing activity occurs daily, the temporal scale is scored as 6. If oil spillage occurs about once per year, then the temporal scale of that hazard scores a 3. The score is then recorded onto the SICA Document and the rationale documented.

Table 2.15. Temporal scale score of activity.

Decadal (1 day every 10 years or so)	Every several years (1 day every several years)	Annual (1-100 days per year)	Quarterly (100-200 days per year)	Weekly (200-300 days per year)	Daily (300-365 days per year)
1	2	3	4	5	6

It may be more logical for some activities to consider the aggregate number of days that an activity occurs. For example, if the activity "fishing" was undertaken by 10 boats during the same 150 days of the year, the score is 4. If the same 10 boats each spend 30 non-overlapping days fishing, the temporal scale of the activity is a sum of 300 days, indicating that a score of 6 is appropriate. In the case where the activity occurs over many days, but only every 10 years, the number of days by the number of years in the cycle is used to determine the score. For example, 100 days of an activity every 10 years averages to 10 days every year, so that a score of 3 is appropriate.

The temporal scale score at Step 3 is not used directly, but the analysis is used in making judgments about level of intensity at Step 7. Obviously, two activities can score the same with regard to temporal scale, but the intensity of each can differ vastly. The reasons for the score are recorded in the rationale column.

2.3.4 Choose the sub-component most likely to be affected by activity (Step 4)

The most vulnerable sub-component must be used for analysis of each identified hazard. This selection must be made on the basis of expected highest potential risk for each 'direct impact of fishing' and 'fishing activity' combination, and recorded in the 'sub-component' column of the SICA Document. The justification is recorded in the rationale column.

2.3.5 Choose the unit of analysis most likely to be affected by activity and to have highest consequence score (Step 5)

The most vulnerable 'unit of analysis' (i.e. most vulnerable species, habitat type or community) must be used for analysis of each identified hazard. The species, habitats, or communities (depending on which component is being analysed) are selected from **Scoping Document S2 (A – C)**. This selection must be made on the basis of expected highest potential risk for each 'direct impact of fishing' and 'fishing activity'

combination, and recorded in the 'unit of analysis' column of the SICA Document. The justification is recorded in the rationale column.

2.3.6 Select the most appropriate operational objective (Step 6)

To provide linkage between the SICA consequence score and the management objectives, the most appropriate operational objective for each sub-component is chosen. The most relevant operational objective code from **Scoping Document S3** is recorded in the 'operational objective' column in the SICA document. Note that SICA can only be performed on operational objectives agreed as important for the (sub) fishery during scoping and contained in **Scoping Document S3**. If the SICA process identifies reasons to include sub-components or operational objectives that were previously not included/eliminated then these sub-components or operational objectives must be re-instated.

2.3.7 Score the intensity of the activity for the component (Step 7)

The score for intensity of an activity considers the direct impacts in line with the categories shown in the conceptual model (Figure 1.2) (capture, direct impact without capture, addition/movement of biological material, addition of non-biological material, disturbance to physical processes, external hazards). The intensity of the activity is judged based on the scale of the activity, its nature and extent. Activities are scored as per intensity scores below.

Table 2.16. Intensity score of activity (Modified from Fletcher et al. 2002).

Level	Score	Description
Negligible	1	remote likelihood of detection at any spatial or temporal scale
Minor	2	occurs rarely or in few restricted locations and detectability even at these scales is rare
Moderate	3	moderate at broader spatial scale, or severe but local
Major	4	severe and occurs reasonably often at broad spatial scale
Severe	5	occasional but very severe and localized or less severe but widespread and frequent
Catastrophic	6	local to regional severity or continual and widespread

This score is then recorded on the **Level 1 (SICA) Document** and the rationale documented.

2.3.8 Score the consequence of intensity for that component (Step 8)

The consequence of the activity is a measure of the likelihood of not achieving the operational objective for the selected sub-component and unit of analysis. It considers the flow on effects of the direct impacts from Step 7 for the relevant indicator (e.g. decline in biomass below the selected threshold due to direct capture). Activities are scored as per consequence scores defined below. A more detailed description of the consequences at each level for each component (key/secondary commercial, bycatch and byproduct, protected species, habitats, and communities) is provided as a guide for scoring the consequences of the activities in the description of consequences table (Table 2.17).

Table 2.17. Consequence score for ERAEF activities (Modified from Fletcher et al. 2002).

Level	Score	Description
Negligible	1	Impact unlikely to be detectable at the scale of the stock/habitat/community
Minor	2	Minimal impact on stock/habitat/community structure or dynamics
Moderate	3	Maximum impact that still meets an objective (e.g. sustainable level of impact such as full exploitation rate for a target species).
Major	4	Wider and longer term impacts (e.g. long-term decline in CPUE)
Severe	5	Very serious impacts now occurring, with relatively long time period likely to be needed to restore to an acceptable level (e.g. serious decline in spawning biomass limiting population increase).
Intolerable	6	Widespread and permanent/irreversible damage or loss will occur-unlikely to ever be fixed (e.g. extinction)

The score should be based on existing information and/or the expertise of the risk assessment group. The rationale for assigning each consequence score must be documented. The conceptual model may be used to link impact to consequence by showing the pathway that was considered. In the absence of agreement or information, the highest score (worst case scenario) considered plausible is applied to the activity.

2.3.9 Record confidence/uncertainty for the consequence scores (Step 9)

The information used at this level is qualitative and each step is based on expert (fishers, managers, conservationists, scientists) judgment. The confidence rating for the consequence score is rated as 1 (low confidence) or 2 (high confidence) for the activity/component. The score is recorded on the SICA Document and the rationale

documented. The confidence will reflect the levels of uncertainty for each score at steps 2, 3, 7 and 8 (see description; Table 2.18).

Table 2.18. Description of Confidence scores for Consequences. The confidence score appropriate to the rationale is used, and documented on the SICA Document.

Confidence	Score	Rationale for the confidence score
Low	1	Data exists, but is considered poor or conflicting
		No data exists
		Disagreement between experts
High	2	Data exists and is considered sound
		Consensus between experts
		Consequence is constrained by logical consideration

2.3.10 Document rationale for each of the above steps (Step 10)

The rationale forms a logical pathway to the consequence score. It is provided for each choice at each step of the SICA analysis.

SICA steps 1-10. Tables of descriptions of consequences for each component and each sub component provide a guide for scoring the level of consequence (see Table above)

Level 1 (SICA) Document L1.1 Key commercial/secondary commercial species.

The direct impact of fishing hazard (i.e. Capture:Fishing) for Patagonian toothfish is not assessed at L1 since it undergoes a stock assessment and therefore does not go to the next level (L2).

