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Australian Government
Australian Fisheries Management Authority

Ecological Risk Assessment for Effects of Fishing

REPORT FOR THE TORRES STRAIT ROCK LOBSTER FISHERY

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This fishery Ecological Risk Assessment (ERA) report should be cited as:

Furlani, D., Dennis, D., Dowdney, J., Butler, A., and Mason, F. (2007) Ecological Risk Assessment for the Effects of Fishing: Report for the Torres Strait Rock Lobster Fishery. Report for the Australian Fisheries Management Authority, Canberra.

<u>Notes to this document:</u>
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.

Executive Summary

This assessment of the ecological impacts of the Torres Strait Rock Lobster Fishery was undertaken using the ERAEF method version 9.2. ERAEF stands for "Ecological Risk Assessment for Effect of Fishing", and was developed jointly by CSIRO Marine and Atmospheric Research, and the Australian Fisheries Management Authority. ERAEF provides a hierarchical framework for a comprehensive assessment of the ecological risks arising from fishing, with impacts assessed against five ecological components – target species; by-product and by-catch species; threatened, endangered and protected (TEP) species; habitats; and (ecological) communities.

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 can be thought of as 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 high 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 fishery. Level 1 screens out activities that are judged to have low impact, and potentially screens out whole ecological components as well. Level 2 is a screening or prioritization process for individual species, habitats and communities at risk from direct impacts of fishing. 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.

The ERAEF for the Torres Strait Rock Lobster Fishery was limited to Level 1 analysis only.

This assessment of the Torres Strait Rock Lobster Fishery includes the following:

- Scoping
- Level 1 results for all components
- No Level 2 analyses have been undertaken at this stage.

Fishery Description

Gear:	Divers/fishers using hand spears or scoop nets
Area:	Western Torres Strait
Depth range:	0 to 25 m
Fleet size:	At the end of June 2005 there were 24 primary vessels with 60 attached tenders and 409 Traditional Inhabitant Boat licences
Effort:	Approximately 5000 tender days per year
Landings:	Approximately 600 tonnes whole weight in 2005
Discard rate:	No discarding; small numbers of juveniles retained for use by indigenous fishers
Main target species:	*Panulirus ornatus* (ornate rock lobster)
Management:	Currently by input controls: seasonal ban on commercial fishing (October-November), hookah ban (December-January), size limit (115 mm tail length), gear restriction (hand capture only). Introduction of Quota Management System planned for 2007
Observer program:	No observer program

Ecological Units Assessed

Target species:	1 (*Panulirus ornatus)*
By-product species:	0
Discard Species:	0
TEP species:	90
Habitats:	158 (157 benthic, 1 overlying pelagic)
Communities:	3 (2 demersal, 1 overlying pelagic)

Level 1 Results

Two ecological components were eliminated at Level 1. The Bycatch-Byproduct component was eliminated – there is no bycatch in the Torres Strait Rock Lobster Fishery. The Communities component was also eliminated – no community hazards were assessed as greater than minor risk (risk score 2).

There was at least one risk score of 3 – moderate – for each of the Target, TEP and Habitat components.

Most hazards (fishing activities) were eliminated at Level 1 (risk scores 1 or 2). One internal fishing activity hazard remained:

- fishing capture (impact on Target component)

Significant external hazards included:

- other fisheries in the region (impact on TEP and Habitat components), and
- other anthropogenic activities (impact on TEP and Habitat components).

No risks were rated as major or above (risk scores 4 or 5).

For the Torres Strait Rock Lobster Fishery, impacts from fishing on all species and habitat components were NOT assessed in more detail at Level 2.

Level 2 Results

Species
No Torres Strait Rock Lobster species were assessed at Level 2 using the PSA analysis.

Habitats
No Torres Strait Rock Lobster habitats were assessed at Level 2 using the habitat PSA analysis.

Communities
The community component was not assessed at Level 2, but should be considered in future assessments when the methods to do this are fully developed.

Summary

A conservative and precautionary approach is taken to management of the Torres Strait Rock Lobster fishery to ensure conservation of the stock for traditional inhabitants. The fishing method (spearing by divers) has little or no impact on the inshore demersal communities, particularly due to the selective nature of fishing and the absence of bycatch or byproduct.

One internal fishery issue emerged from the Level 1 analysis of the Torres Strait Rock Lobster Fishery:

- capture fishing was identified as a hazard related to the single target species.

Capture fishing is addressed through current input controls and managers are moving to a Quota Management System in 2007. The impacts of the adjacent PNG and Queensland lobster fisheries are currently difficult to quantify, particularly due to uncertainty about PNG lobster catch, but both fisheries plan to adopt Quota Management in the near future.

Two external issues emerged as hazards to the TEP and Habitat components;

- other fisheries; and
- other anthropogenic activities.

Managing identified risks

Using the results of the ecological risk assessment, the next steps for each fishery will be to consider and implement appropriate management responses to address these risks. To ensure a consistent process for responding to the ERA outcomes, AFMA has developed an Ecological Risk Management (ERM) framework.

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1. Overview

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

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**). 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.

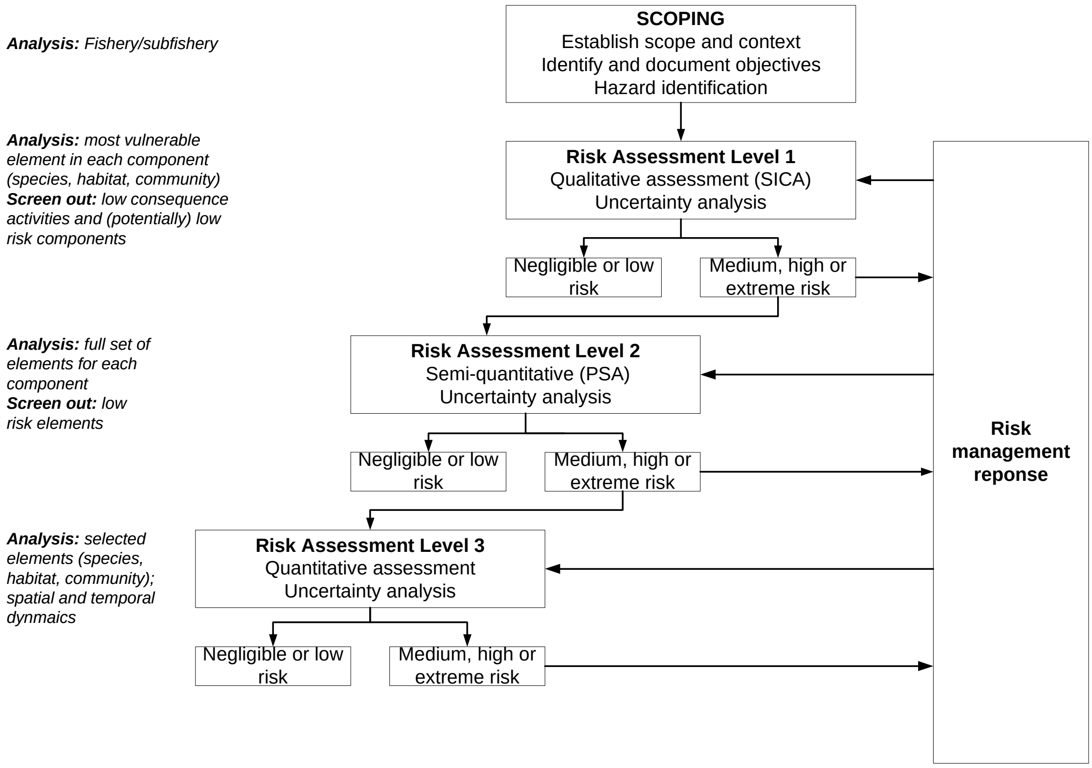


Figure 1. Overview of ERAEF showing focus of analysis for each level at the left in italics.

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 components are evaluated, corresponding to five areas of focus in evaluating impacts of fishing for strategic assessment under Environment Protection and Biodiversity Conservation (EPBC) legislation. The five *components* are:

- Target species
- By-product and by-catch species
- Threatened, endangered and protected species (TEP species)
- Habitats
- Ecological communities

This conceptual model (**Figure 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, TEP 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.

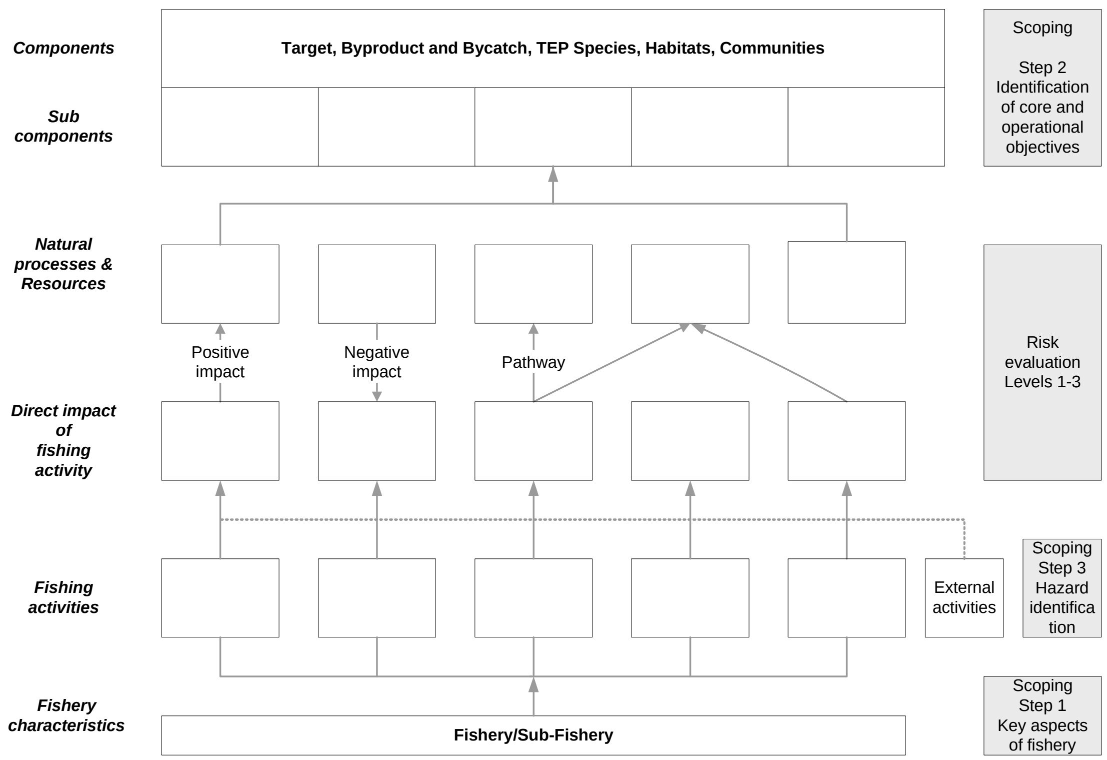


Figure 2. Generic conceptual model used in ERAEF.

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).

A full description of the ERAEF method is provided in the methodology document (Hobday *et al* 2007). 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.

ERAEF stakeholder engagement process

A recognised 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.

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. <u>Identification of units of analysis</u> (species, habitats and communities) potentially impacted by fishery activities (section 2.2.2; Scoping Documents S2A, S2B and S2C).
2. <u>Selection of objectives</u> (section 2.2.3; Scoping Document S3) is a challenging part of the assessment, because these are often poorly defined, particularly with regard to the habitat and communities components. Stakeholder involvement is necessary to agree on the set of objectives that the risks will be evaluated against. A set of preliminary objectives relevant to the sub-components is selected by the drafting authors, and then presented to the stakeholders for modification. An agreed set of objectives is then used in the Level 1 SICA analysis. The agreement of the fishery management advisory body (e.g. the MAC, which contains representatives from industry, management, science, policy and conservation) is considered to represent agreement by the stakeholders at large.
3. <u>Selection of activities</u> (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 finalise 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.

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) can be undertaken in a workshop situation, or prepared ahead by the draft fishery ERA report author and debated at the stakeholder meeting. Because of 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. The rationale for each SICA element must be documented and this may represent a challenge in the workshop situation. Documenting the rationale 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). 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.

Level 2. PSA (Productivity Susceptibility Analysis)

Level 1 assessment for the Torres Strait Rock Lobster Fishery has been completed as required for the ERAEF Stage 2 process. **No Level 2 analysis has been conducted for the Torres Strait Rock Lobster Fishery.** Information regarding Level 2 analysis is included to provide a full understanding of the ERAEF process.

The semi-quantitative nature of this analysis tier should reduce but not eliminate the need for stakeholder involvement. In particular, transparency about the assessment will lead to greater confidence in the results. The components that were identified to be at moderate or greater risk (SICA score > 2) at Level 1 are examined at Level 2. The units of analysis at Level 2 are the agreed set of species, habitat types or communities in each component identified during the scoping stage. A comprehensive set of attributes that are proxies for productivity and susceptibility have been identified during the ERAEF project. Where information is missing, the default assumption is that risk will be set high. Details of the PSA method are described in the accompanying ERAEF Methods Document. Stakeholders can provide input and suggestions on appropriate attributes, including novel ones, for evaluating risk in the specific fishery. The 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 full stakeholder involvement. This is a consultation of the published scientific literature. Further stakeholder input is required when the preliminary gathering of attribute values is completed. In particular, where information is missing, expert opinion can be used to derive the most reasonable conservative estimate. For example, if the species attribute values for annual fecundity have been categorised as low, medium and high on the set [<5, 5-500, >500], estimates for species with no data can still be made. Estimated fecundity of a species such as a broadcast-spawning fish with unknown fecundity, is still likely greater than the cutoff for the high fecundity categorisation (>500). Susceptibility attribute estimates, such as "fraction alive when landed", can also be made based on input from experts such as scientific observers. The final PSA is completed by scientists because access to computing resources, databases, and programming skills is required. Feedback to stakeholders regarding comments received during the preliminary PSA consultations is considered crucial. The final results are then presented to the stakeholder group before decisions regarding Level 3 are made. The stakeholder group may also decide on priorities for analysis at Level 3.

Level 3

This stage of the risk assessment is fully-quantitative and relies on in-depth scientific studies on the units identified as at moderate or greater risk in the Level 2 PSA. 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.

Conclusion and final risk assessment report

The conclusion of the stakeholder consultation process will result 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 the Australian Fisheries Management Authority (AFMA) for a range of management purposes, including to address the requirements of the Environment Protection and Biodiversity Conservation Act (EPBC Act) as evaluated by Department of the Environment and Heritage (DEH).

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 reevaluated, 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.

Each fishery ERA report will be revised at least every four years or as required by Strategic Assessment. However, to ensure that actions in the intervening period do not unduly increase ecological risk, each year certain criteria will be considered. At the end of each year, the following trigger questions should be considered by the MAC for each sub-fishery.

- Has there been a change in the spatial distribution of effort of more than 50% compared to the average distribution over the previous four years?
- Has there been a change in effort in the fishery of more than 50% compared to the four year average (e.g. number of boats in the fishery)?

- Has there been an expansion of a new gear type or configuration such that a new sub-fishery might be defined?

Responses to these questions should be tabled at the relevant fishery MAC each year and appear on the MAC calendar and work program. If the answer to any of these trigger questions is yes, then the sub-fishery should be reevaluated.

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 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, is 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 Torres Strait Rock Lobster (TRL) Fishery.

2.1 stakeholder engagement

2.1 Summary Document SD1. Summary of stakeholder involvement for fishery

Torres Strait Rock Lobster 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 email	March 2004; Updates through to May 2006	AFMA Manager (Torres Strait), Chair Queensland Rock Lobster Association, QDPI&F Manager (Torres Strait)	Knowledge base from historical research considered adequate to proceed to Level 1.
	Review of documents	May 2004	Chair: Queensland Rock Lobster Association	Agreed upon potential hazards.
Level 1 (SICA)	Email discussion	June 2004; Updates through to May 2006	AFMA Manager (Torres Strait); QDPI&F Manager (Torres Strait)	Discussed consequence scoring and scenarios. Agreed no Bycatch/Byproduct component. Habitat and TEP impacts considered negligible. Nature of the fishery impacts predominantly on Target component.
Level 2 (PSA)				Not conducted for Torres Strait Rock Lobster during Stage 2 of the ERAEF process.
ERAEF reporting	AFMA external review comments received	30/06/2006	Liz Cottrell	Comments addressed, changes incorporated where appropriate.
ERAEF reporting	AFMA comments received	14/07/2006		Comments addressed. Final draft submitted
ERAEF reporting	No Stakeholder comments received			Final 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 to complete Levels 1 and 2 and at stakeholder meetings. 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 Documenting 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

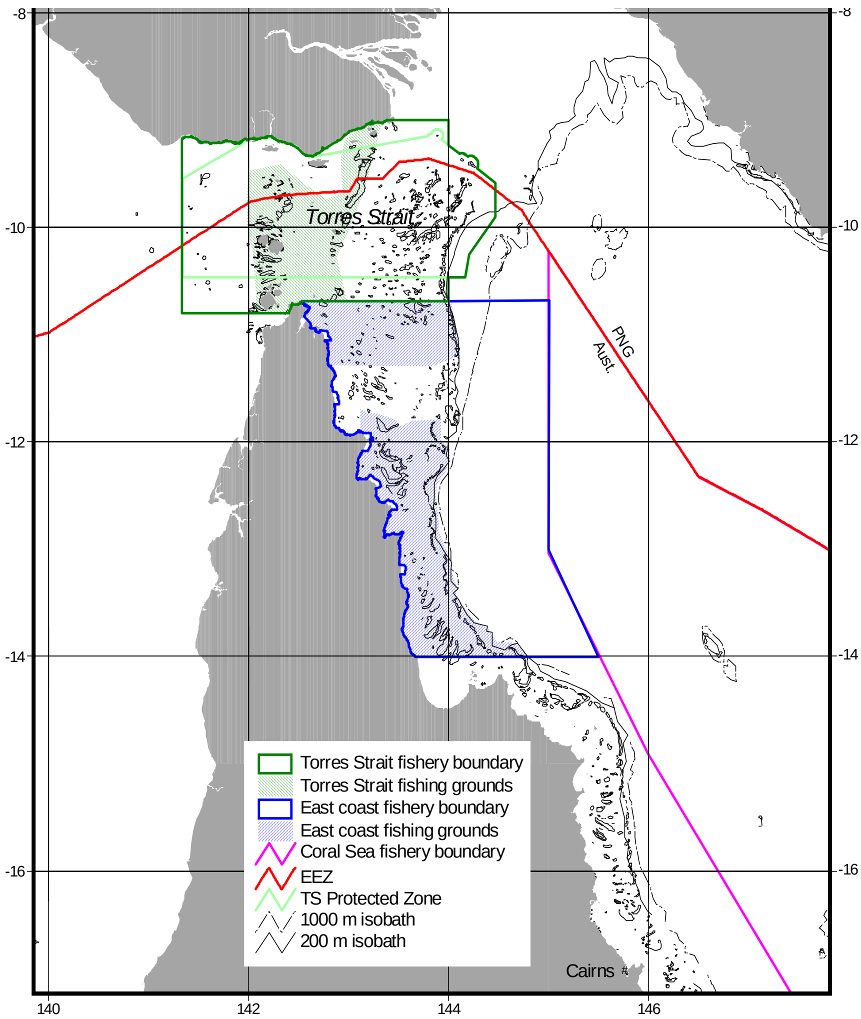
2.2.1 General Fishery Characteristics (Step 1).

The information used to complete this step may come from a range of documents such as the Fishery's Management Plan, Assessment Reports, Bycatch Action Plans, and any other relevant background documents. The level and range of information available will vary. Some fisheries/sub-fisheries will have a range of reliable information, whereas others may have limited information.

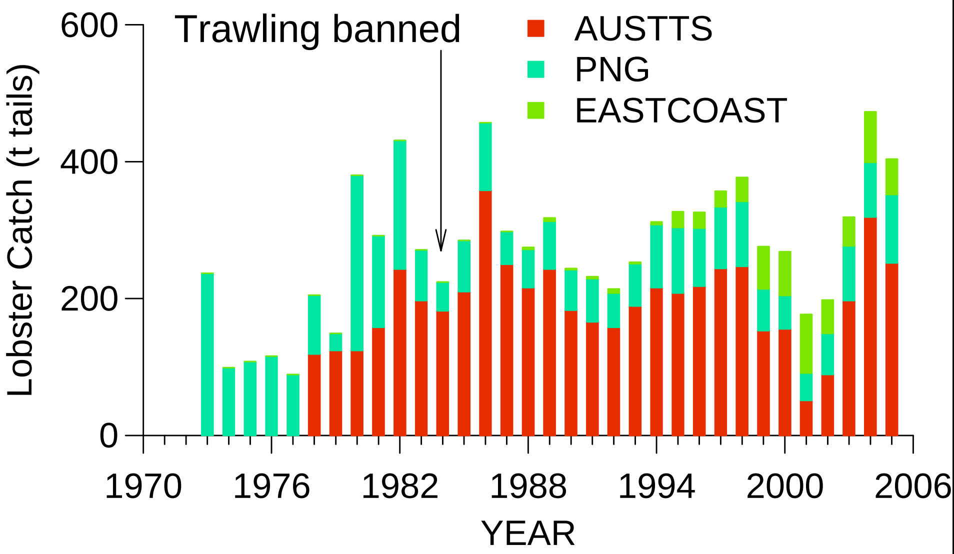
Scoping Document S1 General Fishery Characteristics

Fishery Name: Torres Strait Rock Lobster Fishery
Date of assessment: June 2004, confirmed and updated May 2006
Assessor: Darren Dennis

General Fishery Characteristics	
Fishery Name	Torres Strait Rock Lobster
Sub-fisheries	*Identify sub-fisheries on the basis of fishing method/area.* There are no sub-fisheries based on fishing method or area in the Torres Strait Rock Lobster fishery. However, the fishery is divided into sectors based on the participants and use of the resource as outlined below. Sector 1: Torres Strait Islander commercial divers. Torres Strait islanders operate under a separate commercial licence to that of non-indigenous fishers. There were about 409 TIB licences in the fishery as of June 2005, and this number was capped by the Torres Strait Protected Zone Joint Authority (TS PZJA) in 2003/4 to address latent effort in the fishery. Islander fishers operate exclusively from dinghies out of island communities. Some dinghies are equipped with surface supplied diving equipment but most fishing is done by free diving. The catch is a mixture of tails and live lobsters and the ratio depends on market conditions and abundance, particularly during the seasonal closure (Dec-Jan). Sector 2: Non-indigenous commercial divers. Non-indigenous divers operate almost exclusively from freezer boats that tow 1-7 tender vessels. Almost all tenders (5-7 m) are equipped with surface supplied diving equipment. During 2003, there was a transition from almost all speared and tailed product to 50% tailed and 50% live product. This transition to live was encouraged by CSIRO Marine and Atmospheric Research (CMAR)

	as it adds value to the fishery and reduces fishing mortality. The live lobsters are stored on the primary vessel prior to air freight to Cairns. More recently the fishery has reverted to tailed frozen product due to low market prices for live product. Sector 3: Torres Strait Islander artisanal divers. Torres Strait islanders are permitted to take lobsters for subsistence under the Torres Strait Treaty. The catch is exclusively taken by free diving with a spear. This fishery overlaps with Sector 1 but the annual catches are much smaller.
Sub-fisheries assessed	*The sub-fisheries to be assessed on the basis of fishing method/area in this report.* There are no sub-fisheries considered in this report and the commercial non-islander and islander sectors are combined. The traditional subsistence sector of the fishery is negligible.
Start date/history	*Provide an indication of the length of time the fishery has been operating.* Although commercial fishing began as early as 1969 due to the opening of the first seafood processing factory, reliable fishery statistics are only available from 1978.
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 is contained within the Torres Strait Protected Zone and “outside but near” area. Map 1 (below) shows the fishery jurisdiction boundaries that separate the Torres Strait and Queensland east coast lobster fisheries. 

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 fishery is not divided into zones for management purposes but there are arrangements whereby hookah fishing is not undertaken within close proximity of island communities to preserve the local stocks for islander fishers.
Fishing season	*What time of year does fishing in each sub-fishery occur?* The fishery is closed to all commercial fishing in October-November and is closed to the use of surface supplied diving apparatus (hookah) during December-January. The fishery peaks during May-July prior to the annual breeding migration in August/September.
Target species and stock status	*Species targeted and where known stock status.* The vast majority of the commercial and traditional catch is comprised of the ornate rock lobster *Panulirus ornatus*. Negligible quantities of *P. versicolo*r are taken in eastern Torres Strait. The most recent stock status assessment, which includes the Australian and PNG sectors, indicates that fishing mortality during the late 1990s and early 2000s approached Fmsy (Fishing mortality at maximum sustainable yield) (Ye *et al*. 2004). However, since 2001 when new management arrangements were introduced to allow the stock to recover stock levels have increased. In 2004 and 2005 stock levels and consequently catches increased dramatically, highlighting the variable population dynamics of this species. The 2005 stock was amongst the largest ever recorded.
Bait Collection and usage	*Identify bait species and source of bait used in the sub-fishery. Describe methods of setting bait and trends in bait usage.* No bait is used, and as such none is collected.
Current entitlements	*The number of current entitlements in the fishery. Note latent entitlements. Licences/permits/boats and number active.* Current licences include 409 TIB (Torres Strait islander licences) and 60 non-islander tender licences associated with about 24 primary vessels. AFMA has eliminated some latent effort in the non-islander sector on the basis that without a history of 400kg catch in 2 of the past 5 years the endorsement is lost.
Current and recent TACs, quota trends by method	*The most recent catch quota levels in the fishery by fishing method (sub-fishery). Summary of the recent quota levels in the fishery by fishing method (sub-fishery).In table form* The fishery is currently managed using input controls and there is no TAC. Planned new quota management is due to come into force in 2007.
Current and recent fishery effort trends by method	*The most recent estimate of effort levels in the fishery by fishing method (sub-fishery). Summary of the recent effort trends in the fishery by fishing method (sub-fishery). In table form* Comprehensive monitoring of fishing effort is only available for years since 2003. The non-islander sector is currently monitored through the use of a compulsory logbook, introduced in 1997 and effort in 2004 and 2005 was about 5000 tender days. The effort in the Torres Strait islander fishery is largely unquantified as this sector has only been monitored using a voluntary docket book system since 2003. Effort declined in all sectors of the fishery during 1999-2001 due to declining stocks. The effort has increased steadily since 2001 to around 5000 tender days in the non-islander sector, due to recovering stocks to a level similar to 1998. A precautionary approach was adopted by AFMA in response to the effort increase and there were 30% and 22% reductions in non-islander tender numbers in 2003 and 2004 respectively.
Current and recent fishery catch trends by	*The most recent estimate of catch levels in the fishery by fishing method (sub-fishery) (total and/or by target species). Summary of the recent catch trends in the fishery by fishing method (sub-fishery). In table form*

method	Annual commercial catches were similar during 1994-1998 but dropped by about one third during 1999-2001 due to low abundance of lobsters. Recent catch rates have doubled due to marked stock increase as shown by the fishery-independent surveys. 
Current and recent value of fishery ($)	*Note current and recent value trends by sub-fishery. In table form* ~$AUS 10 million (Ye *et al.* 2004)
Relationship with other fisheries	*Commercial and recreational, state, national and international fisheries List other fisheries operating in the same region any interactions* The Torres Strait Rock Lobster fishery shares the same stock as the TS PNG lobster fishery (managed by the PNG NFA) and the Queensland lobster fishery (managed by QDPI&F). Most of the non-indigenous commercial fishers (Sub-fishery 2) hold dual-endorsed licences for the Torres Strait and Queensland lobster fisheries. Some fishers have endorsements to fish for pearl shell and/or mackerel. There is a small but insignificant recreational fishery for lobsters in Torres Strait regulated by QDPI&F. The commercial catch taken within the TS PZJA is shared between Australia and PNG under a catch sharing arrangement.
Gear	
Fishing gear and methods	*Description of the methods and gear in the fishery, average number days at sea per trip.* The primary fishing method is the use of a hand spear whilst diving with surface supplied diving equipment or free diving. Recently, many non-islander fishers have converted to live capture using a small noose and hand net. This method relies almost invariably on the use of surface supplied diving equipment as most live fishing is done in deep (>10 m) waters. No lobsters are captured using baited traps as this species does not readily enter pots and capture with nets or pots is banned. Torres Strait islanders capture some lobsters at night using a hand-held net from a dinghy (called lamp fishing).
Fishing gear restrictions	*Any restrictions on gear* Limited to capture by hand or hand-held implement
Selectivity of gear and fishing methods	*Description of the selectivity of the sub-fishery methods* There is no bycatch taken in this fishery. The fishing methods detailed above are selective for lobster only.
Spatial gear zone set	*Description where gear set i.e. continental shelf, shelf break, continental slope (range nautical miles from shore)*

