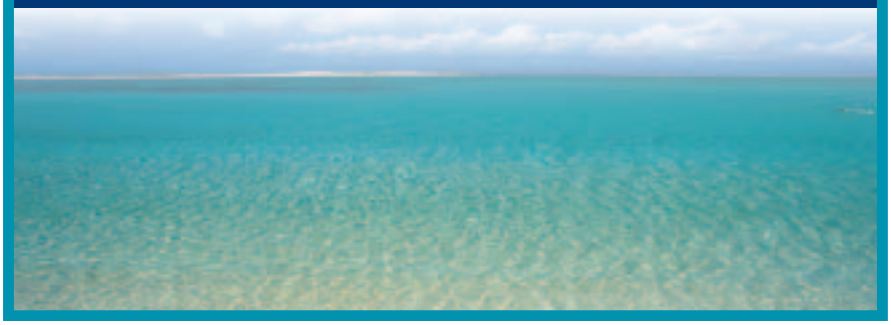
NATIONAL ESD REPORTING FRAMEWORK FOR AUSTRALIAN FISHERIES:

Technical Support Document Ecological components of the 2000/2001 Case Studies

November 2002



Ecologically Sustainable Development

Catching Sustainabilty

FISHERIES RESEARCH & DEVELOPMENT CORPORATION

Department of Fisheries

Fish for the future

Nov 2001

ISSN 0819-4327

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Version 1 November 2002

ABN: 1877098019

Correct Citation:

Whitworth, B., Chesson, J., Fletcher, W.J., Sainsbury, K.J., Fisher, M., Hundloe, T., and A.D.M. Smith 2002. *National ESD Reporting Framework for Australian Fisheries: Technical support Document – Ecological components of the 2000-01 Case Studies.* FRDC Project 2000/145, Canberra, Australia.

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This report forms Publication No. 2 of the FRDC - ESD Reporting and Assessment Subprogram.

The latest version of this report and other material related to the ESD Subprogram may be downloaded from the web site
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Table of Contents

EXECUTIVE SUMMARY

In June 2000, the Standing Committee on Fisheries and Aquaculture[1] (SCFA) developed a draft framework for reporting on ecologically sustainable development (ESD) in Australian fisheries. The draft framework identified eight major components of ESD:

Contributions of the fishery to ecological wellbeing through impacts on:
- Retained species
- Non-retained species
- General ecosystem

Contributions of the fishery to human wellbeing through impacts on:
- Indigenous wellbeing
- Local and regional wellbeing
- National social and economic wellbeing

Factors affecting the ability of the fishery to contribute:
- Impact of the external environment on the fishery Governance

These eight components were subdivided further to create 'generic component trees' which can be modified to suit the needs of individual fisheries. The framework also specified a standard set of headings for reporting on each component. The framework is described fully in a 'How to Guide' (Fletcher et al. 2002).

The framework was tested and modified in a series of case studies covering a variety of fishery types and jurisdictions across Australia. The case studies consisted of a two-day workshop followed by different levels of activity after the workshop depending on the jurisdiction. This report documents the ecological components of eight wild capture fisheries (Table A) at the time the case studies took place.

Table A. The eight case studies.

Fishery
Queensland East Coast Trawl Fishery
Western Australian Aquarium Fishery
Western Australian Rock Lobster Fishery
Victorian Abalone
New South Wales Estuary General Fishery
Northern Territory Barramundi Recreational Fishery
Commonwealth Eastern Tuna and Billfish Fishery
South Australian Lakes and Coorong Fishery

This report does not reflect more recent developments in the case study fisheries, nor does it make any assessment of the adequacy of what was in place or proposed during the case studies. Separate documents are being prepared on social and governance components and on recommended practices drawing on the case study findings and other sources. Information on what worked well during the case study workshops has also been provided in an Appendix.

[1] Following a review of all Ministerial Councils, the SCFA is now largely covered by the Marine and Coastal Committee of the Natural Resources Management Standing Committee.

The main findings for the eight case study fisheries are as follows:

- General

  Operational objectives were often not stated explicitly although they may exist implicitly. This was the case even for the retained species components. Once operational objectives were articulated, identification of indicators tended to flow reasonably easily.

- Retained species: Primary species

  Almost all retained species were managed as individual species, rather than lumping together into species groups.

  Objectives for primary retained species tended to focus on minimising the risk of the stock collapsing. A couple of fisheries suggested targets that aimed for stock abundances above this level and one fishery suggested maintaining stock at a level that would minimise effects on the ecological community.

  The abundance of the primary retained species were being estimated using indicators that varied from catch to sophisticated simulation models that integrate a number of indices. These indicators tended to be used to gauge whether the stock was decreasing, or had passed below a minimum threshold (limit). One fishery looked at the amount of the species caught by the fishery and determined a maximum catch limit.

- Retained species: Byproduct species

  These species were sometimes put in the 'too hard' basket possibly due to uncertainty as to whether the dominant objective should be utilisation or conservation. Byproduct species were mainly managed through maximum catch limits (similar to a TAC) with management responses occurring if this precautionary catch limit was exceeded. These management responses were usually gear restrictions or possession limits. Later case study discussions saw the development of three sub components:

  - Major Byproduct - where the level of capture by the fishery being examined is significant. The species is assessed in the same way as a primary retained species.
  - Minor Byproduct - where the species is mostly taken in another fishery and that fishery will deal with the species explicitly and comprehensively.
  - Other - where no fishery takes a significant amount of this species and it will be dealt with as part of a group (not separately).

  These sub components helped to focus management effort.

- Non-retained species

  Non-retained species were usually divided into species that were caught and species that were affected by fishing but not caught, as well as into threatened and non-threatened (general) species. The non-threatened species were most often dealt with as a group (for example, 'small fish').

  Objectives for non-retained species were mainly based upon a desire to reduce, minimise, or avoid capture. This did not differ substantially between threatened or non threatened species.

  Indicators tended to be based upon total catch, the amount of discards, or the

number of interactions with the fishery (for threatened species), rather than CPUE or the abundance of the species. Process indicators, such as the level of uptake of bycatch reduction devices or codes of practice were also used.

Management responses mainly involved gear modifications. Area closures, further research and education of fishers were also suggested.

- General ecosystem: Effects from removing fish

  The effect on the ecosystem of removing fish was discussed in detail in most of the case studies. Numerous indicators were suggested at the workshops, but without specified objectives or management responses it is difficult to see how performance will be tested at present. This is an area for further development.

- General ecosystem: Benthic biota

  Impacts on the benthic biota were relevant in most of the case study fisheries and were of particular importance for the trawl-based fisheries. Possible indicators and performance limits included the quantity of benthic habitat removed, the percentage of the area trawled or affected and the total fishing effort.

- General ecosystem: Additional components

  Other effects on the ecosystem were separated into effects on the biological ecosystem and effects on the physical ecosystem and these were further sub divided. For example, physical effects from fishing were separated into effects on water quality, air quality and substrate quality.

The case studies provided a wealth of experience and information that shaped the National ESD Reporting Framework and demonstrated that it could be applied effectively to a wide range of circumstances. The companion "How to Guide" (Fletcher et al, 2002) provides assistance with developing an ESD report for a fishery.

1.0 INTRODUCTION

1.1 Background

Ecologically sustainable development (ESD) is '*using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased'* (National Strategy on Ecologically Sustainable Development, 1992). All Australian States and Territories signed on to this strategy and most states have incorporated ESD into their fisheries legislation. However, although government agencies had agreed to the ESD Strategy, fisheries agencies were often unclear on how to implement ESD in fisheries management.

To assist with the implementation of ESD into fisheries management, the then Standing Committee on Fisheries and Aquaculture (SCFA), composed of the directors of all fisheries management agencies along with a reference group of stakeholders including industry, non-government organisations, Environment Australia and other relevant stakeholders, developed a draft ESD reporting framework. This National ESD Reporting Framework for Australian Fisheries developed in June 2000 identified a set of 8 major components of ESD:

Contributions of the fishery to ecological wellbeing through impacts on:
- Retained species

Non-retained species
- General ecosystem

Contributions of the fishery to human wellbeing through impacts on:
- Indigenous wellbeing

Local and regional wellbeing
- National social and economic wellbeing

Factors affecting the ability of the fishery to contribute:
- Impact of the external environment on the fishery Governance

Each of these 8 major components of ESD is further subdivided into more specific sub components to form a series of 'generic component trees'. Each generic component tree is tailored to the needs of a particular fishery, by expanding some components and amalgamating others. Figure 1 provides an example of the generic component tree for impacts on the general ecosystem:

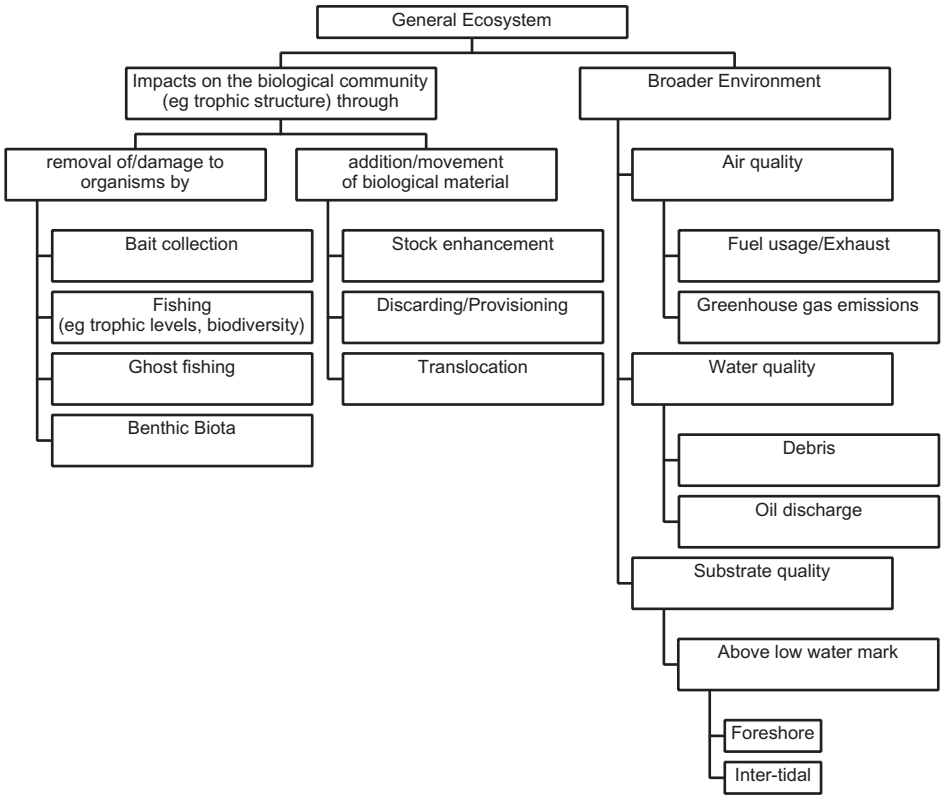


Figure 1. Generic component tree for a fishery's impacts on the general ecosystem.

For each of the lowest level sub-components, such as for benthic biota in Figure 1, a performance report is written that includes the operational objective for that component, the indicator and performance measure to determine whether the fishery is achieving their objective, the data to be used and an evaluation of the data if available, as well as a management response, ie:

Performance Report

Component
Objective
Indicator
Performance measure
Data
Evaluation
Management response

The development of this National ESD Reporting Framework was funded by the FRDC (Fisheries Research and Development Corporation) with direct and indirect assistance of the various State and Commonwealth fishery agencies. One of the outputs of this project is a 'How to Guide' (Fletcher et al., 2002)[2] which gives step-by-step instructions to help a fishery report on ESD. This technical support document forms the other major output of the project and provides a summary of the information generated during the case studies which covered most jurisdictions and types of fisheries.

[2] This is available from the website www.fisheries-esd.com.

1.2 Scope of this report

Australian fisheries are highly variable in the species they catch, methods of fishing and jurisdictional requirements. It was the intention of the SCFA that the National ESD Reporting Framework for Australian Fisheries be applied to all Australian fisheries. In order to test whether this was possible the framework was applied to nine case studies, one aquaculture and eight wild capture fisheries (Table B). These case studies were selected from across Australia to capture the diversity of issues facing Australian fisheries.

Table B. Fishery and aquaculture case study workshops.

Fishery	Date
Queensland East Coast Trawl Fishery	July 2000
Western Australian Aquarium Fishery	July 2000
Western Australian Rock Lobster Fishery	July 2000
Victorian Abalone	August 2000
New South Wales Estuary General Fishery	August 2000
Northern Territory Barramundi Recreational Fishery	September 2000
Queensland Prawn Aquaculture Industry	September 2000
Commonwealth Eastern Tuna and Billfish Fishery	October 2000
South Australian Lakes and Coorong Fishery	June 2001

Ecological information from the eight wild capture fishery case studies has been documented in this 'Technical Support Document'. Social and governance issues were not as well developed and documented during the case study meetings and these will be investigated as part of the next phase of the project and described in other reports. Economic components are already well defined within economic circles in terms of net profit and therefore this component is not dealt with here.

Information provided for each major ecological component has been documented in tables. For example, Table 1a provides performance report details on the primary retained species for each of the case study fisheries. Comparisons between fisheries has been made in the summary provided before each table. Information provided in the tables was based upon current practices in the fishery as well as potential or possible practices, and in some cases merely suggestions presented at the time of the workshops. This report does not assess the adequacy of what was in place or proposed during the case studies and it does not reflect more recent developments in the case study fisheries. Having said that, the WA Rock Lobster Fishery, the NT Barramundi Recreational Fishery and the Victorian Abalone Fishery information in this report was based upon updated material – but even these may not represent final versions. Consequently, the material presented in this technical summary should not be seen as being the current policy for any of the fisheries or relevant jurisdictions.

Additional components for the general ecosystem were separated into effects on the biological ecosystem and effects on the physical ecosystem and these were further sub

divided. For example, physical effects from fishing were separated into effects on water quality, air quality and substrate quality. This report discusses how the general ecosystem components were sub divided in the case study fisheries.

Appendix 1 summarises key messages that came from running the ESD workshops themselves. This should assist fishery managers who are setting up and running ESD workshops for their fisheries.

A short description of each case study fishery is provided in Appendix 2. This provides background information on the species caught, area of the fishery, fishing methods and gear, and management methods.

The companion "How to Guide" (Fletcher et al, 2002) was produced to assist fisheries agencies complete their own ESD reports for their fisheries.

2.0 ECOLOGICAL COMPONENTS OF THE CASE STUDY FISHERIES

2.1 Retained species

The generic component tree developed for 'Retained species' is displayed below. Performance report details for each fishery are given in Table 1a and 1b.

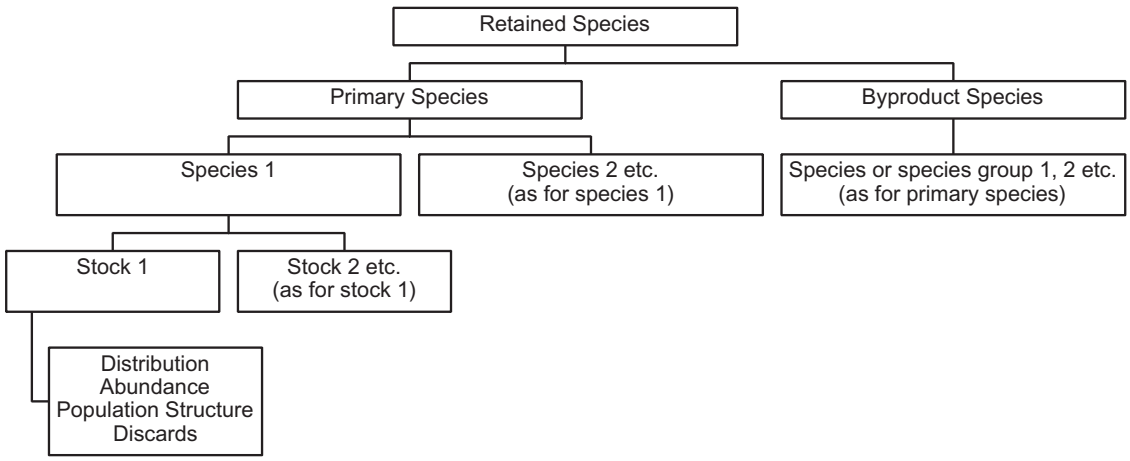


Figure 2. Generic component tree for a fishery's impacts on retained species

2.1.1 Retained species: Primary species

Most, but not all, case study fisheries sub divided their retained species into primary species and byproduct species, as in Figure 2 above. In some cases there were concerns that classifying species as by-product species might result in restricted access to these species in the future. In other cases it was not helpful to classify a species as primary or byproduct because a species may be primary in one sub fishery and byproduct in another sub fishery. Fisheries should choose the classification that is most convenient for them. The choice does not affect subsequent reporting.