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	3	3	Population Size	Patagonian toothfish	1.1	3			Biennial stock assessments negate the need for assessment -no further action required
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									
	Fishing	1	3	3	Population Size	Patagonian toothfish	1.1	3	2	2	Fish escape through net meshes and population size most likely to be affected if post-capture survival is low. Intensity moderate. Consequence minor, tagging surveys successful therefore assume good post-capture survival after escapement. Confidence: high, based on data collected by observers and research conducted in the fishery to date.
	Incidental behaviour	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Gear loss	1	3	3	Population Size	Patagonian toothfish	1.1	2	2	2	Annual gear loss small. Gear loss has potential to alter species composition by direct interactions with species particularly benthic species. Intensity minor, due to limited numbers of vessels in fishery, and management controls requiring attempt to retrieve lost gear. Consequence minor. The types of gear recorded as lost are either small or have a minimal risk of entangling toothfish. Confidence: high, as observers present on all trips and report all gear lost and is reported to AFMA and DOE.
	Anchoring/ mooring	0									
	Navigation/ steaming	1	3	3	Behaviour/movement	Patagonian toothfish	6.1	1	1	2	Navigation/steaming occurs between 1-100 days across the Heard Plateau. Population size most likely impacted. Intensity negligible as unlikely for deepwater demersal species to collide with vesel. Consequence: negligible. Confidence: high, logic.
Addition/ movement of biological material	Translocation of species	1	6	3	Population size	Patagonian toothfish	1.1	1	2	1	Translocation of species via ballast, hull fouling could occur daily. Population size most likely to be affected before major changes in geographic range or genetic structure. =Intensity: negligible the likelihood of temperate water species surviving and establishing as a threat to Patagonian toothfish in sub-antarctic waters is considered negligible. Conseqeunce: minor, due to the potential for the spread of fishborne disease. Confidence: low due to absence of data on susceptibility of Patagonian toothfish to fishborne diseases.
	On board processing	0									
	Discarding catch	0									
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	0									
	Debris	0									
	Chemical pollution	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Addition of non-biological material	Exhaust	1	3	3	Population size	Mackerel icefish	1.1	1	1	2	Exhaust emissions occur daily during the season. Intensity and consequence are both scored as negligible. The limited number of vessels in the fishery coupled with the depth at which target species are found makes it highly unlikely that exhaust gas emissions will have an affect on the target species. Further weather conditions in the region are frequently extreme, rapidly dispersing exhaust emissions. Confidence: high, due to depth of water column separating target species from emissions.
	Gear loss	1	3	3	Population size	Mackerel icefish	1.1	2	2	2	Annual gear loss or HIMI small. The limited number of vessels in the fishery coupled with the type of gear in use indicates a minor intensity value. Consequence: minor. Confidence: high, due to gear loss information from observer and SARAG reports.
	Navigation/ steaming	1	3	3	Behaviour/movement	Mackerel icefish	6.1	1	1	1	Mackerel icefish chosen as mid-water/pelagic species more likely to be affected by noise or echosounders than a demersal species. Intensity: negligible due to the limited number of vessels in the fishery. Consequence: negligible, as only a small area is affected and target species mobility and depth locations seen as mitigating factors. Confidence: low due to lack of data from the HIMI fishery regarding steaming/navigation.
	Activity/ presence on water	1	3	3	Behaviour/movement	Mackerel icefish	6.1	1	1	1	Mackerel icefish chosen as mid-water/pelagic species more likely to be affectedby presence of vessel than a demersal species. Intensity negligible due to the limited number of vessels in the fishery. Consequence is also seen as negligible as only a small area is affected and target species mobility and depth locations seen as mitigating factors. Confidence: low due to lack of data from the HIMI fishery regarding effects of presence/activity.
	Bait collection	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Disturb physical processes	Fishing	1	3	3	Behaviour/movement	Patagonian toothfish	6.1	3	2	1	Patagonian toothfish chosen as demersal species most likely affected by disturbance of the habitat by the trawl. Intensity: moderate as localised grounds are repeatedly targeted. Consequence: minor, only a small area is affected, research to assess benthic impacts has been planned indicating concern over benthic changes but MPAs were declared to preserve habitats. These changes could affect distribution of target stocks. Confidence: low, due to lack of data from the HIMI fishery regarding effects of benthos disturbance.
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/ steaming	1	3	3	Behaviour/movement	Mackerel icefish	6.1	2	1	1	Fishing occurs between 1-100 days, therefore navigation/steaming occurs daily during season. Mackerel icefish chosen as mid-water/pelagic species more likely to be affected than a demersal species. Intensity minor due to the limited number of vessels in the fishery. Consequence: negligible, wake mixing would be undetectable aginst natural variation and unlikley to impact icefish. Confidence: low due to lack of data from the HIMI fishery regarding effects of navigation/steaming.
External Impacts (specify the particular example within each activity area)	Other fisheries: HIMI midwater trawl; HIMI Autolongline	1	4	3	Population size	Patagonian toothfish; Mackerel icefish	1.1	3	3	2	Domestic longline fishery for toothfish and midwater fishery for Mackerel icefish occur in region of fishery and may affect toothfish population. Foreign legal longlining for toothfish is viewed as continual and widespread. Intensity: moderate. Consequence: moderate with the potential to close the HIMI fishery (e.g. Patagonian toothfish stocks reduced below biological limit reference levels). Confidence: high; data from the HIMI longline sub-fishery.
	Aquaculture	0									
	Coastal development	0									
	Other extractive activities	0									
	Other non extractive activities	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Other anthropogenic activities	1	3	4	Behaviour/movement	Mackerel icefish	6.1	1	1	2	Research and tourism and the passage of research/tourist vessels. Mackerel icefish chosen as mid-water/pelagic species more likely to be affected than a demersal species. Intensity negligible due to the limited number of vessels/visits/groups per year. Consequence: negligible, as only a small area is affected and target species mobility and depth locations seen as mitigating factors. Confidence was recorded as high due to data regarding numbers and activities indicates species not at risk.

Level 1 (SICA) Document L1.2 - Byproduct and Bycatch Component.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	3	3	Population size	Grey rockcod	1.1	3	2	2	Fishing occurs widely across the Heard Plateau-a minimum of 123 nm and a maximum of 240 nm separate the three fishing grounds A, B and C. Fishing occurs between 1-100 days. Population size most likely to be affected before other sub-components. Intensity: moderate catches of bycatch species between 2010/11 to 2014/15 (range 0.6 t to 66 t), with greater grey rockcod catches when targetting Patagonian toothfish. Current stock status unknown. Consequence: minor, bycatch levels being monitored. Bycatch levels are below the currently accepted 80 t limit. Last assessment in 1998 and more recently in 2015 (Maschette et al. (2015)). The latter has not been presented to CCAMLR. Biological parameters recently updated (Maschette et al. 2015; Maschette et al. (in prep)). Confidence: high due data collection by observers and research conducted in this fishery to date.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									
	Fishing	1	3	3	Population size	Grey rockcod	1.1	3	2	2	Fishing occurs between 1-100 days (weather permitting). Population size most likely to be affected before other sub-components. Intensity: moderate as catches of this bycatch species peaked in 2012/13 and decreased thereafter. Stock fished to near extinction on the Kerguelen Plateau (1970s/80s). Current stock status is unknown. Consequence rated as minor as bycatch levels being monitored. Confidence: high due to data collection by observers and research conducted in the fishery to date.
	Incidental behaviour	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Gear loss	1	3	3	Population size	Grey rockcod	1.1	2	2	2	Gear loss small. The limited number of vessels in the fishery coupled with the type of gear in use indicates a minor intensity value. Consequence: minor. Confidence: high.
	Anchoring/ mooring	0	0	0							
	Navigation/steaming	1	3	3	Population size	Grey rockcod	1.1	1	1	2	Population size affected by collision with vessel. Intensity negligible as thought unlikely for deepwater demersal species to collide. Consequence: negligible. Confidence: high, logical constraints would suggest impact is minimal.
Addition/ movement of biological material	Translocation of species	1	6	3	Population size	Grey rockcod	1.1	1	2	1	Translocation of species via ballast, hull fouling could occur daily. Population size most likely to be affected before major changes in geographic range or genetic structure. Intensity negligible the likelihood of temperate water species surviving and establishing as a threat to this species in sub-antarctic waters is considered negligible. However conseqeunce scored as minor due to the potential for the spread of fishborne diseas. Confidence: low due to absence of data on susceptibility of this species to fishborne diseases.
	On board processing	0									
	Discarding catch	0									
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	0									
Addition of non-biological material	Debris	0									
	Chemical pollution	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Exhaust	1	3	3	Population size	Grey rockcod	1.1	1	1	2	Exhaust emissions occur 1-100 days. Intensity: negligible. Consequence: negligible. The limited number of vessels in the fishery coupled with the depth at which bycatch species are found makes it highly unlikely that exhaust gas emissions will have an affect on these species. Weather conditions in the region are frequently extreme, rapidly dispersing exhaust emissions. Confidence: high, due to depth of water column separating species from emissions.
	Gear loss	1	3	3	Population size	Grey rockcod	1.1	2	2	2	Gear loss is small. The limited number of vessels in the fishery coupled with the type of gear in use indicates a minor intensity value. Consequence: minor, as losses (e.g. floats, codends, bobbins) recorded from the demersal trawl fishery at HIMI were found. Confidence: high due to information from observers and SARAG reports regarding gear loss at HIMI.
	Navigation/ steaming	1	3	3	Behaviour/movement	Grey rockcod	6.1	1	1	2	Noise, echosounding from navigation/steaming could affect behaviour of this bycatch species. Intensity: negligible due to the limited number of vessels in the fishery. Consequence: negligible, as only a small area is affected and species mobility and depth locations seen as mitigating factors. Confidence: high, logical consideration.
	Activity/ presence on water	1	3	3	Behaviour/movement	Grey rockcod	6.1	1	1	2	Vessels present and active daily while fishing (1-100 days). Behaviour of this bycatch species could be affected by attraction to vessel. Intensity: negligible due to the limited number of vessels in the fishery. Consequence: negligible, as only a small area is affected and species mobility and depth locations seen as mitigating factors. Confidence high, logical consideration.
Disturb physical processes	Bait collection	0									
	Fishing	1	3	3	Behaviour/movement	Grey rockcod	6.1	3	2	1	This byctach species most likely to be affected by habitat disturbance from fishing. Intensity rated as moderate based on possible severe but localised effects of disturbing benthos on trawl grounds. Consequence: minor, only a small area is affected and creation of MPAs has preserved habitat in the