	Diving is restricted mainly to western Torres Strait (west of Warrior Reef) on reefal and inter-reefal habitats
Depth range gear set	*Depth range gear set at in metres* Depth limited by diving limits (generally a maximum depth of 25m).
How gear set	*Description how set, pelagic in water column, benthic set (weighted) on seabed* Divers swim over either reef or inter-reefal habitats and spear or capture lobsters from their daytime shelters
Area of gear impact per set or shot	*Description of area impacted by gear per set (square metres)* Variable and dependent on diver bottom time. Approximately 1 hectare searched per hour bottom time.
Capacity of gear	*Description number hooks per set, net size weight per trawl shot* Variable and dependent on diver experience. Approximately 40 kg of whole lobster is caught per tender vessel.
Effort per annum all boats	*Description effort per annum of all boats in fishery by shots or sets and hooks, for all boats* Approximately 4000 tender days per annum.
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* Gear loss during fishing operations is negligible, as any lost gear can be easily retrieved while diving.
Issues	
Target species issues	*List any issues, including biological information such as spawning season and spawning location, major uncertainties about biology* The fishery is monitored annually by CMAR using fishery-independent dive surveys to estimate the relative abundance of recruit (1+) and stock (2+) lobsters. The relative abundance indices are compared with absolute stock estimates obtained in 1989 and 2002 during extensive dive surveys. Information on recruit and stock abundance is input to a fishery model developed over the past 10 years by CMAR. The stock recruitment relationship forms the basis of the assessment and fishing mortality is assessed relative to biological reference points. There are large variations in the stock-recruitment relationship due to the prolonged larval duration but variation is incorporated in the stock status assessments. The major uncertainty lies in the relationship between the three jurisdictions, the breeding populations within them and the relative contributions of each breeding population to the subsequent stocks.
Byproduct and bycatch issues and interactions	*List any issues, as for the target species above* None.
TEP issues and interactions	*List any issues. This section should consider all TEP 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.* Islander fishers do take small numbers of traditional species, including dugong and turtle, during fishing but catch is considered negligible against catch taken during targeted hunting. Little data are available on the catch of sharks and rays and so it is difficult to assess the issues. The fishery poses no detectable threat to any of the TEPs within the fishery due to the selectivity of the fishing method. As such, TEP issues are considered to be negligible.
Habitat issues and	*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*

interactions	The Torres Strait Rock Lobster fishery poses no detectable threat to any habitats within the fishery, due to the selectivity of the fishing method and the absence of any damage to the seabed or other environments.
Community issues and interactions	*List any issues for any of the community units identified in* ***Scoping Document S1.2****.* None have been identified.
Discarding	*Summary of discarding practices by sub-fishery, including bycatch, juveniles of target species, high-grading, processing at sea.* There is no discarding due to selectivity of the fishery. Some undersized lobsters are speared but the proportion of these is negligible and they are usually taken by islander fishers, who retain the catch for subsistence purposes and are exempt from the size limit.
Management: planned and those implemented	
Management Objectives	*The management objectives from the most recent management plan* The fishery model developed by CMAR assesses the fishing effort and catch relative to biological reference points (BRPs). The BRPs used most recently are the fishing mortality that ensures 50% of maximum recruitment (as measured by the stock recruitment relationship) and Fmsy. New management arrangements were established in 2002 due to recommendations of the 2001 CMAR stock status assessment and stock recovery plan. Minimum size limit was increased to 115 mm tail length (or 90 mm carapace length (CL)), an extended closed season (hookah ban Oct-Jan) was established and a shift in focus from tails to live product was promoted. The stock recovery was contingent on cap in fishing effort at levels similar to the 1990's. This has been addressed recently through the removal of latent effort from the non-islander sector and through reductions in the number of non-islander tenders in 2003, 2004 and 2005 and caps on TIB licences. New management arrangements are being discussed and are scheduled to come into force in 2007 (see **Fishery management plan** below).
Fishery management plan	*Is there a fisheries management plan is it in the planning stage or implemented what are the key features* The current management arrangements for Torres Strait Rock Lobster (TRL), implemented by AFMA, aim to limit the fishery to a biologically sustainable level using input controls with the key feature being that any expansion is limited to the islander sector. A management plan is being developed for TRL, scheduled to be implementation in 2007, and will address the directive of the Protected Zone Joint Authority (PZJA) to move to a quota-managed system.
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.* Current input controls include: a ban on all commercial fishing during October and November, a ban on the use of hookah gear during December and January, a minimum size limit of 115 mm tail length and gear restricted to hand-held implements. Non-islander effort is capped and expansion is limited to the islander sector. The islander sector was capped in 2004 as a precautionary approach while recent commercial catches and effort levels were estimated and stock status was assessed.
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.* The fishery is not managed by output controls.
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.*

	There is currently a minimum size limit of 115 mm tail length (or 90 mm CL), and a closed season between October and January. As the fishery takes only sub-adult animals there is no requirement for a ban on taking breeding lobsters. The practice of trawling for migratory lobsters was banned in 1984 to protect the breeding populations.
Regulations	*Regulations regarding species (bycatch and byproduct, TEP), habitat, and communities; Marpol and pollution; rules regarding activities at sea such as discarding offal and/or processing at sea.* None.
Initiatives and strategies	*BAPs; TEDs; industry codes of conduct, MPAs, Reserves* None required.
Enabling processes	*Monitoring (logbooks, observer data, scientific surveys); assessment (stock assessments); performance indicators (decision rules, processes, compliance; education; consultation process* The commercial catch and effort in the fishery is monitored using logbooks for the non-islander sector and docket books for the islander sector. The abundance of recruiting (1+) and fished (2+) lobsters is monitored annually during fishery-independent population surveys and these data are used in an age-structured fishery model developed by CMAR to conduct a stock status assessment. The fishery model allows the status of the fishery to be assessed against biological reference points and was the basis of new management introduced in 2002. Results of the stock assessment are communicated to managers and stakeholders at bi-annual working group meetings and at RAG meetings. Compliance and licensing are the responsibility of the Queensland DPI&F.
Other initiatives or agreements	*State, national or international conventions or agreements that impact on the management of the fishery/sub-fishery being evaluated.* The protected zone joint authority (PZJA) has responsibility for the TRL fishery, which must be managed in accordance with the Treaty between Australia and PNG (The Torres Strait Treaty, 1985). Articles 22 and 23 of the Treaty outline the catch sharing arrangements that apply to catch taken on both sides of the border.
Data	
Logbook data	*Verified logbook data; data summaries describe programme* Commercial logbook data from the non-islander and islander sectors are managed by AFMA Canberra. The data are collated and verified for TRL working group meetings, held bi-annually. Comprehensive commercial catch data are only available for years since 2001, but in the non-islander sector data are available from 1997 when logbooks became compulsory. Data summaries are used by CMAR in stock status assessments.
Observer data	*Observer programme describe parameters as below* There is no observer program for the TRL fishery.
Other data	*Studies, surveys* Several related historical and recent research studies to address the biological sustainability of the TRL fishery have been undertaken by CMAR using AFMA funds. Annual fishery-independent surveys conducted by CMAR since 1989 provide abundance, age-structure and seabed habitat data, and this information is reported to the Torres Strait Scientific Advisory Committee (TSSAC). Other studies include: spatial and temporal growth, breeding ground surveys, oceanic larval distribution and transport, migration and reproduction and habitat and settlement preference of juvenile lobsters.

2.2.2 Unit of Analysis Lists (Step 2)

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

- Species Components (target, byproduct/discards and TEP components). [Scoping document S2A Species]
- Habitat Component: habitat types. [Scoping document S2B Habitats]
- Community Component: community types. [Scoping document S2C Communities]

Total Ecological Units Assessed for the Torres Strait Rock Lobster fishery

Target species:	1 (*Panulirus ornatus)*
By-product species:	0
Discard Species:	0
TEP species:	90
Habitats:	158 (157 benthic, 1 overlying pelagic)
Communities:	3 (2 demersal, 1 overlying 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/

Target species *[Torres Strait Rock Lobster Fishery]*
This list was obtained by reviewing available fishery literature, and through discussions with stakeholders.

Sp Code	CAAB	Family	Species name	Common name	Role	Source
	28820006	Palinuridae	*Panulirus ornatus*	Ornate rock lobster	Target	TRL04 AFMA logbook

<u>Byproduct species *[Torres Strait Rock Lobster Fishery]*</u>
Byproduct refers to any part of the catch which is kept or sold by the fisher but which is not a target species.

NB. No byproduct is taken in the Torres Strait Rock Lobster Fishery.

<u>Discard species *[Torres Strait Rock Lobster Fishery]*</u>
Bycatch, as defined in the 2000 Commonwealth Policy on Fisheries Bycatch, refers to:

- that part of a fisher's catch which is returned to the sea either because it has no commercial value or because regulations preclude it being retained; and
- that part of the 'catch' that does not reach the deck but is affected by interaction with the fishing gear

However, in the ERAEF method, the part of the target or byproduct catch that is discarded is included in the assessment of the target or byproduct species.

NB. No discarding occurs in the Torres Strait Rock Lobster Fishery.

<u>TEP species [*Torres Strait Rock Lobster Fishery*]</u>
TEP species are those species listed as Threatened, Endangered or Protected under the EPBC Act.

TEP 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 TEP species has been generated for each fishery and is included in the PSA workbook species list. This list has been generated using the DEH Search Tool from the DEH home page *http://www.deh.gov.au/*

For each fishery, the list of TEP species is compiled 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.

TAXA	FAMILY NAME	SCIENTIFIC NAME	COMMON NAME	CAAB	ROLE	SOURCE
Marine mammal	Dugongidae	*Dugong dugon*	Dugong	41206001	TEP	DEH
Marine mammal	Delphinidae	*Tursiops truncatus*	Bottlenose Dolphin	41116019	TEP	DEH
Marine mammal	Delphinidae	*Stenella longirostris*	Long-snouted Spinner Dolphin	41116017	TEP	DEH
Marine mammal	Delphinidae	*Sousa chinensis*	Indo-Pacific Humpback Dolphin	41116014	TEP	DEH
Marine mammal	Delphinidae	*Globicephala macrorhynchus*	Short-finned Pilot Whale	41116003	TEP	DEH
Marine mammal	Delphinidae	*Delphinus delphis*	Common Dolphin	41116001	TEP	DEH
Marine bird	Laridae	*Sterna sumatrana*	Black-naped tern	40128034	TEP	DEH
Marine bird	Laridae	*Sterna anaethetus*	Bridled Tern	40128023	TEP	DEH
Marine bird	Laridae	*Anous minutus*	Black Noddy	40128001	TEP	DEH
Marine bird	Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	40077001	TEP	DEH
Marine bird	Procellariidae	*Pterodroma heraldica*	Herald Petrel	40041023	TEP	DEH
Marine bird	Procellariidae	*Calonectris leucomelas*	streaked shearwater	40041002	TEP	DEH
Marine reptile	Crocodylidae	*Crocodylus porosus*	saltwater crocodile	39140002	TEP	DEH
Marine reptile	Hydrophiidae	*Pelamis platurus*	yellow-bellied seasnake	39125033	TEP	DEH
Marine reptile	Hydrophiidae	*Lapemis hardwickii*	Spine-bellied Seasnake	39125031	TEP	DEH
Marine reptile	Hydrophiidae	*Hydrophis vorisi*	A seasnake	39125030	TEP	DEH
Marine reptile	Hydrophiidae	*Hydrophis pacificus*	Large-headed Seasnake	39125029	TEP	DEH
Marine reptile	Hydrophiidae	*Hydrophis ornatus*	seasnake	39125028	TEP	DEH
Marine reptile	Hydrophiidae	*Hydrophis melanosoma*	Black-banded robust seasnake	39125027	TEP	DEH
Marine reptile	Hydrophiidae	*Hydrophis mcdowelli*	seasnake	39125025	TEP	DEH
Marine reptile	Hydrophiidae	*Hydrophis gracilis*	Slender seasnake	39125023	TEP	DEH
Marine reptile	Hydrophiidae	*Hydrophis elegans*	Elegant seasnake	39125021	TEP	DEH
Marine reptile	Hydrophiidae	*Hydrophis atriceps*	Black-headed seasnake	39125016	TEP	DEH
Marine reptile	Hydrophiidae	*Hydrelaps darwiniensis*	Black-ringed Seasnake	39125015	TEP	DEH
Marine reptile	Hydrophiidae	*Enhydrina schistosa*	Beaked Seasnake	39125013	TEP	DEH
Marine reptile	Hydrophiidae	*Disteira major*	Olive-headed Seasnake	39125011	TEP	DEH
Marine reptile	Hydrophiidae	*Disteira kingii*	spectacled seasnake	39125010	TEP	DEH
Marine reptile	Hydrophiidae	*Astrotia stokesii*	Stokes' seasnake	39125009	TEP	DEH
Marine reptile	Hydrophiidae	*Aipysurus laevis*	Olive Seasnake, Golden Seasnake	39125007	TEP	DEH
Marine reptile	Hydrophiidae	*Aipysurus eydouxii*	Spine-tailed Seasnake	39125004	TEP	DEH
Marine reptile	Hydrophiidae	*Aipysurus duboisii*	Dubois' Seasnake	39125003	TEP	DEH

Marine reptile	Hydrophiidae	*Acalyptophis peronii*	Horned Seasnake	39125001	TEP	DEH
Marine reptile	Laticaudidae	*Laticauda laticaudata*	Large scaled sea krait	39124002	TEP	DEH
Marine reptile	Laticaudidae	*Laticauda colubrina*	Banded wide faced Sea krait	39124001	TEP	DEH
Marine reptile	Cheloniidae	*Natator depressus*	Flatback turtle	39020005	TEP	DEH
Marine reptile	Cheloniidae	*Lepidochelys olivacea*	Olive Ridley turtle	39020004	TEP	DEH
Marine reptile	Cheloniidae	*Eretmochelys imbricata*	Hawksbill turtle	39020003	TEP	DEH
Marine reptile	Cheloniidae	*Chelonia mydas*	Green turtle	39020002	TEP	DEH
Marine reptile	Cheloniidae	*Caretta caretta*	Loggerhead	39020001	TEP	DEH
Teleost	Syngnathidae	*Hippocampus jugumus*	Spiny Seahorse	37282112	TEP	DEH
Teleost	Syngnathidae	*Hippocampus bargibanti*	pygmy seahorse	37282106	TEP	DEH
Teleost	Syngnathidae	*Trachyrhamphus longirostris*	Long-nosed Pipefish, Straight Stick Pipefish	37282101	TEP	DEH
Teleost	Syngnathidae	*Syngnathoides biaculeatus*	Double-ended Pipehorse, Alligator Pipefish	37282100	TEP	DEH
Teleost	Syngnathidae	*Solegnathus sp. 1* [in Kuiter, 2000]	Pipehorse	37282099	TEP	DEH
Teleost	Syngnathidae	*Siokunichthys breviceps*	[a pipefish]	37282097	TEP	DEH
Teleost	Syngnathidae	*Phoxocampus diacanthus*	[a pipefish]	37282096	TEP	DEH
Teleost	Syngnathidae	*Nannocampus lindemanensis*	[a pipefish]	37282093	TEP	DEH
Teleost	Syngnathidae	*Microphis brachyurus*	[a pipefish]	37282090	TEP	DEH
Teleost	Syngnathidae	*Micrognathus natans*	[a pipefish]	37282089	TEP	DEH
Teleost	Syngnathidae	*Micrognathus pygmaeus*	[a pipefish]	37282087	TEP	DEH
Teleost	Syngnathidae	*Micrognathus andersonii*	Anderson's Pipefish, Shortnose Pipefish	37282086	TEP	DEH
Teleost	Syngnathidae	*Hippocampus zebra*	[a pipefish]	37282080	TEP	DEH
Teleost	Syngnathidae	*Hippocampus planifrons*	Flat-face Seahorse	37282078	TEP	DEH
Teleost	Syngnathidae	*Hippichthys spicifer*	[a pipefish]	37282076	TEP	DEH
Teleost	Syngnathidae	*Hippichthys penicillus*	Beady Pipefish, Steep-nosed Pipefish	37282075	TEP	DEH
Teleost	Syngnathidae	*Hippichthys heptagonus*	Madura Pipefish	37282073	TEP	DEH
Teleost	Syngnathidae	*Hippichthys cyanospilos*	Blue-speckled Pipefish, Blue-spotted Pipefish	37282072	TEP	DEH
Teleost	Syngnathidae	*Halicampus spinirostris*	Spiny-snout Pipefish	37282070	TEP	DEH
Teleost	Syngnathidae	*Halicampus nitidus*	Glittering Pipefish	37282069	TEP	DEH
Teleost	Syngnathidae	*Halicampus mataafae*	[a pipefish]	37282068	TEP	DEH
Teleost	Syngnathidae	*Halicampus macrorhynchus*	[a pipefish]	37282067	TEP	DEH
Teleost	Syngnathidae	*Halicampus dunckeri*	Red-hair Pipefish, Duncker's Pipefish	37282066	TEP	DEH
Teleost	Syngnathidae	*Halicampus brocki*	Brock's Pipefish	37282065	TEP	DEH
Teleost	Syngnathidae	*Festucalex gibbsi*	[a pipefish]	37282062	TEP	DEH

Teleost	Syngnathidae	*Festucalex cinctus*	Girdled Pipefish	37282061	TEP	DEH
Teleost	Syngnathidae	*Doryrhamphus janssi*	Cleaner Pipefish, Janss' Pipefish	37282059	TEP	DEH
Teleost	Syngnathidae	*Doryrhamphus melanopleura*	Bluestripe Pipefish	37282058	TEP	DEH
Teleost	Syngnathidae	*Dunckerocampus dactyliophorus*	Ringed Pipefish	37282057	TEP	DEH
Teleost	Syngnathidae	*Cosmocampus maxweberi*	[a pipefish]	37282056	TEP	DEH
Teleost	Syngnathidae	*Corythoichthys schultzi*	Schultz's Pipefish	37282052	TEP	DEH
Teleost	Syngnathidae	*Corythoichthys paxtoni*	[a pipefish]	37282051	TEP	DEH
Teleost	Syngnathidae	*Corythoichthys ocellatus*	Orange-spotted Pipefish, Ocellated Pipefish	37282050	TEP	DEH
Teleost	Syngnathidae	*Corythoichthys intestinalis*	Australian Messmate Pipefish, Banded Pipefish	37282049	TEP	DEH
Teleost	Syngnathidae	*Corythoichthys amplexus*	Fijian Banded Pipefish, Brown-banded Pipefish	37282047	TEP	DEH
Teleost	Syngnathidae	*Choeroichthys suillus*	Pig-snouted Pipefish	37282046	TEP	DEH
Teleost	Syngnathidae	*Choeroichthys sculptus*	[a pipefish]	37282045	TEP	DEH
Teleost	Syngnathidae	*Choeroichthys cinctus*	[a pipefish]	37282043	TEP	DEH
Teleost	Syngnathidae	*Choeroichthys brachysoma*	Pacific Short-bodied Pipefish, Short-bodied pipefish	37282042	TEP	DEH
Teleost	Syngnathidae	*Campichthys tricarinatus*	Three-keel Pipefish	37282040	TEP	DEH
Teleost	Syngnathidae	*Bulbonaricus davaoensis*	[a pipefish]	37282038	TEP	DEH
Teleost	Syngnathidae	*Acentronura breviperula*	Hairy Pygmy Pipehorse	37282035	TEP	DEH
Teleost	Syngnathidae	*Hippocampus taeniopterus*	Spotted Seahorse, Yellow Seahorse	37282033	TEP	DEH
Teleost	Syngnathidae	*Corythoichthys conspicillatus*	Yellow-banded Pipefish, Network Pipefish	37282032	TEP	DEH
Teleost	Syngnathidae	*Halicampus grayi*	Mud Pipefish, Gray's Pipefish	37282030	TEP	DEH
Teleost	Syngnathidae	*Haliichthys taeniophorus*	Ribboned Seadragon, Ribboned Pipefish	37282007	TEP	DEH
Teleost	Syngnathidae	*Trachyrhamphus bicoarctatus*	Bend Stick Pipefish, Short-tailed Pipefish	37282006	TEP	DEH
Teleost	Syngnathidae	*Hippocampus angustus*	Western Spiny Seahorse	37282005	TEP	DEH
Teleost	Solenostomidae	*Solenostomus paradoxus*	Harlequin Ghost Pipefish, Ornate Ghost Pipefish	37281002	TEP	DEH
Teleost	Solenostomidae	*Solenostomus cyanopterus*	Blue-finned Ghost Pipefish, Robust Ghost	37281001	TEP	DEH
Teleost	Syngnathidae	*Hippocampus spinosissimus*	Hedgehog Seahorse		TEP	DEH

Scoping Document S2B1. Benthic Habitats

Risk assessment for benthic habitats considers both the seafloor structure and its attached invertebrate fauna. Because data on the types and distributions of benthic habitat in Australia's Commonwealth fisheries are generally sparse, and because there is no universally accepted benthic classification scheme, the ERAEF methodology has used the most widely available type of data – seabed imagery – classified in a similar manner to that used in bioregionalisation and deep seabed mapping in Australian Commonwealth waters. Using this imagery, benthic habitats are classified based on an SGF score, using sediment, geomorphology, and fauna. Where seabed imagery is not available, a second method (Method 2) is used to develop an inferred list of potential habitat types for the fishery. For details of both methods, see Hobday *et al* (2007).

Existing image data for this region has recently been obtained, and is currently being processed. Consequently, this list for the Torres Strait Rock Lobster fishery grounds is derived using Scoping Method 2 which includes image data from adjacent fisheries (NPF, WA, CSF), depth zones for which data exists, and includes the habitats associated with Torres Strait features identified by Geomorphic Unit mapping as described in the Bioregionalisation of Australia (Harris *et al*, 2003). This approach tends to generate a conservatively large habitat list due to the detailed data available with which to assess habitats.

A list of the benthic habitats for the Torres Strait Rock Lobster Fishery (note: effort occurs in 0-30m generally which is covered by coastal margin and shallow inner shelf depths). Shading denotes habitats occurring within the jurisdictional boundary of the fishery that are not subject to effort from hand collection.

ERA record No.	ERA Habitat #	Sub-biome	Feature/s	ERA Habitat type	SGF Score	Depth (m)	Image available	Reference image location
3767	306	coastal margin	Shelf	mud, irregular, mixed faunal community	033	0-25	N	
3768	308	coastal margin	Shelf	mud, irregular, octocorals	035	0-25	Y	GoC Image data
3769	312	coastal margin	Shelf	mud, subcrop, small sponges	052	0-25	Y	GoC Image Data
3770	314	coastal margin	Shelf	mud, subcrop, mixed faunal community	053	0-25	N	
3771	317	coastal margin	Shelf	mud, subcrop, low encrusting mixed fauna	056	0-25	N	

3772	330	coastal margin	Shelf	Gravel, directed scour, no fauna	310	0-25	Y	GoC Image data
3773	334	coastal margin	Shelf	Gravel, irregular, no fauna	330	0-25	Y	GoC Image data
3774	340	coastal margin	Shelf	Gravel, subcrop, mixed faunal community	353	0-25	Y	GoC Image data
3775	342	coastal margin	Shelf	Gravel, subcrop, octocorals	355	0-25	Y	GoC Image data
3776	345	coastal margin	Shelf	Biogenic, subcrop, no fauna	750	0-25	Y	GoC Image Data
3777	364	coastal margin	Shelf	Biogenic, subcrop, large sponges	751	0-25	Y	GoC Image Data
3778	365	coastal margin	Shelf	Biogenic, subcrop, mixed faunal community	753	0-25	Y	GoC Image Data
3779	367	coastal margin	Shelf	Biogenic, subcrop, Octocorals	755	0-25	Y	GoC Image Data
3780	369	coastal margin	Shelf	Biogenic, subcrop, small/ low encrustors	756	0-25	Y	GoC Image Data
3781	372	coastal margin	Shelf, Fringing reef	Biogenic, low outcrop, large erect sponges	761	0-25	Y	GoC Image Data
3782	373	coastal margin	Shelf, Fringing reef	Biogenic, low outcrop, mixed faunal community	763	0-25	Y	GoC Image Data
3783	374	coastal margin	Shelf, Fringing reef	Biogenic, low outcrop, octocorals	765	0-25	Y	GoC Image Data
3784	376	coastal margin	Shelf, Fringing reef	Biogenic, low outcrop, encrustors	766	0-25	Y	GoC Image Data
3785	378	coastal margin	Shelf, Fringing reef	Biogenic, low outcrop, large sponges	771	0-25	Y	GoC Image Data
3786	380	coastal margin	Shelf, Fringing reef	Biogenic, low outcrop, mixed faunal community	773	0-25	Y	GoC Image Data
3787	382	coastal margin	Shelf, Fringing reef	Biogenic, low outcrop, octocorals	775	0-25	Y	GoC Image Data
3788	384	coastal margin	Shelf, Fringing reef	Biogenic, low outcrop, encrustors	776	0-25	Y	GoC Image Data
3789	386	coastal margin	Shelf, Fringing reef	Biogenic, low outcrop, sedentary	777	0-25	Y	GoC Image Data
3790	388	coastal margin	Shelf, Fringing reef	Biogenic, high outcrop, octocorals	785	0-25	Y	GoC Image Data
3791	391	coastal margin	Shelf, Fringing reef	Biogenic, high outcrop, mixed faunal community	787	0-25	Y	GoC Image Data
3792	394	coastal margin	Shelf	mud, directed scour, seagrass	01SG	0-25	N	f
3793	395	coastal margin	Shelf	mud, wave rippled, seagrass	02SG	0-25	N	f
3794	396	coastal margin	Shelf	mud, irregular, seagrass	03SG	0-25	N	f
3795	398	coastal margin	Shelf	mud, subcrop, bivalve beds	05BV	0-25	N	g
3796	400	coastal margin	Shelf	mud, subcrop, hard corals	05HC	0-25	N	
3797	401	coastal margin	Shelf	mud, subcrop, seagrass	05SG	0-25	N	f
3798	402	coastal margin	Shelf	fine sediments, directed scour, seagrass	11SG	0-25	N	f
3799	403	coastal margin	Shelf	fine sediments, wave rippled, seagrass	12SG	0-25	N	f
3800	405	coastal margin	Shelf	fine sediments, irregular, seagrass	13SG	0-25	N	f
3801	406	coastal margin	Shelf	fine sediments, subcrop, seagrass	15SG	0-25	N	f
3802	408	coastal margin	Shelf	coarse sediments, directed scour, seagrass	21SG	0-25	N	f
3803	409	coastal margin	Shelf	coarse sediments, wave rippled, seagrass	22SG	0-25	N	f
3804	411	coastal margin	Shelf	coarse sediments, irregular, seagrass	23SG	0-25	N	f

3805	413	coastal margin	Shelf	Coarse sediments, subcrop, bivalve beds	25BV	0-25	N	g
3806	414	coastal margin	Shelf	coarse sediments, subcrop, seagrass	25SG	0-25	N	f
3807	418	coastal margin	Shelf	Gravel, irregular, seagrass	33SG	0-25	Y	f
3808	420	coastal margin	Shelf	Gravel, subcrop, hard corals	35HC	0-25	Y	GoC Image data
3809	422	coastal margin	Shelf	Biogenic, subcrop, hard corals	75HC	0-25	Y	GoC Image Data
3810	423	coastal margin	Shelf	Biogenic, subcrop, seagrass	75SG	0-25	N	f
3811	425	coastal margin	Shelf, Fringing reef	Biogenic, low outcrop, hard corals	76HC	0-25	Y	GoC Image Data
3812	426	coastal margin	Shelf, Fringing reef	Biogenic, low outcrop, seagrass	76SG	0-25	N	f
3813	428	coastal margin	Shelf, Fringing reef	Biogenic, high outcrop, hard corals	78HC	0-25	Y	GoC Image Data
3814	429	coastal margin	Shelf, Fringing reef	Biogenic, high outcrop, seagrass	78SG	0-25	N	f
3815	432	coastal margin	Shelf	Biogenic, subcrop, bivalve beds	75BV	0-25	N	g
3816	435	coastal margin	Shelf	Biogenic, low outcrop, bivalve beds	76BV	0-25	N	g
3817	299	inner shelf	Shelf	mud, flat, no fauna	000	25- 100	N	
3818	300	inner shelf	Shelf	mud, flat, low encrusting sponges	002	25- 100	N	
3819	301	inner shelf	Shelf	mud, flat, octocorals	005	25- 100	Y	GoC Image Data
3820	302	inner shelf	Shelf	mud, flat, sedentary (e.g. seapens)	007	25- 100	Y	GoC Image Data
3821	303	inner shelf	Shelf	mud, directed scour, no fauna	010	25- 100	Y	GoC Image Data
3822	304	inner shelf	Shelf	mud, directed scour, mixed faunal community	013	25- 100	Y	GoC Image Data
3823	305	inner shelf	Shelf	mud, directed scour, bioturbators	019	25- 100	Y	GoC Image Data
3824	307	inner shelf	Shelf	mud, irregular, mixed faunal community	033	25- 100	Y	GoC Image Data
3825	309	inner shelf	Shelf	mud, irregular, bioturbators	039	25- 100	Y	GoC Image Data
3826	310	inner shelf	Shelf	mud, subcrop, erect sponges	051	25- 100	Y	GoC Image Data
3827	311	inner shelf	Shelf	mud, subcrop, small sponges	052	25- 100	Y	GoC Image Data
3828	313	inner shelf	Shelf	mud, subcrop, mixed faunal community	053	25- 100	Y	GoC Image Data
3829	315	inner shelf	Shelf	mud, subcrop, octocorals	055	25- 100	Y	Npf Image Data
3830	316	inner shelf	Shelf	mud, subcrop, low encrusting mixed fauna	056	25- 100	Y	GoC Image Data
3831	318	Inner shelf	shelf	fine sediments, irregular, no fauna	130	25- 100	Y	GoC Image Data
3832	092	inner shelf	shelf	fine sediments, irregular, small sponges	132	25- 100	Y	GoC Image Data
3833	319	inner shelf	shelf	fine sediments, irregular, octocorals	135	25- 100	Y	GoC Image Data
3834	320	inner shelf	shelf	fine sediments, irregular, low encrustings	136	25- 100	Y	GoC Image Data
3835	321	inner shelf	shelf	fine sediments, irregular, bioturbators	139	25- 100	Y	GoC Image Data
3836	013	inner shelf	shelf	coarse sediments, flat, large sponges	201	25- 100	Y	GoC Image Data
3837	322	inner shelf	Shelf	Coarse sediments, flat, mixed faunal community	203	25- 100	Y	GoC Image Data