Components

For some fisheries such as NT Barramundi Recreational Fishery, WA Rock Lobster Fishery and Victorian Abalone Fishery there was only one primary species, whereas for Qld East Coast Trawl Fishery, NSW Estuary General Fishery and SA Lakes and Coorong there were many primary species. Almost all primary species were dealt with as separate species in the case studies, although Qld East Coast Trawl Fishery and NSW Estuary General Fishery grouped some primary species into species groups, due to the large number of species.

A number of fisheries divided their primary species components further, to take into account different genetic or demographic stocks, for example WA Rock Lobster Fishery had a separate assessment for Abrolhos islands. Most of the fisheries also looked at population structure, such as age, size and sex of the populations of these

species, and some fisheries looked at the distribution of fish over their range, but these features were usually part of the population model for the species rather than being addressed separately.

Objectives

All the case study fisheries had high level objectives for the primary species that came from the relevant fisheries legislation (Table 1a). Operational objectives, that could be directly measured and assessed against, were however, often not stated explicitly – but they were usually present implicitly. An objective that was commonly stated or suggested across a number of fisheries was to avoid recruitment overfishing (suggested for tiger prawns in Qld East Coast Trawl Fishery, yellowfin bream in NSW Estuary General Fishery, broadbill swordfish in Eastern Tuna and Billfish Fishery and NT Barramundi Recreational Fishery). If we assume that fisheries are using 'recruitment overfishing' to mean fishing that causes a reduction in the spawning biomass of a stock to a level where subsequent recruitment levels are adversely affected, then this objective is consistent with objectives of 'sustaining' or 'conserving' the species. The WA Rock Lobster Fishery translated this objective into a more operational objective, specifying that egg production should remain above a specified limit, namely the 1980 level.

At some workshops the participants generated additional objectives other than to merely avoid overfishing. For example, in addition to objectives for avoiding overfishing, the NSW Estuary General Fishery workshop suggested a number of draft objectives such as - to not increase mortality rates (for yellowfin bream), to achieve, but not exceed MSY (for yellowfin bream) to prevent localised depletions (for mud crabs and eels), and to maximise economic yield per recruit (for eels). The Victorian Abalone fishery aimed to sustain productive capacity of the stocks. The NT Barramundi Recreational Fishery specified a minimum limit below which the stock should not fall, as well as a target for stock abundance.

An objective suggested in the Eastern Tuna and Billfish Fishery for broadbill swordfish, was to maintain population levels within a range that would maintain ecological function. This goes beyond looking at the species as a single entity and incorporates its place within the ecosystem.

The WA Aquarium Fishery, argued that at current catch levels (which was only measured in the thousands of individuals along the entire WA coast) that it is unlikely to have a significant impact on any of its primary retained species. Hence they proposed an objective to maintain the catch below a specified level for each species.

Indicator

Most fisheries used some sort of indicator of abundance to monitor their retained species objectives, but the form of the indicator varied considerably (Table 1a). Some fisheries had estimates of absolute abundance, biomass or egg production. For example the WA Rock Lobster Fishery has developed indices of rock lobster abundance based upon CPUE, catch, spatial information, independent scientific surveys, reproductive status, recruitment and others. Biomass estimates were also suggested for yellowfin bream in NSW Estuary General Fishery.

Estimates of relative abundance were also variable, with the Victorian Abalone Fishery using a complex relative biomass model for blacklip abalone which based estimates on

catch and CPUE, spatial information, size data, mortality estimates, estimated from fishery dependent and independent sampling surveys. The Qld East Coast Trawl Fishery were proposing to use CPUE for each of their major prawn species based upon historical logbook data.

Total catch, using the number of individuals of all species collected, was suggested for the WA Aquarium Fishery, as well as having individual limits for each of the main species such as syngnathids. Similarly, the total collections measured in weight was suggested for coral, living sand and living rocks in the same fishery.

Total catch for the entire fishery and total catch landed per estuary were indicators suggested for mudcrabs in the NSW Estuary General Fishery. This fishery also suggested catch landings by catchment could be recorded for eels as well as recruitment levels to the fishery by looking at relative abundance of glass eels. They also intended to examine the age structures and CPUE in the future for this species.

The Commonwealth Eastern Tuna and Billfish Fishery will probably look mainly at catch trends for broadbill swordfish, with the potential to look at catch at size/age, catch rates, size distribution, maximum size (or percentile), catch and effort, and estimates of spawning biomass or exploitation rates in the future.

Additional indicators for yellowfin bream in the NSW Estuary General Fishery, not commonly mentioned above, included mortality rates and MSY (maximum sustainable yield) as indicators in their own right.

Performance measure

Most of the case study fisheries used minimum limit reference points (Table 1a). For some fisheries this was based upon biomass estimates, below which fish stocks should not fall. For example, the WA Rock Lobster Fishery uses 22% of unfished egg production, whereas the Victorian Abalone Fishery must maintain at least 90% of 1992 biomass or egg levels with 30% risk. The NT Barramundi Recreational Fishery must maintain 50% of B_o as the minimum limit and 70% of B_o as the target. Other fisheries using CPUE tended to have minimum limits of, as a possible example, 70% of 1988-97 CPUE levels for tiger prawns in the Qld East Coast Trawl Fishery.

Another possible performance measure suggested in the case studies was a maximum catch limit, as could be used for broadbill swordfish in the Eastern Tuna and Billfish Fishery. The WA Aquarium Fishery suggested a maximum total catch limit of 100,000 individuals, and maximum limits of 9, 13, and 13 tonnes of coral, living rock and living sand respectively. For individual fish species in the WA Aquarium Fishery the suggested level of catch was not to exceed the long-term average catch by 50% for three (3) consecutive reporting periods.

The NSW Estuary General Fishery proposed a variety of reference points, depending on species. For yellowfin bream the suggested recruitment overfishing limit was 30% of original spawning biomass, to not increase mortality rates above 0.5 and, for the MSY objective, the catch should not change by 20% from the average catch estimated from the last 5 years. For mud crabs they proposed a minimum limit of not less than 70% of the average catch estimated from the last 5 years, and in addition for each estuary to not have a declining catch trend for 3 years in a row. For eels, reference points of, recruitment declining by 40% each year for 2 consecutive years, for each

catchment the catch was not to decline by 30% over a rolling 5 year period, and to maximise economic returns for the fishery.

Data

The types and quantities of data available for analysis were variable (Table 1a). Some fisheries using catch and effort, often modelled using spatial, size and age, reproduction, independent marine surveys, and information from other fisheries, as occurs for the primary species in the Victorian Abalone Fishery, WA Rock Lobster Fishery, NT Barramundi Recreational Fishery and for yellowfin bream in the NSW Estuary General Fishery. Other fisheries only had catch recorded in logbooks as in the WA Aquarium Fishery. For eels and mud crabs in the NSW Estuary General Fishery catch data by estuary is recorded and cross checked with market information, including market value, and for eels relative abundance of glass eels is also recorded.

Management response

There was a large variety of current and potential management responses used by fisheries management agencies to achieve the operational objectives. These are summarised in Table 1b. In general, management responses could be grouped into input controls and output controls. Input controls included measures such as limits on the number of boats, licenses and gear specifications, minimum and maximum fish size limits, limits on reproductive stages that can be retained along with season and area closures.

Suggested output controls included measures such as total allowable catches (TAC), allocation to different sectors, and buy backs of catch. Other forms of management response which do not neatly fit into the above two categories are education and research and these were also quite common.

What if the limit for the performance measure is triggered? For most of the case study fisheries, if the limit was exceeded this would generally trigger a review in the first instance. If the review found that the effects were significant for the species and actually caused by the fishery or the fishery could exacerbate the situation then common management responses proposed included effort reductions, area closures, restrictions on landing certain fish sizes or reproductive individuals.

2.1.2 Retained species: Byproduct species

Most fisheries identified some of the retained species as Byproduct, as in Figure 2. The exceptions included hand collecting fisheries such as WA Aquarium Fishery which only collect the species they specifically target. As mentioned under retained species the term ‘byproduct’ was not used by all fisheries.

Components

For some fisheries, the byproduct species were grouped together and dealt with as one group, for example in the NT Barramundi Recreational Fishery and NSW Estuary General Fishery. In other case studies, species were examined separately so that they could be managed more easily, or in case they became primary species at some stage in the future, or because they are primary species in another fishery and the management arrangements need to be coordinated. It was also recognised that where a

fishery catches a small proportion of the total catch the stock assessment will usually be carried out by the major fishery, but taking into account catches from all fisheries.

Objectives

Most operational objectives for byproduct species were based upon the ideas of 'not increasing capture above historical levels', for example in WA Rock Lobster Fishery, NT Barramundi Recreational Fishery, and this was also a possible objective in the QLD East Coast Trawl Fishery for syngnathids and blue swimmer crabs (Table 1a). It was not clear whether this type of objective was motivated by a desire to protect the species or to minimise conflict amongst competing sectors.

For the Victorian Abalone Fishery, the suggested objective for Green lip Abalone was to rebuild stocks. The Qld East Coast Trawl Fishery also identified other possible operational objectives, for example reducing catches of syngnathids and ceasing catches of blue swimmer crabs altogether.

For byproduct species there are opposing objectives for utilisation and for conservation. In some case study fisheries production objectives appeared to be confused with conservation goals. For example, an objective of 'not increasing catches' can be satisfied when a stock is declining. For these reasons byproduct presents a dilemma for fishery managers. Objectives for byproduct species need further development and thought.

Indicators

There was wide variation in indicators used for byproduct species depending mainly upon the information available (Table 1a). Catch and CPUE were suggested in a number of case study workshops to estimate relative abundance of these species or relative level of exploitation, rather than estimating absolute abundance. These relative levels were mainly determined by comparing catches and catch rates to historical levels and for NT Barramundi Recreational Fishery and Qld East Coast Trawl Fishery this was being done across fisheries for the species as a whole. The Victorian Abalone Fishery was, by contrast, proposing to estimate the abundance of greenlip abalone populations from CPUE and fishery independent diving surveys (done concurrently with the main black lip species).

Performance measures

The most common performance measures were based upon catch and catch rates and were either trends or trigger points (Table 1a). These tended to be precautionary measures based upon limited evidence, for example:

– Management responses will be implemented if an increasing catch trend is detected, as suggested, for example in the NT Barramundi Recreational Fishery and an increasing trend for three years in the Qld East Coast Trawl Fishery for blue swimmers, or

– Management responses will be implemented if a catch or CPUE trigger point is exceeded, such as CPUE decreasing 25% below historical levels for octopus in the WA Rock Lobster Fishery and catches not to exceed current levels for syngnathids in the Qld East Coast Trawl Fishery. Once these triggers are exceeded then extra management responses will be implemented, such as reviewing stock status, or implementing mitigation devices.

On the other hand, the Victorian Abalone Fishery had a target of increasing stocks to at least 300% of present levels.

Data

Information was variable, from almost non existent to a combination of fishery dependent and independent surveys (Table 1a). A number of sources of data were suggested, for example:

- Fishing records - logbooks, recreational competitions
- Landing and Export records,
- Observer studies,
- Records from other fisheries,
- Scientific research surveys,
- Independent marine studies

Fishing records were the most common data, however this was often backed up with extra information, for example WA Rock Lobster Fishery and NT Barramundi Recreational Fishery were using observer studies, with the former being yearly and the latter intermittent. NT Barramundi Recreational Fishery and Qld East Coast Trawl Fishery were also using other fisheries information, from other commercial and recreational fisheries. The Victorian Abalone Fishery were assessing population status through CPUE in logbooks and independent marine surveys. Scientific research surveys were being considered by the NSW Estuary General Fishery while this was being carried out in the QLD East Coast Trawl Fishery (FRDC funded survey).

Management responses

Most fisheries had management controls already in place for byproduct including gear modification to reduce catches, possession limits and size restrictions (Table 1b). Gear modifications in the WA Rock Lobster Fishery for octopus included escape gaps and reduced pot effort. Possession limits were a form of management response in the NT Barramundi Recreational Fishery and for blue swimmer crabs in the Qld East Coast Trawl Fishery. Size/sex restrictions were additional management responses for landing blue swimmer crabs in Qld ECTF, greenlip abalone in Victorian Abalone Fishery, and for NT Barramundi Recreational byproduct species. Specific closed areas were not common management measures for byproduct species although seasonal closures were important in Victorian Abalone Fishery. Potential future management responses included collecting more information, such as for syngnathids and blue swimmer crabs in Qld East Coast Trawl Fishery and for octopus in the WA Rock Lobster Fishery.

What if the performance limit was triggered?

The management responses that would be implemented if a byproduct species was declining, were less clear with WA Rock Lobster Fishery suggesting total catch limits placed on octopus, including more size restrictions in NT Barramundi Recreational Fishery, and extra compliance effort against illegal fishing in Victorian Abalone Fishery. The Victorian Abalone Fishery had an interesting possible management response of rewriting the management plan so each abalone species could be dealt with separately and a zero TAC could then be set for byproduct greenlip abalone.

Since the draft objectives were often not clearly articulated, it is not surprising that the relationship with the potential indicator was not always obvious.

Table 1a. Retained Species: Performance Reports

(Note –The information presented in this table includes suggestions made at the case study workshops and may not reflect the current management arrangements of these fisheries).

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
	Primary species				
NT Barramundi recreational	Retained: Primary species: Barramundi	(Leg) Conserve the species (Pos) Rebuild population abundance above X level (target), not fall below X level (limit) (Pos) Population at level that prevents recruitment overfishing	Relative abundance estimated from model based on catch, CPUE and separate stocks Additional indicators -Catch trends -Fish size	Target - Rebuild greater than 70% B_O, Limit - not below 50% B_O	Data requirements for indicator -A time series of catch and effort data, preferably for each sector -An estimate of total fish population size. Data availability (current – future) -Commercial data - since the 70s. -Daly River tournament records – catch rate (correlated with river flow). -Recreational surveys 1995 & 2000/01. -Indigenous survey 2000/01 -Spot surveys of recreational fishing 1994/95 and 2000/01. -Annual Barracade in Corroboree Billabong, and some years for Yellow Waters -Fishing tour operator logbook returns -"Barra Watch" returns (new).
Victorian Abalone	Retained: Primary species: Blacklip abalone	High level objective to promote a sustainable commercial fishery Productive capacity of stocks sustained into the future at low levels of risk.	Relative biomass (Model Output = $B_{current}$ / B_{1992})	Mature biomass (or egg numbers) at 90% of value estimated for 1992 with 30% risk (lower limit).	Data requirements for indicator -A fishery assessment model has been developed that incorporates reported catch, catch rates (optional) and independently estimated abundance. The model needs to account for all mortality including landed (illegal, legal and recreational), discarding, high grading, and mortality during discarding. The model is highly dependent on spatially variable growth, natural mortality and recruitment parameters. The model can accommodate density dependence.

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
					Data availability (current – future) Past -Catch and effort data, since 1969 (spatial and temporal resolution is improving) -Limited commercial catch-sampling data and estimates of growth and natural mortality. Present -Catch data at the reef complex scale -Commercial catch-sampling program -Relative abundance and length-frequency from fishery independent dive surveys for ten-year time series. -On-board observation provides high-resolution, location-specific, catch rates (weight and numbers), dive profiles of divers. -Both the independent surveys and on-board observations collect semi-quantification ecosystem data. Future -Improved recreational catch data should be available once the National Rec survey is finalised -Estimate quantities and source locations of illegally harvested abalone in progress. -Tagging studies for growth and natural mortality in progress. - Improvements in fishery-dependent data from the commercial sector through -sample divers' catches on landing on-board electronic recording for -length-frequency -numbers of individuals in the catch -time of each measurement -potential to acquire GPS co-ordinates for each measurement.