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											area. However these changes could affect distribution of bycatch stocks. Confidence: low due to lack of data from the HIMI fishery regarding effects of benthos disturbance.
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/steaming	1	3	3	Behaviour/movement	Grey rockcod	6.1	1	1	1	This species chosen as productivity of these species considered much lower than target species. Intensity: negligible due low numbers of vessels in fishery. Consequence: negligible, as only a small area is affected and species mobility and depth locations seen as mitigating factors. Confidence: low due to lack of data from the HIMI fishery regarding effects of navigation/steaming.
External Impacts (specify the particular example within each activity area)	Other fisheries: HIMI midwater trawl; HIMI Autolongline	1	4	3	Population size	Grey rockcod	1.1	4	2	2	Domestic longline fishery for toothfish and midwater fishery for Mackerel icefish occur in region of fishery and might affect population sizes of bycatch species. Grey rockcod is discarded in smaller quantities in the HIMI longline sub-fishery (~ 15 t over the five year assessment period) compared to the demersal trawl sub-fishery. Consequence minor. Confidence: high; data from the HIMI fishery indicates continued fishing efforts in and around the HIMI area.
	Aquaculture	0									
	Coastal development	0									
	Other extractive activities	0									
	Other non-extractive activities	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Other anthropogenic activities	1	3	4	Behaviour/movement	Grey rockcod	6.1	1	1	2	Research and tourism and the passage of research/tourist vessels visit the area several times a year. This species was chosen as productivity of this species considered much lower than target species. Intensity: negligible due to the limited number of vessels/visits/groups per year. Consequence: negligible, as only a small area is affected and species mobility and depth locations seen as mitigating factors. Confidence: high due to data regarding numbers and activities.

Level 1 (SICA) Document L1.3 - Protected Species Component.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	3	3	Population size	Black browed albatross	1.1	2	2	2	Fishing occurs widely across the Heard Plateau-a minimum of 123 nm and a maximum of 240 nm separate the three fishing grounds A, B and C. Fishing occurs between 1-100 days. Population size most likely to be affected before other sub-components. Species chosen since there are about 600 breeding pairs at Heard Island, they are long-lived, show strong site fidelity and have same breeding partner. Intensity: minor, since four interacted with fishing gear (1 dead; 1 injured; 2 not damaged; AFMA Observer data). Consequence minor. Confidence high; two observers present on all trips and research conducted in the fishery to date.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									
	Fishing	1	3	3	Population size	Black browed albatross	1.1	2	2	2	Population size most likely to be affected before other sub-components as albatross numbers are low. Birds often seen interacting with the gear with no apprent injury therefore intensity minor. Consequence: minor. Confidence: high; Two observers present on all trips and research conducted in the fishery to date.
	Incidental behaviour	0									
	Gear loss	1	3	3	Population size	Black browed albatross	1.1	1	1	2	Gear loss occurs occasionally based on observer records. Lost gear may entangle birds. Intensity: negligible due to limited numbers of vessels in fishery, and management controls requiring reporting and encouraging attempts to retrieve lost gear. Consequence: negligible. The types of gear recorded as lost are either small or have a minimal risk of entangling birds. Confidence: high, as observers present on all trips and report all gear lost.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Anchoring/ mooring	0									
	Navigation/steaming	1	3	3	Population size	Black browed albatross	1.1	1	2	2	Population size most likely to be affected before other sub-components as albatross numbers are low. Intesnity: negligible. Seabirds have flown into vessels or fishing gear by accident however only one albatross have been killed. Consequence: minor. Mitigating measures including reduced lighting, bans on net-sonde cables, removal of protruding wires. Confidence: high; two observers present on all trips and research conducted in the fishery to date.
Addition/ movement of biological material	Translocation of species	1	6	3	Population size	Black browed albatross	1.1	1	2	2	Translocation of species via ballast, hull fouling could occur daily. Population size most likely to be affected before major changes in geographic range or genetic structure. Intensity: negligible the likelihood of temperate water species surviving and establishing as a threat to birds in sub-antarctic waters is considered negligible. However consequence scored as minor due to the potential for the spread of disease. Confidence: high; two observers present on all trips and research conducted in the fishery to date.
	On board processing	0									
	Discarding catch	0									
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	0									
Addition of non-biological material	Debris	0									
	Chemical pollution	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Exhaust	1	3	3	Behaviour/movement	Black browed albatross	6.1	1	1	2	Exhaust emissions occur daily during the season (1-100 days). Intensity and consequences considered negligible. The limited number of vessels in the fishery coupled with local weather conditions makes it highly unlikely that exhaust gas emissions will have an affect on protected species. Weather conditions in the region are frequently extreme, rapidly dispersing exhaust emissions. Confidence: high, logical consideration.
	Gear loss	1	3	3	Behaviour/movement	Black browed albatross	6.1	1	1	2	Gear loss occurs inter-annually in small numbers. However, the limited number of vessels in the fishery coupled with the type of gear in use unlikely to alter distribution of seabirds. Intensity negligible. Consequence: negligible. Confidence was recorded as high due to gear loss information from observer reports and SARAG reports for the HIMI fishery.
	Navigation/ steaming	1	3	3	Behaviour/movement	Black browed albatross	6.1	1	1	2	Behaviour/movement most likely to be affected before other sub-components as albatross numbers are critically low. Intensity: negligible due to the limited number of vessels in the fishery. Consequence: negligible, as alteration of behaviour of albatrosss from noise likely to be transient only. Confidence: high, based on data from the HIMI fishery on seabird interactions.
	Activity/ presence on water	1	3	3	Behaviour/movement	Black browed albatross	6.1	1	1	2	Behaviour/movement most likely to be affected before other sub-components but likely to be transient. Intensity: negligible due to the limited number of vessels in the fishery. Consequence: negligible. Confidence: high, due to data from the HIMI fishery on seabird interactions.
Disturb physical processes	Bait collection	0									
	Fishing	1	3	3	Behaviour/movement	Antarctic fur seal; elephant seal	6.1	2	2	1	These seals chosen as species most susceptible to disturbance by demersal trawling. There have been five Antarctic fur seal intercations (all alive) over the study period. Population status is stable. Other seals (species undifferentiated) have also interacted with demeral trawls. The elephant seal has been seen in these waters within fishery boundaries. Intensity: minor due to small area affected and low numbers of vessels in fishery. Consequence: minor as not habitat dependent. Confidence: low, due to lack of data.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/steaming	1	3	3	Behaviour/movement	Killer whale	6.1	1	1	2	Navigation/steaming occurs daily during season. These whales chosen as protected species most susceptible to disturbance by wake mixing, since observed in the fishery while demersal trawling. Both intensity and consequence rated as negligible, only one vessel involved and changes in whale distribution only temporary. Confidence: high; two observers on all trips and whale interaction data suggests impact minimal.
External Impacts (specify the particular example within each activity area)	Other fisheries: HIMI midwater trawl; HIMI Autolongline	1	6	5	Population size	Black browed albatross	1.1	2	2	2	Domestic longline fishery for toothfish and midwater fishery for mackerel icefish occur in region of fishery has recorded some deaths of birds. Intensity: minor. Consequence: minor as this species was not caught in the HIMI longline or midwater sub-fisheries. Confidence: high; data from the HIMI fishery indicates continued fishing efforts in and around the HIMI area.
	Aquaculture	0									
	Coastal development	0									
	Other extractive activities	0									
	Other non-extractive activities	0									
	Other anthropogenic activities	1	3	4	Population size	Black browed albatross	1.1	1	1	2	Research and tourism and the passage of research/tourist vessels visit the area several times a year. Birds may be impacted. Intensity: negligible due to the limited number of vessels/visits/groups per year. Consequence: negligible. Confidence: high due to data regarding numbers and activities.