3838	234	inner shelf	shelf	Coarse sediments, flat, solitary epifauna	207	25- 100	Y	GoC Image Data
3839	323	inner shelf	Shelf	coarse sediments, irregular, small sponges	232	25- 100	Y	Goc Image Data
3840	324	inner shelf	Shelf	coarse sediments, irregular, octocorals	235	25- 100	Y	Goc Image Data
3841	089	inner shelf	shelf	Coarse sediments, irregular, low encrustings	236	25- 100	Y	Goc Image Data
3842	006	inner shelf	shelf	coarse sediments, subcrop, large sponges	251	25- 100	Y	GoC Image Data
3843	282	inner shelf	shelf	Coarse sediments, subcrop, mixed faunal community	253	25- 100	Y	GoC Image Data
3844	325	inner shelf	shelf	gravel, flat, large sponges	301	25- 100	Y	GoC Image Data
3845	326	inner shelf	shelf	gravel, flat, mixed faunal community	303	25- 100	Y	GoC Image Data
3846	327	inner shelf	shelf	gravel, flat, octocorals	305	25- 100	Y	GoC Image Data
3847	328	inner shelf	shelf	gravel, flat, encrustors	306	25- 100	Y	GoC Image Data
3848	329	inner shelf	shelf	gravel, flat, sedentary	307	25- 100	Y	GoC Image Data
3849	331	inner shelf	shelf	gravel/ pebble, directed scour, large sponges	311	25- 100	Y	GoC Image data
3850	001	inner shelf	shelf	gravel/ pebble, directed scour, mixed faunal community	313	25- 100	Y	GoC Image data
3851	332	inner shelf	shelf	gravel/ pebble, directed scour, octocorals	315	25- 100	Y	GoC Image data
3852	333	inner shelf	shelf	gravel/ pebble, directed scour, sedentary	317	25- 100	Y	GoC Image data
3853	242	inner shelf	Shelf	Gravel, irregular, no fauna	330	25- 100	Y	GoC Image Data
3854	335	inner shelf	Shelf	Gravel, irregular, small sponges	332	25- 100	Y	GoC Image Data
3855	336	inner shelf	Shelf	Gravel, irregular, octocorals	335	25- 100	Y	GoC Image Data
3856	337	inner shelf	Shelf	Gravel, irregular, low encrustings	336	25- 100	Y	GoC Image Data
3857	338	inner shelf	shelf	gravel/ pebble, subcrop, large sponges	351	25- 100	Y	GoC Image Data
3858	339	inner shelf	shelf	gravel/ pebble, subcrop, mixed faunal community	353	25- 100	Y	GoC Image Data
3859	341	inner shelf	shelf	gravel/ pebble, subcrop, octocorals	355	25- 100	Y	GoC Image Data
3860	343	inner shelf	shelf	gravel/ pebble, subcrop, sedentary	357	25- 100	Y	GoC Image Data
3861	344	inner shelf	Shelf	Sedimentary rock (?), subcrop, no fauna	650	25- 100	Y	GoC Image Data
3862	345	inner shelf	Shelf	Sedimentary rock (?), Subcrop, large sponges	651	25- 100	Y	GoC Image Data
3863	346	inner shelf	Shelf	Sedimentary rock (?), subcrop, mixed faunal community	653	25- 100	Y	GoC Image Data
3864	347	inner shelf	Shelf	Sedimentary rock (?), Subcrop, Octocorals	655	25- 100	Y	GoC Image Data
3865	348	inner shelf	Shelf	Sedimentary rock (?), subcrop, small/ low encrustors	656	25- 100	Y	GoC Image Data
3866	349	inner shelf	Shelf	Sedimentary Rock (?), subcrop, sedentary	657	25- 100	Y	GoC Image Data
3867	350	inner shelf	Shelf, bioherm	Sedimentary rock (?), low outcrop, large sponges	661	25- 100	Y	GoC Image Data
3868	351	inner shelf	Shelf, bioherm	Sedimentary rock (?), low outcrop, mixed faunal community	663	25- 100	Y	GoC Image Data
3869	352	inner shelf	Shelf, bioherm	Sedimentary rock (?), low outcrop, octocorals	665	25- 100	Y	GoC Image Data
3870	353	inner shelf	Shelf, bioherm	Sedimentary rock (?), low outcrop, encrustors	666	25- 100	Y	GoC Image Data

3871	354	inner shelf	Shelf, bioherm	Sedimentary rock (?), low outcrop, sedentary	667	25- 100	Y	GoC Image Data
3872	004	inner shelf	Shelf, bioherm	Sedimentary rock (?), low outcrop, large sponges	671	25- 100	Y	GoC Image Data
3873	355	inner shelf	Shelf, bioherm	Sedimentary rock (?), low outcrop, mixed faunal community	673	25- 100	Y	GoC Image Data
3874	356	inner shelf	Shelf, bioherm	Sedimentary rock (?), low outcrop, octocorals	675	25- 100	Y	GoC Image Data
3875	357	inner shelf	Shelf, bioherm	Sedimentary rock (?), low outcrop, encrustors	676	25- 100	Y	GoC Image Data
3876	358	inner shelf	Shelf, bioherm	Sedimentary rock (?), low outcrop, sedentary	677	25- 100	Y	GoC Image Data
3877	359	inner shelf	Shelf, bioherm	Sedimentary rock (?), high outcrop, mixed faunal community	683	25- 100	Y	GoC Image Data
3878	360	inner shelf	Shelf, bioherm	Sedimentary rock (?), high outcrop, octocorals	685	25- 100	Y	GoC Image Data
3879	361	inner shelf	Shelf, bioherm	Sedimentary rock (?), high outcrop, encrustors	686	25- 100	Y	GoC Image Data
3880	003	inner shelf	Shelf, bioherm	Sedimentary rock (?), high outcrop, mixed faunal community	693	25- 100	Y	GoC Image Data
3881	362	inner shelf	Shelf, bioherm	Sedimentary rock (?), high outcrop, octocorals	695	25- 100	Y	GoC Image Data
3882	363	inner shelf	Shelf, bioherm	Sedimentary rock (?), high outcrop, encrustors	696	25- 100	Y	GoC Image Data
3883	273	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, subcrop, large sponges	751	25- 100	Y	GoC Image Data
3884	366	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, subcrop, mixed faunal community	753	25- 100	Y	GoC Image Data
3885	368	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, subcrop, octocorals	755	25- 100	Y	GoC Image Data
3886	274	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, subcrop, small/ low encrustors	756	25- 100	Y	GoC Image Data
3887	370	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, subcrop, sedentary	757	25- 100	Y	GoC Image Data
3888	371	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, low outcrop, large sponges	761	25- 100	Y	GoC Image Data
3889	275	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, low outcrop, mixed faunal community	763	25- 100	Y	GoC Image Data
3890	276	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, low outcrop, octocorals	765	25- 100	Y	GoC Image Data
3891	375	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, low outcrop, encrustors	766	25- 100	Y	GoC Image Data
3892	377	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, low outcrop, sedentary	767	25- 100	Y	GoC Image Data
3893	379	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, low outcrop, large sponges	771	25- 100	Y	GoC Image Data
3894	277	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, low outcrop, mixed faunal community	773	25- 100	Y	GoC Image Data
3895	381	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, low outcrop, octocorals	775	25- 100	Y	GoC Image Data
3896	383	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, low outcrop, encrustors	776	25- 100	Y	GoC Image Data
3897	385	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, low outcrop, sedentary	777	25- 100	Y	GoC Image Data
3898	387	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, high outcrop, mixed faunal community	783	25- 100	Y	GoC Image Data
3899	389	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, high outcrop, octocorals	785	25- 100	Y	GoC Image Data
3900	390	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, high outcrop, encrustors	786	25- 100	Y	GoC Image Data
3901	278	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, high outcrop, mixed faunal community	793	25- 100	Y	GoC Image Data
3902	392	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, high outcrop, octocorals	795	25- 100	Y	GoC Image Data

3903	393	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, high outcrop, encrustors	796	25- 100	Y	GoC Image Data
3904	397	inner shelf	Shelf	mud, subcrop, bivalve beds	05BV	25- 100	N	g
3905	399	inner shelf	Shelf	mud, subcrop, hard corals	05HC	25- 100	Y	Npf Image Data
3906	404	Inner shelf	shelf	fine sediments, irregular, hard corals	13HC	25- 100	Y	GoC Image Data
3907	407	inner shelf	Shelf	Coarse sediments, flat, hard corals	20HC	25- 100	Y	GoC Image Data
3908	410	inner shelf	Shelf	coarse sediments, irregular, hard corals	23HC	25- 100	Y	Goc Image Data
3909	412	inner shelf	Shelf	Coarse sediments, subcrop, bivalve beds	25BV	25- 100	N	g
3910	415	inner shelf	shelf	gravel, flat, hard corals	30HC	25- 100	Y	GoC Image Data
3911	416	inner shelf	shelf	gravel/ pebble, directed scour, hard corals	31HC	25- 100	Y	GoC Image data
3912	417	inner shelf	Shelf	Gravel, irregular, Hard corals	33HC	25- 100	Y	GoC Image Data
3913	419	inner shelf	shelf	gravel/ pebble, subcrop, hard corals	35HC	25- 100	Y	GoC Image Data
3914	421	inner shelf	Shelf	Sedimentary Rock (?), subcrop, hard corals	65HC	25- 100	Y	GoC Image Data
3915	424	inner shelf	Shelf, bioherm	Sedimentary rock (?), low outcrop, hard corals	66HC	25- 100	Y	GoC Image Data
3916	427	inner shelf	Shelf, bioherm	Sedimentary rock (?), high outcrop, hard corals	68HC	25- 100	Y	GoC Image Data
3917	430	inner shelf	Shelf, bioherm	Sedimentary rock (?), high outcrop, hard corals	69HC	25- 100	Y	GoC Image Data
3918	431	inner shelf	Shelf	Biogenic, subcrop, bivalve beds	75BV	25- 100	N	g
3919	433	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, subcrop, hard corals	75HC	25- 100	Y	GoC Image Data
3920	434	inner shelf	Shelf	Biogenic, low outcrop, bivalve beds	76BV	25- 100	N	g
3921	436	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, low outcrop, hard corals	76HC	25- 100	Y	GoC Image Data
3922	437	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, high outcrop, hard corals	78HC	25- 100	Y	GoC Image Data
3923	438	inner shelf	Shelf, Fringing reef, bioherm	Biogenic, high outcrop, hard corals	79HC	25- 100	Y	GoC Image Data
3924	017	outer shelf	shelf	fine sediments, subcrop, large sponges	151	100- 200	Y	SE Image Collection
3925	018	outer shelf	shelf	Sedimentary rock, outcrop, encrustors	696	100- 200	Y	SE Image Collection
3926	019	outer shelf	Terrace, Shelf	coarse sediments, subcrop, large sponges	251	100- 200	Y	SE Image Collection
3927	020	outer shelf	shelf	cobble, outcrop, crinoids	464	100- 200	Y	SE Image Collection
3928	022	outer shelf	shelf	Sedimentary rock, subcrop, mixed faunal community	653	100- 200	Y	SE Image Collection
3929	023	outer shelf	shelf	Sedimentary rock, outcrop, large sponges	671	100- 200	Y	SE Image Collection
3930	024	outer shelf	shelf	gravel, irregular, encrustors	336	100- 200	Y	SE Image Collection
3931	025	outer shelf	shelf	coarse sediments, wave rippled, no fauna	220	100- 200	Y	SE Image Collection
3932	026	outer shelf	shelf	coarse sediments, unrippled, encrustors	206	100- 200	Y	SE Image Collection
3933	027	outer shelf	shelf	coarse sediments, current rippled, no fauna	210	100- 200	Y	SE Image Collection
3934	028	outer shelf	shelf	cobble, unrippled, large sponges	401	100- 200	Y	SE Image Collection
3935	029	outer shelf	shelf	coarse sediments, irregular, large sponges	231	100- 200	Y	SE Image Collection

3936	030	outer shelf	shelf	coarse sediments, unrippled, mixed faunal community	203	100- 200	Y	SE Image Collection
3937	032	outer shelf	shelf	cobble, subcrop, crinoids	454	100- 200	Y	SE Image Collection
3938	065	outer shelf	canyon	Sedimentary rock, outcrop, small sponges	672	100- 200	Y	SE Image Collection
3939	100	outer shelf	Shelf	Mud, flat, sedentary (e.g. seapens)	007	100- 200	2	WA Image Collection
3940	101	outer shelf	shelf	coarse sediments, subcrop, small sponges	252	100- 200	N	SE Image Collection
3941	102	outer shelf	shelf	coarse sediments, wave rippled, encrustors	226	100- 200	N	SE Image Collection
3942	103	outer shelf	shelf	coarse sediments, wave rippled, small sponges	222	100- 200	N	SE Image Collection
3943	104	outer shelf	shelf	fine sediments, current rippled, bioturbators	119	100- 200	Y	SE Image Collection
3944	105	outer shelf	shelf	fine sediments, irregular, large sponges	131	100- 200	N	SE Image Collection
3945	106	outer shelf	shelf	fine sediments, irregular, no fauna	130	100- 200	N	SE Image Collection
3946	107	outer shelf	shelf	fine sediments, irregular, small sponges	132	100- 200	N	SE Image Collection
3947	108	outer shelf	shelf	fine sediments, subcrop, mixed faunal community	153	100- 200	N	SE Image Collection
3948	109	outer shelf	shelf	fine sediments, subcrop, small sponges	152	100- 200	Y	SE Image Collection
3949	110	outer shelf	shelf	fine sediments, unrippled, bioturbators	109	100- 200	Y	SE Image Collection
3950	111	outer shelf	Shelf	Fine sediments, unrippled, large/ erect sponges	101	100- 200	3	WA Image Collection
3951	112	outer shelf	shelf	fine sediments, unrippled, no fauna	100	100- 200	Y	SE Image Collection
3952	113	outer shelf	shelf	Fine sediments, unrippled, small sponges	102	100- 200	Y	Norfanz Image Collection
3953	114	outer shelf	shelf	fine sediments, wave rippled, bioturbators	129	100- 200	Y	SE Image Collection
3954	115	outer shelf	shelf	fine sediments, wave rippled, encrustors	126	100- 200	N	SE Image Collection
3955	116	outer shelf	shelf	fine sediments, wave rippled, large sponges	121	100- 200	N	SE Image Collection
3956	117	outer shelf	shelf	fine sediments, wave rippled, no fauna	120	100- 200	N	SE Image Collection
3957	118	outer shelf	shelf	fine sediments, wave rippled, sedentary	127	100- 200	N	SE Image Collection
3958	119	outer shelf	shelf	fine sediments, wave rippled, small sponges	122	100- 200	N	SE Image Collection
3959	120	outer shelf	shelf	gravel, current rippled, bioturbators	319	100- 200	N	SE Image Collection
3960	121	outer shelf	shelf	gravel, wave rippled, bioturbators	329	100- 200	Y	SE Image Collection
3961	122	outer shelf	shelf	gravel, wave rippled, encrustors	326	100- 200	N	SE Image Collection
3962	123	outer shelf	shelf	gravel, wave rippled, large sponges	321	100- 200	N	SE Image Collection
3963	124	outer shelf	shelf	gravel, wave rippled, no fauna	320	100- 200	N	SE Image Collection
3964	125	outer shelf	shelf	mud, subcrop, small sponges	052	100- 200	Y	SE Image Collection
3965	126	outer shelf	shelf	Sedimentary rock, Subcrop, large sponges	651	100- 200	Y	GAB Image Collection
3966	127	outer shelf	shelf	Sedimentary rock, subcrop, small sponges	652	100- 200	Y	SE Image Collection
3967	166	outer shelf	shelf-break	Bryozoan based communities	xx6	100-200, 200-700	N	SE Image Collection
3968	167	outer shelf	shelf-break	fine sediments, irregular, bioturbators	139	100-200, 200-700	N	SE Image Collection

3969	168	outer shelf	shelf-break	fine sediments, irregular, small sponges	132	100-200, 200-700	N	SE Image Collection
3970	169	outer shelf	shelf-break	fine sediments, unrippled, bioturbators	109	100-200, 200-700	N	SE Image Collection
3971	170	outer shelf	shelf-break	fine sediments, unrippled, no fauna	100	100-200, 200-700	N	SE Image Collection
3972	171	outer shelf	shelf-break	fine sediments, unrippled, octocorals	105	100-200, 200-700	N	SE Image Collection
3973	172	outer shelf	shelf-break	Igneous rock, high outcrop, no fauna	590	100-200, 200-700	N	SE Image Collection
3974	173	outer shelf	shelf-break	mud, unrippled, no fauna	000	100-200, 200-700	N	SE Image Collection
3975	174	outer shelf	shelf-break	mud, unrippled, sedentary	007	100-200, 200-700	N	SE Image Collection
3976	175	outer shelf	shelf-break	Sedimentary rock, subcrop, crinoids	654	100-200, 200-700	N	SE Image Collection
3977	176	outer shelf	shelf-break	Sedimentary rock, subcrop, small sponges	652	100-200, 200-700	N	SE Image Collection
3978	177	outer shelf	shelf	mud, unrippled, low encrusting sponges	002	100- 200	N	SE Image Collection
3979	178	outer shelf	shelf	mud, unrippled, bioturbators	009	100- 200	N	SE Image Collection
3980	179	outer shelf	shelf	mud, subcrop, erect sponges	051	100- 200	N	SE Image Collection
3981	180	outer shelf	shelf	mud, subcrop, low encrusting mixed fauna	056	100- 200	N	SE Image Collection
3982	181	outer shelf	shelf	fine sediments, unrippled, encrustors	106	100- 200	N	SE Image Collection
3983	183	outer shelf	shelf	fine sediments, current rippled, no fauna	110	100- 200	N	SE Image Collection
3984	184	outer shelf	shelf	fine sediments, current rippled, low/ encrusting sponges	112	100- 200	N	SE Image Collection
3985	185	outer shelf	shelf	fine sediments, irregular, low encrusting mixed fauna	136	100- 200	N	SE Image Collection
3986	187	outer shelf	shelf	fine sediments, irregular, bioturbators	139	100- 200	N	SE Image Collection
3987	188	outer shelf	shelf	fine sediments, rubble banks, low encrusting sponges	142	100- 200	N	SE Image Collection
3988	189	outer shelf	shelf	fine sediments, subcrop, mixed low fauna	156	100- 200	N	SE Image Collection
3989	190	outer shelf	shelf	coarse sediments, unrippled, no fauna	200	100- 200	N	SE Image Collection
3990	192	outer shelf	shelf	gravel/ pebble, current rippled, large sponges	311	100- 200	N	SE Image Collection
3991	193	outer shelf	shelf	gravel/ pebble, current rippled, mixed low fauna	316	100- 200	N	SE Image Collection
3992	194	outer shelf	shelf	gravel/ pebble, wave rippled, low encrusting sponges	322	100- 200	N	SE Image Collection
3993	195	outer shelf	shelf	gravel, wave rippled, encrustors	326	100- 200	N	SE Image Collection
3994	196	outer shelf	shelf	gravel, wave rippled, encrustors	346	100- 200	N	SE Image Collection
3995	197	outer shelf	shelf	cobble, unrippled, low/ encrusting mixed fauna	406	100- 200	N	SE Image Collection
3996	198	outer shelf	shelf	cobble, current rippled, low/ encrusting mixed fauna	416	100- 200	N	SE Image Collection
3997	209	Outer shelf	Terrace	Coarse sediments, Subcrop, Mixed faunal community	253	100- 200	Y	GAB Image Collection
3998	219	outer shelf	Shelf	mud, unrippled, small or large sponges	001	100- 200	Y	WA Image Collection
3999	220	outer shelf	Shelf	Mud, flat, octocorals	005	100- 200	Y	WA Image Collection
4000	223	outer shelf	Shelf	mud, current rippled, bioturbators	019	100- 200	Y	WA Image Collection
4001	224	outer shelf	Shelf	mud, wave rippled, no fauna	020	100- 200	Y	WA Image Collection

4002	225	outer shelf	Shelf	Mud, irregular, bioturbators	039	100- 200	Y	WA Image Collection
4003	226	outer shelf	Shelf	Mud, subcrop, mixed faunal community	053	100- 200	Y	WA Image Collection
4004	233	outer shelf	Shelf	Coarse sediments, unrippled, octocoral/ and bryozoans??	205	100- 200	Y	WA Image Collection
4005	246	outer shelf	Shelf	cobble/boulder (slab), outcrop, mixed low encrustors	466	100- 200	Y	WA Image Collection
4006	254	outer shelf	Shelf	Sedimentary rock (?), low outcrop, large erect sponges	661	100- 201	Y	WA Image Collection
4007	255	outer shelf	Shelf	Sedimentary rock (?) low outcrop, mixed faunal community	663	100- 200	Y	WA Image Collection
4008	258	outer shelf	Shelf	Sedimentary rock (?), low outcrop, mixed faunal community	673	100- 200	Y	WA Image Collection
4009	259	outer shelf	Shelf	Rock (sedimentary?), outcrop (low, holes and cracks etc), encrustors	676	100- 200	Y	WA Image Collection
4010	260	outer shelf	Shelf	Rock (sedimentary?), outcrop, solitary	677	100- 200	Y	WA Image Collection
4011	263	outer shelf	Shelf	Rock (sedimentary?), high outcrop, ?small sponges	682	100- 200	Y	WA Image Collection
4012	266	outer shelf	Shelf	Rock (sedimentary?),, high outcrop, large sponges	691	100- 200	Y	WA Image Collection
4013	268	outer shelf	Shelf	Sedimentary rock (?), high outcrop, mixed faunal community	693	100- 200	Y	WA Image Collection
4014	279	outer shelf	Shelf	mud, current rippled, no fauna	010	100- 200	Y	WA Image Collection
4015	280	outer shelf	Shelf	Rock (sedimentary?), high outcrop, solitary	681	100- 201	Y	WA Image Collection
4016	281	outer shelf	Shelf	Rock/ biogenic matrix, low outcrop, mixed faunal community	763	100-200	Y	WA Image Collection
4017	033	upper slope	slope	Sedimentary rock, subcrop, mixed faunal community	653	200- 700	Y	SE Image Collection
4018	034	upper slope	slope	Sedimentary rock, outcrop, encrustors	696	200- 700	Y	SE Image Collection
4019	035	upper slope	slope	Sedimentary rock, outcrop, encrustors	666	200- 700	Y	SE Image Collection
4020	036	upper slope	Slope	Sedimentary, subcrop, small encrustors (hydroids?)	656	200- 700	Y	WA Image Collection
4021	039	upper slope	slope	Sedimentary rock, outcrop, crinoids	684	200- 700	Y	SE Image Collection
4022	040	upper slope	slope	fine sediments, subcrop, sedentary	157	200- 700	Y	SE Image Collection
4023	041	upper slope	Slope	fine, irregular, bioturbators	139	200- 700	3	WA Image Collection
4024	043	upper slope	slope	coarse sediments, unrippled, low mixed encrustors	206	200- 700	Y	SE Image Collection
4025	044	upper slope	slope, canyon, Terrace	fine sediments, unrippled, bioturbators	109	200- 700	Y	SE Image Collection
4026	045	upper slope	slope	coarse sediments, unrippled, sedentary	207	200- 700	Y	SE Image Collection
4027	046	upper slope	slope	fine sediments, unrippled, no fauna	100	200- 700	Y	SE Image Collection
4028	066	upper slope	canyon	Sedimentary rock, outcrop, crinoids	694	200- 700	Y	SE Image Collection
4029	067	upper slope	canyon, slope	Sedimentary rock, subcrop, large sponges	651	200- 700	Y	SE Image Collection
4030	069	upper slope	canyon	cobble, outcrop, crinoids	464	200- 700	Y	SE Image Collection
4031	070	upper slope	canyon	Sedimentary rock, subcrop, small sponges	652	200- 700	Y	SE Image Collection
4032	071	upper slope	Shelf break, Canyon	Sedimentary, low outcrop, small encrustors	676	200- 700	3	WA Image Collection

4033	072	upper slope	Slope, Canyon	coarse sediments, irregular, bioturbators	239	200- 700	Y	SE Image Collection
4034	073	upper slope	Terrace, canyon	Fine sediments, irregular, Small encrustors / erect forms (including bryozoans)	136	200-700	Y	GAB Image Collection
4035	076	upper slope	canyon, slope	coarse sediments, irregular, low mixed encrustors	236	200- 700	Y	SE Image Collection
4036	077	upper slope	canyon, slope	fine sediments, subcrop, small sponges	152	200- 700	Y	SE Image Collection
4037	078	upper slope	Slope, canyon, Terrace	Fine sediments, unrippled, Solitary epifauna	107	200- 700	2	WA Image Collection
4038	128	upper slope	slope	Bryozoan based communities	xx6	200- 700	N	SE Image Collection
4039	129	upper slope	slope	cobble, debris flow, encrustors	446	200- 700	Y	SE Image Collection
4040	130	upper slope	slope	cobble, debris flow, no fauna	440	200- 700	Y	SE Image Collection
4041	131	upper slope	slope	cobble, debris flow, octocorals	445	200- 700	N	SE Image Collection
4042	132	upper slope	slope	cobble, debris flow, small sponges	442	200- 700	Y	SE Image Collection
4043	133	upper slope	Slope	Fine, current rippled, no fauna	110	200- 700	Y	WA Image Collection
4044	134	upper slope	slope	fine sediments, subcrop, large sponges	151	200- 700	N	SE Image Collection
4045	136	upper slope	slope	fine sediments, unrippled, encrustors	106	200- 700	Y	SE Image Collection
4046	137	upper slope	slope	Fine sediments, unrippled, small sponges	102	200- 700	Y	Norfanz Image Collection
4047	138	upper slope	slope	gravel, debris flow, encrustors	346	200- 700	Y	SE Image Collection
4048	139	upper slope	slope	gravel, debris flow, no fauna	340	200- 700	N	SE Image Collection
4049	140	upper slope	slope	mud, irregular, bioturbators	039	200- 700	Y	SE Image Collection
4050	141	upper slope	Slope	mud, unrippled, distinct infaunal bioturbators	009	200- 700	Y	WA Image Collection
4051	142	upper slope	slope	mud, unrippled, encrustors	006	200- 700	Y	SE Image Collection
4052	143	upper slope	slope	mud, unrippled, large sponges	001	200- 700	N	SE Image Collection
4053	144	upper slope	slope, Canyon	mud, unrippled, sedentary	007	200- 700	Y	SE Image Collection
4054	145	upper slope	slope, Canyon	Sedimentary, low outcrops on steep slope, large sponges	671	200- 700	2	WA Image Collection
4055	146	upper slope	slope	Sedimentary rock, low outcrop, small sponges	672	200- 700	Y	SE Image Collection
4056	148	upper slope	Terrace, slope	Sedimentary rock, Subcrop, Octocorals (gold corals / seawhips)	655	200-700	Y	GAB Image Collection
4057	202	upper slope	Terrace	Mud, Unrippled, No fauna	000	200-700	Y	GAB Image Collection
4058	216	upper slope	Canyon	Sedimentary rock, low outcrop, Octocorals (gold corals / seawhips)	675	200-700	Y	GAB Image Collection
4059	217	upper slope	Canyon	Sedimentary rock, High Outcrop, Small encrustors / erect forms (including bryozoans)	686	200-700	Y	GAB Image Collection
4060	218	upper slope	Canyon	Sedimentary rock, High Outcrop, Sedentary: e.g. seapens	687	200-700	Y	GAB Image Collection
4061	227	upper slope	Slope	Fine sediments, unrippled, sponges	101	200- 700	Y	WA Image Collection
4062	231	upper slope	Slope	Fine sediments, irregular, glass sponge (stalked)	137	200- 700	Y	WA Image Collection
4063	235	upper slope	Slope	Coarse sediments, rippled, no fauna	210	200- 700	Y	WA Image Collection