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
WA Rock Lobster	Retained: Primary species: Rock Lobster	Maintaining the spawning stock of western rock lobster at, or above, a level that minimises the risk of recruitment overfishing.	Estimates (indices) of the level of breeding stock and associated egg production by: ·Monitoring of abundance and size frequency of breeding females in commercial catch (monitoring spawning index) ·Fishery independent, survey of breeding grounds prior to rock lobster season (independent breeding stock survey index")	For acceptable performance, estimate of current level of egg production should be above the agreed limit reference point. (estimated 1970s level- 22% of the unfished level)	Data requirements and availability -Independent survey of breeding stock (indice)- available since 1991. -Relative number and sizes of breeding (berried, setose and spawning size) lobsters collected by fishers and observers- available since 1970. -Computer modelling and simulations based on catch data, puerulus settlement and breeding stock estimates- undertaken annually but extent of analysis may vary.
WA Rock Lobster	Retained: Primary species: Rock lobster: Rock Lobster Abrolhos		Abrolhos Islands closed during the spawning season. The total catch in this region can be used as an indicator of spawning biomass. .		
WA Aquarium	Retained: Fish: Total no.s	(l) To maintain the total catch at a level where the best estimate is it does not impact on the stocks significantly on the large number of targeted species.	Reported total commercial catch through the CAESS	Trigger point of 100,000 recorded specimens	-Catch records- Monthly Fisher Returns - 1995 onwards
WA Aquarium	Retained: Fish: Individual fish	(l) To maintain the total catch of any one species at a level that does not impact on a stock significantly	Reported total number of individual species taken through the CAESS	Catch not to exceed long term average catch of individual species by 50% for three (3) consecutive	-Catch records- Monthly Fisher Returns - 1995 onwards

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
				reporting periods	
WA Aquarium	Retained: Fish: Individual fish: Syngnathids	(l) To maintain the total catch of any one species at a level that does not impact on a stock significantly	Reported total number of individual species taken through the CAESS	Catch not to exceed long term average catch of individual species by 50% for three (3) consecutive reporting periods	-Catch records- Monthly Fisher Returns - 1995 onwards
WA Aquarium	Retained: Coral	(l) The amount of coral taken is not at a level that will have a significant impact on the natural habitat	Weight of coral removed per year	Total set at 9 tonnes	-Reporting system for landings of corals -Catch records- Monthly Fisher Returns - 1995 onwards
WA Aquarium	Retained: Living rock/sand	(l) To maintain the collection of living rock/sand at a level that will not have significant impacts on the natural habitat to effect the ecology of resident species	The weight of living rock and living sand removed each year	Total living rock removed- 13 tonnes Total Living sand removed- 13 tonnes	-Reporting system for landings of living rock and living sand -Catch records- Monthly Fisher Returns - 1995 onwards for living rock, -2000 for living sand
QLD ECTF	Retained: Primary species: Prawns: Tiger prawns	-Broad objective- To minimise the risk of having recruitment overfishing. -(p) No significant decline in abundance of tiger prawns relative to the period 1988-1997 (because there was no recruitment overfishing during this period.)	Nominal CPUE over the period 1 March – 30 June and 1 September –31 Dec.	Above the reference point of 70% of the 1988-1997 level is acceptable Below the reference point is not acceptable	Data requirements for indicator -Catch and effort information from logbooks Data availability (current – future) -1988- present
NSW Estuary General	Retained: Shellfish: Mud crabs	-Maintain the NSW stock at a level that can support a small commercial and recreational fishery -To prevent localised depletion	-Total commercial landings and/or catch per unit effort -Commercial landings and/or catch per unit effort by estuary	(Trigger points) Total catch less than 70% of a rolling 5 years average For each NSW estuary, catch declines for 3 years in a row	Data requirement and availability -Catch – total and by estuary- available with annual cross checks with market data and field observer programs
NSW Estuary General	Retained: Finfish: Yellowfin Bream	<u>Sustainability</u> -To maintain the spawning stock of yellowfin bream at	-Mortality rates (currently 0.4) -Age structure	(Trigger points) -Decline in spawning biomass to 30% of	Data requirement and availability -Catch- available with annual cross checks with market data and field observer programs

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
		or above an appropriate level that minimises the risk of recruitment overfishing. -To not increase total fishing mortality rate Yield -To achieve MSY {and MEY (not exceeding MSY)}.	-Estimates of biomass from modelling -The indicator of MSY is catch yield per recruit	unfished state -Increasing mortality rates Z > 0.5 For MSY – if catch changes by 20% from a rolling 5 year average	-Validated subset of CPUE- yet to be done -Growth rate- FRDC study and literature -Natural mortality- estimates from literature -Age structure of commercial landings- available since 1995 -Reproductive biology: Fecundity, Size/age at first maturity, Spawning period- known from literature -Catch by all sectors- commercial available, sporadic recreational information for some estuaries, indigenous catch is currently part of either commercial or recreational sectors.
NSW Estuary General	Retained: Finfish: Eels	-To ensure that the escapement level of eels (glass eels and sub-adults) to reach spawning age is sufficient to maintain current levels of recruitment -To avoid local (catchment based) depletion -To maximise economic yield per recruit	-Setting up program to monitor eel recruitment (by relative abundance of glass eels) -Commercial fishery landings (by catchment) -Future - Age structure, CPUE -Relative market value of each general size grading of eels	(Trigger points) Limits -Recruitment of glass eels declines by 40% each year over 2 consecutive years -Commercial catch trend in any one catchment changes by 30% over a rolling 5 year period Target -Maximise economic return from the fishery, (size gradings)	Data requirements and availability -Commercial catch data – total and by estuary- available monthly with cross checks with market data and field observer programs. -Relative abundance of glass eels- current research program and ongoing surveys -Market value by size grading- Glass eel data from permit holders, small eel data currently unavailable, large eel data available from SFM records.
ET&B	Retained: Primary species: Broadbill swordfish	There is no current explicit objective Possibilities ·Keep the stock of swordfish within accepted/acceptable/ meaningful ecological limits to allow long term yields ·Maintain the level of spawning biomass of swordfish above the	Possibilities (spatial element) Now Catch at size/age Catch rates Size Distribution Maximum Size (or percentile) Catch Effort	Possible accepted limits could be – Can Do Now The commercial catch should not exceed ??t. Ultimately Fishing mortality/exploitation rate does not exceed	Data requirements for indicator Now -Catch by all Stakeholders Future – eg building a model -Size Data -Catch Rates (in context –develop reasons and performance measures) -Stock Assessment -Discards

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
		minimum acceptable levels (limit type) ·Keep the exploitable biomass near as possible to ?? (target). ·Keep the catch levels at ??? (because we think it is OK at the moment) ·Avoid overfishing.	Future Estimate of spawning biomass Exploitation rates	??? Spawning biomass is not less than ?? of unfished levels	-Quality assured catch rates Data availability (current – future) -Catch -Some size data -Catch rates (spatially collected)
SA L&C	Retained: Native: Cockles	Operational Objective (l) -Non-specified (p) -Maintain the stock at a level that would allow the current catch levels in the longer term -Minimise the chance of recruitment overfishing of this stock -The distribution of cockles is ??? -The fishery operates in ??% of this range.	Short Term -Commercial catch Medium Term -Commercial catch rate?? Longer term -Fishery independent /fisher assisted survey of catch rate within and outside fishing area to estimate relative abundance.	Example -Catch < 800 tonnes and > 500 tonnes (Commercial & rec??)	Data required & availability -Commercial catch- since 1950 -Catch and effort data- for medium term
	Byproduct species				
NT Barramundi recreational	Retained: Byproduct: Other Species: Incidental, by product and unwanted captures	(L) Conserve the species (P) Not to increase the levels of incidental capture	Catch, CPUE	Not increasing	Data requirements for indicator -Recreational and Indigenous surveys. -'Barrawatch' collects a set of recreational data. -Fishing tournament data can be useful. -Commercial log book monitoring. Data availability (current – future) -Rec and Indigenous survey, for 95 and 2000 -Fishing tournament data -Fisheries Action Program trial time series -CPUE data for recreational Barramundi fishing.

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
					-Commercial data returns and CPUE.
Victorian Abalone	Retained: Byproduct: Greenlip abalone	Recover the spawning stock to a level that will support a commercial fishery.	Estimates of abundance.	Substantial increase (say ~300%) in abundance to eventually make it worthwhile for a commercial fishery.	Data requirements for indicator -Repeat surveys and estimate habitat area as well as the density of abalone. Data availability (current – future) Past -Fishery independent surveys- 1in Central Zone, 2 in Western Zone. -Reported commercial catch and effort Current -No current independent surveys. -Reporting of commercial catch and effort. Future -No future surveys planned. Need additional resources to complete follow-up surveys.
WA Rock Lobster	Retained: Byproduct: Octopus	(l) Minimise the risk of overfishing by limiting catches of the WRL fishery to historical, sustainable levels.	Catch rate for octopus by lobster fishing- independent observers.	A decline in the calculated rate per pot lift more than 25% outside the range of recorded variation.	Data requirements and availability Annual weight of octopus per pot and trap lift- observer data available.
QLD ECTF	Retained: Byproduct: Finfish: Bony fish: Syngnathids	(l) Broad objective- To ensure that all species are taken in an ecologically sustainable way – assessed within 2 years (p) No current operational objective: Possible 'Conflicting' objectives: ·Not to increase the level of catch of syngnathids ·Reduce the catch of syngnathids ·Allow current arrangements to occur.	Catch Rate (independent surveys in scallop grounds)	Level of catch not to exceed the current levels.	Data requirements for indicator -Logbook data Data availability (current – future) -Just beginning to collect -Export data available- limited value/precision

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
QLD ECTF	Retained: Byproduct: Crustaceans: Crabs: Blue Swimmers	(l) Broad objective- To ensure sustainability of the whole resource with respect to the capture by all methods, (p) Possible operational objectives- ·To not increase the trawl catch from historic levels	-Catch -Catch rate by pots for local fisheries/stocks -Trawl survey (fishery independent) for some regions	The share/catch by the ECTF does not increase each year for three years	Data requirements for indicator -Catch by each sector Data availability (current – future) -Logbook -Trawl Survey -Processor Returns -Recreational fishing database (every 2nd year by region)
SA L&C	Retained: Native: Others (major catch in marine scale fishery/ or river fishery)	Operational Objective (p) -To maintain catches at low levels relative to other fisheries.	-Catch (in L&C)	(p)- Twice the five-year average of the percentage of total catch taken by the Lakes and Coorong fishery.	Data required & availability -Catch (in L&C) available -Total Catch in all Commercial Fisheries available

Table 1b. Retained Species: Performance Reports – Possible Management Responses

(Note –The information presented in this table includes suggestions made at the case study workshops and may not reflect the current management arrangements of these fisheries).

Fishery	Component	Management responses
	Primary species	
NT Barramundi recreational	Retained: Primary species: Barramundi	What is the NT doing to keep within the appropriate stock size range? Now -Amateur possession limits -Closed seasons – commercial & minor recreational -Size limits -Tour Operator Licence applicant have to meet set criteria -Annual stock assessment -Limited commercial licences and gear restrictions -Encourage catch and release -Voluntary buybacks of commercial licences -Built-in protection from the remote (uneconomic) nature of the region – wet season, no infrastructure, isolated, big tides etc….. -Beginning to collect information in recreational only regions. -Beginning to look at the impacts of catch and release. Future -Recreational licences to fund buy backs and R&D -Introducing a probabilistic means of assessing future stock levels under different management regimes -Allocating proportions of the resource to different sectors -Identify and protect spawning areas -Review Barramundi Fishery plan – set up triggers, catch shares etc -Continue with FRDC post-release mortality proposal. What do you do if the performance measure (limit) is breached? -Establish review group with timeline -Look at implications for all sectors (needs are different) -Determine why this is likely to have occurred -Implement necessary response.

Fishery	Component	Management responses
Victorian Abalone	Retained: Primary species: Blacklip abalone	Current -Zoning, Legal Minimum Length (LMLs), and the TAC. These affect assessment model current and projected levels of relative biomass estimated. Future -Separate analyses could be made at the scale of headlands and bays to avoid more localised depletion. These analyses would require more estimates of growth and natural mortality than currently available. Finer-scale management than the existing management zones. Specification of management actions if the performance measure is triggered is included in the draft Management Plan as follows: -Trigger responses -If trigger reference points reached Minister notified. The Abalone TAC-Setting Sub-committee (ATACCS) will meet, determine its assessment and advise Minister. Its advice and recommendation submitted through the Fisheries Co-Management Council, with a copy to Fisheries Victoria. ATACCS will recommend one of the following courses of action to the Minister; (i) No action be taken, but re-evaluated after observation of the behaviour of the resource after a year or; (ii) Immediate intensive investigation undertaken to clarify components of the performance of the resource or the stock assessment prior to further decisions and action or; (iii) Action to adjust total allowable catch (TAC) and/or legal minimum length (LML) for the immediately following years, with the objective of restoring the mature biomass (or egg numbers) to above the trigger reference point within three years.
WA Rock Lobster	Retained: Primary species: Rock Lobster	Current: To ensure maintenance of the required level of breeding stock: a. Input controls based on individual transferable effort (tradable units that allow use of a finite number of pots according to the number of units held) with the ability to vary the total number of pots used in the fishery during a fixed fishing season. b. Fishing season from 15 November to 30 June to limit catches. c. Total number of pots limited (69,288 units or 56906 pots used after pot reductions and pots lost through prosecutions) within the fishery, within each zone of the fishery and by each vessel in the fishery. d. Prohibitions on the taking of berried, setose, tarspot, oversize females (>105 mm N of 30oS and >115 mm S of that line) and animals smaller than < 76mm e. Zone-based management reduces the risk of local concentrated fishing effort depleting key elements of the breeding stock. f. Compliance policing focuses on checks of the legality of lobsters consigned to processors. g. Escape gaps that decrease catches of undersized lobsters. h. Limits on the size and structure of pots used to trap lobster are designed to maintain the current level of fishing efficiency. i. Limits on the use of new technology that may increase fishing efficiency.