Level 1 (SICA) Document L1.4 - Habitat Component (pelagic)

Only impacts on pelagic habitat assessments are displayed as benthic habitats have been assessed by Welsford et al. (2014).

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	3	3	Habitat structure and function	Benthic habitat - not assessed	5.1	3			Habitat assessment negates the need for assessment -no further action required
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									
	Fishing	1	3	3	Habitat structure and function	Benthic habitat - not assessed	5.1	3			Habitat assessment negates the need for assessment -no further action required
	Incidental behaviour	0									
	Gear loss	1	3	3	Habitat structure and function	Benthic habitat - not assessed	5.1	1			Habitat assessment negates the need for assessment -no further action required
	Anchoring/ mooring	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/ steaming	1	3	3	Water quality	Heard/ McDonald Islands Pelagic Provinces - Plateau	1.1	1	1	2	Fishing activity hence Navigation/steaming occurs between 1-100 days over the main trawl grounds. Navigation/steaming was considered to influence water quality by disrupting the water column. Intensity: Negligible because it was considered unlikely that there would be detectable impacts on pelagic habitat water quality. Consequence: therefore Negligible. Confidence: high because negative interactions between Navigation/steaming and pelagic habitat were considered very unlikely.
Addition/ movement of biological material	Translocation of species	1	6	3	Habitat structure and function	Benthic habitat - not assessed	5.1	1			Habitat assessment negates the need for assessment -no further action required
	On board processing	0									
	Discarding catch	0									
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	0	0	0							
Addition of non-biological material	Debris	0	0	0							
	Chemical pollution	0									
	Exhaust	1	3	3	Air quality	Benthic habitat - not assessed	2.1	1			Habitat assessment negates the need for assessment -no further action required
	Gear loss	1	3	3	Habitat structure and function	Benthic habitat - not assessed	5.1	1			Habitat assessment negate the need for assessment -no further action required

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Navigation/ steaming	1	3	3	Water quality	Heard/ McDonald Islands Pelagic Provinces - Plateau	1.1	1	1	2	Fishing activity hence Navigation/steaming occurs between 1-100 days over the main trawl grounds. Navigation/steaming was considered to influence water quality by disrupting the water column. Intensity: Negligible because it was considered unlikely that there would be detectable impacts on pelagic habitat water quality. Consequence: Negligible. Confidence: high because negative interactions between Navigation/steaming and pelagic habitat were considered very unlikely.
	Activity/ presence on water	1	3	3	Habitat structure and function	Heard/ McDonald Islands Pelagic Provinces - Plateau	5.1	1	1	2	The environment will be impacted by noise and visual stimuli, birds and seals may be attracted to fishing operations. Intensity: negligible because it is unlikely to have detectable impact on habitat Consequence: negligible unlikely to have any impact Confidence: high unlikely to impact habitat
Disturb physical processes	Bait collection	0									
	Fishing	1	3	3	Habitat structure and function	Benthic habitat - not assessed	5.1	3			Habitat assessment negate the need for assessment -no further action required
	Boat launching	0	0	0							
	Anchoring/ mooring	0	0	0							
	Navigation/steaming	1	3	3	Water quality	Heard/ McDonald Islands Pelagic Provinces - Plateau	1.1	1	1	2	Fishing activity hence Navigation/steaming occurs between 1-100 days over the main trawl grounds. Navigation/steaming was considered to influence water quality by disrupting the water column. Intensity: Negligible because it was considered unlikely that there would be detectable impacts on pelagic habitat water quality. Consequence: Negligible. Confidence: high because negative interactions between Navigation/steaming and pelagic habitat were considered very unlikely.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
External Impacts (specify the particular example within each activity area)	Other fisheries HIMI midwater trawl; HIMI Autolongline	1	4	3	Habitat structure and function	Benthic habitat - not assessed	5.1	4			Habitat assessment negate the need for assessment -no further action required
	Aquaculture	0									
	Coastal development	0									
	Other extractive activities	0									
	Other non extractive activities	0									
	Other anthropogenic activities	1	3	4	Water quality	Heard/ McDonald Islands Pelagic Provinces - Plateau	1.1	1	1	1	Major shipping routes, tourism. Intensity: minor activities could impact habitats. Consequence: minor restricted area rare event short term effects. Confidence: low limited information

Level 1 (SICA) Document L1.5 - Community Component.