4064	236	upper slope	Slope	Coarse sand, rippled, solitary epifauna	217	200- 700	Y	WA Image Collection
4065	237	upper slope	Slope	Coarse sand, wave rippled, bryozoan turf	226	200- 700	Y	WA Image Collection
4066	238	upper slope	Slope	Coarse sediments, irregular, octocorals (matrix of solsomalia – dead corals)	235	200- 700	Y	WA Image Collection
4067	239	upper slope	Slope	Coarse sediments, subcrop, large (?) sponges	251	200- 700	Y	WA Image Collection
4068	240	upper slope	Slope	Sedimentary, subcrop, octocorals	255	200- 700	Y	WA Image Collection
4069	241	upper slope	Slope	Coarse sediments, subcrop, low encrusting community (ascidians)	256	200- 700	Y	WA Image Collection
4070	247	upper slope	slope	Boulders, low outcrop, no fauna	470	200- 700	Y	Norfanz Image Collection
4071	251	upper slope	Slope	Sedimentary, subcrop, no fauna	650	200- 700	Y	WA Image Collection
4072	256	upper slope	Slope	Sedimentary, outcrop, octocorals	665	200- 700	Y	WA Image Collection
4073	257	upper slope	Shelf break	Sedimentary, low outcrop, no fauna	670	200- 700	3	WA Image Collection
4074	261	upper slope	Slope	Sedimentary, outcrop, sedentary (anemones)	677	200- 700	Y	WA Image Collection
4075	264	upper slope	Slope	Sedimentary, high outcrop, octocoral	683	200- 700	Y	WA Image Collection
4076	265	upper slope	Slope	Sedimentary rock (mudstone?), high outcrop, no fauna	690	200- 700	3	WA Image Collection
4077	267	upper slope	Slope	Sedimentary rock (mudstone?), high outcrop, small sponges	692	200- 700	Y	WA Image Collection
4078	269	upper slope	Slope	Sedimentary, outcrop, octocorals	695	200- 700	Y	WA Image Collection
4079	270	upper slope	Slope	Sedimentary, high outcrop, solitary epifauna	697	200- 700	Y	WA Image Collection
4080	284	upper slope	slope	Coarse sediments, unrippled, large sponges	201	200- 700	Y	Norfanz Image Collection
4081	285	upper slope	slope	Coarse sediments, unrippled, octocorals	205	200- 700	Y	Norfanz Image Collection
4082	286	upper slope	slope	Cobble/ boulder, debris, sedentary	447	200- 700	Y	Norfanz Image Collection
4083	287	upper slope	slope	slabs and boulders, low outcrop, octocorals	475	200- 700	Y	Norfanz Image Collection
4084	288	upper slope	slope	Igneous Rock (?), low outcrop, octocorals	565	200- 700	Y	Norfanz Image Collection
4085	289	upper slope	slope	Igneous Rock (?), low outcrop, mixed faunal community	573	200- 700	Y	Norfanz Image Collection
4086	290	upper slope	slope	Igneous Rock (?), high outcrop, no fauna	590	200- 700	Y	Norfanz Image Collection
4087	291	upper slope	slope	Igneous Rock (?), high outcrop, mixed faunal community	593	200- 700	Y	Norfanz Image Collection
4088	292	upper slope	slope	Sedimentary Rock , subcrop, sedentary	657	200- 700	Y	Norfanz Image Collection
4089	293	upper slope	slope	Rock/ biogenic matrix, low outcrop, mixed faunal community	763	200- 700	Y	Norfanz Image Collection
4090	049	mid-slope	slope	Igneous rock, high outcrop, crinoids	594	700- 1500	Y	SE Image Collection
4091	050	mid-slope	slope	cobble, debris flow, encrustors	446	700- 1500	Y	SE Image Collection
4092	051	mid-slope	slope	cobble, outcrop, no fauna	460	700- 1500	Y	SE Image Collection
4093	052	mid-slope	slope	Sedimentary rock, outcrop, octocorals	675	700- 1500	Y	SE Image Collection
4094	053	mid-slope	slope	Igneous rock, low outcrop, sedentary	567	700- 1500	Y	SE Image Collection

4095	054	mid-slope	slope	Sedimentary rock, outcrop, crinoids	694	700- 1500	Y	SE Image Collection
4096	055	mid-slope	slope	Sedimentary rock, unrippled, sedentary	607	700- 1500	Y	SE Image Collection
4097	056	mid-slope	slope, canyons, seamounts	Sedimentary rock, outcrop, mixed faunal community	673	700- 1500	Y	SE Image Collection
4098	057	mid-slope	slope	fine sediments, subcrop, bioturbators	150	700- 1500	Y	SE Image Collection
4099	058	mid-slope	slope	cobble, unrippled, small sponges	402	700- 1500	Y	SE Image Collection
4100	059	mid-slope	Seamount, Slope	coarse sediments, irregular,low encrusting	236	700- 1500	Y	SE Image Collection
4101	060	mid-slope	slope	cobble, outcrop, crinoids	464	700- 1500	Y	SE Image Collection
4102	061	mid-slope	slope	fine sediments, irregular, bioturbators	139	700-1500	Y	SE Image Collection
4103	062	mid-slope	slope	coarse sediments, unrippled, octocorals	205	700-1500	Y	SE Image Collection
4104	063	mid-slope	slope	fine sediments, unrippled, octocorals	105	700-1500	Y	SE Image Collection
4105	064	mid-slope	slope	Sedimentary slab and mud boulders, outcrop, crinoids	464	700-1500	Y	SE Image Collection
4106	080	mid-slope	seamount, Terrace	Sedimentary rock, outcrop, encrustors	676	700-1500	Y	SE Image Collection
4107	081	mid-slope	seamount	Sedimentary rock, unrippled, no fauna	600	700-1500	Y	SE Image Collection
4108	084	mid-slope	seamount, canyon	Sedimentary rock, outcrop, sedentary	677	700-1500	Y	SE Image Collection
4109	085	mid-slope	seamount	Sedimentary rock, unrippled, encrustors	606	700-1500	Y	SE Image Collection
4110	150	mid-slope	slope	coarse sediments, current rippled, no fauna	210	700-1500	N	SE Image Collection
4111	151	mid-slope	slope	coarse sediments, current rippled, octocorals	215	700-1500	N	SE Image Collection
4112	152	mid-slope	slope	coarse sediments, current rippled, sedentary	217	700-1500	N	SE Image Collection
4113	153	mid-slope	slope	coarse sediments, unrippled, no fauna	200	700-1500	N	SE Image Collection
4114	154	mid-slope	slope	cobble, debris flow, crinoids	444	700-1500	N	SE Image Collection
4115	155	mid-slope	slope	slabs/ boulders, debris flow, octocorals	445	700-1500	Y	SE Image Collection
4116	156	mid-slope	Slope	Fine, unrippled, no obvious fauna	100	700-1500	Y	WA Image Collection
4117	156	mid-slope	Terrace	Fine sediments, Unrippled, No fauna	100	700-1500	Y	GAB Image Collection
4118	157	mid-slope	Slope	Igneous rock, high outcrop, octocoral	595	700-1500	Y	WA Image Collection
4119	158	mid-slope	slope	mud, current rippled, bioturbators	019	700-1500	N	SE Image Collection
4120	159	mid-slope	Slope	Mud, irregular, bioturbators	039	700-1500	Y	WA Image Collection
4121	160	mid-slope	slope	mud, irregular, sedentary	037	700-1500	N	SE Image Collection
4122	161	mid-slope	slope	mud, unrippled, small sponges	002	700-1500	N	SE Image Collection
4123	162	mid-slope	slope	Sedimentary rock, debris flow, crinoids	644	700-1500	N	SE Image Collection
4124	163	mid-slope	Terrace	Sedimentary rock, High Outcrop, Octocorals	695	700-1500	Y	GAB Image Collection
4125	164	mid-slope	slope	Sedimentary rock, subcrop, crinoids	654	700-1500	Y	SE Image Collection
4126	207	mid-slope	Terrace	Coarse sediments, directed scour, Small encrustors / erect forms (including bryozoans)	216	700-1500	Y	GAB Image Collection

4127	208	mid-slope	Seamount	Coarse sediments, Highly irregular, Mixed faunal community	233	700-1500	Y	GAB Image Collection
4128	210	mid-slope	Seamount	Cobble / boulder, Debris flow / rubble banks, Sedentary: e.g. seapens	447	700-1500	Y	GAB Image Collection
4129	211	mid-slope	Seamount	Igneous / metamorphic rock, Subcrop, Small encrustors	556	700-1500	Y	GAB Image Collection
4130	212	mid-slope	Seamount	Igneous / metamorphic rock, Subcrop, Sedentary: e.g. seapens	557	700-1500	Y	GAB Image Collection
4131	213	mid-slope	Seamount	Igneous / metamorphic rock, Low Outcrop, Octocorals	575	700-1500	Y	GAB Image Collection
4132	214	mid-slope	Seamount	Igneous / metamorphic rock, Low Outcrop, Small encrustors	576	700-1500	Y	GAB Image Collection
4133	215	mid-slope	Seamount	Igneous / metamorphic rock, Low Outcrop, Sedentary	577	700-1500	Y	GAB Image Collection
4134	221	mid-slope	Slope	Mud, irregular, crinoids	005	700-1500	Y	WA Image Collection
4135	222	mid-slope	Slope	Mud, flat, solitary	007	700-1500	Y	WA Image Collection
4136	228	mid-slope	Slope	Fine, unrippled, solitary	107	700-1500	Y	WA Image Collection
4137	230	mid-slope	Slope	fine sediments, irregular, no fauna	130	700-1500	Y	WA Image Collection
4138	232	mid-slope	Slope	Fine sediments, subcrop, octocorals	155	700-1500	Y	WA Image Collection
4139	243	mid-slope	Slope	Gravel, irregular, low encrustings	336	700-1500	2	WA Image Collection
4140	244	mid-slope	Slope	Igneous rock/boulder, rubble bank, none	440	700-1500	Y	WA Image Collection
4141	245	mid-slope	Slope	boulders and slabs, subcropping, octocorals	455	700-1500	Y	WA Image Collection
4142	248	mid-slope	Slope	Igneous rock, rubble bank, no fauna	540	700-1500	Y	WA Image Collection
4143	249	mid-slope	Seamount	Igneous rock, rubble bank, octocorals	545	700-1500	Y	WA Image Collection
4144	250	mid-slope	Seamount	Igneous rock, low outcrop, no fauna	570	700-1500	Y	WA Image Collection
4145	252	mid-slope	Slope	Sedimentary, subcrop, small encrustors	656	700-1500	2	WA Image Collection
4146	253	mid-slope	Slope	rock (conglomerate/sedimentary), subcrop, bioturbators	659	700-1500	Y	WA Image Collection
4147	262	mid-slope	Slope	sedimentary/mudstone, high outcrop, no fauna	680	700-1500	Y	WA Image Collection
4148	294	mid-slope	slope	Fine sediments, unrippled, bioturbators	109	700-1500	Y	Norfanz Image Collection
4149	295	mid-slope	slope	Fine sediments, subcrop, encrustors	156	700-1500	Y	Norfanz Image Collection
4150	296	mid-slope	slope	Coarse sediments, irregular, no fauna	230	700-1500	Y	Norfanz Image Collection
4151	297	mid-slope	slope	Coarse sediments, subcrop, no fauna	250	700-1500	Y	Norfanz Image Collection
4152	298	mid-slope	slope	Coarse sediments, low outcrop, no fauna	260	700-1500	Y	Norfanz Image Collection

Scoping Document S2B2. Pelagic Habitats

A list of the pelagic habitats for the Torres Strait Rock Lobster Fishery. Shading denotes habitats occurring within the jurisdictional boundary of the fishery that are not subject to effort from lobster collection.

ERAEF Habitat Number	Pelagic Habitat type	Depth (m)	Comments	Reference
P4	North Eastern Pelagic Province - Oceanic	0 – > 600	this is a compilation of the range covered by Oceanic Community (1) and (2)	dow167A1, A2, A4
P5	Northern Pelagic Province - Coastal	0 – 200		dow167A1, A2, A4
P14	North Eastern Pelagic Province - Coastal	0 – 200		dow167A1, A2, A4

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.

Demersal communities in which fishing activity occurs within the Torres Strait Rock Lobster Fishery (indicated by X). Shaded cells indicate all communities within the province.

Demersal community	Cape	North Eastern	North Eastern Transition	Central Eastern	Central Eastern Transition	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]		x																	
Outer Shelf 110 – 250m [1,2,4]																			
Upper Slope 250 – 565m [3,4]																			
Mid–Upper Slope 565 – 820m[3,5]																			
Mid Slope 820 – 1100m[3,5]																			
Lower slope/ Abyssal > 1100m[6]																			
Reef 0 -110m[7, 8]		x																	
Reef 110-250m[8]																			
Seamount 0 – 110m																			
Seamount 110- 250m																			
Seamount 250 – 565m																			
Seamount 565 – 820m																			
Seamount 820 – 1100m																			
Seamount 1100 – 3000m																			

Plateau 0 – 110m																			
Plateau 110- 250m[9]																			
Plateau 250 – 565m[9]																			
Plateau 565 – 820m																			
Plateau 820 – 1100m																			

[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, and [3]upper and midslope communities combined. At Heard/McDonald Is: [4]outer shelf and upper slope combined (100-500m), [5]mid and upper slopes combined into 3 trough and southern slope communities (500-100m), [9]plateaux equivalent to Shell and Western Banks (100-500m) 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.

Scoping Document S2C2. Pelagic Communities

Pelagic communities that overlie demersal communities occurring within the jurisdictional area of the Torres Strait RockLobster Fishery (indicated by x) although fishing activity may not necessarily occur in all. Shaded cells indicate all communities that exist in the province.

Pelagic community	North Eastern	Eastern	Southern	Western	Northern	North Western	Heard and McDonald Is[2]	Macquarie Is
Coastal pelagic 0-200 m[1]					x			
Oceanic (1) 0 – 600m								
Oceanic (2) >600m								
Seamount oceanic (1) 0 – 600m								
Seamount oceanic (2) >600m								
Oceanic (1) 0 – 200m								
Oceanic (2) 200-600m								
Oceanic (3) >600m								
Seamount oceanic (1) 0 – 200m								
Seamount oceanic (2) 200 – 600m								
Seamount oceanic (3) >600m								
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								
Oceanic (1) 0-1000m								
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). [2] Coastal pelagic zone at Heard and McDonald Is broadened to cover entire plateau to maximum of 1000m.

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, TEP, 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 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), 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

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
	"What is the general goal?"	*As shown in sub-component model diagrams at the beginning of this section.*	*"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).*
Target Species	Avoid recruitment failure of the target 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 add in rationale for each objective 1.2 1.3 1.4
		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 GAB	2.1
		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
		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

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
		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 5.2
		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
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 1.2 1.3 1.4
		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
		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
		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
		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

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
		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
TEP species	Avoid recruitment failure of TEP species Avoid negative consequences for TEP 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 1.2 1.3 1.4
		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 GAB	2.1
		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
		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
		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
		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

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
		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
Habitats	Avoid negative impacts on the quality of the 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
		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
		3. Substrate quality	3.1 Sediment quality does not change outside acceptable bounds	Sediment chemistry, stability, particle size, debris, pollutant concentrations	3.1
		4. Habitat types	4.1 Relative abundance of habitat types does not vary outside acceptable bounds	Extent and area of habitat types, % cover, spatial pattern, landscape scale	4.1
		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
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
		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

Component	Core Objective	Sub-component	Example Operational Objectives	Example Indicators	Rationale
		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
		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
		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

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. **Table 4** 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: Torres Strait Rock Lobster
Sub-fishery Name:
Date: May 2004, updated May 2006

Direct impact of Fishing	Fishing Activity	Score (0/1)	Documentation of Rationale
Capture	Bait collection	0	Bait is not required by the fishery. No bait collection occurs.
	Fishing	1	Lobsters are caught by targeted hand fishing. Undersized lobsters are retained by the islander sector for consumption and are very rarely taken by non-indigenous fishers.
	Incidental behaviour	1	Lobster fishers catch small amounts of finfish for immediate consumption. Vessels are limited to an onboard catch of fish of 20 kg at any time.
Direct impact without capture	Bait collection	0	Not required by the fishery
	Fishing	1	Due to the selectivity of the fishing method employed, direct impact without capture is likely to be negligible. Lobsters may move to avoid capture. Lobsters very rarely escape alive after spearing injury.
	Incidental behaviour	1	Some non-target finfish are likely caught and returned during fishing from dinghies or freezer boats, or may escape from hook and line. Impacts are considered negligible.
	Gear loss	1	Possible loss of diving and spearing equipment but this is unlikely to have any direct impacts, and is therefore considered negligible
	Anchoring/ mooring	1	Possible damage to epibenthos when anchoring but freezer boats avoid anchoring on shallow reef due to difficulties with subsequent retrieval. As such, coral damage is considered highly unlikely.
	Navigation/steaming	1	Freezer boats and tender vessels often travel considerable distances to reach fishing areas. Collisions with marine organisms e.g. dugong, turtle, are possible but highly unlikely due to the noise of vessels. There may be some disturbance through noise and vibration.

Direct impact of Fishing	Fishing Activity	Score (0/1)	Documentation of Rationale
Addition/ movement of biological material	Translocation of species (boat launching, reballasting)	1	Translocation of species is unlikely to occur because most trips are local, and there is only a small likelihood of introducing a non-endemic species because seabed communities throughout the range of the fishery are very similar. (Rock lobsters are predominantly airfreighted from Torres Strait to Cairns, with a small percentage being transported by boat at the end of the season in some years only.) Discussions between DAFF, PNG and Biosecurities Australia have occurred to consider future movement of live lobsters from PNG to Cairns, and poses greater future risk potential than the present operations (pers. comm.. J. Prescott).
	On board processing	1	Tailing of lobsters occurs on board in the same area as capture.
	Discarding catch	0	Due to the selectivity of the fishing method, no bycatch is taken and there is therefore no discarding. Undersized lobsters are retained by the islander sector for consumption and are very rarely taken by non-indigenous fishers.
	Stock enhancement	0	Not practiced
	Provisioning	0	Not practiced
	Organic waste disposal	1	Disposal of organic wastes (food scraps, sewage) occurs as a result of general fishing vessel operations and is unlikely to affect behaviour/ movement of any animals. This disposal relates only to the small number of freezer boat operators and is considered to have negligible impact.
Addition of non-biological material	Debris	1	There is negligible debris disposed of during general fishing vessel operations. The short length of trips (7-10 days) allows non-biodegradable materials to be retained on board and disposed of on land.
	Chemical pollution	1	Fuel and lubricant pollution is possible but considered to be negligible in this fishery. Some detergents are used to clean on-board processing facilities but these are generally biodegradable.
	Exhaust	1	Possible addition of exhaust materials into the air or water but considered negligible in this fishery.
	Gear loss	1	Possible loss of diving and spearing equipment is unlikely due to ease of retrieval, and would have miniml impact.
	Navigation/ steaming	1	Freezer boats and tender vessels often travel considerable distances to reach fishing areas. Some disturbance may occur through noise and vibration, and through addition of chemicals associated with exhaust.
	Activity/ presence on water	1	Negligible in this fishery.
Disturb physical processes	Bait collection	0	Not required by fishery
	Fishing	0	No disturbance caused by fishery due to the method of fishing

Direct impact of Fishing	Fishing Activity	Score (0/1)	Documentation of Rationale
	Boat launching	1	There may be some minimal disturbance from boats used by islander fishers being dragged across substrates in shallow areas opposite island communities, and some minimal foreshore impacts where fishers cross intertidal habitats to reach fishing locations. However, these impacts are not specific to this fishery. Effects from this fishery are considered negligible.
	Anchoring/ mooring	1	Any damage to coral reef habitats is considered to be negligible as fishers prefer to anchor on sand due to the ease of anchor retrieval.
	Navigation/ steaming	1	The physical processes on the intertidal benthos and the pelagos may be impacted by turbulent action of propellers in the shallows, or by wake formation. Given the dynamic nature of such tropical environs it is highly unlikely such disturbances would have any persistent impact.
External Hazards (specify the particular example within each activity area)	Other capture fishery methods	1	There is a small recreational fishery for lobster in Torres Strait, restricted by daily bag limits (3 per person). The catch of lobsters by islanders for local consumption is alos small in comparison to commercial catch. Migratory lobsters are caught incidentally by prawn trawlers during Aug/Sept and returned alive. The Torres Strait, PNG and Queensland East Coast lobster fisheries also share the same stock.
	Aquaculture	0	Aquaculture activity (pearl culture) occurs within the Torres Strait area, but is negligible and does not interact with this fishery.
	Coastal development	1	There are some islands supporting small (<1000) indigenous populations within the Torres Strait fishing area. It is likely that these small populations will not increase in the future; mainly due to limited employment opportunities. The number of islands and area of fringing reef potentially impacted is small compared with the extent of these habitats in TS. Thus, the overall consequences to inshore benthic habitats will be negligible.
	Other extractive activities	0	No other extractive activities known in this area
	Other non-extractive activities	0	There are shipping lanes in the Torres Strait area but very rarely within the area worked by the fishery.
	Other anthropogenic activities	1	Line-fishing and indigenous catches of turtles and dugongs and may affect the same fish communities. Substantial catches are taken for subsistence and cultural purposes and the impacts are managed by AFMA (Skewes *et al* 2002). Oil spills have occurred in the area of the fishery but the long-term impacts were minimal.

Table 4. 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 crews 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.
	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	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

Direct Impact of Fishing	Fishing Activity	Examples of Activities Include
	movements, reballasting)	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.
	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

Direct Impact of Fishing	Fishing Activity	Examples of Activities Include
		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. 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 Torres Strait PZJA website at www.pzja.gov.au and include the following:

- Torres Strait Protected Zone Joint Authority (PZJA) Management Paper
- PZJA Fisheries Management Notices

Other publications that may provided information include

- BRS Fishery Status Reports
- Torres Strait tropical rock lobster information sheet http://www.pzja.gov.au/resources/publications/info_sheets/lobster.pdf

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, 19 out of 26 possible internal activities were identified as occurring in this fishery. Three out of six external activities were identified. No Bycatch component exists for the Torres Strait Rock Lobster Fishery. Thus, a total of 22 activity-component scenarios will be considered at Level 1. This results in 88 total scenarios (of 160 possible) to be developed and evaluated using the unit lists (species, habitats, 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 (target; bycatch and byproduct; TEP 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 subcomponent
- 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 (target, bycatch and byproduct, and TEP 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.

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.

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 3. 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 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.

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 localised 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 below. A more detailed description of the consequences at each level for each component (target, bycatch and byproduct, TEP species, habitats, and communities) is provided as a guide for scoring the consequences of the activities in the description of consequences table (see **Table 5**, **Appendix C**).

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.

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

2.3.1 Level 1 (SICA) Documents

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 Table5, Appendix C)

L1.1 - Target 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	Internal / External
Capture	Bait collection	0										I
	Fishing	1	3	5	Age/ sex/ size structure	*Panulirus ornatu*, Ornate rocklobsters	4.1	3	3	2	The fishery extends across Torres Strait but is largely restricted to west of the Warrior Reef complex. There is a total ban on fishing between Oct-Nov and a hookah ban from Dec-Jan but there is considerable free-diving during the hookah ban. =>Intensity moderate; recently the fisheries catch has increased markedly in response to recovering stocks. Local depletions occur due to intense seasonal fishing but much of the stock is untouched due to depth limitations of diving and unviable low densities in some habitats. =>Consequence moderate: Management objectives dictate a conservative and precautionary approach to conserve stocks for traditional inhabitants. To this end, recent reductions in latent effort and cuts in active effort of 30% were imposed. =>Confidence high: Recruit and stock sizes are monitored annually by fishery-independent surveys and stock status is assessed by a fishery model developed over a decade. There are some problems in determining total catch but general agreement among experts as to the appropriate level.	I
	Incidental behaviour	1	3	5	Behaviour/movement	*Panulirus ornatu*, Ornate rocklobsters	6.1	1	1	1	Fishing for finfish while off watch occurs but is unlikely to impact on lobsters except through the possibility of small scale movement. =>Intensity negligible =>consequence negligible =>confidence low – there are no documented data to refute or confirm this.	I
Direct impact	Bait collection	0										I

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	Internal / External
without capture	Fishing	1	3	5	Population size	*Panulirus ornatu,* Ornate rocklobsters	1.2	1	1	2	Negligible numbers of lobsters escape after being speared. There is a slightly higher incidence of escapes in the live fishery but no subsequent mortality. =>Intensity negligible, remote likelihood of any impact on stocks. =>Consequence negligible; highly unlikely to be detectable at any scale. =>Confidence high; agreement amongst experts through logic.	I
	Incidental behaviour	1	3	5	Behaviour/movement	*Panulirus ornatu,* Ornate rocklobsters	6.1	1	1	1	Fishing for finfish while off watch occurs but is unlikely to impact on lobsters except through the possibility of small scale movement. =>Intensity negligible =>consequence negligible =>confidence low – there are no documented data to refute or confirm this.	I
	Gear loss	1	3	5	Behaviour/movement	*Panulirus ornatu,* Ornate rocklobsters	6.1	1	1	1	Gear loss would be negligible as retrieval of any dropped gear would be easy while diving. At worst, gear temporarily lost may cause small scale movement in resident lobsters =>Intensity negligible =>consequence negligible =>confidence low – there are no documented data to refute or confirm this.	I
	Anchoring/ mooring	1	3	5	Population size	*Panulirus ornatu,* Ornate rocklobsters	1.2	1	1	2	Anchoring is of extremely small spatial extent and lobsters will avoid anchors. =>Intensity and consequence negligible, =>confidence high; agreement among experts through logic.	I
	Navigation/ steaming	1	3	5	Behaviour/movement	*Panulirus ornatu,* Ornate rocklobsters	6.1	3	1	1	Rock lobsters are demersal so boats are highly unlikely to cause them damage in shallow water. Engine noise and vibration may cause short-term small-scale movement or behaviour changes. =>Intensity increasing as fishing effort increases. Potential to decrease when planned new quota management comes into force in 2007 =>consequence negligible =>confidence low – there are no documented data to refute or confirm this.	I
Addition/ movement of biological material	Translocation of species	1	5	5	Population size	*Panulirus ornatu,* Ornate rocklobsters	1.2	1	1	2	Most boat movement is within the TS area, with negligible risk of species translocation. In some years, a small percentage of lobsters are transported by boat to Cairns at the end of the fishing season. As such, the spatial scale of the hazard has been increased to reflect this greater range. Green mussels are an introduced species within the Cairns area and have the potential to be translocated to TS on boat hulls and through ballast waters. =>Intensity negligible, movement between Cairns and TS rarely occurs. =>consequence negligible, unlikely to impact lobsters. =>confidence high, logical constraints	I

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	Internal / External
	On board processing	1	3	5	Population size	*Panulirus ornatu*, Ornate rocklobsters	1.2	3	1	2	Speared lobsters are tailed at sea on the fishing grounds but evidence shows discarded heads are rapidly assimilated by local communities, principally by resident fishes. =>Intensity increasing as fishing effort increasing. Potential for effort to decrease when planned new quota management comes into force in 2007. =>consequence is likely to be very low =>confidence is high due to general agreement amongst experts.	I
	Discarding catch	0										I
	Stock enhancement	0										I
	Provisioning	0										I
	Organic waste disposal	1	3	5	Behaviour/movement	*Panulirus ornatu*, Ornate rocklobsters	6.1	2	1	1	Restricted to the small number of freezer boats and temporally restricted by closures, weather and tidal current regimes. Therefore, no persistent disposal in any one area of the fishery. At worst, short-term small-scale movement or behaviour changes may result. =>Intensity minor; recent fishing effort increasing but organic waste disposal would be minimal. Potential for fishing effort to decrease when planned new quota management comes into force in 2007, which will also impact on waste disposal intensity. =>consequence negligible =>confidence low – there are no documented data to refute or confirm this.	I
Addition of non-biological material	Debris	1	3	3	Behaviour/movement	*Panulirus ornatu*, Ornate rocklobsters	6.1	2	1	1	Effects of debris on TRL are likely to be negligible. Avoidance of debris may cause short-term small-scale movement. =>Intensity minor; recent fishing effort increasing but debris is minimal. Potential to decrease when planned new quota management comes into force in 2007 =>consequence negligible =>confidence low – there are no documented data to refute or confirm this.	I
	Chemical pollution	1	3	3	Population size	*Panulirus ornatu*, Ornate rocklobsters	1.2	2	1	1	Traces of petroleum pollution are a regular feature of fishery operations but have trivial impacts on target stock. =>Intensity minor; recent fishing effort increasing but chemical inputs minimal. Potential to decrease when planned new quota management comes into force in 2007 =>consequence negligible =>confidence low – there are no documented data to refute or confirm this.	I