Fishery	Component	Management responses
		Future -Management arrangements over the past 8 years have seen the abundance of large breeding females increase greatly. -For 2001/02 season, the maximum size limit will be removed for one season to allow increased catches. -Decision rules to improve the management of the breeding stock levels are currently being developed. Actions if Performance Limit Exceeded -Strategies available for further protection of breeding stock if required include: a. Further reductions in the total number of pots. b. A reduction fishing season length or within season closures. c. Changes to minimum and maximum size gauges to protect juvenile and large breeding females. d. Area closures. -Periodically reduce effective fishing effort, due to increasing fishing efficiency, through reduction in total number of pots, and research into fishing efficiency to gauge this effect.
WA Aquarium	Retained: Fish: Total no.s	-Maintain limited number of licensed operators under the Management Plan -Maintain current gear restrictions and method of operation -Maintain current boat replacement provisions limiting boat size to 8 metres -Maintain current closed areas with extended refugia a further management strategy -Codify the industry Code of Conduct -If the total numbers of specimens taken exceeds the performance measure this will result a review of the plan.
WA Aquarium	Retained: Fish: Individual fish	-Maintain limited number of licensed operators under the Management Plan -Maintain current gear restrictions and method of operation -Maintain current boat replacement provisions limiting boat size to 8 metres -Maintain current closed areas with extended refugia a further management strategy Codify the industry Code of Conduct, to minimise possibility of localised depletion -If the total numbers of individual specimens taken exceeds the performance measure this will result in a review of the level of effort directed to relevant species
WA Aquarium	Retained: Fish: Individual fish: Syngnathids	-Maintain limited number of licensed operators under the Management Plan -Maintain current gear restrictions and method of operation -Maintain current boat replacement provisions limiting boat size to 8 metres -Maintain current closed areas with extended refugia a further management strategy -Codify the industry Code of Conduct to minimise possibility of localised depletion -If the total numbers of individual specimens taken exceeds the performance measure this will result in a review of the level of effort directed to relevant species

Fishery	Component	Management responses
WA Aquarium	Retained: Coral	-Maintain limited number of licensed operators under the Management Plan -Maintain current restrictions on method of operation and monitoring of daily landing weights -Regulation of areas that corals can be collected -Maintain current closed areas with extending the refugia a further management strategy -Codify the industry Code of Conduct to minimise possibility of localised depletion -Sanctions are applicable under the Management Plan for excess collections over quota allocation
WA Aquarium	Retained: Living rock/sand	-Maintain limited number of licensed operators under the Management Plan -Maintain current gear restrictions and method of operation -Maintain current boat replacement provisions limiting boat size to 8 metres -Maintain current closed areas with extended refugia a further management strategy -Codify the industry Code of Conduct to minimise possibility of localised depletion of living rocks -Sanctions are applicable under the Management Plan for excess collections over quota allocations
QLD ECTF	Retained: Primary species: Prawns: Tiger prawns	Current- What is being done to not exceed reference point? -Closures -Fishing Effort limitations -Fishing Gear limitations Current- What will be done if it is exceeded? -Review the assessment and fishery. It was recognised that there is no time frame for review if triggered, and no prescribed management actions apart from review. Future -Build appropriate level of precaution into performance measures -Attempt to use standardised CPUE data -Investigate feasibility of separating 2 species -Develop a specific review timeframe if triggered
NSW Estuary General	Retained: Shellfish: Mud crabs	Current -Legal minimum size = 8.5 cm carapace length and Protection for berried female mud crabs -Gear restrictions and Limited endorsement numbers -Time & area closures – refer to Table X Generally: -Habitat protection/rehabilitation -Bag limits for recreational sector -All current size limits, bag limits etc reviewed every 5 years

Fishery	Component	Management responses
		Future -Cooperative with QLD with respect to management of the mud crab populations -To obtain trends in non-commercial sector catches -Reduce the level of illegal catches If performance measure limits are triggered -Initiate review to investigate causes, including changes to effort, market characteristics or natural environment interactions -Change management arrangements appropriately to restore indicator to within the acceptable range in a specified time frame -If localised depletion is due to fishing mortality instigate management action to limit effort in the affected estuaries or regions
NSW Estuary General	Retained: Finfish: Yellowfin Bream	Current -Legal minimum size = 25 cm total length -Gear restrictions and Limited endorsement numbers -Time & area closures -BRD's in some estuary general fishing methods Generally: -Habitat protection/Rehabilitation -Bag limits for recreational sector -Mandatory BRD's in BB, PJ, Clarence Estuary Prawn Trawl -All current size limits, bag limits etc reviewed every 5 years Future -Improve data quality or develop a new index of abundance (eg. from field observer or fishery independent data) -Review the catch return forms or instigate a voluntary logbook -Influence the management of other fisheries to reduce levels of bycatch by other fisheries (discards etc) -Minimise the level of discarding in all fishing methods that impact on the stocks -Incorporate the results of the research on bycatch in all fishing gear types -Further develop stock assessment methods to incorporate probabilistic approaches -Improve compliance with existing regulations (both recreational and commercial) If performance measure limits are triggered -Initiate review to investigate the possible causes -Change management arrangements appropriately to restore indicator to within the acceptable range in a specified time frame
NSW estuary general	Retained: Finfish: Eels	Current -Expand Estuary general fishery to include harvesting of glass eels for aquaculture and collection in farm dams and impoundments

Fishery	Component	Management responses
		-Standardise management arrangements for eels across all sectors of the (expanded) fishery -Limited no. of endorsements for tidal waters (but restructuring program needed - latent effort problem) and permits for farm dams -No fishing in freshwater streams and a few closed areas in tidal waters -Size limit for adult eels = 30 cm -Limited catches of glass eels for use in aquaculture facilities and research -Zoning will limit ability of fishers to target eels in specific catchments, but should be kept under review to ensure that localised depletion objective is not compromised. Limit access to individual catchments where necessary -Prohibit the landing and selling of silver (adult) eels – except for research purposes Future -Improve quality of effort data and develop an appropriate CPUE index -Remove different and duplicated data collection mechanisms in the farm dam/impoundment and estuary parts of the fishery -Collect species composition information within the glass eel and adult (eg. longfin vs southern conger vs shortfin eels) components of the fishery If performance measure limits are triggered -Initiate review to investigate the possible causes, including changes to effort, market characteristics or natural environment interactions -Change management arrangements appropriately to restore indicator to within the acceptable range in a specified time frame -If localised depletion occurs due to fishing mortality instigate management action to limit effort in the affected catchments -Regulate the catch of size gradings that are shown to adversely affect economic yield per recruit
ET&B	Retained: Primary species: Broadbill swordfish	Current to keep within the acceptable range -Limited Entry, Boat Limits and Gear restrictions -Area closures Future to keep within the acceptable range -Get an interim figure ratified by the AFMA board and work with other governments on agreement on the figure and begin the process to increase the level of confidence in a figure (more formal risk assessment including all elements in the objective eg ecological function). -Implement management plan arrangements If triggered (after figure is ratified) -Limited capacity to act at present - TAEs, TACs, closures, permits, gear restrictions, time closures, etc
SA L&C	Retained: Native: Cockles	Current Commercial

Fishery	Component	Management responses
		-Limited entry- Only 30 people with access -Only allowed two people per team Recreational -None specific yet (but see below) Both -Closed season from the 1 June to 31 October -Minimum size limit of 35 mm shell width (relates to ?? of sexual maturity) Future Commercial -All the current management arrangements are under review with the proposal to make a detailed management plan. Recreational -Bag limits to be introduced 1 July – 600 cockles per person per day Actions if Performance Limit is Exceeded? -If catch exceeds 800 tonnes – Alter management arrangements to reduce the catch to return the catch to acceptable limits unless better information is available to justify an increase in the acceptable/sustainable levels. -If drops below 500 tonnes - Review the possible reasons to see if market conditions have impacted effort levels or if this is due to a real drop in abundance of cockles and increased management may be needed.
	Byproduct species	
NT Barramundi recreational	Retained: Byproduct: Other Species: Incidental, by product and unwanted captures	What is being done to keep within agreed bycatch limits Current -Marine wildlife – closed areas, gear controls, education, training -Fish - possession limits, gear controls, closed areas. Future -Marine wildlife – as above -Fish – may have more size limits.
Victorian Abalone	Retained: Byproduct: Greenlip abalone	Current -Seasonal closure of six months duration to protect spawning aggregations, LML of 130 mm, and conservative possession limit for recreational fishers of 2 per person per day during open season (winter-spring). Future -Separate TACs from blacklip abalone and set the TACs (Central and Western zones) for greenlip to zero. Amend Fisheries Act 1995 to split green and blacklip abalone. Continued focus on illegal fishers. No changes for recreational access.

Fishery	Component	Management responses
WA Rock Lobster	Retained: Byproduct: Octopus	Current -Despite the increase in pot hauling speeds, it is considered the increase in the number of required escape gaps and pot reductions introduced over the past 20 years has greatly reduced their potential catch. Future -Under the developing fisheries policy a number of commercial octopus fishermen will be licensed. Their records of catch and effort should allow a more informed measurement of stock abundance. Actions if Performance Limit is Exceeded? -A review initiated. If evidence of a risk of stock collapse measures put in place to reduce the catch of octopus eg - a prohibition on the take of rock lobster fishermen taking octopus or an annual limit of the catch taken by rock lobster fishermen.
QLD ECTF	Retained: Byproduct: Finfish: Bony fish: Syngnathids	Current -Collect data -Review is required within 2 years. Future -Design a pilot on-board observer program
QLD ECTF	Retained: Byproduct: Crustaceans: Crabs: Blue Swimmers	Current -Possession Limits -Male only fishery -Legal Size (conservative) -Collect catch information by each sector Future -Survival of discards by the different methods?? -Will need to be assessed as all species to be reviewed by 2002
SA L&C	Retained: Native: Others (major catch in marine scale fishery/ or river fishery)	Actions if Performance Limit is Exceeded? -Review to see if there has been an overall increase in catch, or a shift in allocation. -If it is an overall increase in catch a more thorough review should be undertaken to see if this increase in exploitation is sustainable and meeting the specific objectives of these species (most of which would be examined within the Marine Scale Fishery plans).

2.2 Non retained species

The generic component tree developed for 'Non retained species' is displayed below (Fig 3). Performance report details for each fishery are given in Table 2a and 2b.

Non retained species are defined as "*those **species** caught or directly impacted by the fishery but not used"* (see Fletcher et al., 2002 for more details – emphasis added to highlight these are species based reports not issue based reports). 'Non retained species' are often called 'bycatch' but this term means different things to different people. For example, some people may call byproduct species bycatch, whereas others do not. Similarly, others refer to the discards of target species as by-catch. A reduction in 'bycatch' can also be achieved by using more of the catch, but this does not necessarily help the individual species. As a result of these problems and the fact that different people define 'bycatch' differently, we use the term 'Non retained species' to reduce confusion.

The non-retained species were split into a number of categories based on whether they were captured or not (directly affected but not captured), and into their conservation status – eg either listed as a threatened species or not (general species).

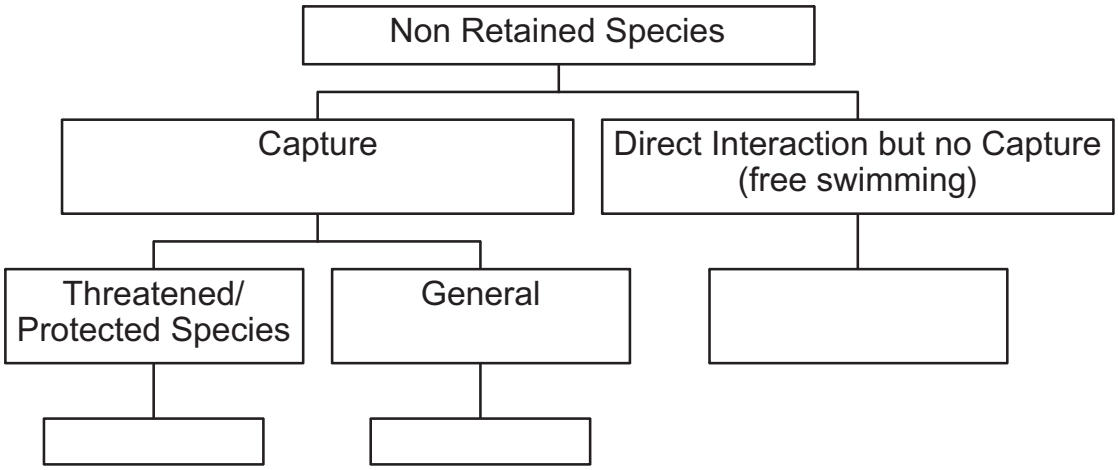


Figure 3. Generic component tree for a fishery's impacts on non retained species

2.2.1 Non retained species: General species

All case study fisheries except the Victorian Abalone Fishery identified species that they caught but didn't retain. Not all fisheries wrote performance reports for this component in the case study reports (Table 2a). For example, during the meetings the WA Aquarium Fishery rated these components as low risk under current management arrangements and didn't develop draft performance reports.

Components

General non retained species, sometimes called 'other non retained species', were separated by some fisheries into species groups, for example the Eastern Tuna and Billfish Fishery had components for black and blue marlins, sharks, rays, SBT and

other fish, whereas the Qld East Coast Trawl Fishery just had one component for non retained species. For each sub fishery of the NSW Estuary General Fishery non retained species were grouped together, except for the Fish Haul sub fishery where three species, Australian bass, river gars and estuary perch, were also separated out into components. NT Barramundi Recreational Fishery combined non retained and byproduct components together into one component.

Objectives

Objectives were variable, nevertheless, themes of reducing, minimising, or avoiding capture were most common (Table 2a). The QLD East Coast Trawl Fishery had an objective to reduce the total amount of general bycatch by 40% over 5 years through the use of BRDs and area closures. The NSW Estuary General Fishery and Eastern Tuna and Billfish Fishery suggested trying to minimise the amounts of non-retained species captured. The Eastern Tuna and Billfish Fishery has an objective to prohibit the catch of blue and black marlin and since the workshop have developed objectives to reduce, to the greatest extent possible, the interaction and potential for capture, as well as the mortality and injury, of bycatch species. They also have objectives to develop, where appropriate, mechanisms to convert bycatch into byproduct, as well as increasing community and industry awareness on bycatch issues/activities. For the NT Barramundi Recreational Fishery, it was suggested that not increasing the catches of non retained species/byproduct species should be the objective.

Indicators

Indicators tended to be based upon total catch or the amount of discards, rather than CPUE (Table 2a). Other possible indicators included 'process indicators' such as the level of uptake of BRDs (Bycatch Reduction Devices) by the NSW Estuary General Fishery, the level of uptake of Codes of Practice. In addition, estimating the mortality of discarded fish was being considered in NSW Estuary General Fishery and Eastern Tuna and Billfish Fishery.

Performance measure

The performance measures varied (Table 2a), with NSW Estuary General Fishery suggested trying to achieve a decreasing trend in the relative and absolute abundance of discarded fish, as well as suggesting an increasing trend in uptake of BRDs and Codes of Practice. NT Barramundi Recreational Fishery suggested that the trend in catch does not increase. The Eastern Tuna and Billfish Fishery had a trigger limit of greater than 0 tonnes for blue and black marlins, meaning that any catch landed would trigger a management review. Qld East Coast Trawl Fishery's performance measure is to achieve a 40% reduction in Bycatch over 5 years. NSW Estuary General Fishery also suggested that in the future the performance measure could be a target based upon the ratio of retained and discarded catch.

Data

Qld East Coast Trawl Fishery and NSW Estuary General Fishery are using observer studies to estimate non retained species (Table 2a). NSW Estuary General Fishery is also using compliance surveys and gear records from fishers and Qld East Coast Trawl Fishery is also completing a mapping survey of the seafloor. Eastern Tuna and Billfish

Fishery is mainly using compliance, logbook records and previous observer surveys for blue and black marlin, and will be reviewing data and validating data for other general non retained species..

Management responses

Gear manipulations appeared to be the most common management response to reduce the capture of non retained species (Table 2b). The WA Aquarium Fishery suggested maintaining current collection methods that minimise the collection of species that are not wanted (ie non retained species). The Qld East Coast Trawl Fishery are implementing BRDs (Bycatch Reduction Devices) gear modifications across the fishery, while NSW Estuary General Fishery are currently assessing how much catch is discarded using different mesh and gears and then they will implement appropriate gear changes and Codes of Practice to minimise the capture of species that are not wanted (ie non retained species). Area closures were also commonly suggested, in Qld East Coast Trawl Fishery, NT Barramundi Recreational Fishery, Eastern Tuna and Billfish Fishery, and NSW Estuary General Fishery. Additional management measures included a possible 25% reduction in effort in Qld East Coast Trawl Fishery, and education of fishers in NSW Estuary General Fishery, Eastern Tuna and Billfish Fishery and NT Barramundi Recreational Fishery.

2.2.2 Non retained species: Threatened/protected species

A few of the case study fisheries identified potential interactions with threatened or protected species, whereas for other fisheries this component was not applicable. Some fisheries used the term ‘threatened’ very specifically, as defined by Environment Australia, to mean those species under threat of extinction, and used ‘protected’ to include all other species listed as protected. Whereas other fisheries used the terms interchangeably.

Components

Some fisheries, such as Eastern Tuna and Billfish Fishery and SA Lakes and Coorong Fishery, looked at groups of threatened/protected species, such as seabirds, turtles, seals, cetaceans and sharks, whereas other fisheries such as WA Rock Lobster Fishery looked at some species individually as separate components. The NSW Estuary General Fishery tended to separate out threatened species into individual components because different sub fisheries might affect different threatened species, for example the meshing sub fishery might affect turtles and little penguins, while the trapping sub fishery might affect tortoises or platypuses. The NSW Estuary General Fishery and the SA Lakes and Coorong Fishery did not write performance reports for these components.