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
Capture	Bait collection	0									
	Fishing	1	3	3	Trophic/size structure	Outer Heard Plateau 100-500m; Inner Heard Plateau 100-500m; South Eastern trough	4.1	2	2	1	Inner and Outer Heard Plateau and South Eastern Trough were chosen because fishing has focussed on southern edges of the Inner Heard plateau community (localised in all years) and also on the Outer Heard Plateau community (localised 3 years) and a small section of South Eastern Trough (all years). None of Outer Heard Plateau community and about half of the Inner Heard Plateau falls within the Marine Reserve. Fishing occurs between 1-100 days. Trophic/size structure of these communities likely to be affected as smaller size fish are harvested (CCAMLR 2016), which may change community structure dynamics. Intensity: minor, occurs at a few restricted locations of each community. Consequence: minor, minimal impact on community structure or dynamics assuming fishery managed within sustainable levels and fishing occurs over a small part of each community. Confidence: low, as fishery is closely monitored for target species and bycatch species but data unknown for impacts on other community species.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	0									
	Fishing	1	3	3	Species composition	Outer Heard Plateau 100-500m; Inner Heard Plateau 100-500m	1.1	3	2	2	Fish escape through net meshes and species composition most likely to be affected if post-capture survival is low. Intensity: moderate. Consequence: minor, tagging surveys of toothfish successful therefore assume good post-capture survival after escapement. Confidence: high, based on data collected by observers and research conducted in the fishery to date.
	Incidental behaviour	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Gear loss	1	3	3	Species composition	Outer Heard Plateau 100-500m; Inner Heard Plateau 100-500m	1.1	1	2	2	Gear loss occurs inter-annually in small amounts based on observer records. Gear loss has potential to alter species composition by direct interactions with species particularly benthic species. Intensity: negligible due to limited numbers of vessels in fishery, and management controls designed to reduce/monitor interactions with these species. Consequence: minor. The types of gear recorded as lost are either small or have a minimal risk of entangling rare/endangered species.Confidence: high, as observers present on all trips and report all gear lost.
	Anchoring/ mooring	0									
	Navigation/ steaming	1	3	3	Species composition	Heard Plateau 0-1000m pelagic	1.1	2	1	2	Navigation/steaming occurs between 1-100 days mainly across the Heard Plateau. Navigation/steaming has potential to alter species composition by direct impact with rare/endangered species including birds. Intensity: minor due to limited numbers of vessels in fishery, and management controls designed to reduce/monitor interactions with these species. Consequence: negligible. Confidence: high as the data on population sizes and incidents is well documented.
Addition/ movement of biological material	Translocation of species	1	6	3	Species composition	Outer Heard Plateau 100-500m; Inner Heard Plateau 100-500m	1.1	1	2	1	Translocation of species via ballast, hull fouling could occur. Species composition most likely to be affected before major changes in geographic range or genetic structure. Intensity: negligible the likelihood of temperate water species surviving and establishing as a threat to sub-antarctic communities is considered negligible. However, consequence scored as minor due to the potential for the spread of fishborne diseaes. Confidence: low.
	On board processing	0									
	Discarding catch	0									
	Stock enhancement	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Provisioning	0									
	Organic waste disposal	0									
Addition of non-biological material	Debris	0									
	Chemical pollution	0									
	Exhaust	1	3	3	Distribution of community	Heard Plateau 0-1000m pelagic	3.1	1	1	2	Exhaust emissions occurs daily during the season. Intensity and consequence both scored as negligible. Limited vessels in the fishery and birds not fish most likely species to interact but their mobility renders them unlikely to be affected by exhaust gas emissions. Weather conditions in the region are frequently extreme, rapidly dispersing exhaust emissions. Confidence: high, logical consideration.
	Gear loss	1	3	3	Species composition	Outer Heard Plateau 100-500m; Inner Heard Plateau 100-500m	1.1	1	1	2	Annual gear loss small. Gear loss has potential to alter species composition by direct impact with rare/endangered species. Intensity rated as negligible due to limited numbers of vessels in fishery. Consequence: negligible. The gear types recorded as lost are either small or have a minimal risk of entangling species or altering habitat of habitat-dependent speices. Confidence: high, due records of amount and type of gear lost.
	Navigation/ steaming	1	3	3	Distribution of community	Heard Plateau 0-1000m pelagic	3.1	1	1	2	Navigation/steaming has the potential to alter community distributions by attracting species to the vessels and alter foraging patterns. Intensity: negligible, due to small number of vessels involved. Consequence: negligible, due to the small number of vessels involved. Confidence: high, due to observer data on interactions with vessels navigating/steaming in the fishery.
	Activity/ presence on water	1	3	3	Distribution of community	Heard Plateau 0-1000m pelagic	3.1	1	1	2	Activity/presence has the potential to alter community distributions by attracting species to the vessel and alter foraging patterns. Intensity: negligible, due to small number of vessels involved. Consequence:

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
											negligible, due to the small number of vessels involved. Confidence: high, due to observer data on interactions with vessels steaming in the fishery.
Disturb physical processes	Bait collection	0									
	Fishing	1	3	3	Distribution of community	Outer Heard Plateau 100-500m; Inner Heard Plateau 100-500m	3.1	3	2	1	Fishing has the potential to alter distribution of community by disturbing seafloor and benthos and thus affect habitat-dependent species. Intensity: moderate, as grounds are continuously targeted once identified as productive. Consequence: minor as area relatively small and likelihood of detection small. Confidence: low, due to insufficient data.
	Boat launching	0	0	0							
	Anchoring/ mooring	0	0	0							
	Navigation/steaming	1	3	3	Distribution of community	Heard Plateau 0-1000m pelagic	3.1	1	1	2	Navigation/steaming has the potential to alter community distributions by wake mixing of the pelagic community. Intensity: negligible, due to small number of vessels involved and known wind mixing depths exceeding wake mixing. Consequence: negligible, due to the small number of vessels involved. Confidence: high, due consideration of logical constraints.
External Impacts (specify the particular example within each activity area)	Other fisheries: HIMI midwater trawl; HIMI Autolongline	1	4	3	Species composition	South Eastern Trough 500-1000m; Outer Heard Plateau 100-500m	1.1	4	2	2	Domestic longline fishery for toothfish and midwater trawl fishery for Mackerel icefish occur in region of fishery and might affect population sizes of species. The main community impacted by longline sub-fishery is the Southern Lower Slope (>1000 m), which is not different to the most vulnerable communities impacted by demersal trawling. Intensity: minor. Consequence: minor. Confidence: high; data from the HIMI fishery indicates continued fishing efforts in and around the HIMI area.
	Aquaculture	0									
	Coastal development	0									

Direct impact of fishing	Fishing Activity	Presence (1) Absence (0)	Spatial scale of Hazard (1-6)	Temporal scale of Hazard (1-6)	Sub-component	Unit of analysis	Operational objective (S2.1)	Intensity Score (1-6)	Consequence Score (1-6)	Confidence Score (1-2)	Rationale
	Other extractive activities	0									
	Other non-extractive activities	0									
	Other anthropogenic activities	1	3	4	Distribution of community	Outer Heard Plateau 100-500m; Inner Heard Plateau 100-500m	3.1	1	1	2	Research and tourism and the passage of research/tourist vessels visit the area several times a year. Intensity: negligible due to the limited number of vessels/visits/groups per year. Consequence: negligible, as only a small area is affected and species mobility and depth locations seen as mitigating factors. Confidence: high due to data regarding numbers and activities.

2.3.11 Summary of SICA results

Table 2.19. Level 1 (SICA) Document L1.6. Summary table of consequence scores for all activity/component combinations. Those that scored ≥3 are highlighted grey and bolded if high confidence. * existing stock assessment –assessment not required. existing benthic habitat assessment-assessment not required. Note: external hazards are not considered at Level 2.**

Direct impact	Activity	Key/secondary commercial species	Byproduct & bycatch species	Protected species	Habitats	Communities
Capture	Bait collection	0	0	0	0	0
	Fishing	*	2	2	**	2
	Incidental behaviour	0	0	0	0	0
Direct impact without capture	Bait collection	0	0	0	0	0
	Fishing	2	2	2	**	2
	Incidental behaviour	0	0	0	0	0
	Gear loss	2	2	1	**	2
	Anchoring/ mooring	0	0	0	0	0
	Navigation/ steaming	1	1	2	1	1
Addition/ movement of biological material	Translocation of species	2	2	2	**	2
	On board processing	0	0	0	0	0
	Discarding catch	0	0	0	0	0
	Stock enhancement	0	0	0	0	0
	Provisioning	0	0	0	0	0
	Organic waste disposal	0	0	0	0	0
Addition of non-biological material	Debris	0	0	0	0	0
	Chemical pollution	0	0	0	0	0
	Exhaust	1	1	1	**	1
	Gear loss	2	2	1	**	1
	Navigation/ steaming	1	1	1	1	1
	Activity/ presence on water	1	1	1	1	1
Disturb physical processes	Bait collection	0	0	0	0	0
	Fishing	2	2	2	**	2
	Boat launching	0	0	0	0	0
	Anchoring/mooring	0	0	0	0	0
	Navigation/steaming	1	1	1	1	1
External Impacts	Other fisheries	**3**	2	2	**	2
	Aquaculture	0	0	0	0	0
	Coastal development	0	0	0	0	0
	Other extractive activities	0	0	0	0	0
	Other non-extractive activities	0	0	0	0	0
	Other anthropogenic activities	1	1	1	1	1