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	Internal / External
	Exhaust	1	3	5	Population size	*Panulirus ornatu*, Ornate rocklobsters	1.2	2	1	1	Exhaust emission is a regular feature of fishery operations but has trivial impacts on the target stock. Intensity minor =>consequence negligible =>confidence low – there are no documented data to refute or confirm this.	I
	Gear loss	1	3	2	Behaviour/movement	*Panulirus ornatu*, Ornate rocklobsters	6.1	1	1	1	Gear loss would be negligible as retrieval of any dropped gear is easy while diving. At worst, gear temporarily lost may cause small scale movement of resident lobsters =>Intensity negligible =>consequence negligible =>confidence low – there are no documented data to refute or confirm this.	I
	Navigation/ steaming	1	3	5	Behaviour/movement	*Panulirus ornatu*, Ornate rocklobsters	6.1	2	1	1	At worst, short-term small-scale movement or behaviour changes may result from engine vibration and noise. =>Intensity minor; recent fishing effort increasing and need to navigate to fishing areas. Potential to decrease when planned new quota management comes into force in 2007 =>consequence negligible =>confidence low – there are no documented data to refute or confirm this.	I
	Activity/ presence on water	1	3	5	Behaviour/movement	*Panulirus ornatu*, Ornate rocklobsters	6.1	2	1	1	At worst, short-term small-scale movement or behaviour changes may result from presence of boats with associated noise and activities in the areas that lobsters inhabit. =>Intensity minor; recent fishing effort increasing. Potential for effort to decrease when planned new quota management comes into force in 2007 =>consequence negligible =>confidence low – there are no documented data to refute or confirm this.	I
Disturb physical processes	Bait collection	0										I
	Fishing	0										I
	Boat launching	1	3	3	Population size	*Panulirus ornatu*, Ornate rocklobsters	1.2	1	1	1	Restricted to isolated intertidal habitats and impacts are not likely to persist due to the dynamic nature of the environment. =>Intensity negligible =>consequence negligible =>confidence low – there are no documented data available.	I

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	Internal / External
	Anchoring/ mooring	1	3	5	Behaviour/movement	*Panulirus ornatu*, Ornate rocklobsters	6.1	1	1	1	There are negligible impacts due to a preference for anchoring on sand sediments. At worst, anchoring may cause lobsters to move to avoid sediment disturbed by the anchor. =>Intensity negligible =>consequence negligible =>confidence low; there are no documented data or observer information to refute or confirm this.	I
	Navigation/steaming	1	3	5	Behaviour/movement	*Panulirus ornatu*, Ornate rocklobsters	6.1	2	1	1	Small-scale water column disturbance may result from boats navigating through the area. Impact on lobsters is thought to be negligible. =>Intensity minor; recent fishing effort increasing. Potential for effort to decrease when planned new quota management comes into force in 2007. =>Consequence negligible =>confidence low; there are no documented data or observer information to refute or confirm this.	I
External Impacts (specify the particular example within each activity area)	Other fisheries	1	3	5	Population size	*Panulirus ornatu*, Ornate rocklobsters	1.1 1.2 1.3	3	2	1	The PNG and Queensland East Coast lobster fisheries fish the same shared stock. Both fisheries have seen increased catches recently due to recovering stocks. There is general agreement between the jurisdictions to integrate management and research over the three sectors. =>Intensity moderate: exploitation is considered high in PNG and moderate in Queensland but much of the stock is protected by depth. =>Consequence minor; annual monitoring in Torres Strait suggests external fisheries are fished at sustainable levels. =>Confidence low; there is some concern about commercial data collection in PNG.	E
	Aquaculture	0										E
	Coastal development	1	2	6	Behaviour/movement	*Panulirus ornatu*, Ornate rocklobsters	6.1	2	2	1	Terrestrial runoff and coastal activity from indigenous island populations may impact on lobster movement within the near-shore area. =>Intensity minor =>consequence minor =>confidence low; no documented data or observer reports are available.	E
	Other extractive activities	0										E
	Other non-extractive activities	0										E
	Other anthropogenic activities	1	3	6	Population size	*Panulirus ornatu*, Ornate rocklobsters	1.1 1.2 1.3	2	1	2	Indigenous catches of food species may affect the same communities. =>intensity minor =>consequence negligible =>confidence high (Skewes *et al* 2002).	E

L1.2 - Byproduct and Bycatch Component;

NB. No Byproduct/bycatch component occurs in the Torres Strait Rock Lobster Fishery

L1.3 - TEP 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	Internal / External
Capture	Bait collection	0										I
	Fishing	1	3	5	Behaviour /movement	Green turtle	6.1	2	1	1	Divers may come across turtles while fishing. Turtles are likely to be disturbed and move away. =>Intensity minor. =>consequence negligible =>confidence low. There are no documented data or to confirm this but logic dictates that there would be minor consequences from this, particularly in comparison with impacts of targeted hunting.	I
	Incidental behaviour	1	3	5	Population size	Dugong	1.1	2	2	2	Dugongs are rarely captured by indigenous fishers during lobster fishing. This activity only occurs in NW Torres Strait in a small area and predominantly during the SE trade wind season (May-Aug). Captures during lobster fishing are rare compared with targeted hunting. =>Intensity minor. =>consequence minor =>confidence high – agreement by experts through logic.	I
Direct impact without capture	Bait collection	0										I
	Fishing	1	3	5	Interaction with fishery	Dugong	7.1	1	2	1	Dugongs may be chased during lobster fishing without capture. The impacts of these events on the population are unknown, but likely to be negligible, particularly when compared with targeted hunting. =>Intensity negligible =>consequence minor =>confidence low; there are no documented data or observer information to refute or confirm this.	I
	Incidental behaviour	1	3	5	Behaviour /movement	Dugong	6.1	1	1	1	Dugongs may move to investigate incidental activities around a boat or move away to avoid capture, changing their behaviour for a short time only. =>Intensity negligible =>consequence negligible	I

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	Internal / External
											=>confidence low; no data are available but logic suggests that consequences are negligible.	
	Gear loss	1	3	5	Behaviour /movement	Green turtle	6.1	1	1	2	Impacts from gear loss are negligible as any dropped equipment can easily be retrieved while diving. Turtles may be disturbed by falling gear or by divers retrieving gear =>intensity negligible =>consequence negligible =>confidence high; gear loss is considered to be very low by managers and AFMA.	I
	Anchoring/ mooring	1	3	5	Population size	Green turtle	1.1	1	1	1	Anchors may strike resting turtles, but events are rare (as evidenced by incidences in Moreton Bay where traffic is dense). The impact on the population is highly likely to be negligible (1-5 turtles). =>Intensity negligible =>consequence negligible =>confidence low – there are no documented data to refute or confirm this.	I
	Navigation/ steaming	1	3	5	Behaviour /movement	*Calonectris leucomelas* Streaked shearwater	6.1	2	1	1	Steaming lobster vessels may temporarily disturb resting birds due to engine vibration and noise. Streaked shearwaters are known to rest on the water. =>Intensity minor =>consequence negligible =>confidence low; there are no documented data or observer information to refute or confirm this.	I
Addition/ movement of biological material	Translocation of species	1	5	5	Population size	Syngnathidae	1.1	1	2	2	Most boat movement is within the TS area, with negligible risk of species translocation. In some years, a small percentage of lobsters are transported by boat to Cairns at the end of the fishing season. As such, the spatial scale of the hazard has been increased to reflect this greater range. Green mussels are an introduced species within the Cairns area and have the potential to be translocated to TS on boat hulls and through ballast waters. =>Intensity negligible, movement between Cairns and TS rarely occurs. =>consequence minor, syngnathids may have habitat altered by collinisation of mussels, ultimately impacting on reproduction and population size. =>confidence high, logical constraints	I
	On board processing	1	3	5	Interaction with fishery	Dugong	7.1	2	1	1	Dugongs may be repelled by disposal of processing wastes. This interaction with the fishery would be short and the incidence of occurrence is low. =>Intensity minor; fishing effort increasing. =>consequence negligible =>confidence low.	I

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	Internal / External
	Discarding catch	0										I
	Stock enhancement	0										I
	Provisioning	0										I
	Organic waste disposal	1	3	5	Interaction with fishery	Dugong	7.1	1	1	1	Dugongs may be repelled by disposal of organic wastes. This interaction with the fishery would be short and the incidence of occurrence is low. =>Intensity negligible =>consequence negligible =>confidence low.	I
Addition of non-biological material	Debris	1	3	3	Population size	Turtles, streaked shearwater	1.1	1	2	2	Turtles may be attracted by floating debris and try to ingest it, which could cause harm. =>Intensity negligible as debris is minimal, but is of concern as fishing effort is increasing. Potential to decrease as planned quota management comes into force in 2007. =>Consequence minor; consequences of ingestion of small pieces of plastic are well documented in turtles and seabirds and can pose a life threatening risk to chicks and individuals, which may have more severe consequences for threatened populations if incidence were to increase. =>Confidence high, data are available on the effects of plastic ingestion.	I
	Chemical pollution	1	3	3	Behaviour /movement	Dugong	6.1	1	1	1	Oils, fumes and detergents used on lobster vessels may result in avoidance of areas by dugongs. =>Intensity negligible – pollution is likely to be very low, =>consequence negligible – such events would be rare and occur only in isolated cases. =>Confidence low – no data are available.	I
	Exhaust	1	3	5	Behaviour/movement	Dugong	6.1	1	1	1	Exhaust outputs from lobster vessels may result in avoidance of areas by dugongs. =>Intensity negligible – pollution is likely to be very low, =>consequence negligible – such events would be rare and occur only in isolated cases. =>Confidence low – no data are available.	I
	Gear loss	1	3	2	Population size	Dugong	1.1	1	1	2	Impacts from gear loss are negligible as any dropped equipment can easily be retrieved while diving. Turtles may be disturbed by falling gear or divers retrieving gear =>intensity negligible =>consequence negligible =>confidence high; gear loss is considered to be very low by managers and AFMA.	I

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	Internal / External
	Navigation/ steaming	1	3	5	Behaviour /movement	*Calonectris leucomelas* Streaked shearwater	6.1	2	1	1	Steaming lobster vessels may temporarily disturb resting birds due to engine vibration and noise. Streaked shearwaters are known to rest on the water. =>Intensity minor =>consequence negligible =>confidence low; there are no documented data or observer information to refute or confirm this.	I
	Activity/ presence on water	1	3	5	Behaviour/movement	Dugong	6.1	2	1	2	Vessels and fishers in and on the sea are likely to cause avoidance by dugongs but interactions are very minor, and dugongs are perceptive to noise. Interactions are restricted to times of strong wind when dugongs are unable to detect a vessel or diver. =>Intensity minor. =>consequence negligible. =>confidence high.	I
Disturb physical processes	Bait collection	0										I
	Fishing	0										I
	Boat launching	1	3	3	Behaviour/movement	Green turtle	1.2	1	1	1	Restricted to isolated intertidal habitats and impacts are not likely to persist due to the dynamic nature of the environment. Turtles may move to avoid sediment disturbance =>Intensity minor =>consequence minor =>confidence high.	I
	Anchoring/ mooring	1	3	5	Behaviour/movement	Green turtle	6.1	1	1	1	There are negligible impacts due to a preference for anchoring on sand sediments. At worst, anchoring may cause turtles to move to avoid sediment disturbed by the anchor. =>Intensity negligible =>consequence negligible =>confidence low; there are no documented data or observer information to refute or confirm this.	I
	Navigation/steaming	1	3	5	Behaviour/movement	Dugong	6.1	2	1	1	Small-scale water column disturbances may result from boats navigating through the area. Propeller wash from primary and tender vessels may result in avoidance by dugongs but these events would be very rare and the consequence negligible. Impact on dugongs is thought to be negligible. =>Intensity minor; recent fishing effort increasing, but potential to decrease in the future as planned new quota management comes into force in 2007. =>Consequence negligible =>confidence low; there are no documented data or observer information to refute or confirm this.	I

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	Internal / External
External Impacts (specify the particular example within each activity area)	Other fisheries	1	3	5	Population size,	Dugong	1.1	3	3	2	Dugongs are targeted by indigenous fishers within the Torres Strait fishery area. Hunting occurs mainly in NW Torres Strait and predominantly during the SE trade winds (May-August). Dugong catches and stocks are monitored by AFMA, and managers have fairly high confidence in the data available. =>Intensity moderate =>consequence moderate =>confidence high (Skewes *et al* 2002)	E
	Aquaculture	0										E
	Coastal development	1	2	6	Population size,	turtles	1.1 1.2 1.3	2	2	1	Terrestrial runoff and coastal activity from indigenous island populations may impact on turtle movement within the near-shore area, affecting egg laying and thus population size. =>Intensity minor =>consequence minor as impacts a limited area =>confidence low; no documented data or observer reports are available.	E
	Other extractive activities	0										E
	Other non-extractive activities	0										E
	Other anthropogenic activities	1	3	6	Population size	*dugong*	1.1 1.2 1.3	2	3	2	Indigenous catches of food species may affect the same communities. These catches include dugong, turtle and lobster =>intensity minor =>consequence moderate =>confidence high (pers. comm. Torres Strait Fisheries Manager).	E

L1.4 - Habitat 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	Internal / External
Capture	Bait collection	0										I
	Fishing	1	3	5	Habitat structure and Function	Biogenic outcrop, mixed faunal community, Coastal margin depths	5.1	2	2	1	Hand collection of lobster extends across Torres Strait but is largely restricted to west of the Warrior Reef complex. There is a total ban on fishing (Oct-Nov) and a hookah ban (Dec-Jan) but considerable free-diving is done during the hookah ban. Diving activity is limited to depths <25m, on predominantly shallow coral reefs; can be highly localised. Habitat unlikely to be captured during fishing for lobster, unless using nets at night. Some corals and fragile rigid fauna may be damaged and possibly killed through contact, or during stabilising of diver during capture and exploration of nooks. =>Intensity minor, local depletions of target species point to intense seasonal fishing. =>Consequence minor, across the scale of the fishery and recovery of habitat likely to be rapid in shallow, highly productive depths. =>Confidence low; no data on effects on habitat are available.	I
	Incidental behaviour	1	3	5	Habitat structure and Function	Northern Coastal pelagic provinces.	5.1	1	1	1	There is low impact from trolling, line and spear fishing for private consumption when off watch. =>Intensity negligible. =>Consequence negligible. Activities unlikely to affect benthic habitats. =>Confidence low – there are no documented data to refute or confirm this.	I
Direct impact without capture	Bait collection	0										I
	Fishing	1	3	5	Habitat structure and Function	Biogenic outcrop, mixed faunal community, Coastal margin depths	5.1	3	2	1	The search for target species involves some exploration of nooks and crannies in shallow water reefs. Some corals and fragile rigid fauna may be damaged and possibly killed through contact, or during stabilising of diver during capture and exploration. Fishing may involve the use of nets (at night) which may lead to damage/ mortality of biogenic habitat in the process. =>Intensity moderate in highly localised areas of effort. =>Consequence minor, across the scale of the fishery, recovery of habitat is likely to be rapid in shallow, highly productive depths, depending on the frequency of	I

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	Internal / External
											damaging interaction. =>Confidence low; no data on effects on habitat are available.	
	Incidental behaviour	1	3	5	Habitat structure and Function	Northern Coastal pelagic provinces.	5.1	1	1	1	There is low impact from trolling, line and spear fishing for private consumption when off watch. =>Intensity negligible. =>Consequence negligible. Activities unlikely to affect benthic habitats. =>Confidence low – there are no documented data to refute or confirm this.	I
	Gear loss	1	3	5	Habitat structure and Function	Biogenic outcrop, mixed faunal community, Coastal margin depths	5.1	1	1	1	Impacts of gear loss would be negligible as retrieval of any dropped gear is easy while diving. At worst, gear temporarily lost may cause small scale damage to fauna contacted. =>Intensity negligible. =>Consequence negligible. =>Confidence low – there are no documented data to refute or confirm this.	I
	Anchoring/ mooring	1	3	5	Habitat structure and Function	coarse sediments, current scoured, soft corals, coastal margin	5.1	2	2	1	Vessels anchor off a small number of islands and predominantly on bare sand (to reduce risk of hook-up). Direct impact to soft coral structure may occur with use of anchors. In intense anchoring locations coral death is possible and effects are observable. =>Intensity minor; relatively localised. =>Consequence minor if fishers spread effort, but may be locally intense if the same reef systems are harvested frequently. =>Confidence low, there are documented effects, but the extent in this area is unknown.	I
	Navigation/ steaming	1	3	5	Habitat types	Sediment habitats with seagrass, coastal margin	4.1	1	1	1	Lobster tenders may occasionally impact inter-tidal seagrass habitats while steaming. =>Intensity negligible. =>Consequence expected to be negligible, as these meadows are tropical and adapted to naturally dynamic conditions. =>Confidence low; the effects of navigation/ steaming are unknown for this region.	I
Addition/ movement of biological material	Translocation of species	1	5	5	Habitat structure and Function	Biogenic outcrop, mixed faunal community, Coastal margin depths	5.1	1	2	2	Most boat movement is within the TS area, with negligible risk of species translocation. In some years, a small percentage of lobsters are transported by boat to Cairns at the end of the fishing season. As such, the spatial scale of the hazard has been increased to reflect this greater range. Green mussels are an introduced species within the Cairns area and have the potential to be translocated to TS on boat hulls and through ballast waters. =>Intensity negligible, movement	I

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	Internal / External
											between Cairns and TS occurs only rarely. =>consequence minor, habitat structure and function may be altered through collinisation by mussels, impacting on sedimentation rates and associated faunal communities. =>confidence high, impacts of mussel introduction well documented in other areas.	
	On board processing	1	3	5	Substrate quality	fine sediments, irregular, bioturbators, coastal margin	3.1	2	1	1	When lobsters are cleaned and tailed at sea, the discarded heads may impact the local substrate and water quality. If discards are of considerable volume, and contain hard parts, they may reach and accumulate on the benthos, causing locally anoxic conditions for fauna in fine sediments. =>Intensity minor. =>Consequence negligible; there is a low likelihood of accumulation in the same location over the scale of the fishery. =>Confidence low; data on areas/ volumes of discarding are unknown for this region.	I
	Discarding catch	0										I
	Stock enhancement	0										I
	Provisioning	0										I
	Organic waste disposal	1	3	5	Water quality	Northern Coastal pelagic provinces.	1.1	1	2	2	Organic waste disposal is possible on a daily basis over the entire scale of fishing effort. Water quality of pelagic habitats is considered to experience the greatest impact from organic waste disposal. The overall volume of waste is likely to be too small to reach the benthos, or accumulate even if it does. =>Intensity negligible. =>Consequence minor, addition of high nutrient material is realistically expected to cause short-term peaks in productivity or scavenging species interactions, with minimal detectability within minutes to hours. =>Confidence high; logical constraints.	I
Addition of non-biological material	Debris	1	3	3	Habitat structure and function	Northern Coastal pelagic province	5.1	2	2	2	Debris poses the greatest risk to the structure and function of pelagic habitat of the Torres Strait coastal zone. =>Intensity: difficult to predict. However, minor if MARPOL rules are strictly adhered to, and the overall volume of debris is small (greatest volumes of debris within these zones are likely to come from all sources outside of this fishery e.g. foreign fishing vessels, gillnetters, other fishers in TS grounds). =>Consequence minor, but habitat quality is compromised. =>Confidence in the consequence was high.	I

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	Internal / External
	Chemical pollution	1	3	3	Water quality	Northern Coastal pelagic provinces.	1.1	1	2	1	On rare occasions diesel oil or detergent may be spilled from a lobster vessel. =>Intensity negligible; small spatial and temporal scale of these spills. =>Consequence minor; localised and quickly dispersed if spill is small. =>Confidence low; no data are available.	I
	Exhaust	1	3	5	Air quality	Northern Coastal pelagic provinces.	2.1	1	1	1	Lobster tenders operating with divers will expel exhaust throughout the fishery. This is likely to impact bird species through reduced air quality. Quantities of exhaust fumes released will vary between vessels. =>Intensity negligible. =>Consequence negligible; emissions are rapidly dispersed. =>Confidence low; little data are available.	I
	Gear loss	1	3	2	Habitat structure and Function	Biogenic outcrop, mixed faunal community, Coastal margin depths	5.1	1	1	1	Impacts from gear loss would be negligible as retrieval of any dropped gear would be easy while diving. Gear not retrieved would eventually become habitat. =>Intensity negligible. =>Consequence negligible. =>Confidence low – there are no documented data to refute or confirm this.	I
	Navigation/ steaming	1	3	5	Water quality	North Eastern Pelagic Province - Plateau	1.1	2	1	1	Addition of non-biological factors (eg noise and movement) will occur during the normal course of traveling between fishing operations. =>Intensity negligible. =>Consequence negligible due to remote likelihood of detection at any spatial or temporal scale. =>Confidence low no data	I
	Activity/ presence on water	1	3	5	Water quality	North Eastern Pelagic Province - Plateau	5.1	2	1	2	Localised vessel and diver activity may disrupt normal habitat function as a result of reduced water quality, causing species to alter their behaviour. =>Intensity negligible over scale of fishery =>Consequence negligible, remote likelihood of impact at any spatial or temporal scale. =>Confidence high, considered to occur only for the length of time the disturbance is present.	I
Disturb physical processes	Bait collection	0										I
	Fishing	0										I
	Boat launching	1	3	3	Substrate quality	Sediment habitats with seagrass,	3.1	2	1	2	Dinghies are launched daily from some island communities and may disturb sediments supporting seagrasses. =>Intensity minor over scale of fishery =>Consequence negligible; likely to be well used	I

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	Internal / External
						coastal margin					launching points, and very small total area of activity =>Confidence high, logical constraints.	
	Anchoring/ mooring	1	3	5	Substrate quality	Sediment habitats with seagrass, coastal margin	3.1	1	1	2	Use of anchors may disturb sediments =>Intensity negligible, sediments are likely to settle rapidly =>Consequence negligible to sediment; habitats adapted to frequent disturbance =>Confidence high, logical constraints.	I
	Navigation/steaming	1	3	5	Water quality	North Eastern Pelagic Province - Plateau	1.1	1	1	2	Disturbance of physical processes will occur during the normal course of steaming throughout the fishing zone. Turbulence and disturbance of pelagic water quality is unlikely to affect normal water column processes for long. =>Intensity and Consequence negligible due to remote likelihood of detection at any spatial or temporal scale, and interactions that may be occurring are not detectable against natural variation. =>Confidence high because of logical constraints.	I
External Impacts (specify the particular example within each activity area)	Other fisheries	1	3	5	Habitat structure and Function	Biogenic outcrop, mixed faunal community, Coastal margin depths	5.1	3	3	1	Area subject to fishing by indigenous, PNG and Queensland East Coast Lobster Fisheries; Dugong/Turtle, pearl, and line fisheries; with differing degrees of benthic impact =>Intensity moderate, effects are possibly moderate in concentrated areas if the same reef systems are harvested. =>Consequence may be moderate in restricted locations if the benthos is damaged during capture. =>Confidence low; actual effort may overlap but data to assess cumulative effects are lacking.	E
	Aquaculture	0										E
	Coastal development	1	2	6	Habitat types	Sediment habitats with seagrass, coastal margin	4.1	2	2	1	Terrestrial runoff and coastal activity from indigenous island populations may impact on seagrass habitat within the near-shore area, threatening survival of seagrasses. =>Intensity minor =>consequence minor as expected to be minimal from anthropogenic effects in this region. =>confidence low; known impact on seagrasses but no documented data are available for TS.	E
	Other extractive activities	0										E

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	Internal / External
	Other non-extractive activities	0										E
	Other anthropogenic activities	1	3	6	Habitat structure and Function	Biogenic outcrop, mixed faunal community, Coastal margin depths	5.1	2	**3**	2	Indigenous catches of food species may affect the same habitats. Tourism and recreational fishing are limited and thus not of concern. These catches include dugong, turtle and lobster =>intensity minor =>consequence moderate =>confidence high (pers. comm. Torres Strait Fisheries Manager).	E

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	Internal / External
Capture	Bait collection	0										I
	Fishing	1	3	5	Species composition	North Eastern Transition Inner Shelf	1.1	2	2	2	The fishery extends across Torres Strait but is largely restricted to west of the Warrior Reef complex. The fishery is managed conservatively to meet the objectives of the Torres Strait Treaty. To this end new management arrangements were introduced in 2001 including an increased size limit and a hookah ban (Dec-Jan), but considerable free-diving is still done during the hookah ban. => Intensity minor; recent effort cuts of 30% although the fishery catch has increased markedly in response to recovering stocks. Local depletions occur due to intense seasonal fishing but much of the rock lobster stock is untouched due to depth limitations of diving and unviable low densities in some habitats. =>Consequence minor: recent effort cuts of 30% and a latent effort reduction were imposed to preserve stocks but it is possible to have detectable changes to the community species composition without a major change in function. =>Confidence high: Recruit and stock sizes are monitored annually by fishery-independent surveys and stock status assessed by fishery models developed over a decade. Some problems exist in determining total catch but there is general agreement amongst experts.	I
	Incidental behaviour	1	3	5	Species composition	North Eastern Transition Inner Shelf	1.1	1	1	1	Fishing for finfish while off watch occurs but unlikely to impact on species composition =>Intensity negligible => consequence negligible =>confidence low – no data to refute or confirm	I
Direct impact without capture	Bait collection	0										I
	Fishing	1	3	5	Species composition	North Eastern Transition Inner Shelf	1.1	1	1	2	Negligible numbers of lobsters escape after being speared. There is a slightly higher incidence of escapes in the live fishery but no subsequent mortality. =>Intensity negligible, remote likelihood of any impact on species composition =>Consequence negligible; highly unlikely to be detectable at any scale. =>Confidence high; agreement by experts through logic.	I

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	Internal / External
	Incidental behaviour	1	3	5	Species composition	North Eastern Transition Inner Shelf	1.1	1	1	1	Fishing for finfish while off watch occurs but is unlikely to impact on species composition of community =>Intensity negligible => consequence negligible => confidence low – there are no documented data to refute or confirm this.	I
	Gear loss	1	3	5	Species composition	North Eastern Transition Inner Shelf	1.1	1	1	1	The impacts of gear loss would be negligible as retrieval of any dropped gear would be easy while diving. => Intensity negligible => consequence negligible => confidence low – there are no documented data to refute or confirm this.	I
	Anchoring/ mooring	1	3	5	Species composition	North Eastern Transition Inner Shelf	1.1	1	1	2	Anchoring is of extremely small spatial extent and unlikely to disturb the distribution of communities except on a scale of metres. =>Intensity and consequence negligible, =>confidence high; agreement amongst experts through logic.	I
	Navigation/ steaming	1	3	5	Species composition	Northern - Coastal East Cape York	1.1	1	1	1	Intensity is negligible as no interactions between vessels and the pelagic community members are recorded =>consequence negligible =>confidence low, no data are available.	I
Addition/ movement of biological material	Translocation of species	1	5	5	Species composition	Northern - Coastal East Cape York	1.1	1	2	2	Most boat movement is within the TS area, with negligible risk of species translocation. In some years, a small percentage of lobsters are transported by boat to Cairns at the end of the fishing season. As such, the spatial scale of the hazard has been increased to reflect this greater range. Green mussels are an introduced species within the Cairns area and have the potential to be translocated to TS on boat hulls and through ballast waters. =>Intensity negligible, movement between Cairns and TS occurs only rarely. =>consequence minor, collinisation by mussels would impact the species communities presently occurring.. =>confidence high, impacts of mussel introduction well documented in other areas.	I
	On board processing	1	3	5	Distribution of community	North Eastern Transition Inner Shelf	3.1	3	2	1	Speared lobsters are tailed at sea on the fishing grounds but evidence shows discarded heads are rapidly scavenged by resident fishes and are therefore likely to disrupt the distribution of the community =>Intensity moderate; increasing as fishing effort increases. Potential to decrease when planned new quota management comes into force in 2007 =>consequence minor as changes will be localised but temporary. =>confidence low, no data are available.	I