Objectives

Depending on the situation the main objectives were to avoid or stop catching, to reach an acceptable level of capture or to minimise capture and interactions (Table 2a). At the workshop the Eastern Tuna and Billfish Fishery stated the objective of avoiding capture, and this has been updated more recently to, avoid and/or reduce the likelihood of negative interactions with protected species and to promote high survival rates of

released protected species. The Qld East Coast Trawl Fishery suggested an objective of no captures and another possible objective of reaching an acceptable level of captures, while the WA Rock Lobster Fishery had the objective to minimise captures and interactions.

Indicators

CPUE, Catch, Interactions with boats, and independent breeding surveys were the main indicators suggested for threatened species (Table 2a). Catch Per Unit Effort (CPUE) is being used for seabirds in the Eastern Tuna and Billfish Fishery and for sealions in the WA Rock Lobster Fishery and total catch by turtle species in the Qld East Coast Trawl Fishery. WA Rock Lobster Fishery were also recording interactions with boats, and each of the fisheries above suggested independent scientific surveys of known breeding sites, although how this could be done was less clear.

Performance measure

The WA Rock Lobster Fishery requires that interactions with or deaths of sealions must not increase over time. The Qld East Coast Trawl Fishery has a target of total catches per turtle species less than 5% of estimated 1992 levels, within 5 years and Eastern Tuna and Billfish Fishery has a maximum limit of 0.05 seabirds per 1000 longline hooks by 2002 (Table 2a).

Data

Available data were mainly catches, CPUE or interactions recorded in observer surveys or logbook records (Table 2a). Qld East Coast trawl is completing experimental comparisons of trawls with and without TEDs and BRDs for each major trawl sector. It was also suggested that independent breeding records of threatened species could be collected in the future.

Management responses

A common management response was to improve recording of interactions between threatened species and fishers, through logbooks and independent observers, to get a true indication of these rare events, such as for sealions in the WA Rock Lobster Fishery and seabirds in the Eastern Tuna and Billfish Fishery (Table 2b). If a negative interaction is determined then area closures where the threatened species is common was suggested for turtles in QLD East Coast Trawl Fishery, for seabirds in Eastern Tuna and Billfish Fishery and for sealions in the WA Rock Lobster Fishery. In addition gear modification could be implemented and Turtle Excluder Devices are mandatory in the QLD East Coast Trawl Fishery, pot modifications are possible in the WA Rock Lobster Fishery, and chutes and other gear modifications are being trialed in the Eastern Tuna and Billfish Fishery. The latter fishery suggests that after trials are completed ineffective gear modifications should be removed and they also suggested effort reduction as a possible management response. These fisheries also suggested fisher education as an important management response.

2.2.3 Non retained species: Direct impact but not caught

Species impacted by the fishing activity but not actually brought onto deck was thought to be of minor risk in all the case study fisheries examined. Even though it was

considered a minor component, some fisheries still identified potential interactions that they wished to address, particularly where threatened species might be involved, and therefore these species have been tackled as a priority. Because threatened species were the priority species to be examined first this component may overlap with the 'threatened species' component discussed previously. However, in the future, when more is known about these effects, other 'non threatened' species are likely to also be covered and therefore this component should remain separate. Only one fishery wrote performance reports for this component.

Component

This component was not often examined in detail due to minimal information and rarity of events. Some fisheries felt a good start would be to look at any possible impacts on threatened species and the WA Rock Lobster Fishery separated the component into impacts on leatherback turtles and on whales/dolphins as a useful starting point. The Eastern Tuna and Billfish Fishery divided the component into impacts from the boat and from entanglement in fishing gear, and then further subdivided components into possible species that could be affected. The SA Lakes and Coorong Fishery were mainly looking at the effects of fishing disturbing breeding birds and feeding birds, in the RAMSAR listed wetland.

Objective

The objective for the two WA Rock Lobster Fishery components was to minimise direct and indirect impacts (Table 2a).

Indicator

Indicators were mainly observed interactions with fishing boats or recorded deaths (Table 2a).

Performance measure

Trends over time should not increase (Table 2a).

Data

Interactions and deaths recorded in logbooks or by observer surveys and reports through the media. Records of turtles found dead on beaches was another possible source of data (Table 2a).

Management response

Fisheries management responses for the WA Rock Lobster Fishery (Table 2b) tended to be based upon finding out more information by improving recording in fishers logbooks and independent surveys as well as researching through the literature and other agencies on relevant species-fishing gear interactions. Future management responses would be to implement gear changes to protect those species being affected but not brought onto the deck. Fisher education was also suggested as a management response.

Table 2a. Non Retained Species: Performance Reports

(Note –The information presented in this table includes suggestions made at the case study workshops and may not reflect the current management arrangements of these fisheries).

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
	Threatened/listed species				
WA Rock Lobster	Non retained: Captured: Threatened/listed: Australian white-naped hair sea lion.	To minimise capture and direct interactions with sea lions	-Relative number of sea lions found in traps or related fishing gear (per pot lift). -Fishery interactions	Observers- Any increase in relative interactions or > 1 sea-lion death per year will require more direct measures to reduce such interaction. Logbooks- Any increase in relative level of recorded interactions with seals leading to their death.	Data Requirements and Availability -Number of seal interactions- Observer reports since 2001 -Number of seal interactions recorded- logbooks since 2001 -Independent population levels and interaction with lobster fishing- Possibly available from CALM
QLD ECTF	Non retained: Captured: Threatened/protected: Turtles	(l) Broad objective is the protection of each of the turtle populations (p) -To have an acceptable level of turtle capture or mortality by species -No turtle capture	-Turtle captures by species -	(l) -Capture of turtles by species is less than 5% of those captured in 1992.	Data requirements for indicator -Records of turtle capture by the fishery Data availability (current – future) -Logbook- since April 2000 -Robins 92-94 survey of data collected by industry- for comparison to present. Comparisons of trawls with and without TEDs
Eastern T&BF	Non retained: Captured: Threatened/protected: Seabirds	(l)Avoid and/or reduce the likelihood of negative interactions with protected species and to promote high	Seabird CPUE (Catch/ hooks) across fishery, or a region, per year. (p) Surveys of	CPUE below 0.05 per thousand hooks by end of 2002. (p) -Albatross decline	Data requirements for indicator -Logbook information -Observer data -Independent survey data

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
		survival rates of released protected species.	albatross		Data availability (current – future) -Limited observer data- need more
	General species				
NT Barramundi recreational	Retained: Byproduct: Other Species: Incidental, by product and unwanted captures	(Leg) Conserve the species (Pos) Not to increase the levels of incidental capture	Catch, CPUE	Not increasing	Data requirements for indicator -Recreational and Indigenous surveys. -'Barrawatch' collects a set of recreational data. -Fishing tournament data can be useful. -Commercial logbook monitoring. Data availability (current – future) -Rec and Indigenous survey, for 95 and 2000 -Fishing tournament data -Fisheries Action Program trial time series -CPUE data for recreational barramundi fishing. -Commercial data returns and CPUE.
WA Aquarium	Non retained: Captured and discarded: General(Bycatch)	To maintain the current fishing methods which ensure that bycatch levels remain minimal	N/Applicable	N/Applicable	N/Applicable
QLD ECTF	Non retained: Captured and discarded: General(Bycatch)	(l) Broad objective is sustainable levels of bycatch that do not impact upon bycatch species/biodiversity etc.	Bycatch catch levels	By catch to be reduced by 40% within 5 years.	Data requirements for indicator -Bycatch levels (by area?) -Observer data by species/groups

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
		Opp Objective- Reduce general bycatch by 40% from previous/ historic levels			Data availability (current – future) -Previous incidental data -FRDC observer survey beginning -Mapping of marine biodiversity (CRC) -Experimental comparisons (northern region)
Eastern T&BF	Non retained: Captured and discarded: Other: General	(l) To reduce, to the greatest extent possible, the interaction and potential for capture, as well as the mortality and injury, of bycatch species. They also have objectives to develop, where appropriate, mechanisms to convert bycatch into byproduct. Increasing community and industry awareness on bycatch issues/activities.	(l) -To be determined after data review	To be determined after assessment	Data requirements for indicator -To be determined after validation of fishery data -Potentially Wildlife and environmental data - Data availability (current – future) -Observer surveys on Japanese boats -catch and discards recorded in logbooks -Research surveys
Eastern T&BF	Non retained: Captured and discarded: Other: Marlin: Blue and Black	(l) It is prohibited to catch these species	(l) -Landed catch (p) -Catch discarded dead or injured.	Any catch landed triggers a review	Data requirements for indicator -Landed catch Data availability (current – future) -Landed catch is available
NSW Estuary General	Non retained: Captured and discarded: Other – hauling	(p) Minimise discards and subsequent mortality	-Ratio of discards: retained catch -Total discards -Mortality rates of discards -Uptake of appropriate	Good practice- Current - Decreasing trend in monitoring estimates of relative/absolute levels of discards. -Increased uptake of	Data requirements for indicator -Observer data on retained and discards -Estimates of mortality rates for discards -Level of use of BRDs in

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
			BRD gear and/or codes of practice -Public complaints	appropriate BRD devices. -Increased use of codes of practice Good practice- Future -Ratio of discards: retained less than the agreed value- target needs to be decided using ecological significance.	fishing gear Data availability (current – future) -Observer data and mortality estimates available for most gear types by end of 2000. -Gear information from fishers. -Compliance surveys/rates
	Direct impact but not captured				
WA Rock Lobster	Non retained: Direct impact but not caught in pots: Threatened/listed species: Turtles: Leatherback turtles.	Minimise direct and indirect interactions on leatherback turtles.	-Number of recorded Leatherback deaths and captures per year	Any increase in number of logged observations, media reports or other recorded interactions.	Data Requirements and Availability -Number of Leatherback interactions- Observer reports since 2001 -Number of Leatherback interactions recorded- logbooks since 2001 -Independent population levels and interaction with lobster fishing- Possibly available from CALM -Number of media/press reports of interactions between rock lobster fishing and leatherback turtles- availability unknown, but literature searches in the future
WA Rock Lobster	Non retained: Direct impact but not caught in pots:	Minimise direct and indirect interactions with dolphins and	-Number of whale and dolphin interactions	Any increase in number of logged observations,	Data Requirements and Availability

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
	Threatened/listed species: Whales and dolphins.	whales.	recorded and press reported/per year.	media reports or other recorded interactions.	-Number of whale and dolphin interactions- Observer reports since 2001 -Number of whale and dolphin interactions recorded- logbooks since 2001 -Independent population levels and interaction with lobster fishing- Possibly available from CALM -Number of media/press reports of interactions between rock lobster fishing and whales and dolphins- availability unknown, but literature searches in the future

Table 2b. Non Retained Species: Performance Reports – Possible Management Responses

(Note –The information presented in this table includes suggestions made at the case study workshops and may not reflect the current management arrangements of these fisheries).

Fishery	Component	Management responses
	Threatened/listed species	
WA Rock Lobster	Non retained: Captured: Threatened/listed: Australian white-naped hair sea lion.	Current -Monitor techniques from around the World for avoiding capture of fauna, such as sealions, in rock lobster and other pot based fisheries. -Collecting data to obtain the level of interaction between lobster gear and sealion pups, whales, turtles, seabirds, etc. during the 2000/01 season using a logbook and survey approach. Data collected will be reviewed at the end of year. Future -Increase awareness of the issue with fishers. If performance level triggered -If there is a significant adverse interaction with sea-lions: measures may be taken to limit fishing adjacent to favoured sea-lion habitat, and/or trial the use of techniques to discourage seal-lion pups from entering traps or interacting with lobster fishing.
QLD ECTF	Non retained: Captured: Threatened/protected: Turtles	-Testing effective BRD Designs in progress Turtle Excluder Devices (TED's) mandatory -Education programme – turtle bycatch plan -Targeted closures in areas of high turtle abundance
Eastern T&BF	Non retained: Captured: Threatened/protected: Seabirds	Current -Development of regulations -Range of actions specified in the Threat Abatement Plan (TAP) Future -Possibly develop an interim measure –could be no measurement beforehand or stage targets. -Implement bycatch data collection program and a bycatch risk assessment. -Develop an Industry Code of Practice to promote mitigation measures, reduce interactions, ensure handling and care results in high survival rates of released protected bycatch, -Assess and modify fishing gear and practices to reduce negative interactions improve seabird survival after release (possible tagging study). -Investigate the utility of the use of spatial/temporal closures

Fishery	Component	Management responses
		-Implement Actions from the Threat Abatement Plan requiring the adoption of seabird mitigation strategies If performance level triggered (if the catch rate is too high, or if seabird abundance declines), possible actions may be: -A review of why there was a decline in abundance or the catch rate has not declined sufficiently. What was adopted, effective and other factors. What was the species composition of the catch and where was it taken. -Possibly a reduction in effort. -This possibly may lead increase in the observer coverage/compliance? -If the objective is achieved, review with the view to remove any unnecessary measures.
	General species	
NT Barramundi recreational	Retained: Byproduct: Other Species: Incidental, by product and unwanted captures	What is being done to keep within agreed bycatch limits Present -Marine wildlife – closed areas, gear controls, education, training -Fish - possession limits, gear controls, closed areas. Future -Marine wildlife – as above -Fish – may have more size limits.
WA Aquarium	Non retained: Captured and discarded: General(Bycatch)	Current -Maintain current gear restrictions and method of operation
QLD ECTF	Non retained: Captured and discarded: General(Bycatch)	-Bycatch Reduction Devices (BRD's) are now compulsory -Effort levels to be reduced by 25% -Area Closures
ET&B	Non retained: Captured and discarded: Other: General	Future -Develop gear to increase selectiveness and decrease capture of bycatch. -Develop an Industry Code of practice to promote mitigation devices and reduce discarding and increase survival of discarded species. -Fishing gear assessments and modifications -Investigate the utility of spatial/temporal closures, -Develop cooperative bycatch management arrangements for multi-jurisdictional fisheries -To decrease the amount of discarding, markets will be encouraged to make use of those species and convert bycatch into by-product. -Establish an awareness program to raise awareness and encourage participation of stakeholders in bycatch management. -Education program on bycatch for operators.

Fishery	Component	Management responses
ET&B	Non retained: Captured and discarded: Other: Marlin: Blue and Black	Zero landed catch and a review if any catch landed. -Other management responses- as identified under Protected species and General bycatch species sections in the ET&B fishery, apply to blue and black marlin.
NSW Estuary General	Non Retained: Captured and discarded: Other – hauling	Current -Mesh Size and other gear arrangements. -Conducting surveys and gear trials. -Time and area closures. Future (priority for commercially and recreationally important species eg undersize) -Develop a code of practice. -Education of the fishers. -Meeting an environmental accreditation scheme??
	Direct impact but not captured	
WA Rock Lobster	Non retained: Direct impact but not caught in pots: Threatened/listed species: Turtles: Leatherback turtles.	Current -Monitor techniques from around the World for avoiding interactions with turtles in rock lobster and other pot based fisheries. -Pots are generally pulled daily which maximises the chance that any tangled turtles can be released alive. -Total pot numbers have been reduced over the past few years (18% reduction in 93/94). -Collecting data to obtain the level of interaction between lobster gear and sealion pups, whales, turtles, seabirds, etc. during the 2000/01 season using a logbook and survey approach. Data collected will be reviewed at the end of year. Future -Contacted CALM to determine if the interaction between commercial lobster fishermen and turtles is monitored and recorded. -Possibly commercial and recreational fishers could provide information on sightings, to assist with spatial and temporal information. Interest could be generated by articles in fishing magazines, requesting information and photos on sightings (live and dead). If performance level triggered -A review of the potential methods to reduce the level of interactions would be instigated.
WA Rock Lobster	Non retained: Direct impact but not caught in pots: Threatened/listed species:	-Monitor techniques from around the World to help discourage and minimise interactions with turtles in pot based fisheries.