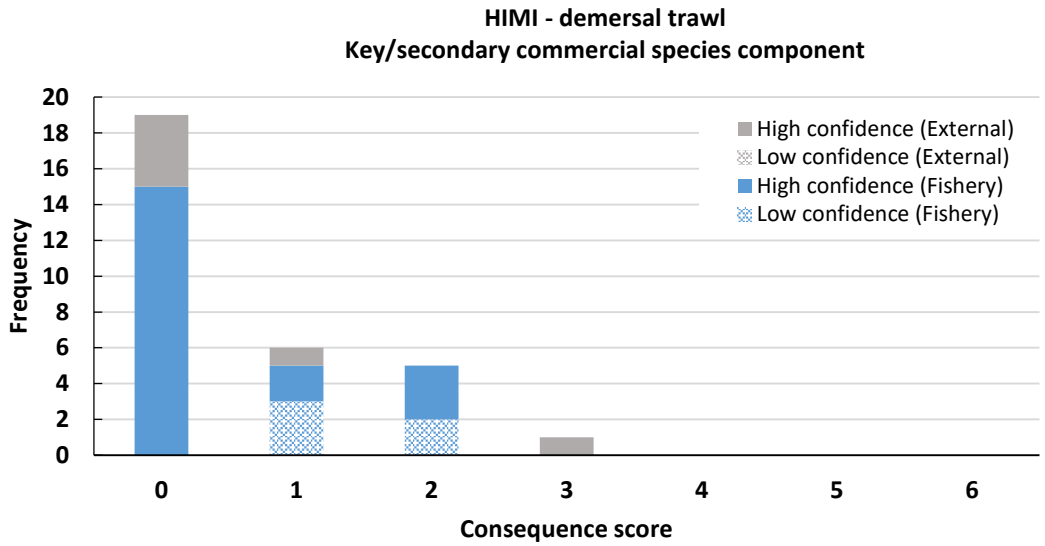


Figure 2.2. Key/secondary commercial species: Frequency of consequence score by high and low confidence.

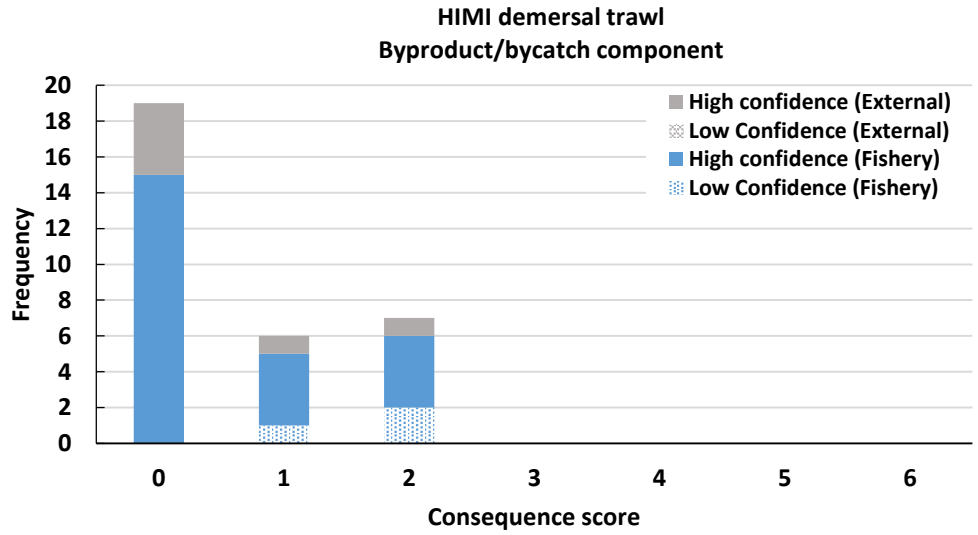


Figure 2.3. Byproduct and bycatch species: Frequency of consequence score by high and low confidence.

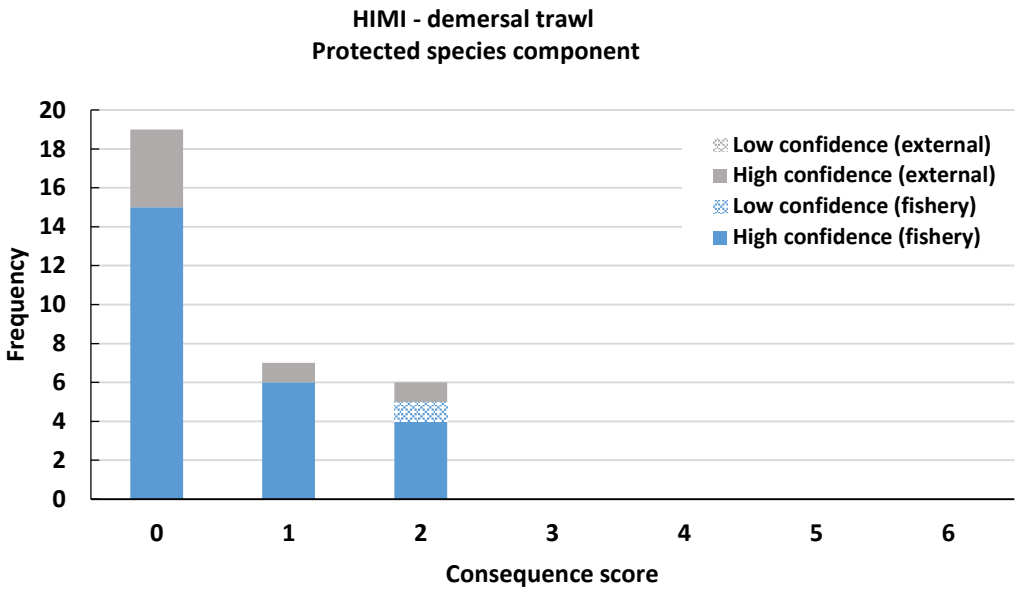


Figure 2.4. Protected species: Frequency of consequence score by high and low confidence.