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	Internal / External
	Discarding catch	0										I
	Stock enhancement	0										I
	Provisioning	0										I
	Organic waste disposal	1	3	5	Distribution of community	Northern - Coastal East Cape York	3.1	2	1	1	Restricted to the small number of freezer boats and temporally restricted by closures, weather and tidal current regimes. Therefore, there is no persistent disposal in any one area of the fishery – the distribution of the community might be temporarily affected due to attraction or repulsion. =>Intensity minor. =>consequence negligible – impacts are only temporary =>confidence low – there are no documented data to refute or confirm this.	I
Addition of non-biological material	Debris	1	3	3	Species composition	Northern - Coastal East Cape York	1.1	2	1	1	There may be impacts on pelagic community members from ingestion of debris. =>Intensity minor; recent fishing effort increasing but debris is minimal. =>Consequence negligible =>confidence low – there are no documented data to refute or confirm this.	I
	Chemical pollution	1	3	3	Species composition	Northern - Coastal East Cape York	1.1	2	1	1	Traces of petroleum pollution are a regular feature of fishery operations and might impact the species composition of the pelagic community =>Intensity minor; recent fishing effort increasing but chemical inputs are minimal =>consequence negligible as inputs disperse quickly and are unlikely to impact species =>confidence low – there are no documented data to refute or confirm this.	I
	Exhaust	1	3	5	Distribution of community	Northern - Coastal East Cape York	3.1	2	1	1	Exhaust emissions are a regular feature of fishery operations. Birds are most likely to be impacted but are highly mobile and therefore unlikely to be affected. =>Intensity minor =>consequence negligible due to ability to avoid =>confidence low – there are no documented data to refute or confirm this.	I
	Gear loss	1	3	2	Distribution of community	North Eastern Transition Inner Shelf	3.1	1	1	1	Impacts from gear loss would be negligible as retrieval of any dropped gear would be easy while diving => Intensity negligible =>consequence negligible =>confidence low – there are no documented data to refute or confirm this.	I
	Navigation/ steaming	1	3	5	Distribution of community	Northern - Coastal East Cape York	3.1	2	1	1	Short-term disturbance of distribution of community members might result from engine vibration and noise. =>Intensity minor, though will increase with increasing fishing effort. Potential to decrease when planned new quota management comes into force in 2007	I

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	Internal / External
											=>consequence negligible =>confidence low – no documented data to refute or confirm this.	
	Activity/ presence on water	1	3	5	Distribution of community	Northern - Coastal East Cape York	3.1	2	1	1	At worst, short-term small-scale movement or behavioural changes may result from the presence of boats and associated noise and activities. =>Intensity minor; recent fishing effort increasing. Potential to decrease when planned new quota management comes into force in 2007 =>consequence negligible =>confidence low – there are no documented data to refute or confirm this.	I
Disturb physical processes	Bait collection	0										I
	Fishing	0										I
	Boat launching	1	3	3	Species composition	North Eastern Transition Inner Shelf	1.1	1	1	1	Restricted to isolated intertidal habitats and impacts are not likely to persist due to the dynamic nature of the environment. =>Intensity negligible, =>consequence negligible =>confidence low – no documented data are available.	I
	Anchoring/ mooring	1	3	5	Distribution of community	North Eastern Transition Inner Shelf	3.1	1	1	1	There are negligible impacts due to a preference for anchoring on sand sediments. At worst, anchoring may cause disruption to distribution of community avoid sediment disturbed short-term by the anchor. =>Intensity negligible as on a scale of metres only =>consequence negligible =>confidence low; there are no documented data or observer information to refute or confirm this.	I
	Navigation/steaming	1	3	5	Distribution of community	Northern - Coastal East Cape York	3.1	2	1	1	Small-scale water column disturbances may result from boats navigating through the area. Impacts on distribution of community are unlikely to be detectable =>intensity minor; recent fishing effort increasing. Potential to decrease when planned new quota management comes into force in 2007. =>consequence negligible =>confidence low; there are no documented data or observer information to refute or confirm this.	I
External Impacts (specify the particular example within each activity area)	Other fisheries	1	3	5	Functional group composition	North Eastern Transition Inner Shelf	2.1	3	2	1	The PNG and Queensland East Coast lobster fisheries fish the same shared stock. Both fisheries have seen increased catches recently due to recovering stocks. There is general agreement between the jurisdictions to address integrated management and research to cover the three sectors. =>Intensity moderate: exploitation is considered high in PNG and moderate in Queensland but much of the stock is conserved by	E

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	Internal / External
											depth. =>Consequence minor; annual monitoring in Torres Strait suggests external fisheries are fished at sustainable levels and therefore unlikely to impact functional group composition. =>Confidence low; Some concern about commercial data collection in PNG.	
	Aquaculture	0										E
	Coastal development	1	2	6	Species composition	North Eastern Transition Inner Shelf	1.1	1	1	1	There is limited developed on inhabited islands within the fishery =>intensity negligible as only limited and localised potential impacts from sewage discharge and dumping of rubbish =>consequences negligible as unlikely to affect species composition =>confidence low as no data are available.	E
	Other extractive activities	0										E
	Other non-extractive activities	0										E
	Other anthropogenic activities	1	3	6	Species composition	Northern - Coastal East Cape York	1.1	2	1	2	Indigenous fishing for food may affect species composition of communities =>intensity minor =>consequence negligible =>confidence high (Skewes *et al* 2002).	E

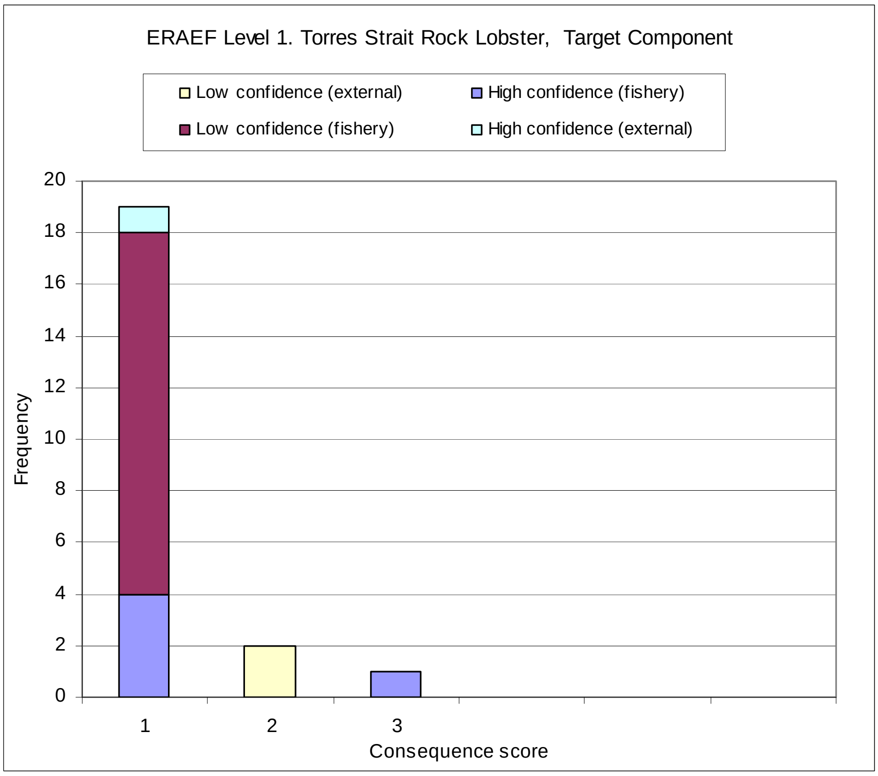
2.3.11 Summary of SICA results

The report provides a summary table (**Level 1 (SICA) Document L1.6**) of consequence scores for all activity/component combinations and a table showing those that scored 3 or above for consequence, and differentiating those that did so with high confidence (in bold).

Level 1 (SICA) Document L1.6. Summary table of consequence scores for all activity/component combinations.

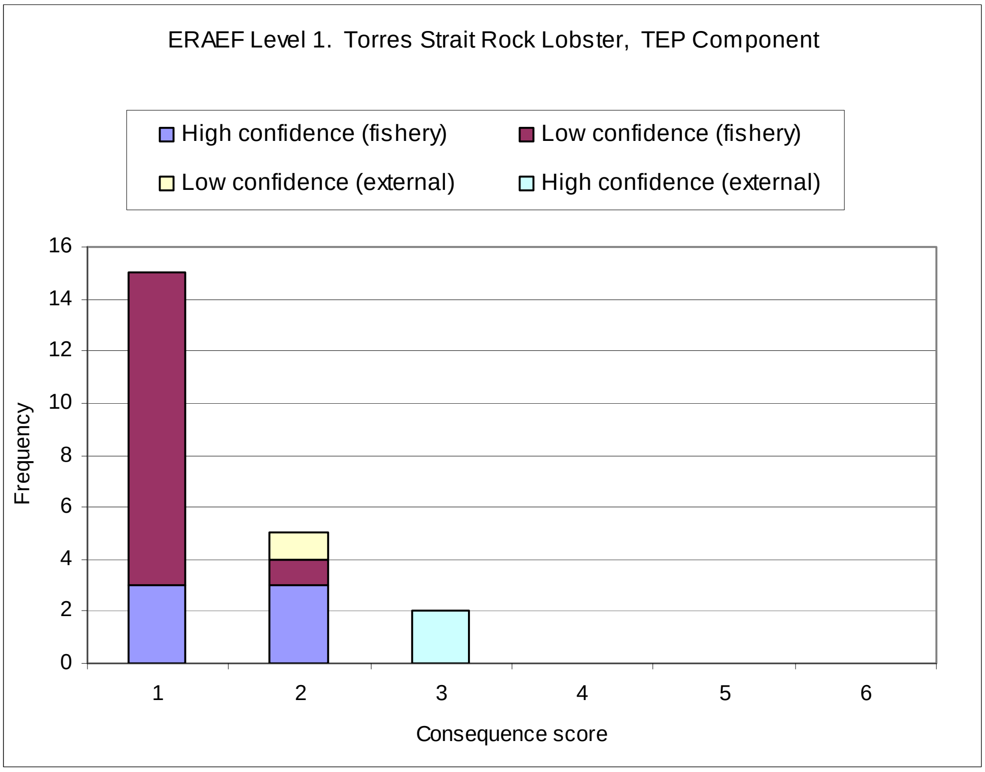
Direct impact	Activity	Target species	Byproduct and bycatch species	TEP species	Habitats	Communities
Capture	Bait collection		-			
	Fishing	**3**	-	1	2	**2**
	Incidental behaviour	1	-	**2**	1	1
Direct impact without capture	Bait collection					
	Fishing	**1**	-	2	2	**1**
	Incidental behaviour	1	-	1	1	1
	Gear loss	1	-	**1**	1	1
	Anchoring/ mooring	**1**	-	1	2	**1**
	Navigation/ steaming	1	-	1	1	1
Addition/ movement of biological material	Translocation of species	**1**		**2**	**2**	**2**
	On board processing	**1**	-	1	1	2
	Discarding catch					
	Stock enhancement					
	Provisioning					
	Organic waste disposal	1	-	1	**2**	1
Addition of non-biological material	Debris	1	-	**2**	**2**	1
	Chemical pollution	1	-	1	2	1
	Exhaust	1	-	1	1	1
	Gear loss	1	-	**1**	1	1
	Navigation/ steaming	1	-	1	1	1
	Activity/ presence on water	1	-	**1**	**1**	1
Disturb physical processes	Bait collection					
	Fishing					
	Boat launching	1	-	1	**1**	1
	Anchoring/ mooring	1	-	1	**1**	1
	Navigation/steaming	1	-	1	**1**	1
Note: external hazards are not considered at Level 2 in the PSA analysis						
External hazards	Other fisheries	2	-	**3**	3	2
	Aquaculture					
	Coastal development	2	-	2	2	1
	Other extractive activities					
	Other non extractive activities					
	Other anthropogenic activities	**1**	-	**3**	**3**	**1**

Target species: Frequency of consequence score differentiated between high and low confidence.

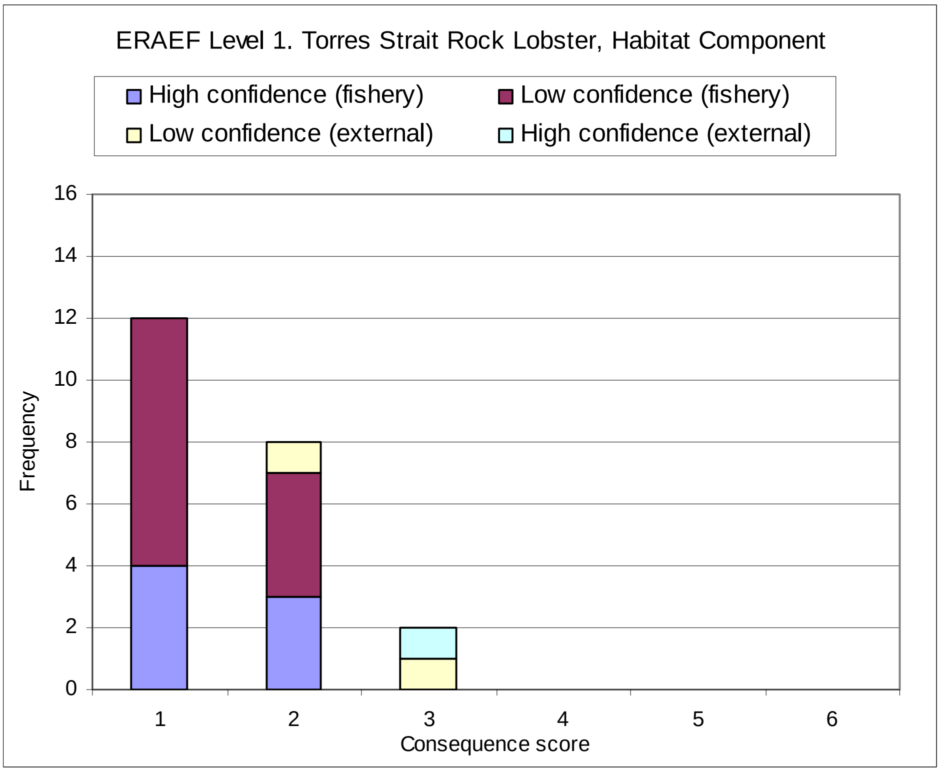


Byproduct and bycatch species:
NB. There is no associated bycatch in the Torres Strait Rock Lobster Fishery.

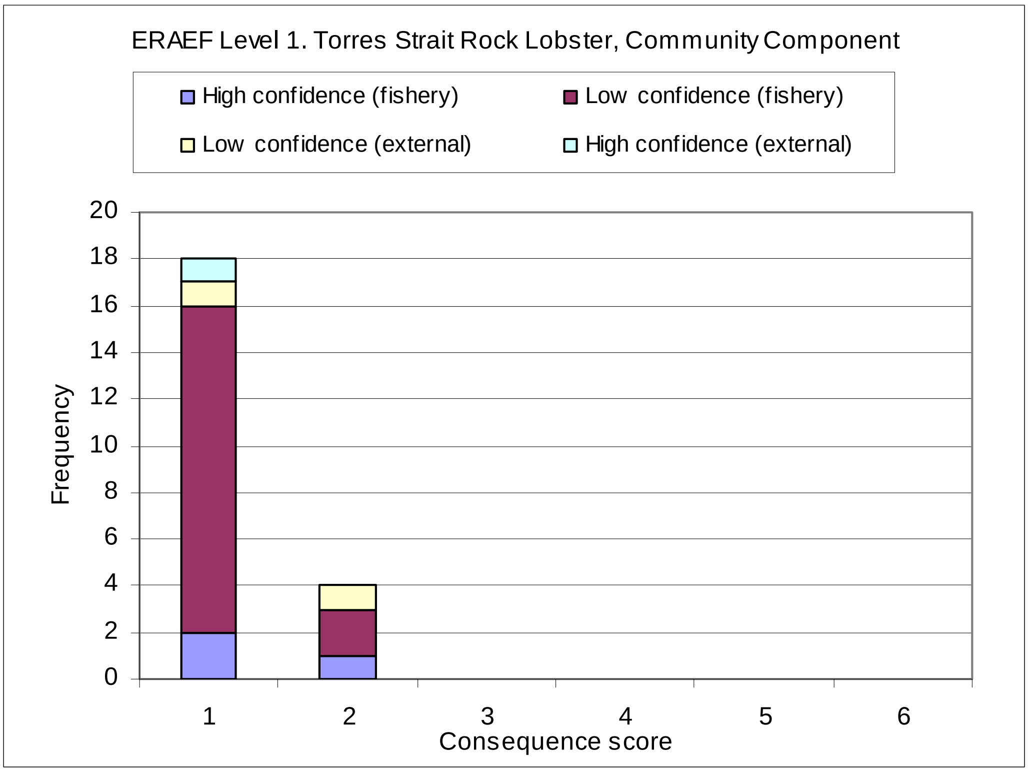
TEP species: Frequency of consequence score differentiated between high and low confidence (SICA excel workbook)



Habitats: Frequency of consequence score differentiated between high and low confidence



Communities: Frequency of consequence score differentiated between high and low confidence (SICA excel workbook)



2.3.12 Evaluation/discussion of Level 1

Three components assessed in the level 1 analysis contained consequence scores of three (moderate risk). The hazards involved are:

- Capture fishing (Target component);
- External hazards: Other fisheries (TEP and Habitat components); and
- External hazards: Other anthropogenic activities (TEP and Habitat components).

Confidence was high for each of the hazards assessed at moderate risk, with the exception of the impact of other fisheries on habitat, where a lack of specific data on which to base assessment resulted in a low confidence score.

Capture fishing in the Torres Strait Rock Lobster fishery is managed under a conservative and precautionary approach to ensure conservation of the stock for traditional inhabitants. As such, mitigating measures are in place to ensure that the hazard presented by capture fishing is contained. The planned move to a Quota Management system, to be initiated in 2007, will also serve to address the inherent capture risk on this single target species.

Hazards identified for the TEP and Habitat components where external hazards only.

There were no components examined at Level 2 for this fishery during Stage 2 of the ERAEF process.

2.3.13 Components to be examined at Level 2

No Level 2 analysis has been conducted for the Torres Strait Rock Lobster Fishery. Level 1 assessment for the Fishery has been completed as required for the ERAEF Stage 2 process. As such, further documentation in this report is included only as a means of understanding the ERAEF process in full.

Generally, as a result of the preliminary SICA analysis, the components to be examined at Level 2 are those with any consequence scores of 3 or above.

2.4 Level 2 Productivity and Susceptibility Analysis (PSA)

NB. No PSA has been produced for the Torres Strait Rock Lobster Fishery as part of the Stage 2 ERAEF process.

When the risk of an activity at Level 1 (SICA) on a component is moderate or higher and no planned management interventions that would remove this risk are identified, an assessment is generally required at Level 2. The PSA approach is a method of assessment which allows all units within any of the ecological components to be effectively and comprehensively screened for risk. The units of analysis are the complete set of species habitats or communities identified at the scoping stage. The PSA results in sections 2.4.2 and 2.4.3 of this report measure risk from direct impacts of fishing only, which in all assessments to date has been the hazard with the greatest risks identified at Level 1. Future iterations of the methodology will include PSAs modified to measure the risk due to other activities, such as gear loss.

The PSA approach is based on the assumption that the risk to an ecological component will depend on two characteristics of the component units: (1) the extent of the impact due to the fishing activity, which will be determined by the susceptibility of the unit to the fishing activities (Susceptibility) and (2) the productivity of the unit (Productivity), which will determine the rate at which the unit can recover after potential depletion or damage by the fishing. It is important to note that the PSA analysis essentially measures potential for risk, hereafter noted as 'risk'. A measure of absolute risk requires some direct measure of abundance or mortality rate for the unit in question, and this information is generally lacking at Level 2.

The PSA approach examines attributes of each unit that contribute to or reflect its productivity or susceptibility to provide a relative measure of risk to the unit. The following section describes how this approach is applied to the different components in the analysis. Full details of the methods are described in Hobday et al. (2007).

<u>Species</u>

The following Table outlines the seven attributes that are averaged to measure productivity, and the four aspects that are multiplied to measure susceptibility for all the species components.

	Attribute
Productivity	Average age at maturity
	Average size at maturity
	Average maximum age
	Average maximum size
	Fecundity
	Reproductive strategy
	Trophic level
Susceptibility	Availability considers overlap of fishing effort with a species distribution

	Encounterability considers the likelihood that a species will encounter fishing gear that is deployed within the geographic range of that species (based on two attributes: adult habitat and bathymetry)
	Selectivity considers the potential of the gear to capture or retain species
	Post capture mortality considers the condition and subsequent survival of a species that is captured and released (or discarded)

The productivity attributes for each species are based on data from the literature or from data sources such as FishBase. The four aspects of susceptibility are calculated in the following way:

Availability considers overlap of effort with species distribution. For species without distribution maps, availability is scored based on broad geographic distribution (global, southern hemisphere, Australian endemic). Where more detailed distribution maps are available (e.g. from BIOREG data or DEH protected species maps), availability is scored as the overlap between fishing effort and the portion of the species range that lies within the broader geographical spread of the fishery. Overrides can occur where direct data from independent observer programs are available.

Encounterability is the likelihood that a species will encounter fishing gear deployed within its range. Encounterability is scored using habitat information from FishBase, modified by bathymetric information. Higher risk corresponds to the gear being deployed at the core depth range of the species. Overrides are based on mitigation measures and fishery independent observer data.

For species that do encounter gear, **selectivity** is a measure of the likelihood that the species will be caught by the gear. Factors affecting selectivity will be gear and species dependent, but body size in relation to gear size is an important attribute for this aspect. Overrides can be based on body shape, swimming speed and independent observer data.

For species that are caught by the gear, **post capture mortality** measures the survival probability of the species. Obviously, for species that are retained, survival will be zero. Species that are discarded may or may not survive. This aspect is mainly scored using independent filed observations or expert knowledge.

Overall susceptibility scores for species are a product of the four aspects outlined above. This means that susceptibility scores will be substantially reduced if any one of the four aspects is considered to be low risk. However the default assumption in the absence of verifiable supporting data is that all aspects are high risk.

<u>Habitats</u>

Similar to species, PSA methods for habitats are based around a set of attributes that measure productivity and susceptibility. Productivity attributes include speed of regeneration of fauna, and likelihood of natural disturbance. The susceptibility attributes for habitats are described in the following Table.

Aspect	Attribute	Concept	Rationale
Susceptibility			
Availability	General depth range (Biome)	Spatial overlap of subfishery with habitat defined at biomic scale	Habitat occurs within the management area
Encounterability	Depth zone and feature type	Habitat encountered at the depth and location at which fishing activity occurs	Fishing takes place where habitat occurs
	Ruggedness (fractal dimension of substratum and seabed slope)	Relief, rugosity, hardness and seabed slope influence accessibility to different sub-fisheries	Rugged substratum is less accessible to mobile gears. Steeply sloping seabed is less accessible to mobile gears
	Level of disturbance	Gear footprint and intensity of encounters	Degree of impact is determined by the frequency and intensity of encounters (inc. size, weight and mobility of individual gears)
Selectivity	Removability/ mortality of fauna/ flora	Removal/ mortality of structure forming epifauna/ flora (inc. bioturbating infauna)	Erect, large, rugose, inflexible, delicate epifauna and flora, and large or delicate and shallow burrowing infauna (at depths impacted by mobile gears) are preferentially removed or damaged.
	Areal extent	How much of each habitat is present	Effective degree of impact greater in rarer habitats: rarer habitats may maintain rarer species.
	Removability of substratum	Certain size classes can be removed	Intermediate sized clasts (~6 cm to 3 m) that form attachment sites for sessile fauna can be permanently removed
	Substratum hardness	Composition of substrata	Harder substratum is intrinsically more resistant
	Seabed slope	Mobility of substrata once dislodged; generally higher levels of structural fauna	Gravity or latent energy transfer assists movement of habitat structures, eg turbidity flows, larger clasts. Greater density of filter feeding animals found where currents move up and down slopes.
Productivity			
Productivity	Regeneration of fauna	Accumulation/ recovery of fauna	Fauna have different intrinsic growth and reproductive rates which are also variable in different conditions of temperature, nutrients, productivity.
	Natural disturbance	Level of natural disturbance affects intrinsic ability to recover	Frequently disturbed communities adapted to recover from disturbance

Communities

PSA methods for communities are still under development. Consequently, it has not yet been possible to undertake level 2 risk analyses for communities.

During the Level 2 assessment, each unit of analysis within each ecological component (species or habitat) is scored for risk based on attributes for productivity and susceptibility, and the results are plotted as shown in Figure 13.

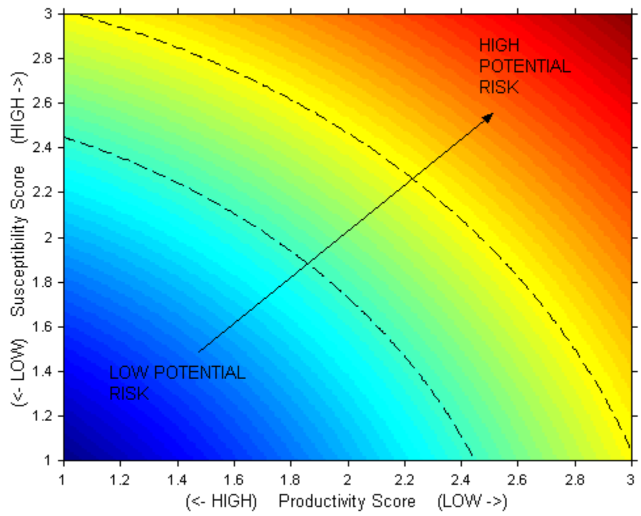


Figure 13. The axes on which risk to the ecological units is plotted. The *x*-axis includes attributes that influence the productivity of a unit, or its ability to recover after impact from fishing. The *y*-axis includes attributes that influence the susceptibility of the unit to impacts from fishing. The combination of susceptibility and productivity determines the relative risk to a unit, i.e. units with high susceptibility and low productivity are at highest risk, while units with low susceptibility and high productivity are at lowest risk. The contour lines divide regions of equal risk and group units of similar risk levels.

There are seven steps for the PSA undertaken for each component brought forward from Level 1 analysis.

Step 1	Identify the units excluded from analysis and document the reason for exclusion
Step 2	Score units for productivity
Step 3	Score units for susceptibility
Step 4	Plot individual units of analysis onto a PSA Plot
Step 5	Ranking of overall risk to each unit
Step 6	Evaluation of the PSA analysis
Step 7	Decision rules to move from Level 2 to Level 3

2.4.1 Units excluded from analysis and document reasons for exclusion (Step 1)

Species lists for PSA analysis are derived from recent observer data where possible or, for fisheries with no observer programs, from logbook and scientific data. In some logbook data, there may only be family level identifications. Where possible these are resolved to species level by cross-checking with alternative data sources and discussion with experts. In cases where this is not possible (mainly invertebrates) the analysis may be based on family average data.

ERA Species ID	Taxa Name	Scientific Name	CAAB Code	Family Name	Common Name	Role In Fishery	Source	Reason for removal

2.4.2 and 2.4.3 Level 2 PSA (Steps 2 and 3)

Summary of Species PSA results

The results in the Tables below provide details of the PSA assessments for each species, separated by role in the fishery, and by taxa where appropriate. These assessments are limited to direct impacts from fishing, and the operational objective is to avoid over-exploitation due to fishing, either as over-fishing or becoming over-fished. The risk scores and categories (high, medium or low) reflect potential rather than actual risk using the Level 2 (PSA) method. For species assessed at Level 2, no account is taken of the level of catch, the size of the population, or the likely exploitation rate. To assess actual risk for any species requires a Level 3 assessment which does account for these factors. However, recent fishing effort distributions are considered when calculating the availability attribute for the Level 2 analysis, whereas the entire jurisdictional range of the fishery is considered at Level 1.

The PSA analyses do not fully take account of management actions already in place in the fishery that may mitigate for high risk species. Some management actions or strategies, however, can be accounted for in the analysis where they exist. These include spatial management that limits the range of the fishery (affecting availability), gear limits that affect the size of animals that are captured (selectivity), and handling practices that may affect the survival of species after capture (post capture mortality). Management strategies that are not reflected in the PSA scores include limits to fishing effort, use of catch limits (such as TACs), and some other controls such as seasonal closures.

It should be noted that the PSA method is likely to generate more false positives for high risk (species assessed to be high risk when they are actually low risk) than false negatives (species assessed to be low risk when they are actually high risk). This is due to the precautionary approach to uncertainty adopted in the PSA method, whereby attributes are set at high risk levels in the absence of information. It also arises from the nature of the PSA method assessing potential rather than actual risk, as discussed above. Thus some species will be assessed at high risk because they have low productivity and are exposed to the fishery, even though they are rarely if ever caught and are relatively abundant.