Fishery	Component	Management responses
	Whales and dolphins.	Future -Contacted CALM to determine if the interaction between commercial lobster fishermen and whales and dolphins is monitored and how to deal with unintentional feeding of dolphins when returning protected rock lobsters to the water. If performance level triggered -A review of the potential methods to reduce the level of interactions would be instigated.

2.3 General ecosystem effects

NT Barramundi Recreational Fishery combined all biological community effects into one component and all physical effects into another component. The SA Lakes and Coorong Fishery looked at the General ecosystem component tree separately for the commercial sector and then for the recreational sector. Otherwise, most fisheries used the generic component trees (Fig. 4) with minimal alteration.

The generic component tree developed for 'General ecosystem effects' is displayed below. Performance report details for each fishery are given in Table 3a and 3b.

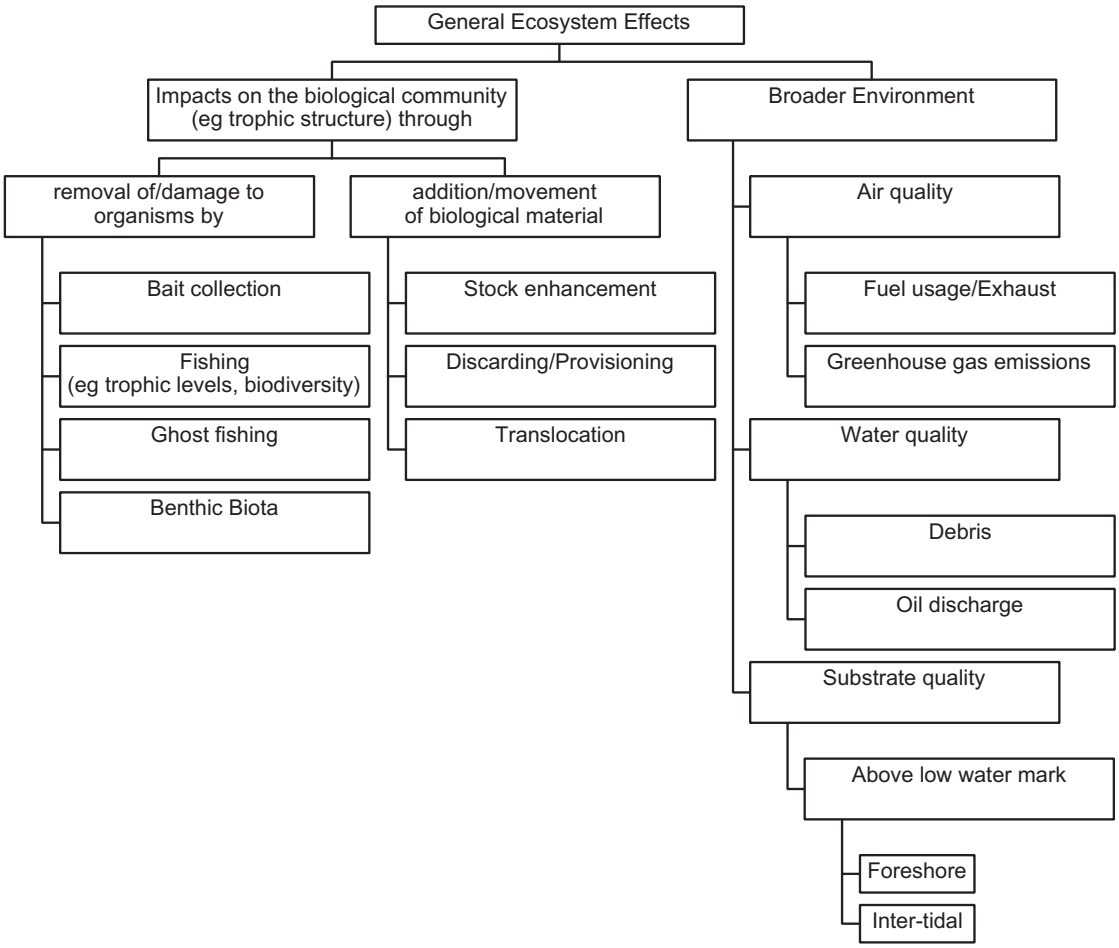


Figure 4. Generic component tree for a fishery's impacts on the general ecosystem

2.3.1 General ecosystem effects: Tropic impacts from fishing

All the case study fisheries had this component.

Component

This component was usually associated with an analysis of potential trophic or biodiversity impacts that may be caused from the removal of "material" by the fishery.

The component was not usually subdivided, although often a number of indicators might be used to report on the component, for example the Victorian Abalone Fishery was examining various functional groups of species separately. The WA Rock Lobster Fishery basically divided components into inshore and offshore areas. The Eastern Tuna and Billfish Fishery and SA Lakes and Coorong Fishery divided into effects from different sub fisheries. Therefore, it is possible to divide components further into functional or key groups of species, into different sub fisheries, or into different regions/areas. In contrast to the above fisheries the NT Barramundi Recreational Fishery combined all their effects on the biological general ecosystem into one component. SA Lakes and Coorong did not write a performance report for this component in their case study.

Objective

Effects on the general ecosystem from removing fish/marine resources was discussed in detail in most of the case studies but operational objectives are particularly difficult to identify or agree upon (Table 3a). This is an area that needs further development. Objectives tended to focus on not having a significant effect on the biological community when removing fish. What the 'significant effect' could be was usually defined in the performance measure. In addition to this base objective the WA Aquarium fishery included taking into account localised depletions and the Eastern Tuna and Billfish Fishery suggested ensuring healthy populations of directly impacted species.

An alternative, possibly more general objective was to minimise impacts from the fishery on the general ecosystem, suggested as a possible objective by the Eastern Tuna and Billfish Fishery and NSW Estuary General fishery. The WA Rock lobster fishery combined both these ideas into an objective for minimal impact on the ecosystem and no effects on biodiversity.

In addition to these objectives the NT Barramundi Recreational Fishery had an objective to develop Code of Practice and an educational package to raise awareness of the issues.

Indicator

There were three main types of indicators (Table 3a), those indicators that measured the total level of fish removals and aimed to minimise the impacts of removals, those fisheries that looked at the composition of the catch as an index of the 'health' of the marine community, and those fisheries that looked at the marine community independently of the fishery to determine marine 'health'.

Total removals: The WA Aquarium Fishery suggested looking at the total removal of fish from the environment, while on the other hand WA Rock Lobster Fishery estimated the total biomass of lobsters left in the ecosystem compared to unfished levels.

Composition of catch: The NSW Estuary General Fishery were thinking of looking at comparisons over time of taxa and/or their abundance, or focal taxa within the catch, perhaps comparing these species in fished vs non-fished areas. Numerous possible indicators were identified in the Eastern Tuna and Billfish Fishery, such as looking at

indicator species: across taxa, across trophic groups, or focus on at-risk species, looking at the catch as a whole: such as biodiversity, evenness or trophic levels of the catch, to more unusual methods, such as Carbon budgets of the catch, and species comparison between commonly fished, rarely fished and unfished areas.

Marine community: The Victorian Abalone fishery was looking at monitoring the functional ecological groups within the marine ecosystem itself, such as habitat, predators and competitors, rather than just looking at the catch. The Eastern Tuna and Billfish Fishery suggested remote sensing of chlorophyll levels in the ocean.

The NT Barramundi Recreational Fishery was developing a Code of Practice and education packages.

Performance measure

Determining what a significant effect on the marine community is particularly difficult and is a very new area in fishery management. The WA Aquarium Fishery was thinking of using a precautionary catch limit for retained species that would trigger a management response if exceeded. NSW Estuary General Fishery suggested change outside natural variation should trigger a management response. Victorian Abalone fishery suggested a change in abundance of functional groups greater than 10% from average levels for past 3 years would trigger a management response.

The NT Barramundi Recreational Fishery was looking at the understanding of, and compliance with, education packages and Codes of Practice respectively, as well as periodic monitoring and reporting against 'Australia's estuaries project' (see Table 3a).

Data

WA Aquarium Fishery suggests data from total catches recorded in log books, whereas WA Rock Lobster Fishery were looking at estimates of total abundance, puerulus settlement surveys and indexes from rock lobster landings (Table 3a). NSW Estuary General Fishery suggests numerous sources of data including logbook catch data, sporadic scientific surveys and possibly independent surveys of non-fished vs fished areas. Victorian Abalone Fishery are using their independent dive surveys of the Abalone beds and extending these surveys to look at the marine ecosystem and functional groups. Eastern Tuna and Billfish Fishery suggested possible data sources such as logbooks, observer studies and fishery independent marine surveys and remote sensing.

NT Barramundi Recreational were considering analysing compliance data and the numbers of aquatic pest incursions. Possible future data may include discarded fishing gear and marine debris and monitoring of the environment.

Management response

Fisheries that directed their objectives and indicators towards minimising their effect on the primary species, which by default would minimise effects on the general ecosystem, could also direct their management responses at the primary species. This was the case with the WA Rock Lobster Fishery and WA Aquarium Fishery (Table 3b).

For fisheries that tried to actually get a measure, or gain an indication of the health of

the marine ecosystem itself, management responses were far less clear (Table 3b). The only suggestion was in the Victorian Abalone Fishery where they suggested possibly manipulating levels of urchins or abalone.

The NT Barramundi Recreational Fishery's management response was to develop a Code of Practice and to work with other agencies (Table 3b).

2.3.2 General ecosystem effects: Benthic biota

Benthic biota was relevant in all fisheries examined except for Victorian Abalone Fishery and Eastern Tuna and Billfish Fishery workshops. The latter is a pelagic fishery and doesn't touch the bottom, except on rare occasions when a purse seine net may touch the top of a seamount, and the Abalone fishery is a hand collection fishery. WA Rock Lobster Fishery rated general benthic effects as low risk, but separated out coral as an important benthic biota that may be affected. SA Lakes and Coorong Fishery also rated this component as low risk because their nets barely touch the bottom, and in the case of cockle rakes they work through a sand substrate with biota that are used to disturbance. Four fisheries have written performance reports for this component, to date.

Component

This component could form a part of the previous general biological community effects, but is of particular importance in some fisheries and is therefore dealt with separately. The Qld East Coast Trawl workshop examined this component in detail subdividing it into subcomponents of different benthic habitats. WA Rock Lobster Fishery subdivided this component into effects on coral and effects on other benthos. SA Lakes and Coorong Fishery workshop divided this component into effects from cockle rakes and effects from 4WD vehicles on benthic biota. The NT Barramundi Recreational Fishery combined this component with substrate and water quality and is dealing with them in a Code of Practice.

Objective

WA Aquarium Fishery suggested objectives to maintain the collection of coral and rock at low levels to minimise impact on surrounding areas and to prohibit collection in areas with a high aesthetic value. Qld East Coast Trawl Fishery workshop generated a number of possible objectives such as reducing the area of trawling or fishing effort by certain percentages, and/or to limit trawling expansion and these objectives were time bound to two to five years. They also have broader objectives to conserve certain percentages of the different benthic habitats (Table 3a). WA Rock Lobster Fishery had an objective to prevent human impacts on coral.

Indicator

Quantity of benthic habitat removed, area trawled or affected and fishing effort, are all possible indicators (Table 3a). NT Barramundi Recreational Fishery suggested compliance levels with Codes of Practice. WA Rock Lobster Fishery were waiting on results from research projects for more information.

Performance measure

Qld East Coast Trawl Fishery have a performance measure set by the Great Barrier Reef Marine Park Authority of a 15% reduction in trawl area and effort over three years, and suggest other possible performance measures such as not allowing trawling in new areas, maximum effort capped at 1996 level, or a reduction in effort by 25% over 5 years. WA Aquarium Fishery suggests a precautionary maximum limit for total benthic removals. NT Barramundi Recreational Fishery suggest a performance measure of an increasing uptake of Codes of Practice (see Table 3a).

Data

Area trawled in the Queensland East Coast Trawl Fishery can be determined using VMS (Vessel Monitoring Systems), and fishing effort is recorded in logbooks (Table 3a). Research projects looking at benthic habitats and effects of trawling are taking place and have taken place in the QLD ECTF. The quantity and locality of coral and rocks removed in the WA Aquarium Fishery are recorded in logbooks. The WA Rock Lobster Fishery is going to review current and past research projects for this component. Apart from compliance data NT Barramundi Recreational Fishery have limited information and will look into non-fishery data.

Management response

Current management responses that went across all the case study fisheries, including WA Aquarium Fishery, Qld East Coast Trawl Fishery, NT Barramundi Recreational Fishery and WA Rock Lobster Fishery, included area closures or limitation, gear specifications, and Codes of Conduct or Practice for benthic biota issues (Table 3b). The commercial fisheries also had limited entry to control and minimise impacts. In addition, Qld East Coast Trawl Fishery had targets for reduction in area trawled and trawling effort, while the WA Rock Lobster Fishery were carrying out research to clarify the issue and identify methods for improvement. Compliance surveys were also a common management response to deter non-compliance with Codes of Practice.

Table 3a. General Ecosystem: Performance Reports

(Note –The information presented in this table includes suggestions made at the case study workshops and may not reflect the current management arrangements of these fisheries).

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
	Removal of species				
Victorian Abalone	General ecosystem: Removal of captured species on ecosystem	-Ecosystem health (including genetic integrity) not jeopardised by abalone fishery practices.	-Functional Groups and Keystone Species.	-Abundance of major functional groups remains within 10% of average values for previous 3 years on a regional scale. Functional groups include crustose coralline algae (CCA), kelp canopy, predators and competitors.	Data requirements for indicator -Habitat: Cover abundance of major algal groups such as kelps and CCA eg. Phyllospora comosa, Sporolithon sp. -Grazers/Competitors: Abundance estimates of urchins, turbo. -Predators: Qualitative estimates of abundance of sea stars, crabs, lobsters wrasses, morwong, rays and heterodontid sharks (e.g. Port Jackson sharks). -fishery data Data availability (current – future) Past -Limited. Current -150 fixed sites are measured each year. -Habitat data collected during fishery independent surveys and reported by divers (On-board observations).

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
					-Algal cover-abundance estimates. -Qualitative abundance estimates of known competitor and predator species. -Transect counts of urchins, sea stars, turbo, crabs, lobsters commenced during 2001. -Marine GIS database- includes abalone habitat data collected in these and other projects. Future -Improved understanding should lead to improved performance indicators. -GIS will include additional data in the future -Additional data from the Marine Park in non-fished areas.
WA Lobster	General Ecosystem: Removal of captured species on ecosystem	-To ensure lobster fishing has minimal impact on the inshore ecosystem and no implications to biodiversity on the fishing grounds requires the maintenance of high total biomass levels of lobsters in both inshore and offshore areas.	-The total biomass of rock lobsters inshore and offshore areas	-Maintain total biomass of lobsters greater than 80% of unfished levels given variations in recruitment.	Data Requirements and Availability -Monthly monitoring of pueruli settlement, available monthly- since 1968 -Annual landed octopus index- since CAES database created -Total biomass of lobsters (coastal and offshore)- preliminary data available.
WA Aquarium	General Ecosystem: Removal of captured species on ecosystem	-To maintain the total catch of these species at levels that do not have a significant effect on	-Total commercial catch	-Total catch below the level specified for Retained Species.	Data requirements for indicator -Assessments against the performance measure for

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
		other components of the ecosystem, including localised depletions		-Compliance with Code of Conduct to minimise localised depletions of particular species.	Retained Species -Commercial catch records through -Monthly Fisher Returns - 1995 onwards
ET&B	General Ecosystem: Removal of captured species on ecosystem	(l)- To have regard to the impact on non-target species and the long term sustainability of the marine environment. (p) -Maintain (or where necessary restore) ecosystem integrity through maintaining biodiversity, functional ecosystem relationships & trophic processes and ensure that there are healthy populations of all species directly impacted by the fishery. (p) -Minimise impacts of this component of the fishery on the ecosystem relationships and processes.	Possible -Abundance or exploitation rate of indicator species or a number of them (species from different trophic levels, vulnerable ones – life history, mobility). (determine the lowest productivity stock –which may become the main driver of management) -Species Biodiversity (number, evenness, abundance dominance) -Composite Indicator (trend through time) -Remote sensing chlorophyll levels? -Compare areas that have different levels of fishing history. -Mean catch trophic level over time. -Fraction of the total carbon budget ends up in the catch.	unsure	Data requirements for indicator Data from the Fishing Industry -standardised (restricted, directed by some plan to ensure standardising sampling, observer program etc..) -non standardised (eg all logbook information, not very robust) -Data from independent surveys -Measuring exploitation rate quickly. Data availability (current – future) -Logbook data -Some observer data -Some scientific survey data????