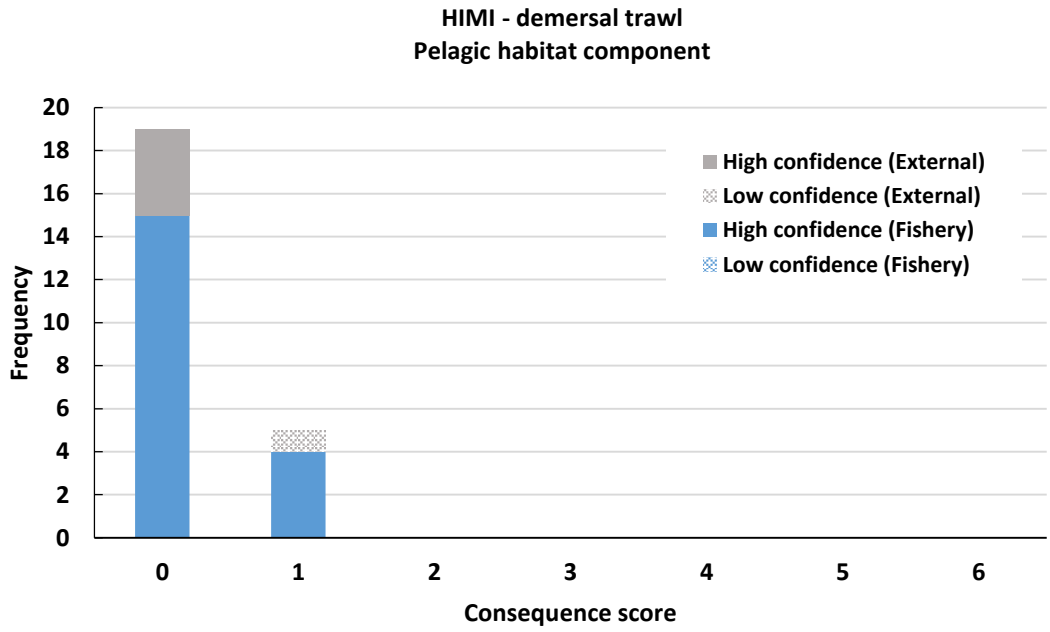


Figure 2.5. Habitat (pelagic): Frequency of consequence score by high and low confidence (not including activities impacting benthic habitats).

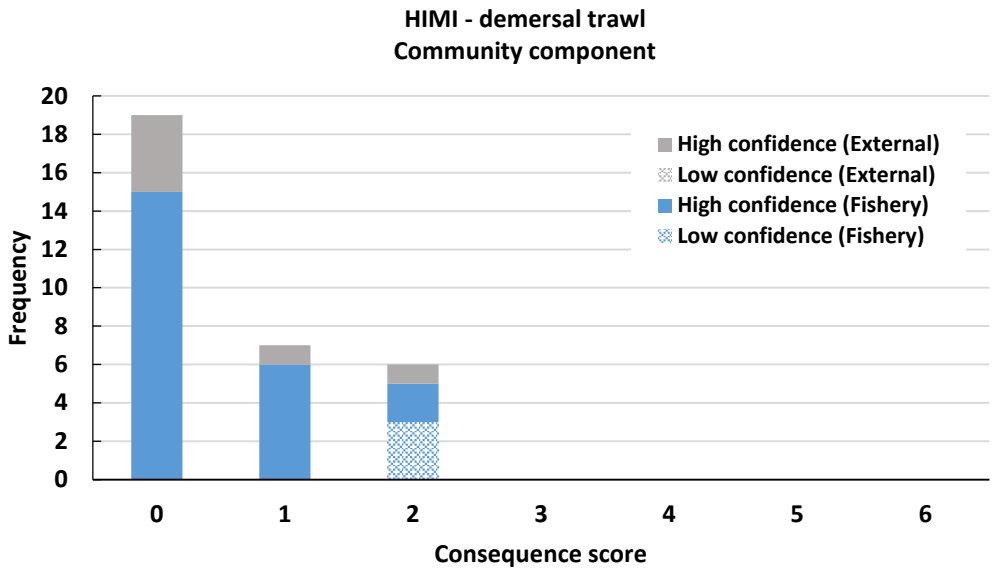


Figure 2.6. Communities: Frequency of consequence score by high and low confidence.

2.3.12 Evaluation/discussion of Level 1

All hazards (fishing activities) were eliminated at Level 1 (risk scores 1 or 2; Table 2.19; Figure 2.2-

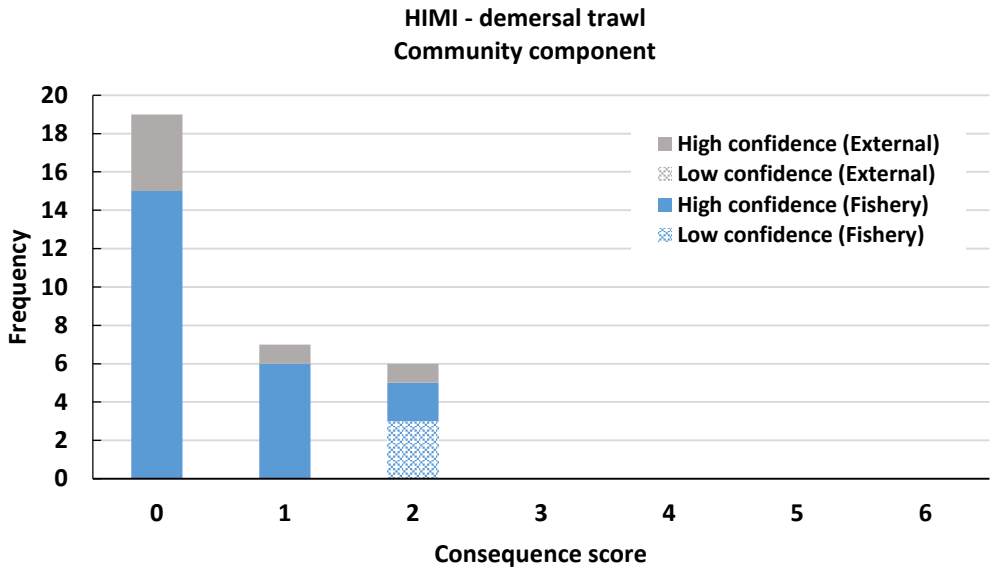


Figure 2.6). All three ecological components (i.e. byproduct/bycatch, protected species and communities) were considerd to have a minor external impact by other fisheries. By contrast, the key/secondary commercial species component was considered to have a moderate external impact by other fisheries.

They grey rockcod (*Lepidonotothen squamifrons*) was identified as the most vulnerable bycatch species (risk score 2), based on total annual bycatch from the sub-fishery. Total removals have been below the annual 80 t bycatch limit (average 28.3%), in place since 1998, following an assessment based on a Generalized Yield Model (GYM). This work has recently been repeated incorporating updated estimated biological parameters and recent recruitment as part of an Honours thesis (Maschette 2015; Maschette et al. 2015). It has shown the presence of three distinct areas (i) Pike and Discovery Banks; (ii) Shell Bank and (iii) Main Trawl Grounds West, with the lowest estimated biomass and the occurrence of most fishing in the latter area (Fig. 2.21 in Maschette 2015). Only the first two areas fall predominantly within the HIMI Marine Reserve but all areas are subject to CCAMLR Conservation measure that stipulate a maximum rockcod catch and "move-on rules" to help protect these areas. The 2015 GYM-estimates which bycatch limits are based on are subject to uncertainty and have not yet been presented to CCAMLR.

There were 13 of the 32 possible activity scenarios identified as leading to some form of impact in each of the five ecological components (key/secondary commercial, byproduct/bycatch, protected species, habitats and communities) assessed for the HIMI demersal trawl sub-fishery (i.e. activities occurred in sub-fishery). All of the 11 possible internal activities identified (i.e. direct impact of fishing) were identified as having a minor or below impact for each ecological component. The impact of all five activities identified (i.e. four internal; one external) on the "Heard/McDonald Islands pelagic provinces-Plateau" habitat were negligible.

2.3.13 Components to be examined at Level 2

As a result of the SICA analysis, no components are to be examined at Level 2, since all consequence scores were ≤ 2.