In the PSA Tables below, the “Comments” column is used to provide information on one or more of the following aspects of the analysis for each species: use of overrides to alter susceptibility scores (for example based on use of observer data, or taking account of specific management measures or mitigation); data or information sources or limitations; and information that supports the overall scores. The use of over-rides is explained more fully in Hobday et al (2006).

The PSA Tables also report on “missing information” (the number of attributes with missing data that therefore score at the highest risk level by default). There are seven attributes used to score productivity and four aspects (availability, encounterability, selectivity and post capture mortality) used to score susceptibility (though encounterability is the average of two attributes). An attribute or aspect is scored as missing if there are no data available to score it, and it has defaulted to high risk for this reason. For some species, attributes may be scored on information from related species or other supplementary information, and even though this information is indirect and less reliable than if species specific information was available, this is not scored as a missing attribute.

There are differences between analyses for TEP species and the other species components. In particular, target, by-product and by-catch species are included on the basis that they are known to be caught by the fishery (in some cases only very rarely). However TEP species are included in the analysis on the basis that they occur in the area of the fishery, whether or not there has ever been an interaction with the fishery recorded. For this reason there may be a higher proportion of false positives for high vulnerability for TEP species, unless there is a robust observer program that can verify that species do not interact with the gear.

Observer data and observer expert knowledge are important sources of information in the PSA analyses, particularly for the bycatch and TEP components. There is no observer program currently in place for this fishery.

A summary of the species considered at Level 2 is presented below, sorted by component, by taxa within components, and then by the overall risk score [high (>3.18), medium (2.64-3.18), low<2.64)]

ERA species ID	Scientific name	Common name	average logbook catch (kg) 2001-04	Missing > 3 attributes (Y/N)	Number of missing productivity attributes (out of 7)	Number of missing susceptibility attributes (out of 4)	Productivity (additive) 1- low , 3 - high	Susceptibility (multiplicative) 1- low , 3 - high	Overall risk score 1.41- low , 4.24 - high	Override used?	PSA risk category	Comments

Summary of Habitat PSA results

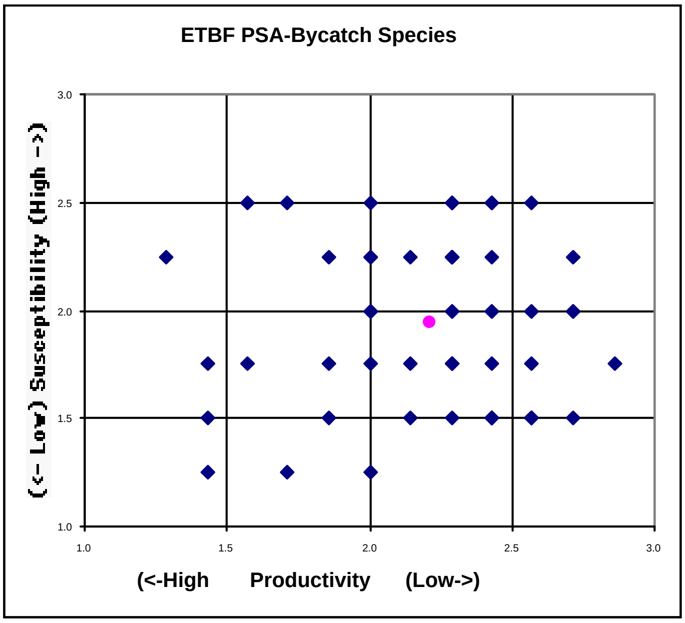
A summary of the habitats considered at Level 2 is presented below, and is sorted by the overall risk score (high, medium, low), by sub-biome, and by SGF score (Habitat type).

Record #	ERA habitat #	Sub-biome	Feature	Habitat Name	SGF Score	*n* missing attributes	Productivity score (Average)	Susceptability score (Multiplicative)	Overall Risk Score (P&Sm)	Overall Risk Ranking (2D multiplicative)	Risk ranking over-ride	Rationale

2.4.4 PSA Plot for individual units of analysis (Step 4)

The average productivity and susceptibility scores for each unit of analysis (e.g. for each species) are then used to place the individual units of analysis on 2D plots (as below). The relative position of the units on the plot will determine relative risk at the unit level as per PSA plot below. The overall risk value for a unit is the Euclidean distance from the origin of the graph. Units that fall in the upper third of the PSA plots are deemed to be at high risk. Units with a PSA score in the middle are at medium risk, while units in the lower third are at low risk with regard to the productivity and susceptibility attributes. The divisions between these risk categories are based on dividing the area of the PSA plots into equal thirds. If all productivity and susceptibility scores (scale 1-3) are assumed to be equally likely, then 1/3rd of the Euclidean overall risk values will be greater than 3.18 (high risk), 1/3rd will be between 3.18 and 2.64 (medium risk), and 1/3rd will be lower than 2.64 (low risk).

Results of the PSA plot from PSA workbook ranking worksheet, would follow the format of the example below:



PSA plot for target species
PSA plot for byproduct species
PSA plot for discards/bycatch species
PSA plot for TEP species
PSA plot for habitats
PSA plot for communities

The overall risk value for each unit is the Euclidean distance from the origin to the location of the species on the PSA plot. The units are then divided into three risk categories, high, medium and low, according to the risk values (**Figure 17)**. The cut-offs for each category are thirds of the total distribution of all possible risk values (**Figure 17)**.

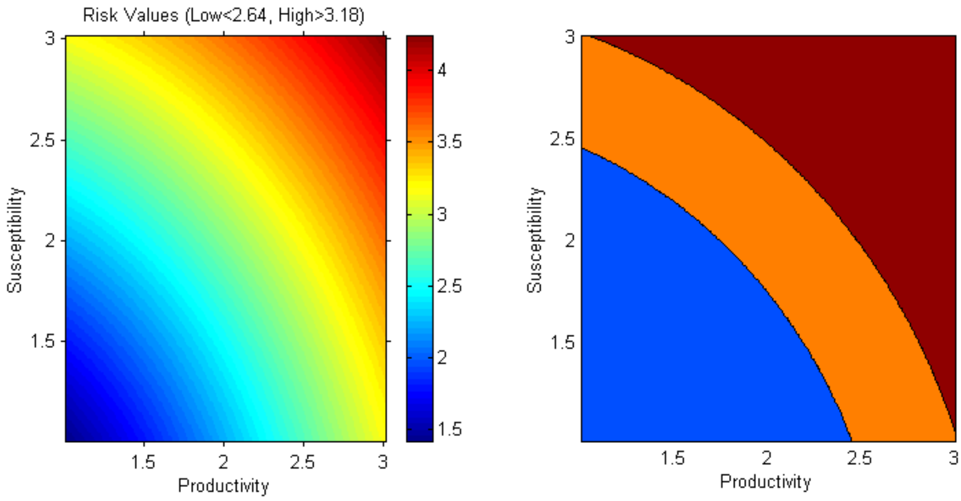


Figure 17. Overall risk values in the PSA plot. Left panel. Colour map of the distribution of the euclidean overall risk values. Right panel. The PSA plot contoured to show the low risk (blue), medium risk (orange) and high risk (red) values.

The PSA output allows identification and prioritisation (via ranking the overall risk scores) of the units (e.g. species, habitat types, communities) at greatest risk to fishing activities. This prioritisation means units with the lowest inherent productivity or highest susceptibility, which can only sustain the lowest level of impact, can be examined in detail. The overall risk to an individual unit will depend on the level of impact as well its productivity and susceptibility.

2.4.5 Uncertainty analysis ranking of overall risk (Step 5)

The final PSA result for a species is obtained by ranking overall risk value resulting from scoring the productivity and susceptibility attributes. Uncertainty in the PSA results can arise when there is imprecise, incorrect or missing data, where an average for a higher taxonomic unit was used (e.g. average genera value for species units), or because an inappropriate attribute was included. The number of missing attributes, and hence conservative scores, is tallied for each unit of analysis. Units with missing scores will have a more conservative overall risk value than those species with fewer missing attributes, as the highest score for the attribute is used in the absence of data. Gathering the information to allow the attribute to be scored may reduce the overall risk value. Identification of high-risk units with missing attribute information should translate into prioritisation of additional research (an alternative strategy).

A second measure of uncertainty is due to the selection of the attributes. The influence of particular attributes on the final result for a unit of analysis (e.g. a habitat unit) can be quantified with an uncertainty analysis, using a Monte Carlo resampling technique. A set of productivity and susceptibility scores for each unit is calculated by removing one of the productivity or susceptibility attributes at a time, until all attribute combinations have been used. The variation (standard deviation) in the productivity and susceptibility scores is a measure of the uncertainty in the overall PSA score. If the uncertainty analysis shows that the unit would be treated differently with regard to risk, it should be the subject of more study.

The validity of the ranking can also be examined by comparing the results with those from other data sources or modelling approaches that have already been undertaken in specific fisheries. For example, the PSA results of the individual species (target, byproduct and bycatch and TEP) can be compared against catch rates for any species or against completed stock assessments. These comparisons will show whether the PSA ranking agrees with these other sources of information or more rigorous approaches.

<u>Availability of Information</u>

The ability to score each species based on information on each attribute [varied/did not vary] between the attributes (as per summary below). With regard to the productivity attributes, [least known productivity attribute] was missing in [X]% of [units], and so the most conservative score was used, while information on [best known productivity attribute] could be found or calculated for [Y% of units]. The current method of scoring the susceptibility attributes provides a value for each attribute for each species – some of these are based on good information, whereas others are merely sensible default values.

Summary of the success of obtaining information on the set of productivity and susceptibility attributes for the species. Where information on an attribute was missing the highest score was used in the PSA.

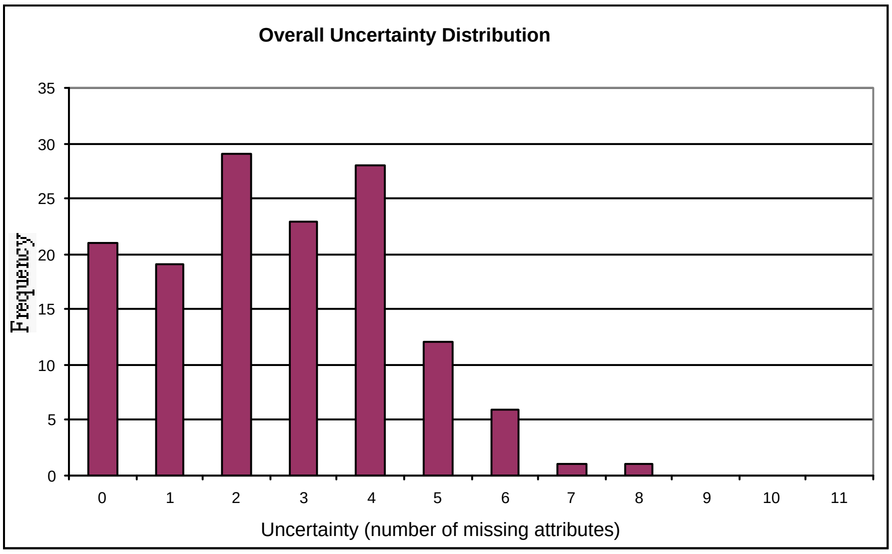
Results from PSA workbook ranking worksheet (species only).

Productivity Attributes	Average age at maturity	Average max age	Fecundity	Average max size	Average size at Maturity	Reproductive strategy	Trophic level (fishbase)
Total species scores for attribute							
n species scores with attribute unknown, (conservative score used)							
% unknown information							
Susceptibility Attributes	Availability	Encounterability		Selectivity	PCM		
		Bathymetry overlap	Habitat				
Total species scores for attribute							
n species scores with attribute unknown, (conservative score used)							
% unknown information							

Each species considered in the analysis had information for an average of [A, (B%)] productivity attributes and [C (D%)] susceptibility attributes. This meant that, on average, conservative scores were used for less than [E%] of the attributes for a single species. [Units] had missing information for between [F and G] of the combined [H] productivity and susceptibility attributes.

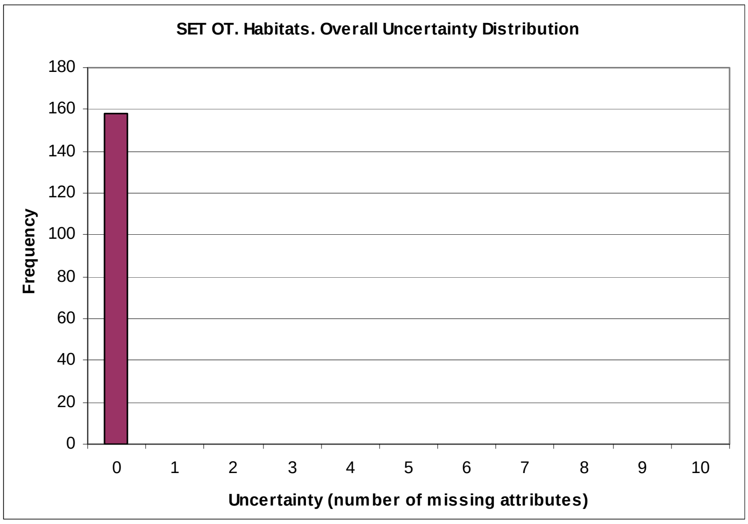
Results Overall uncertainty distribution in PSA workbook ranking graphs worksheet

Species uncertainty distribution histogram would follow the format of the example below:



Species: Overall uncertainty distribution - frequency of missing information for the combined productivity and susceptibility attributes

Habitats: Twenty-one attributes are used in the habitat PSA. All attributes are scored according to Habitat attribute tables 9-27. Only attributes that could be ranked are utilised and therefore there are no missing attributes. [example below]



Habitats: Overall uncertainty distribution- frequency of missing information for the combined productivity and susceptibility attributes

<u>Correlation between Attributes</u>
In situations where attributes are strongly correlated only one of them should be included in the final PSA (Stobutzki *et al*., 2001).

Species component: The attributes selected for productivity and susceptibility [were/were not] strongly correlated (as per correlation matrix below for Productivity and susceptibility). The strongest productivity attribute correlation was between [attribute J and attribute K], while the strongest susceptibility correlation was between [attribute L and attribute M]. This correlation analysis suggests that each attribute [was/was not] "measuring" a different aspect of the [unit] characteristics and [all/not all] attributes were suitable for inclusion in the PSA.

	Age at maturity	Max age	Fecundity	Max size	Min size at maturity	Reproductive strategy	Trophic level
Age at maturity	X						
Max age		X					
Fecundity			X				
Max size				X			
Min size at maturity					X		
Reproductive strategy						X	
Trophic level							X

Correlation matrix for the species productivity attributes. The correlation (r) is based on the scores within each attribute pair. Results from PSA workbook ranking graphs worksheet.

	Availability	Encounterability	Selectivity	Post-capture mortality
Availability	X			
Encounterability		X		
Selectivity			X	
Post-capture mortality				X

Correlation matrix for the four species susceptibility attributes. The correlation (r) is based on the scores within each attribute pair. Results from PSA workbook ranking graphs worksheet.

Habitat Component: The attributes selected for productivity and susceptibility [were/not] strongly correlated (as per correlation matrix below for productivity and susceptibility). There was [X] correlation between the productivity attributes Regeneration of Fauna and Natural disturbance (r = [x]). The susceptibility correlation could not be calculated between the Availability and any other aspect, because there was no variation in the Availability score. There [was/X] correlation between the attributes used to calculate Encounterability and Selectivity. All attributes were suitable for inclusion in the PSA.

Productivity Correlation Matrix	Regeneration of fauna	Natural disturbance
Regeneration of fauna	X	
Natural disturbance	X	X

Correlation matrix for the habitat productivity attributes. The correlation (r) is based on the scores within each attribute pair. Results from PSA workbook ranking graphs worksheet.

Susceptibility Correlation Matrix	Availability score	Encounterability score (average)	Selectivity score (average)
Availability score	X		
Encounterability score (average)	X	X	
Selectivity score (average)	X	X	X

Correlation matrix for the three habitat susceptibility attributes. The correlation (r) is based on the scores within each attribute pair. Results from PSA workbook ranking graphs worksheet.

Productivity and Susceptibility Values for Species

The average productivity score for all [units] was [X ± Y] (mean ± SD of scores calculated using n-1 attributes) and the mean susceptibility score was [X ± Y] (as per summary of average productivity and susceptibility scores as below). Individual scores are shown in Appendix B: Summary of PSA results. The [small/large] variation in the average of the boot-strapped values (using n-1 attributes), indicates the productivity and susceptibility scores [are/are not] robust to elimination of a single attribute. Information for a single attribute [does not/does] have a disproportionately large effect on the productivity and susceptibility scores. Information was missing for an average of [Z] attributes out of [Y] possible for each [unit].

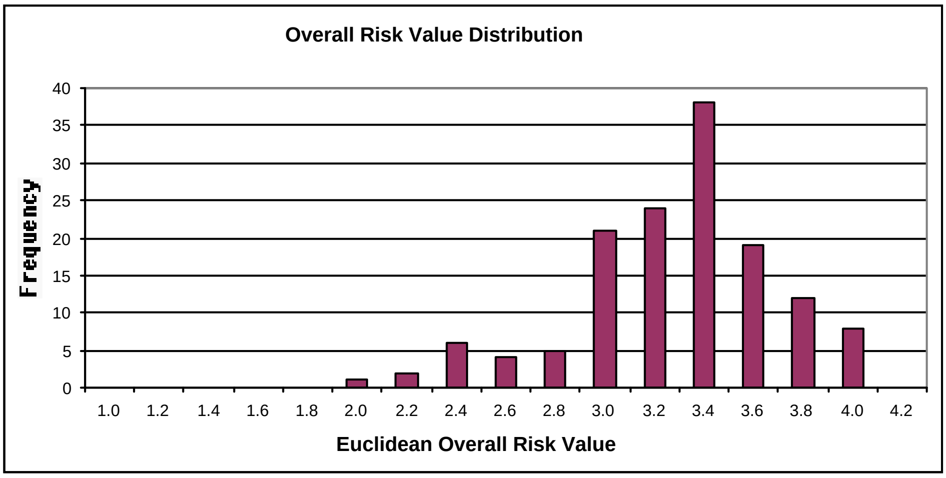
Productivity and Susceptibility Values for Habitat units.

The average productivity score for all habitats was [X ± Y] (mean ± SD of scores calculated using n-1 attributes) and the mean susceptibility score was [X ± Y] (as per summary of average productivity and susceptibility scores as below). Individual scores are shown in Appendix B: Summary of PSA results. The small/large variation in the average of the boot-strapped values (using n-1 attributes), indicates the productivity and susceptibility scores are robust to elimination of a single attribute. Information for a single attribute [does not/does] have a disproportionately large effect on the productivity and susceptibility scores. Information was missing for an average of [Z] attributes out of [Y] possible for each [unit].

Overall Risk Values for Species

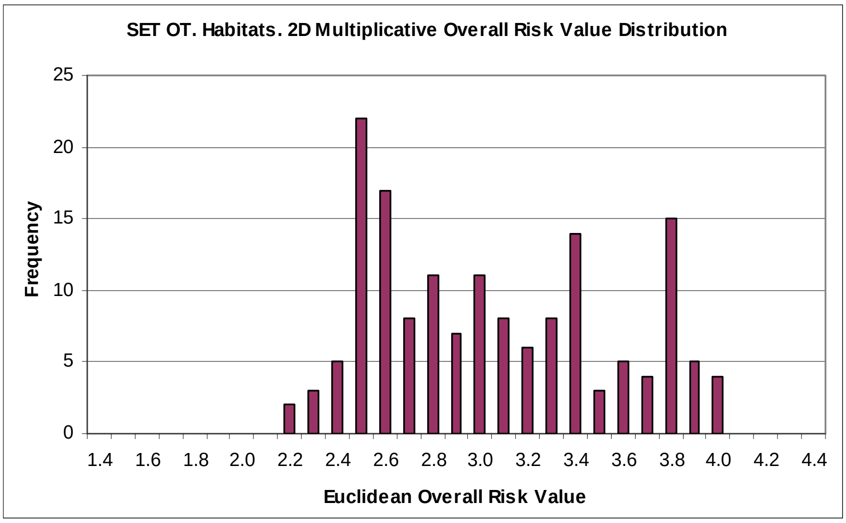
The overall risk values (Euclidean distance on the PSA plot) could fall between 1 and 4.24 (scores of 1&1 and 3&3 for both productivity and susceptibility respectively). The mean observed overall risk score was [X], with a range of [Y – Z]**.**
The actual values for each species are shown in Appendix B: Summary of PSA results. A total of [A units, (B%)] were classed as high risk, [B (C%)] were in the medium risk category, and [D (E%)] as low risk**.**

<u>Results</u>: Frequency distribution of the overall PSA risk values .
Evaluation example only



Frequency distribution of the overall risk values generated for the [X units] in the [fishery sub-fishery] PSA.

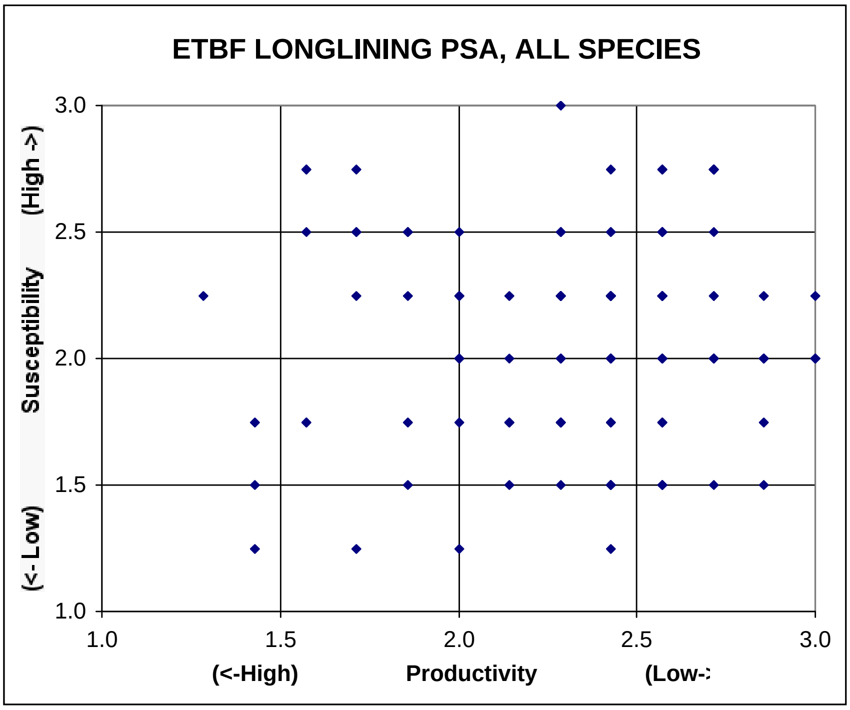
<u>Overall Risk Values for Habitats</u>
The overall risk values (Euclidean distance on the PSA plot) could fall between 1 and 4.24 (scores of 1&1 and 3&3 for both productivity and susceptibility respectively). The mean observed overall risk score was 3.01, with a range of 2.18- 3.97**.**
The actual values for each species are shown in Appendix B: Summary of PSA results. A total of 46 units, (29%) were classed as high risk, 58units, (37%) were in the medium risk category, and 54 (34%) as low risk**.**



Frequency distribution of the overall risk values generated for the [X] habitat types in the [fishery sub-fishery] PSA.

The distribution of the overall risk values of all species is shown on the PSA plot below. The species are distributed in the [all/lower left/upper right] parts of the plot, indicating that [both high and low risk units] are potentially impacted in the [fishery sub-fishery].

Results Plot for all species in the sub-fishery PSA risk values.
Evaluation example only



PSA plot for all [units] in the [fishery sub-fishery]. Species in the upper right of the plot are at highest risk.

The number of attributes with missing information is of particular interest, because the conservative scoring means these units may be scored at higher risk than if all the information was known. This relationship between the overall risk score and the number of missing attributes shows that an increase in the number of missing attributes (and hence conservative scores used) results in a skew to higher risk values. This suggests that as information becomes available on those attributes, the risk values may decline for some units.

All attributes are treated equally in the PSA, however, information on some attributes may be of low quality.

2.4.6 Evaluation of the PSA results (Step 6)

No PSA has been produced for the Torres Strait Rock Lobster Fishery during Stage 2 of the ERAEF process.

Species components:

Overall

Results

Discussion

Habitat components:

Overall

Results:

Summary of the average productivity, susceptibility and overall risk scores.

Component	Measure	
All habitats	Number of habitats	X
	Average of productivity total	X
	Average of susceptibility total	X
	Average of overall risk value (2D)	X
	Average number of missing attributes	0

PSA (productivity and susceptibility) risk categories for the habitat component.

Risk category	High	Medium	Low	Total
Total Habitats	X	X	X	X

PSA (productivity and susceptibility) risk categories for sub-biome (depth zone) fished (before override adjustment).

2D Risk Score	Inner-shelf	Outer-shelf	Upper-slope	Mid-slope	Total habitats
High	X	X	X	X	X
Medium	X	X	X	X	X
Low	X	X	X	X	X
Total	X	X	X	X	X

PSA (productivity and susceptibility) risk categories for sub-biome fished after Risk Ranking adjustment (stakeholder/expert override).

2D Risk Score	Inner-shelf	Outer-shelf	Upper-slope	Mid-slope	Total habitats
High	X	X	X	X	X
Medium	X	X	X	X	X
Low	X	X	X	X	X
Total	X	X	X	X	X

[No] inner shelf habitats are classified as high risk, [X] as medium risk, and [X] as low risk. [X] outer shelf habitats produce high risk scores, [X] medium and [X] are at low risk. Of the upper slope [X] are classified as high risk, [X] at medium and [no] upper slope habitats appear at low risk. Habitats at mid-slope depths are either at high risk (X) or at medium risk (X), none are considered low risk.

Discussion

****

2.4.7 Decision rules to move from Level 2 to Level 3 (Step 7)

For the PSA overall risk values, units that fall in the upper third (risk value > 3.18) and middle third (2.64 < risk value < 3.18) of the PSA plots are deemed to be at high and medium risk respectively. These need to be the focus of further work, either through implementing a management response to address the risk to the vulnerable species or by further examination for risk within the particular ecological component at Level 3. Units at low risk, in the lower third (risk value <2.64), will be deemed not at risk from the sub-fishery and the assessment is concluded for these units.

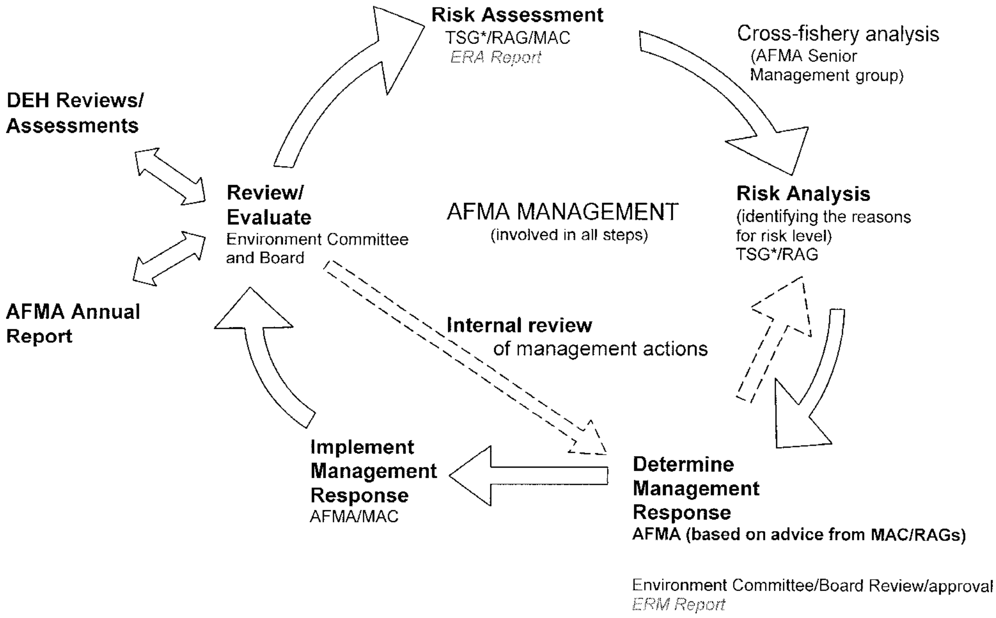
For example, if in a Level 2 analysis of habitat types, two of seven habitat types were determined to have risk from the sub-fishery, only those two habitat types would be considered at Level 3.