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
			-Geographical range of dependent species (contraction is related to fish downs).		
NSW Estuary General	General ecosystem: Removal of captured species on ecosystem	-Minimise the impacts -Ensure removals do not significantly alter the community structure/food web structure (total biodiversity, eg species richness evenness)	Possible -Species richness, evenness. -Relative changes in the catch composition of estuarine species over time (ie decades) and at the appropriate spatial scale. -Abundance of key indicator species/ communities. -Total number of species caught in this fishery or in other fisheries. -Relative catch of dependent species in this and other fisheries -Comparison between opened and closed estuaries or aquatic reserves within some estuaries. -Fraction of the total carbon budget ends up in catch. -Trophic level through time?	-Detecting change outside the expected natural range	Data requirements for indicator -Species catch records. -Any surveys of the regions over the past. -Experimental surveys (closed vs open etc). Data availability (current – future) -Catch records from all commercial fisheries since 1940. -Survey information from assorted studies - some over time?
NT Barramundi	General ecosystem: Removal/Translocation/	(l) -Translocation of species. -Policy and codes of practice	-Production of Codes of Practice and	-Understanding of educational material.	Data requirements for indicator -Analysis of compliance

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
recreational	Damage of organisms	ensure do not remove or damage species or habitats. (p) -Develop educational package to raise social and community awareness of the issues.	educational material to cover such things as bait collection and movement, ghost fishing, movement of weeds, the role of boats/trailers as a dispersant -(p) Public education as to the role of habitats. -(p) Baseline data from 'Australia's Estuaries Project'.	-Compliance with the Codes of Practice. -Periodic reporting against "Australia's Estuaries Project".	statistics. -Numbers/type of aquatic pest incursions. Data availability (current – future) -Limited published information on mangrove and nearshore seabed habitat. -Discarded fishing gear and general marine debris (future project). -Ongoing monitoring of environment through FAP, NHT and other projects.
	Benthic biota:				
WA Aquarium	General ecosystem: Removal or damage to ecological community: Benthic biota: Corals and living rocks	-Maintain total collection of corals and living rocks at levels that will not significantly impact on the ecosystem or surrounding habitat. -Ensure that collections of corals and living rocks prohibited in areas of high aesthetic value.	Localities and weight of corals and living rocks removed each year	The weight of coral removed each year will be 9 tonnes The weight of living rock removed each year will be 13 tonnes	Data requirements for indicator -Reporting system for landing of corals and living rock -Commercial catch records through -Monthly Fisher Returns - 1995 onwards
WA Lobster	General Ecosystem: Removal or damage to ecological community: Benthic biota: Coral	To prevent damage to coral bottom through human activity.	Determined following completion of review	TBA	TBA -Past studies of human impact on the Abrolhos coral reefs. -Scoping of future research on the impact of natural and human use on the marine environment at the Abrolhos Islands- Jan 2001.
QLD ECTF	General Ecosystem: Removal or damage to ecological community:	(l) -By 1 January 2005, reduce the % of benthos that is impacted by trawls	-Amount of each type of Benthos -Effort	GBRMPA-A reduction in trawl effort and trawled area by 15%	Data requirements for indicator -Identification of habitat types and locations.

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
	through fishing: Benthic biota (Habitat): Other Benthos	-Broad objective is to ensure functional benthic habitats are in the ecosystem. (p) -Reducing the impact of trawling on the benthos. -Trawling is conducted such that no habitat types are reduced by a significant amount. GBRMPA -Reduce damage to the seabed to an acceptable level -Avoid expansion. -Mitigate in areas still trawled.	-Area Trawled	over three years. (p) -Areas that have not been trawled are not trawled in the future (including closed areas). -Reduction in effort levels by 25% over 5 years. -Effort capped at 1996 levels. -% of fishers using best practice environmental friendly gear.	-Areas fished. -Effort levels by area (swept area and intensity) -Relative impacts by habitat. -% of entire WH area available to trawling. -% of entire habitat available to trawling. -level of compliance. Data availability (current – future) -FRDC - QDPI & CSIRO {Green Zone} report -Logbooks -VMS - -Scenario modelling -Mapping marine biodiversity (CRC- Reef) -Deep water seagrass surveys
NT Barramundi Recreational	General ecosystem: Substrate and water quality (Including Benthic Biota)	(l) -To protect habitat. (p) -Develop educational package to raise social and community awareness of the issues.	Production of EMS/ EMP and Codes of Practice to deal with rubbish/pollution and movement issues.	Understanding and adoption of EMS/EMP and Codes of Practice.	Data requirements for indicator -Determine the effect of boat movement on river habitat -Continue monitoring for pollutants in waterways. Data availability (current – future) -Limited. Primarily with the Department of Lands Planning and Environment.

Table 3b. General Ecosystem: Performance Reports – Possible Management Responses

(Note –The information presented in this table includes suggestions made at the case study workshops and may not reflect the current management arrangements of these fisheries).

Fishery	Component	Objective (legislated and possible)	Indicator	Performance measure	Data
	through fishing: Benthic biota (Habitat): Other Benthos	-Broad objective is to ensure functional benthic habitats are in the ecosystem. (p) -Reducing the impact of trawling on the benthos. -Trawling is conducted such that no habitat types are reduced by a significant amount. GBRMPA -Reduce damage to the seabed to an acceptable level -Avoid expansion. -Mitigate in areas still trawled.	-Area Trawled	over three years. (p) -Areas that have not been trawled are not trawled in the future (including closed areas). -Reduction in effort levels by 25% over 5 years. -Effort capped at 1996 levels. -% of fishers using best practice environmental friendly gear.	-Areas fished. -Effort levels by area (swept area and intensity) -Relative impacts by habitat. -% of entire WH area available to trawling. -% of entire habitat available to trawling. -level of compliance. Data availability (current – future) -FRDC - QDPI & CSIRO {Green Zone} report -Logbooks -VMS - -Scenario modelling -Mapping marine biodiversity (CRC- Reef) -Deep water seagrass surveys
NT Barramundi Recreational	General ecosystem: Substrate and water quality (Including Benthic Biota)	(l) -To protect habitat. (p) -Develop educational package to raise social and community awareness of the issues.	Production of EMS/ EMP and Codes of Practice to deal with rubbish/pollution and movement issues.	Understanding and adoption of EMS/EMP and Codes of Practice.	Data requirements for indicator -Determine the effect of boat movement on river habitat -Continue monitoring for pollutants in waterways. Data availability (current – future) -Limited. Primarily with the Department of Lands Planning and Environment.

Fishery	Component	Management responses
	Removal of species	
WA Aquarium	General Ecosystem: Removal of captured species on ecosystem	-Maintain limited number of licensed operators under the Management Plan. -Maintain current gear restrictions and method of operation. -Maintain current boat replacement provisions limiting boat size to 8 metres. -Codify the industry Code of Conduct to minimise possibility of localised depletion. -Ensure that the spatial distribution of fishing is not too concentrated.
Victorian Abalone	General ecosystem: Removal of captured species on ecosystem	-Undetermined for abalone fisheries, although experimental manipulations of sea urchins and abalone have been trialed in NSW.
WA Lobster	General Ecosystem: Removal of captured species on ecosystem	-Keep lobster biomass levels at current levels using the fishery regulations outlined retained species section. -Changes to minimum legal sizes and the reproductive stages allowed to be retained have increased the standing stock of lobsters in the deeper regions which would therefore have reduced any potential for flow-on impacts.
ET&B	General Ecosystem: Removal of captured species on ecosystem	unsure
NSW Estuary General	General ecosystem: Removal of captured species on ecosystem	unsure
NT Barramundi Recreational	General ecosystem: Removal/Translocation/ Damage of organisms	-Codes of Practice and educational packages to be developed -Need to agree on responsibilities with other agencies and Commonwealth.
	Benthic biota	
WA Aquarium	General ecosystem: Removal or damage to ecological community: Benthic biota: Corals and living rocks	-Maintain limited number of licensed operators under the Management Plan. -Maintain current restrictions on method of operation and daily weights that can be taken. -Regulation of areas where coral and living rocks can be collected. -Maintain current closed areas with extended refugia a further management strategy. -Codify the industry Code of Conduct to minimise possibility of localised depletion of corals. -Monitoring the landings of coral and living rocks. -Sanctions are applicable under the Management Plan for excess collections over quota allocation.

2.4 General ecosystem components: Other impacts on biological community

Whilst the previous two issues (tropic impacts and benthic effects) were present in nearly all fisheries, the following issues were each relevant in only a few cases.

2.4.1 Bait collection

In general, Bait collection was not relevant in the case study fisheries because bait was not used in the fishery or because bait collection was managed as a separate fishery management unit. Bait is not used in the WA Aquarium Fishery, the Victorian Abalone Fishery, the commercial sector of the SA Lakes and Coorong Fishery or the Qld East Coast Trawl Fishery because these fisheries use hand collection methods, mesh nets or trawl nets. However, the Eastern Tuna and Billfish Fishery did have a small number of fishers (mainly tuna longliners) who collected their own bait and this was managed as part of the fishery. This fishery separated out the components as follows (Figure 5):

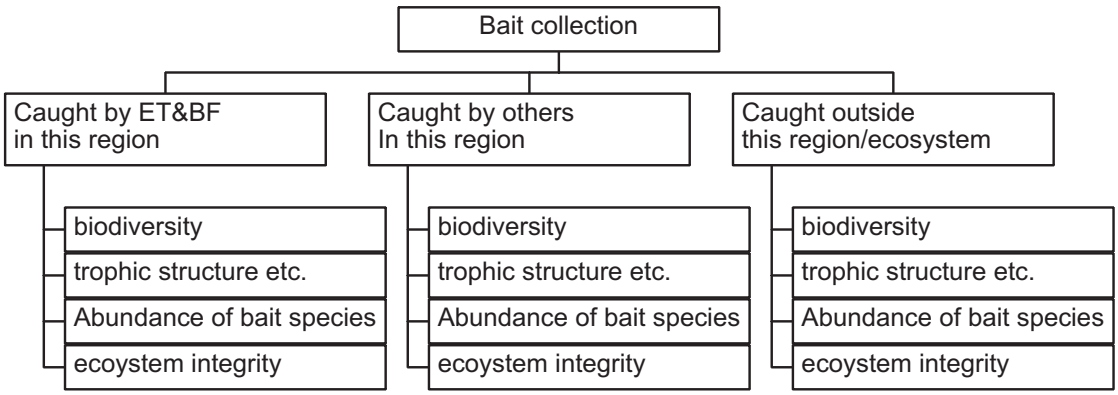


Figure 5. Suggested Bait collection components in the Eastern Tuna and Billfish Fishery

The Eastern Tuna and Billfish Fishery had direct responsibility for the management of the components on the left, ie 'Caught by ET&BF in this region', while the other two branches of components would be covered by State or other Commonwealth fisheries management programs.

WA Rock Lobster Fishery separated bait into effects from disease and effects on the ecosystem, but these were ranked as a low risk. NSW Estuary General Fishery also recognised that bait collection occurred for some of the sub fisheries within their fishery but rated this component as a low risk issue. SA Lakes and Coorong Fishery also rated this issue as low risk for the recreational sector of the fishery.

2.4.2 Ghost fishing

Ghost fishing was not relevant in Victorian Abalone Fishery and WA Aquarium fishery that use mainly hand collection methods. NSW Estuary General Fishery separated the ghost fishing component into Traps and Mesh nets and they rated mesh nets as low

risk. In NSW ghost fishing was not relevant in the hand collection part of the fishery and discarded fishing lines are covered in the Water quality debris component. Ghost fishing was not considered a relevant component in the Qld East Coast Trawl Fishery.

Although it was recognised that ghost fishing could occur in the WA Rock Lobster Fishery this was rated as low risk, due to the high value of the pots and therefore their high rates of retrieval and the fact that pots are made out of cane and wood and would break down fast, compared with metal or plastic. For the Eastern Tuna and Billfish Fishery ghost fishing was considered a very low risk because if longlines were lost the lines would quickly settle on the bottom, taking them out of the reach of most fish, the design of the gear minimises the amount of line/number of hooks that can be lost, and the high value of the lines encourages retrieval of gear. The SA Lakes and Coorong Fishery rated this component low risk from both commercial and recreational sectors.

2.4.3 Stock enhancement

None of the case study fisheries examined rated stock enhancement as relevant in their fishery at the moment. However, stock enhancement is important to keep within the generic component tree structure because it is relevant in some freshwater fisheries and may be important in a number of marine fisheries in the future.

2.4.4 Discarding/provisioning

This component looks at the effects that discarding may have on the marine biological community. WA Rock lobster Fishery, NT Barramundi Recreational Fishery and WA Aquarium Fishery did not think this component was relevant in their fisheries. NSW Estuary General Fishery, Qld East Coast Trawl Fishery, and SA Lakes and Coorong Fishery thought it relevant but just used the generic component sub division of trophic and biodiversity effects. However, the Eastern Tuna and Billfish Fishery workshop separated this component into effects of discards, effects of chumming, and from stealing from hooks (Figure 6). They further sub divided effects of Discards into live, dead and offal. Each sub component relates to different processes on the boat and would need different management responses to control or minimise. Chumming mainly relates to the pole and line sub fishery, and stealing from hooks relates to the longline sub fishery. Interestingly, stealing from hooks was often by killer whales!

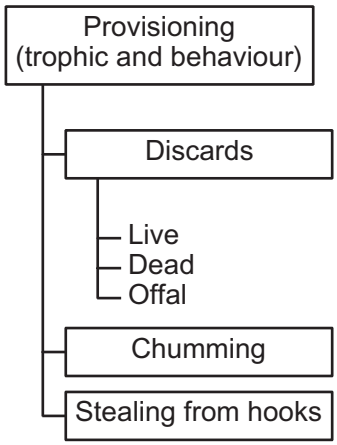


Figure 6. Discarding/provisioning components in the Eastern Tuna and Billfish Fishery

2.4.5 Translocation

Translocation was not deemed relevant in the Victorian Abalone Fishery, the WA Rock Lobster Fishery and the commercial sector of the SA Lakes and Coorong Fishery. WA Aquarium Fishery thought that translocation was more an issue for people who kept the aquarium fish. NSW Estuary General Fishery separated out the Translocation component into effects from transferring pests between estuaries (such as algae), and effects from discarding old bait, on biodiversity and trophic structure. Similarly the Eastern Tuna and Billfish Fishery thought there could be effects from bait translocation on biodiversity and trophic structure. Qld East Coast Trawl Fishery and the recreational sector of the SA Lakes and Coorong Fishery used the standard translocation component, not sub dividing.

2.5 General ecosystem components: Broader environment

2.5.1 Air quality: Fuel usage/Exhaust

The NT Barramundi Recreational Fishery and the Victorian Abalone did not think this component relevant to their fishery. The Qld East Coast Trawl Fishery and Eastern Tuna and Billfish Fishery used the generic component for fuel usage/exhaust without subdividing further. NSW Estuary General Fishery used the generic component but rated this issue as low risk. On the other hand the SA Lakes and Coorong Fishery divided this component into fuel type and vehicle maintenance. The SA Lakes and Coorong commercial fishing industry, through their Environmental Management System (EMS), is investigating fuel usage and the best motors and fuels to improve air quality and show responsible environmental performance. The recreational sector had similar goals in their management strategy.

2.5.2 Air quality: Greenhouse gas emissions

As above, with the exceptions that the Eastern Tuna and Billfish Fishery wanted to look specifically at potential effects on ozone from the boats large freezers and therefore renamed this component Ozone. The WA Rock Lobster Fishery combined the two air quality components fuel usage/exhaust and greenhouse gas emissions together, and rated the issue as low risk. SA Lakes and Coorong Fishery used the standard component for the recreational and commercial sectors.