3 General discussion and research implications

3.1 Level 1

All hazards (fishing activities) were eliminated at Level 1 (risk scores ≤2; Table 2.19; Figure 2.2-

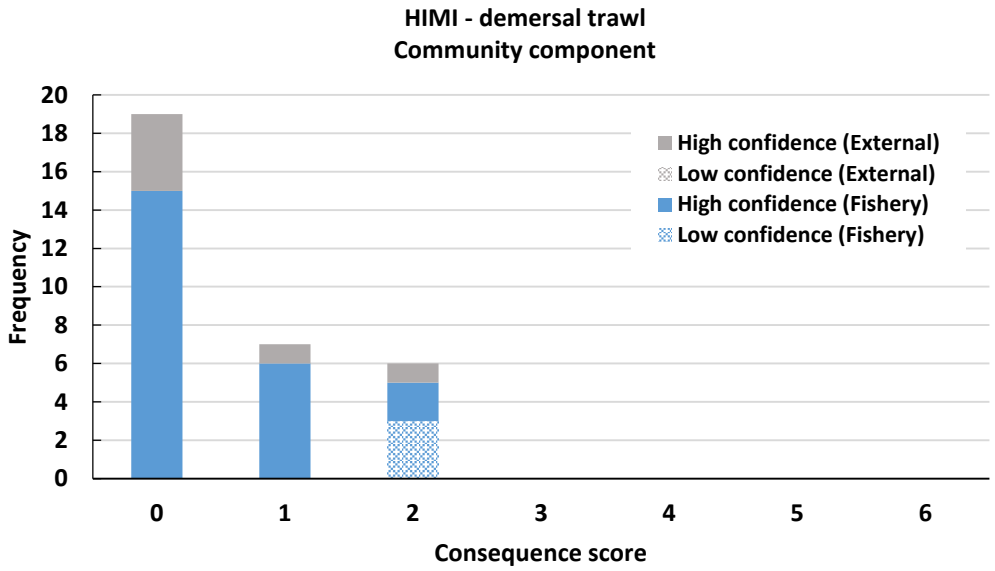


Figure 2.6**).** All three ecological components (i.e. byproduct/bycatch, protected species and communities) were considerd to have a minor external impact by other fisheries. By contrast, the key/secondary commercial species component was considered to have a moderate external impact by other fisheries.

There were 13 of the 32 possible activity scenarios identified as leading to some form of impact in each of the five ecological components (key/secondary commercial, byproduct/bycatch, protected species, habitats and communities) assessed for the HIMI demersal trawl sub-fishery (i.e. activities occurred in sub-fishery). All 11 possible internal activities identified i.e. direct impact of fishing were identified as having a minor or below impact on each ecological component. The impact of all five activities identified (i.e. four internal; one external) on the “Heard/McDonald Islands pelagic provinces-Plateau” habitat were negligible.

3.2 Level 2

3.2.1 Species at risk

A Level 2 analysis was not triggered for any ecological component: key/seconday commercial species, byproduct/bycatch species, protected species, habitats and communities, as all risk scores were ≤2.

Residual risk

As discussed elsewhere in this report (Section 1), the ERAEF methods are both hierarchically structured and precautionary. The Level 1 (SICA) analyses are used to identify potential hazards associated with fishing and which broad components of the ecological system they apply to. The Level 2 (PSA) analyses consider the direct impacts of fishing on individual species and habitats (rather than whole components), but the large numbers of species that need to be assessed and the nature of the information available for most species in the PSA analyses limits these analyses in several important respects. These include that some existing management measures are not directly accounted for, and that no direct account is taken of the level of mortality associated with fishing. Both these factors are taken into account in the ERAEF framework at Level 3, but the analyses reported here stop at Level 2. This means that the risk levels for species must be regarded as identifying potential rather than actual risk, and due to the precautionary assumptions made in the PSA analyses, there will be a tendency to overestimate absolute levels of risk from fishing.

In moving from ERA to ERM, AFMA will focus scarce resources on the highest priority species and habitats (those likely to be most at risk from fishing). To that end, and because Level 3 analyses are not yet available for most species, AFMA (with input from CSIRO and other stakeholders) has developed guidelines to assess “residual risk” for those species identified as being at high potential risk based on the PSA analyses. The residual risk guidelines will be applied on a species by species basis, and include consideration of existing management measures not currently accounted for in the PSA analyses, as well as additional information about the levels of direct mortality. These guidelines will also provide a transparent process for including more precise or missing information into the PSA analysis as it becomes available.

CSIRO and AFMA will continue to work together to include the broad set of management arrangements in Level 2 analyses, and these methods will be incorporated in future developments of the ERAEF framework. CSIRO has also undertaken some preliminary Level 3 analyses for bycatch species for several fisheries,

and these or similar methods will also form part of the overall ERAEF framework into the future.

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Glossary of Terms

Assemblage	A subset of the species in the community that can be easily recognized and studied. For example, the set of sharks and rays in a community is the Chondricythian assemblage.
Attribute	A general term for a set of properties relating to the productivity or susceptibility of a particular unit of analysis.
Bycatch species	A non-target species captured in a fishery, usually of low value and often discarded (see also Byproduct).
Byproduct species	A non-target species captured in a fishery, but it may have value to the fisher and be retained for sale.
Community	A complete set of interacting species.
Component	A major area of relevance to fisheries with regard to ecological risk assessment (e.g. target species, bycatch and byproduct species, threatened and endangered species, habitats, and communities).
Component model	A conceptual description of the impacts of fishing activities (hazards) on components and sub-components, linked through the processes and resources that determine the level of a component.
Consequence	The effect of an activity on achieving the operational objective for a sub-component.
Core objective	The overall aim of management for a component.
End point	A term used in risk assessment to denote the object of the assessment; equivalent to component or sub-component in ERAEF
Ecosystem	The spatially explicit association of abiotic and biotic elements within which there is a flow of resources, such as nutrients, biomass or energy (Crooks, 2002).
External factor	Factors other than fishing that affect achievement of operational objectives for components and sub-components.
Fishery method	A technique or set of equipment used to harvest fish in a fishery (e.g. long-lining, purse-seining, trawling).
Fishery	A related set of fish harvesting activities regulated by an authority (e.g. South-East Trawl Fishery).
Habitat	The place where fauna or flora complete all or a portion of their life cycle.
Hazard identification	The identification of activities (hazards) that may impact the components of interest.
Indicator	Used to monitor the effect of an activity on a sub-component. An indicator is something that can be measured, such as biomass or abundance.
Likelihood	The chance that a sub-component will be affected by an activity.

Operational objective	A measurable objective for a component or sub-component (typically expressed as “the level of X does not fall outside acceptable bounds”)
Precautionary approach	The approach whereby, if there is uncertainty about the outcome of an action, the benefit of the doubt should be given to the biological entity (such as species, habitat or community).
PSA	Productivity-Susceptibility Analysis. Used at Level 2 in the ERAEF methodology.
Scoping	A general step in an ERA or the first step in the ERAEF involving the identification of the fishery history, management, methods, scope and activities.
SICA	Scale, Impact, Consequence Analysis. Used at Level 1 in the ERAEF methodology.
Sub-component	A more detailed aspect of a component. For example, within the target species component, the sub-components include the population size, geographic range, and the age/size/sex structure.
Sub-fishery	A subdivision of the fishery on the basis of the gear or areal extent of the fishery. Ecological risk is assessed separately for each sub-fishery within a fishery.
Sustainability	Ability to be maintained indefinitely
Target species	A species or group of species whose capture is the goal of a fishery, sub-fishery, or fishing operation.
Trophic position	Location of an individual organism or species within a foodweb.
Unit of analysis	The entities for which attributes are scored in the Level 2 analysis. For example, the units of analysis for the Target Species component are individual “species”, while for Habitats, they are “biotypes”, and for Communities the units are “assemblages”.

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