The output from the Level 2 analysis will result in four options:

- The risk of fishing on a unit of analysis within a component (e.g. single species or habitat type) is not high, the rationale is documented, and the impact of the fishing activity on this unit need not be assessed at a higher level unless management or the fishery changes.
- The risk of fishing on a unit is high but management strategies are introduced rapidly that will reduce this risk, this unit need not be assessed further unless the management or the fishery changes.
- The risk of fishing on a unit is high but there is additional information that can be used to determine if Level 3, or even a new management action is required. This information should be sought before action is taken
- The risk of fishing on a unit is high and there are no planned management interventions that would remove this risk, therefore the reasons are documented and the assessment moves to Level 3.

At level 2 analysis, a fishery can decide to further investigate the risk of fishing to the species via a level 3 assessment or implement a management response to mitigate the risk. To ensure all fisheries follow a consistent process in responding to the results of the risk assessment, AFMA has developed an ecological risk management framework. The framework (see Figure x below) makes use of the existing AFMA management structures to enable the ERAs to become a part of normal fisheries management, including the involvement of fisheries consultative committees. A separate document, the ERM report, will be developed that outlines the reasons why species are at high risk and what actions the fishery will implement to respond to the risks.

Figure x: Ecological Risk Management Framework



*TSG – Technical Support Group - currently provided by CSIRO.

2.5 Level 3

Level 3 analyses have not been undertaken for species, habitats or communities associated with the Torres Strait Rock Lobster Fishery as part of this ERAEF process. Stock assessments have been carried out for the Torres Strait lobster stock.

The status of the Torres Strait lobster stock is assessed annually using an age-structured fishery model with inputs from annual fishery-independent population surveys conducted by CMAR (Ye *et al.* 2004). Fishery-independent surveys have been conducted annually since 1989 to:

- estimate the absolute or relative abundance of the recruiting (1+) and fished (2+) year-classes,
- monitor the size/age distribution of the population, and
- monitor the seabed habitats in the area of the fishery.

A stock recruitment relationship was developed based on the abundance of the fished (2+) year-class in year X (as a proxy for the breeding year-class) and the subsequent recruits (1+) in year X+2.

In 1989 absolute abundance of the Torres Strait lobster population was estimated at 14 million (± 20%) by surveying 542 transects throughout the area of the fishery (Pitcher *et al.* 1992a). The estimated fishable stock was 5200-8000 t whole weight and, given the annual catch was ~600 t, the fishery was deemed to be under-exploited.

Since 1989, abbreviated surveys have been conducted at a sub-set of the original sites to estimate relative abundance of the recruiting and fished year-classes. Stock levels declined steadily during the 1990s but recruit abundance was variable. However, during 1999-2001 a dramatic decline in both stock and recruit abundance, and results of fishery modeling, indicated the stock was biologically over-fished. New management arrangements were introduced in 2001 to allow the stock to recover to 1990s levels. Since 2001, and possibly due to the new management arrangements, there has been a steady increase in stock abundance to levels near that recorded in 1989. However, as a result, effort levels and catch levels in the fishery have also increased to near record levels. The latest assessment of stock status, using the CMAR fishery model, indicates that the population has been biologically sustainably fished during most years of the period studied (1989-2005).

As a result of the 2005 decision by the Protected Zone Joint Authority (PZJA) to change management of the Torres Strait Rock Lobster Fishery to a Quota Managed System (QMS), a method is currently being developed to set a total allowable catch (TAC) for the year 2007. The TAC will be set by the Torres Strait Resource Assessment group (RAG) and based on outcomes of the most recent stock assessment using the age-structured fishery model developed by CSIRO Marine and Atmospheric Research (CMAR).

3. General discussion and research implications

The Torres Strait Rock Lobster Fishery is a diving collection fishery operating in Western Torres Strait waters, principally west of Warrior Reef, in shallow coral-reef areas of less than 25 m depth. Three sectors are involved in this fishery: Torres Strait islander commercial divers, non-islander commercial divers, and Torres Strait artisanal divers. Collection is predominantly by way of hand-spear, but more recently some use of hand-held nets has also been recorded. As such, this is a highly selective fishery with minimal impact associated with the fishing method.

The Torres Strait Rock Lobster Fishery is currently managed by input controls, including a seasonal ban on commercial fishing from October to November, a hookah ban between December and January, and a minimum size limit of 115 mm tail length. The introduction of a Quota Management system is planned for 2007.

3.1 Level 1

Three components assessed in the level 1 analysis contained consequence scores of three. The hazards involved within these components are:

- Internal hazard: Capture fishing (Target component);
- External hazards: Other fisheries (TEP and Habitat); and
- External hazards: Other anthropogenic activities (TEP and Habitat).

The Torres Strait Rock Lobster fishery is managed under a conservative and precautionary approach to ensure conservation of the stock for traditional inhabitants and industry. As such, with regard to the Target component, measures are in place to ensure that the hazard presented by capture fishing is contained.

It is difficult to assess the absolute risk to the Torres Strait Rock Lobster target species population without an integrated stock assessment to determine the status of the whole lobster stock, including impacts presented by the external fisheries. Comprehensive commercial catch monitoring is required before such an assessment is possible. This may be achieved once all fisheries move to Quota Management in the near future (planned enforcement in 2007). As such, the key recommendations from this assessment are to move to an integrated assessment of the whole lobster stock, and to monitor catch and effort by all sectors that use this resource.

3.2 Level 2

Level 2 assessment has not been carried out for the Torres Strait Rock Lobster Fishery as part of the Stage 2 ERAEF process.

3.3 Key Uncertainties / Recommendations for Research and Monitoring

It is difficult to assess the absolute risk to the Torres Strait Rock Lobster target species population as a result of external fisheries impacts without an integrated stock assessment to determine status of the whole lobster stock. Comprehensive commercial catch monitoring is required before such an assessment is possible. This may be achieved once all fisheries move to Quota Management in the near future (planned enforcement in 2007).

As such, the key recommendations from this assessment are to move to integrated assessment of the whole lobster stock and to monitor commercial catch and effort for all sectors of the stock.

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Glossary of Terms

Assemblage	A subset of the species in the community that can be easily recognised 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".

Appendix A: General summary of stakeholder feedback

Date	Format received	Comment from stakeholder	Action/explanation
		No stakeholder comments on final draft received	

See section 2.1 for Stakeholder involvement

Appendix B: PSA results - summary of stakeholder discussions

Level 2 (PSA) Document L2.1. Summary table of stakeholder discussion regarding PSA results.

The following species were discussed at the INSERT FISHERY GROUP NAME meeting on INSERT DATE and LOCATION. ALL or SELECTED high risk species were discussed.

Taxa name	Scientific name	Common name	Role in fishery	PSA risk ranking (H/M/L)	Comments from meeting, and follow-up	Action	Outcome	Possible management response

NB. No Level 2 analysis has been conducted for the Torres Strait Lobster Fishery.

Appendix C: SICA consequence scores for ecological components

Table 5A. Target Species. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for target species.

(Modified from Fletcher *et al*. 2002)

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
Population size	**1. Population size** Insignificant change to population size/growth rate (r). Unlikely to be detectable against background variability for this population.	**1. Population size** Possible detectable change in size/growth rate (r) but minimal impact on population size and none on dynamics.	**1. Population size** Full exploitation rate but long-term recruitment dynamics not adversely damaged.	**1. Population size** Affecting recruitment state of stocks and/or their capacity to increase	**1. Population size** Likely to cause local extinctions if continued in longer term	**1. Population size** Local extinctions are imminent/immediate
Geographic range	**2. Geographic range** No detectable change in geographic range. Unlikely to be detectable against background variability for this population.	**2. Geographic range** Possible detectable change in geographic range but minimal impact on population range and none on dynamics, change in geographic range up to 5 % of original.	**2. Geographic range** Change in geographic range up to 10 % of original.	**2. Geographic range** Change in geographic range up to 25 % of original.	**2. Geographic range** Change in geographic range up to 50 % of original.	**2. Geographic range** Change in geographic range > 50 % of original.
Genetic structure	**3. Genetic structure** No detectable change in genetic structure. Unlikely to be detectable against background variability for this population.	**3. Genetic structure** Possible detectable change in genetic structure. Any change in frequency of genotypes, effective population size or number of spawning units up to 5%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units up to 10%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units up to 25%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units, change up to 50%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units > 50%.

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
Age/size/sex structure	**4. Age/size/sex structure** No detectable change in age/size/sex structure. Unlikely to be detectable against background variability for this population.	**4. Age/size/sex structure** Possible detectable change in age/size/sex structure but minimal impact on population dynamics.	**4. Age/size/sex structure** Impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely affected.	**4. Age/size/sex structure** Long-term recruitment dynamics adversely affected. Time to recover to original structure up to 5 generations free from impact.	**4. Age/size/sex structure** Long-term recruitment dynamics adversely affected. Time to recover to original structure up to 10 generations free from impact.	**4. Age/size/sex structure** Long-term recruitment dynamics adversely affected. Time to recover to original structure > 100 generations free from impact.
Reproductive capacity	**5. Reproductive capacity** No detectable change in reproductive capacity. Unlikely to be detectable against background variability for this population.	**5. Reproductive capacity** Possible detectable change in reproductive capacity but minimal impact on population dynamics.	**5. Reproductive capacity** Impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely affected.	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery up to 5 generations free from impact.	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery up to 10 generations free from impact.	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery > 100 generations free from impact.
Behaviour/movement	**6. Behaviour/ movement** No detectable change in behaviour/ movement. Unlikely to be detectable against background variability for this population. Time taken to recover to pre-disturbed state on the scale of hours.	**6. Behaviour/ movement** Possible detectable change in behaviour/ movement but minimal impact on population dynamics. Time to return to original behaviour/ movement on the scale of days to weeks.	**6. Behaviour/ movement** Detectable change in behaviour/ movement with the potential for some impact on population dynamics. Time to return to original behaviour/ movement on the scale of weeks to months.	**6. Behaviour/ movement** Change in behaviour/ movement with impacts on population dynamics. Time to return to original behaviour/ movement on the scale of months to years.	**6. Behaviour/ movement** Change in behaviour/ movement with impacts on population dynamics. Time to return to original behaviour/ movement on the scale of years to decades.	**6. Behaviour/ movement** Change to behaviour/ movement. Population does not return to original behaviour/ movement.

Table 5B. Bycatch and Byproduct species. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for bycatch/byproduct species.

(Modified from Fletcher *et al*. 2002)

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
Population size	**1. Population size** Insignificant change to population size/growth rate (r). Unlikely to be detectable against background variability for this population.	**1. Population size** Possible detectable change in size/growth rate (r) but minimal impact on population size and none on dynamics.	**1. Population size** No information is available on the relative area or susceptibility to capture/ impact or on the vulnerability of life history traits of this type of species Susceptibility to capture is suspected to be less than 50% and species do not have vulnerable life history traits. For species with vulnerable life history traits to stay in this category susceptibility to capture must be less than 25%.	**1. Population size** Relative state of capture/susceptibility suspected/known to be greater than 50% and species should be examined explicitly.	**1. Population size** Likely to cause local extinctions if continued in longer term	**1. Population size** Local extinctions are imminent/immediate
Geographic range	**2. Geographic range** No detectable change in geographic range. Unlikely to be detectable against background	**2. Geographic range** Possible detectable change in geographic range but minimal impact on population range and none on	**2. Geographic range** Change in geographic range up to 10 % of original.	**2. Geographic range** Change in geographic range up to 25 % of original.	**2. Geographic range** Change in geographic range up to 50 % of original.	**2. Geographic range** Change in geographic range > 50 % of original.

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
	variability for this population.	dynamics, change in geographic range up to 5 % of original.				
Genetic structure	**3. Genetic structure** No detectable change in genetic structure. Unlikely to be detectable against background variability for this population.	**3. Genetic structure** Possible detectable change in genetic structure. Any change in frequency of genotypes, effective population size or number of spawning units up to 5%.	**3. Genetic structure** Detectable change in genetic structure. Change in frequency of genotypes, effective population size or number of spawning units up to 10%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units up to 25%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units up to 50%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units > 50%.
Age/size/sex structure	**4. Age/size/sex structure** No detectable change in age/size/sex structure. Unlikely to be detectable against background variability for this population.	**4. Age/size/sex structure** Possible detectable change in age/size/sex structure but minimal impact on population dynamics.	**4. Age/size/sex structure** Detectable change in age/size/sex structure. Impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely damaged.	**4. Age/size/sex structure** Long-term recruitment dynamics adversely affected. Time to recover to original structure up to 5 generations free from impact.	**4. Age/size/sex structure** Long-term recruitment dynamics adversely affected. Time to recover to original structure up to 10 generations free from impact.	**4. Age/size/sex structure** Long-term recruitment dynamics adversely affected. Time to recover to original structure > 100 generations free from impact.
Reproductive capacity	**5. Reproductive capacity** No detectable change in reproductive capacity. Unlikely to be detectable against background variability for this	**5. Reproductive capacity** Possible detectable change in reproductive capacity but minimal impact on population dynamics.	**5. Reproductive capacity** Detectable change in reproductive capacity, impact on population dynamics at maximum sustainable level,	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery up to 5	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to	**5. Reproductive capacity** Change in reproductive capacity adversely affecting long-term recruitment dynamics. Time to recovery > 100 generations free from

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
	population.		long-term recruitment dynamics not adversely damaged.	generations free from impact.	recovery up to 10 generations free from impact.	impact.
Behaviour/movement	**6. Behaviour/ movement** No detectable change in behaviour/ movement. Unlikely to be detectable against background variability for this population. Time taken to recover to pre-disturbed state on the scale of hours.	**6. Behaviour/ movement** Possible detectable change in behaviour/ movement but minimal impact on population dynamics. Time to return to original behaviour/ movement on the scale of days to weeks.	**6. Behaviour/ movement** Detectable change in behaviour/ movement with the potential for some impact on population dynamics. Time to return to original behaviour/ movement on the scale of weeks to months.	**6. Behaviour/ movement** Change in behaviour/ movement with impacts on population dynamics. Time to return to original behaviour/ movement on the scale of months to years	**6. Behaviour/ movement** Change in behaviour/ movement with impacts on population dynamics. Time to return to original behaviour/ movement on the scale of years to decades.	**6. Behaviour/ movement** Change to behaviour/ movement. Population does not return to original behaviour/ movement.

Table 5C. TEP species. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for TEP species.

(Modified from Fletcher *et al.* 2002)

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
Population size	**1. Population size** Almost none are killed.	**1. Population size** Insignificant change to population size/growth rate (r). Unlikely to be detectable against background variability for this population.	**1. Population size**. State of reduction on the rate of increase are at the maximum acceptable level. Possible detectable change in size/ growth rate (r) but minimal impact on population size and none on dynamics of TEP species.	**1. Population size** Affecting recruitment state of stocks or their capacity to increase.	**1. Population size** Local extinctions are imminent/immediate	**1. Population size** Global extinctions are imminent/immediate
Geographic range	**2. Geographic range** No interactions leading to impact on geographic range.	**2. Geographic range** No detectable change in geographic range. Unlikely to be detectable against background variability for this population.	**2. Geographic range** Possible detectable change in geographic range but minimal impact on population range and none on dynamics. Change in geographic range up to 5 % of original.	**2. Geographic range** Change in geographic range up to 10% of original.	**2. Geographic range** Change in geographic range up to 25% of original.	**2. Geographic range** Change in geographic range up to 25% of original.
Genetic structure	**3. Genetic structure** No interactions leading to impact on genetic structure.	**3. Genetic structure** No detectable change in genetic structure. Unlikely to be detectable against background variability for this population.	**3. Genetic structure** Possible detectable change in genetic structure but minimal impact at population level. Any change in frequency of genotypes, effective	**3. Genetic structure** Moderate change in genetic structure. Change in frequency of genotypes, effective population size or number of spawning units up to	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units up to 25%.	**3. Genetic structure** Change in frequency of genotypes, effective population size or number of spawning units up to 25%.

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
			population size or number of spawning units up to 5%.	10%.		
Age/size/sex structure	**4. Age/size/sex structure** No interactions leading to change in age/size/sex structure.	**4. Age/size/sex structure** No detectable change in age/size/sex structure. Unlikely to be detectable against background variability for this population.	**4. Age/size/sex structure** Possible detectable change in age/size/sex structure but minimal impact on population dynamics.	**4. Age/size/sex structure** Detectable change in age/size/sex structure. Impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely damaged.	**4. Age/size/sex structure** Severe change in age/size/sex structure. Impact adversely affecting population dynamics. Time to recover to original structure up to 5 generations free from impact	**4. Age/size/sex structure** Impact adversely affecting population dynamics. Time to recover to original structure > 10 generations free from impact
Reproductive capacity	**5. Reproductive capacity** No interactions resulting in change to reproductive capacity.	**5. Reproductive capacity** No detectable change in reproductive capacity. Unlikely to be detectable against background variability for this population.	**5. Reproductive capacity** Possible detectable change in reproductive capacity but minimal impact on population dynamics.	**5. Reproductive capacity** Detectable change in reproductive capacity, impact on population dynamics at maximum sustainable level, long-term recruitment dynamics not adversely damaged.	**5. Reproductive capacity** Change in reproductive capacity, impact adversely affecting recruitment dynamics. Time to recover to original structure up to 5 generations free from impact	**5. Reproductive capacity** Change in reproductive capacity, impact adversely affecting recruitment dynamics. Time to recover to original structure > 10 generations free from impact
Behaviour/movement	**6. Behaviour/ movement** No interactions resulting in change to behaviour/ movement.	**6. Behaviour/ movement** No detectable change in behaviour/ movement. Time to return to original	**6. Behaviour/ movement** Possible detectable change in behaviour/ movement but minimal impact on	**6. Behaviour/ movement** Detectable change in behaviour/ movement with the potential for some impact on	**6. Behaviour/ movement** Change in behaviour/ movement, impact adversely affecting population dynamics.	**6. Behaviour/ movement** Change in behaviour/ movement. Impact adversely affecting population dynamics.

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
		behaviour/ movement on the scale of hours.	population dynamics. Time to return to original behaviour/ movement on the scale of days to weeks	population dynamics. Time to return to original behaviour/ movement on the scale of weeks to months	Time to return to original behaviour/ movement on the scale of months to years.	Time to return to original behaviour/ movement on the scale of years to decades.
Interaction with fishery	**7. Interactions with fishery** No interactions with fishery.	**7. Interactions with fishery** Few interactions and involving up to 5% of population.	**7. Interactions with fishery** Moderate level of interactions with fishery involving up to10 % of population.	**7. Interactions with fishery** Major interactions with fishery, interactions and involving up to 25% of population.	**7. Interactions with fishery** Frequent interactions involving ~ 50% of population.	**7. Interactions with fishery** Frequent interactions involving the entire known population negatively affecting the viability of the population.

Table 5D. Habitats. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for habitats. Note that for sub-components Habitat types and Habitat structure and function, time to recover from impact scales differ from substrate, water and air. Rationale: structural elements operate on greater timeframes to return to pre-disturbance states.

(Modified from Fletcher *et al.* 2002)

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
Substrate quality	**1. Substrate quality** Reduction in the productivity (similar to the intrinsic rate of increase for species) on the substrate from the activity is unlikely to be detectable. Time taken to recover to pre-disturbed state on the scale of hours.	**1. Substrate quality** Detectable impact on substrate quality. At small spatial scale time taken to recover to pre-disturbed state on the scale of days to weeks, at larger spatial scales recovery time of hours to days.	**1. Substrate quality** More widespread effects on the dynamics of substrate quality but the state are still considered acceptable given the percent area affected, the types of impact occurring and the recovery capacity of the substrate. For impacts on non-fragile substrates this may be for up to 50% of habitat affected, but for more fragile habitats, e.g. reef substrate, to stay in this category the % area affected needs to be smaller up to 25%.	**1. Substrate quality** The level of reduction of internal dynamics of habitats may be larger than is sensible to ensure that the habitat will not be able to recover adequately, or it will cause strong downstream effects from loss of function. Time to recover from local impact on the scale of months to years, at larger spatial scales recovery time of weeks to months.	**1. Substrate quality** Severe impact on substrate quality with 50 - 90% of the habitat affected or removed by the activity which may seriously endanger its long-term survival and result in changes to ecosystem function. Recovery period measured in years to decades.	**1. Substrate quality** The dynamics of the entire habitat is in danger of being changed in a major way, or > 90% of habitat destroyed.
Water quality	**2. Water quality** No direct impact on water quality. Impact unlikely to be detectable. Time taken to recover to	**2. Water quality** Detectable impact on water quality. Time to recover from local impact on the scale of days to weeks, at	**2. Water quality** Moderate impact on water quality. Time to recover from local impact on the scale of weeks to months, at	**2. Water quality** Time to recover from local impact on the scale of months to years, at larger spatial scales recovery time	**2. Water quality** Impact on water quality with 50 - 90% of the habitat affected or removed by the activity which may	**2. Water quality** The dynamics of the entire habitat is in danger of being changed in a major way, or > 90% of

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
	pre-disturbed state on the scale of hours.	larger spatial scales recovery time of hours to days.	larger spatial scales recovery time of days to weeks.	of weeks to months.	seriously endanger its long-term survival and result in changes to ecosystem function. Recovery period measured in years to decades.	habitat destroyed.
Air quality	**3. Air quality** No direct impact on air quality. Impact unlikely to be detectable. Time taken to recover to pre-disturbed state on the scale of hours.	**3. Air quality** Detectable impact on air quality. Time to recover from local impact on the scale of days to weeks, at larger spatial scales recovery time of hours to days.	**3. Air quality** Detectable impact on air quality. Time to recover from local impact on the scale of weeks to months, at larger spatial scales recovery time of days to weeks.	**3. Air quality** Time to recover from local impact on the scale of months to years, at larger spatial scales recovery time of weeks to months.	**3. Air quality** Impact on air quality with 50 - 90% of the habitat affected or removed by the activity .which may seriously endanger its long-term survival and result in changes to ecosystem function. Recovery period measured in years to decades.	**3. Air quality** The dynamics of the entire habitat is in danger of being changed in a major way, or > 90% of habitat destroyed.
Habitat types	**4. Habitat types** No direct impact on habitat types. Impact unlikely to be detectable. Time taken to recover to pre-disturbed state on the scale of hours to days.	**4. Habitat types** Detectable impact on distribution of habitat types. Time to recover from local impact on the scale of days to weeks, at larger spatial scales recovery time of days to months.	**4. Habitat types** Impact reduces distribution of habitat types. Time to recover from local impact on the scale of weeks to months, at larger spatial scales recovery time of months to < one year.	**4. Habitat types** The reduction of habitat type areal extent may threaten ability to recover adequately, or cause strong downstream effects in habitat distribution and extent. Time to recover from impact on the scale of > one year to < decadal	**4. Habitat types** Impact on relative abundance of habitat types resulting in severe changes to ecosystem function. Recovery period likely to be > decadal	**4. Habitat types** The dynamics of the entire habitat is in danger of being changed in a catastrophic way. The distribution of habitat types has been shifted away from original spatial pattern. If reversible, will require a long-term recovery period, on

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
				timeframes.		the scale of decades to centuries.
Habitat structure and function	**5. Habitat structure and function** No detectable change to the internal dynamics of habitat or populations of species making up the habitat. Time taken to recover to pre-disturbed state on the scale of hours to days.	**5. Habitat structure and function** Detectable impact on habitat structure and function. Time to recover from impact on the scale of days to months, regardless of spatial scale	**5. Habitat structure and function** Impact reduces habitat structure and function. For impacts on non-fragile habitat structure this may be for up to 50% of habitat affected, but for more fragile habitats, to stay in this category the % area affected needs to be smaller up to 20%. Time to recover from local impact on the scale of months to < one year, at larger spatial scales recovery time of months to < one year.	**5. Habitat structure and function** The level of reduction of internal dynamics of habitat may threaten ability to recover adequately, or it will cause strong downstream effects from loss of function. For impacts on non-fragile habitats this may be for up to 50% of habitat affected, but for more fragile habitats, to stay in this category the % area affected up to 25%. Time to recover from impact on the scale of > one year to < decadal timeframes.	**5. Habitat structure and function** Impact on habitat function resulting from severe changes to internal dynamics of habitats. Time to recover from impact likely to be > decadal.	**5. Habitat structure and function** The dynamics of the entire habitat is in danger of being changed in a catastrophic way which may not be reversible. Habitat losses occur. Some elements may remain but will require a long-term recovery period, on the scale of decades to centuries.

Table 5E. Communities. Description of consequences for each component and each sub-component. Use table as a guide for scoring the level of consequence for communities.

(Modified from Fletcher *et al*. 2002)

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
Species composition	**1. Species composition** Interactions may be occurring which affect the internal dynamics of communities leading to change in species composition not detectable against natural variation.	**1. Species composition** Impacted species do not play a keystone role – only minor changes in relative abundance of other constituents. Changes of species composition up to 5%.	**1. Species composition** Detectable changes to the community species composition without a major change in function (no loss of function). Changes to species composition up to 10%.	**1. Species composition** Major changes to the community species composition (~25%) (involving keystone species) with major change in function. Ecosystem function altered measurably and some function or components are locally missing/declining/increasin g outside of historical range and/or allowed/facilitated new species to appear. Recovery period measured in years.	**1. Species composition** Change to ecosystem structure and function. Ecosystem dynamics currently shifting as different species appear in fishery. Recovery period measured in years to decades.	**1. Species composition** Total collapse of ecosystem processes. Long-term recovery period required, on the scale of decades to centuries
Functional group composition	**2. Functional group composition** Interactions which affect the internal dynamics of communities leading to change in functional group composition not detectable against natural variation.	**2. Functional group composition** Minor changes in relative abundance of community constituents up to 5%.	**2. Functional group composition** Changes in relative abundance of community constituents, up to 10% chance of flipping to an alternate state/ trophic cascade.	**2. Functional group composition** Ecosystem function altered measurably and some functional groups are locally missing/declining/increasin g outside of historical range and/or allowed/facilitated new species to appear. Recovery period measured in months to years.	**2. Functional group composition** Ecosystem dynamics currently shifting, some functional groups are missing and new species/groups are now appearing in the fishery. Recovery period measured in years to decades.	**2. Functional group composition** Ecosystem function catastrophically altered with total collapse of ecosystem processes. Recovery period measured in decades to centuries.

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
Distribution of the community	**3. Distribution of the community** Interactions which affect the distribution of communities unlikely to be detectable against natural variation.	**3. Distribution of the community** Possible detectable change in geographic range of communities but minimal impact on community dynamics change in geographic range up to 5 % of original.	**3. Distribution of the community** Detectable change in geographic range of communities with some impact on community dynamics Change in geographic range up to 10 % of original.	**3. Distribution of the community** Geographic range of communities, ecosystem function altered measurably and some functional groups are locally missing/declining/increasin g outside of historical range. Change in geographic range for up to 25 % of the species. Recovery period measured in months to years.	**3. Distribution of the community** Change in geographic range of communities, ecosystem function altered and some functional groups are currently missing and new groups are present. Change in geographic range for up to 50 % of species including keystone species. Recovery period measured in years to decades.	**3. Distribution of the community** Change in geographic range of communities, ecosystem function collapsed. Change in geographic range for >90% of species including keystone species. Recovery period measured in decades to centuries.
Trophic/size structure	**4. Trophic/size structure** Interactions which affect the internal dynamics unlikely to be detectable against natural variation.	**4. Trophic/size structure** Change in mean trophic level, biomass/ number in each size class up to 5%.	**4. Trophic/size structure** Changes in mean trophic level, biomass/ number in each size class up to 10%.	**4. Trophic/size structure** Changes in mean trophic level. Ecosystem function altered measurably and some function or components are locally missing/declining/increasin g outside of historical range and/or allowed/facilitated new species to appear. Recovery period measured in years to decades.	**4. Trophic/size structure** Changes in mean trophic level. Ecosystem function severely altered and some function or components are missing and new groups present. Recovery period measured in years to decades.	**4. Trophic/size structure** Ecosystem function catastrophically altered as a result of changes in mean trophic level, total collapse of ecosystem processes. Recovery period measured in decades to centuries.

Sub-component	Score/level					
	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe	6 Intolerable
Bio-geochemical cycles	**5. Bio- and geochemical cycles** Interactions which affect bio- & geochemical cycling unlikely to be detectable against natural variation.	**5. Bio- and geochemical cycles** Only minor changes in relative abundance of other constituents leading to minimal changes to bio- & geochemical cycling up to 5%.	**5. Bio- and geochemical cycles** Changes in relative abundance of other constituents leading to minimal changes to bio- & geochemical cycling, up to 10%.	**5. Bio- and geochemical cycles** Changes in relative abundance of constituents leading to major changes to bio- & geochemical cycling, up to 25%.	**5. Bio- and geochemical cycles** Changes in relative abundance of constituents leading to Severe changes to bio- & geochemical cycling. Recovery period measured in years to decades.	**5. Bio- and geochemical cycles** Ecosystem function catastrophically altered as a result of community changes affecting bio- and geo- chemical cycles, total collapse of ecosystem processes. Recovery period measured in decades to centuries.