2.5.3 Water quality: Debris

Most fisheries classified the effect of fishing debris on water quality as a relevant component. Qld East Coast Trawl Fishery, WA Aquarium Fishery and WA Rock Lobster Fishery just used the generic component of debris, with WA Rock Lobster Fishery rating this component as low risk. Other fisheries separated debris into sub components, for example NSW Estuary General Fishery separated the Debris components into Fishing line, Plastic, and Gutting (Fig. 7).

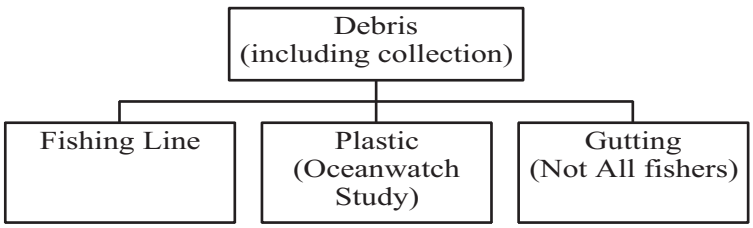


Figure 7. Debris components in the NSW Estuary General Fishery.

While the Eastern Tuna and Billfish Fishery separated the debris component into intentional and un intentional and further sub divided each of these into fishing gear debris and garbage debris, with fishing gear debris including things such as longlines, nets, light sticks, etc, and boat garbage debris including galley waste and garbage. 'Intentional' discarding of debris did not mean that fishers were throwing things overboard, it just meant that the discarding of debris could have been prevented by securing, by placing in bins and taking back to shore. 'Intentional' discarded debris could be covered under the Code of Practice and is covered by MARPOL to a certain extent.

The SA Lakes and Coorong Fishery commercial sector divided the debris component into litter and processing waste and were covering it in their environmental management system (EMS), whereas the recreational sector of the same fishery were looking just at litter.

2.5.4 Water quality: Oil discharge

Most fisheries included this component, but didn't sub divide or examine in detail. On the other hand, WA Aquarium Fishery and WA Rock Lobster Fishery both thought this component wasn't relevant to their fisheries.

NT Barramundi Recreational Fishery combined both debris and pollution together under their Substrate and Water Quality component.

2.5.6 Substrate quality: Above low water mark

This component, that looks at the effects of fishing on the shore or inter-tidal zone was considered not relevant in the Qld East Coast Trawl Fishery, the Eastern Tuna and Billfish Fishery and Victorian Abalone Fishery. However in the other fisheries this component was relevant and sub divided in a number of cases. WA Aquarium Fishery used the generic separation into foreshore and inter-tidal, whereas the SA Lakes and Coorong Fishery divided first into recreational and commercial sectors and then into foreshore and intertidal because the environmental risks were different between sectors. Alternatively, the NSW Estuary General Fishery divided this component first into effects from driving vehicles and effects from hauling, and then under hauling they separated foreshore and inter-tidal. WA Rock Lobster Fishery separated out the Abrolhos islands for special attention under this component (although this was also rated as low risk).

2.5.7 Substrate quality: Below low water mark

All case study fisheries thought this component to be relevant, ie effects on the physical seafloor or substrate. However, some fisheries, such as WA Rock Lobster Fishery, WA Aquarium Fishery, NSW Estuary General Fishery, SA Lakes and Coorong Fishery moved this component from under the component ‘substrate quality’, to under the component ‘benthic biota’, since usually similar processes affected the benthic biota on the seafloor and the seafloor itself. WA Rock Lobster Fishery only examined the effect on coral not all substrates.

Qld East Coast Trawl Fishery and the Eastern Tuna and Billfish Fishery kept this component under substrate quality. Qld East Coast Trawl Fishery broke this component down into physical structures, and then further into moorings and anchorages. Eastern Tuna and Billfish Fishery, a pelagic fishery, wanted to look at the effects from waste disposal.

2.6 Additional general ecosystem components

Most fisheries didn’t substantially change the General ecosystem component tree, just subdividing or amalgamating components. However, some fisheries did add components that were not in the generic component trees. The NSW Estuary General Fishery added ‘noise impacts’, and ‘visual impacts and navigation hazards’. The Eastern Tuna and Billfish Fishery had the potential impacts from FADs (Fish Aggregating Devices) on fish behaviour and ecology. The WA Rock Lobster Fishery has an additional component for ‘bird interactions’.

3.0 ACKNOWLEDGMENTS

As with the *"How To Guide"*, this report was only possible due to the generous support and involvement of many people around the country. The financial support from FRDC was a vital part of this project but there were also significant in-kind contributions from most fisheries management agencies and industry stakeholders.

We are mostly indebted to the local case study managers in each jurisdiction that organized the case study meetings, the outputs of which formed the basis of this technical support document. The majority of the information came from the stakeholder participants at each of the case studies who provided their thoughts and opinions in a generally open and helpful atmosphere.

Finally, the text was prepared for publication by Sandy Clarke from the Community Relations Branch of the Department of Fisheries in WA.

4.0 APPENDICES

Appendix 1: Review of the case study workshop process

The process of carrying out the ESD workshops has been reviewed. Some recommendations are made below that should improve the running and efficiency of an ESD workshop, or similar workshops such as for risk assessment.

Developing a fishery ESD report: Using the workshop process

This project used a consultative workshop process to develop ESD reports for fisheries. Workshops were carried out over two days and they involved identifying ESD components for the fishery, assessing the risk for each component, and developing a performance report for each of these components (The workshop Agenda is provided at the end of this appendix). Using workshops, generally had the following advantages:

- involved a greater diversity of points of view, which assisted greatly when identifying components, assessing risk and developing objectives for components,
- allowed the expression and explanation of these points of view amongst stakeholders,
- ensured better explanation of technical issues which helped reduce confusion,
- assisted with communication and education of stakeholders,
- helped to create ownership of the ESD report by stakeholders.

The disadvantages of workshops were that they:

- could be quite expensive and time consuming,
- may run 'off track' if a good facilitator was not present,
- were reliant upon the stakeholders present (and indigenous people rarely attended).

The following sections deal in more detail with the workshop process and how it can be best used for development of ESD reports in fisheries, in an efficient yet fair manner. The issue of engaging indigenous people needs further investigation and lessons from engaging indigenous people in NT and WA may be a good start.

Who should be involved in the workshops?

Workshops can vary in size and attendees depending upon what the fishery wants to achieve. For the Fishery ESD project it was found that a small group of knowledgeable and representative stakeholders was the best and these should include at least:

- ESD project team and facilitator: These people have a good working knowledge of the ESD 'How To' Guide and can help facilitate the meeting
- The local case study manager: This is the person who will be responsible for ensuring that all the appropriate people attend the meetings, receive the material in a timely fashion and ensure that the reports are written in a consistent manner,
- Local stakeholders: A strong level of local involvement is vital to ensure that the results of each case study will be relevant to local conditions, regulations and issues. It will also assist in the transfer of methodology and increase awareness of ESD in the local community. The local participants at these workshops include a local case study manager (most likely to be the relevant fisheries manager) with other relevant stakeholders including representatives from the fishery/industry being assessed (e.g. Management Advisory Committee members), researchers, management and compliance staff, local conservation groups, relevant indigenous groups (perhaps through parallel methods) and recreational groups,
- Other stakeholders: Other relevant government agencies (e.g. State EPA) should be involved. In most cases there should also be participation by Environment Australia.

How to run an efficient ESD workshop

The details of how these workshops have proceeded includes:

Before a workshop

Instructions for local case study managers

It is best to send out background material to each participant about six weeks before the workshop is to take place, and at the very least 2 weeks before the workshop. This background material should include:

- the outline of what the process is trying to achieve – ie generate an ESD report for the fishery (send them the *'How To' Guide* - or the Fishery ESD web address for an electronic version).
- a set of draft, or initial component trees for the fishery adjusted by the manager/scientist as a starting point, along with the generic component trees, so everyone can see how the component trees have been changed.
- background material, giving an outline of the fishery, a summary of the biology of the species involved, and notes on the environment where fishing operations are occurring. This is needed to give context to the discussions.

The local case study manager should also:

- Arrange venue and facilities,
- Develop attendee list (see above list of suggested attendee categories) and facilitate their attendance.

- Arrange for the collation of all relevant material - obtain copies of any relevant assessments, research data, management plans, regulations, codes of conduct etc.

It is also useful for the local case study manager to:

- Arrange for a high quality computer projector (1000 dpi resolution), electronic whiteboards ,
- Organise a 15 minute talk on the fishery (could be either the manager, a fisher or both)

Instructions for all attendees

All other attendees should identify the SPECIFIC issues/components relevant to this fishery and compare these with the generic component trees and look for areas where additions or deletions of components will be necessary. If possible lodge any suggestions with the project team and/or the Local Case Study Manager before the workshop, otherwise bring these to the meeting. In addition collate/ bring/ distribute any relevant material for identified issues to assist with the risk assessment.

At the workshop

Preliminary - An introductory talk is normally given to clarify the objectives for those who read the material and instruct those who did not. There are usually a large number of participants that do not have time to read the material provided. (The powerpoint presentation that is shown by the ESD project team at the introduction of case study workshops can be found in Appendix 3).

Modifying Trees – It is useful to give an explanation of the generic component structure in the beginning of the workshop. These discussions will be more fruitful and efficient if each of the attendees has examined the component trees before the meeting and comes along with their suggestions as to what amendments will need to be made.

The group will need to modify the generic structure to meet specific issues for their fishery by adding sub-components that are not covered adequately in the generic structure, or by showing or deleting sub-components that are not relevant. If any of the generic sub-components are removed, a written justification should be provided as to why they are not applicable to this fishery. A sub-component can only be removed if the issue is not significant, not just because there is no data available for it.

The case studies ran most smoothly when a person used a computer with a projector to modify the trees during the discussions. The MS organizational chart software is relatively simple to use, but the person operating the computer should be familiar with this before the meeting.

The discussions to adapt each of the eight generic component trees should be restricted to no more than 45 minutes each and preferably less than 30 minutes. It is best if someone provides a five-minute introduction on each of the component trees, to assist in the efficiency of the discussions.

It is important to ensure that this stage of the process only identifies the issues and is not prioritisation, so there should be virtually no discussion of how important an issue is unless someone raises an issue that is absolutely wrong/inappropriate. Even this may

be useful to document because in many cases the articulation of what is *not* important is more valuable than what is important.

Facilitation - Administration

In circumstances where there is likely to be a large degree of dissent on issues, particularly between fisheries agency/department staff and other stakeholders, it may be prudent - or more efficient - to use the services of an independent facilitator to manage proceedings. The alternative is to have the manager, or someone else from the agency/department, chair the proceedings. However, a vital element in this is that the facilitator (be they independent or agency/department-based) needs to have a good understanding of the full ESD Reporting process and at least a passing understanding of the fishery. Unless this is the case, it may be difficult to control proceedings and achieve a sensible outcome.

Someone - not the facilitator - should be set up with a computer and computer-projector, so as to be able to assist the facilitator and display/amend the component trees, as the workshop progresses. Consequently, this 'assistant' can alter the trees when issues are identified or removed. If this alteration can be done in 'real time', those involved in the workshop can see exactly what is happening, which helps the workshop to progress. Notes on why certain issues were removed should be kept, as this will need to be justified in the final report.

The use of a "parking space" whiteboard has been very useful for documenting issues that are not relevant to the current discussion but need to be addressed at some stage and not forgotten. At the end of the workshop the list of issues on the whiteboard should be dealt with, or crossed off if they have already been covered. Using this method helps workshops flow and gives everyone a voice.

Suggested agenda for case study workshops

Day One (until morning tea)

Task 1: Provide an Overview of ESD (see Appendix 3 for presentation)

- What is ESD?
- How does ESD fit into Fisheries Management
- Describe the National ESD Reporting Framework
- How does it relate to other initiatives (EPBC Act, EMS).
- Provide Descriptions of the fishery to be assessed, both the biology and fishery

Day One (morning tea until lunch)

Task 2: Develop component trees for this fishery (do not attempt to define the specific objectives and indicators at this stage)

Discuss each of the draft component trees. These discussions will be more fruitful and efficient if each of the attendees has examined the component trees before the meeting and comes along with their suggestions as to what amendments will need to be made.

The group will need to modify the generic framework to meet specific issues for the fishery by adding sub-components that are not covered adequately by the sub-components already showing and deleting sub-components that are not relevant. If any of the generic sub-components are removed, you should provide written justification as to why they are not applicable to this fishery. For a sub-component to be removed this requires the issue to not be significant, not just that you have no data.

The discussions to adapt each of the 8 generic component trees should be restricted to no more than 30 minutes each.

Day One (Lunch till late)

Task 3: Complete Risk Assessment for Identified Issues

Using the component trees developed earlier in the day, begin to step through each of the issues and determine risks associated with the operation of the fishery.

This process is designed to determine which issues require specific management actions and hence specific objectives and measurement of performance. Consequently, all target species are likely to require ongoing assessments because some management actions are likely to already be in place (e.g. effort controls, biological restrictions – size limits etc). The risk assessments therefore only need to be completed for the by-product components, all the non-retained species, and ecosystem components.

A prioritisation process can be applied to the social and economic issues based upon the importance to future management/access.

Day two

Task 4: Completion of Example Performance Reports

It is important to provide at least a few example reports for each of the component trees. This may involve developing a report where there is already an objective/indicator/measure available from a current management plan/arrangement. In many cases, however, it will first need to involve discussions with the stakeholder group present as to what these might be.

Wherever possible, it will be helpful to get agreement during the meeting about what should be in the performance report. Any proposed objective and performance measure would, in most cases, require subsequent ratification. If, however, agreement cannot be reached on a specific objective or performance level during the meeting, then each of the propositions can be recorded (along with any justifications) and used as the basis for later consultation. This should not be seen as a failure, but as a means of identifying the specific issues that will require further attention.

It is expected that at best only brief notes would be made for the other headings (such as indicator, performance measure, data, evaluation), and these would need to be fleshed out subsequently.

Task 5: Comparison of ESD report to that required by EA and others

Explain the generic EA application "front end" and discuss the issues specific to this fishery and how they may affect an application to Environment Australia.

Tips for explaining the concepts of Risk Assessment

It often takes a reasonable length of time for participants at a 'risk assessment' workshop to become familiar with the process and what is required. It is useful, therefore, to run through a few examples that provide sufficient contrasts in consequence and likelihood to demonstrate how issues should be rated.

It is common for people to initially get confused in the assignment of issues to the correct categories within the consequence and likelihood tables. This confusion often arises because they try to directly rate the 'risk', not the two components of 'risk'.

Figure 15 (see below) has been used at the beginning of a number of workshops to illustrate the difference between 'consequence', 'likelihood' and 'risk'.

Some practical examples are shown below.

Example 1 – The pilchard mortalities that occurred around Australia's south coast some years ago. These caused a severe 'consequence' (Consequence level 3) but this only occurred rarely (Likelihood level 3). This is illustrated by the dark shaded section in Figure 15 – most of the time the consequence is 'nil', but when a disease event hits, the consequence increases to 'severe'. Hence the overall Risk Rating for this issue is 9 – which is a 'moderate' risk.

Example 2 - The impact of the prawn trawl fishery on the king prawn stocks in Shark Bay. With the current levels of effort and the dynamics of this species, the 'likelihood' is that every year (eg Likelihood level 6) there will be a 'moderate' consequence (Consequence level 2) on the stocks. This is illustrated by the medium shaded section of Figure 15 – every year the line will be in the same place. The Risk Rating for this would be 12 - which is also only a 'moderate' risk..

Example 3 - The impact by a South Coast trawl fishery on byproduct tropical species. Due to the location of these tropical fish outside their spawning range, these individuals are unlikely to contribute to any spawning biomass of their species and the impacts of their capture will at most be negligible (Consequence level 0). Furthermore, as capture only occurs in the years when a strong Leeuwin current sweeps them south the likelihood (illustrated by the light shaded regions) will only be 'unlikely' (Likelihood level 3). This produces a Risk Rating of 0 – a 'negligible' risk.

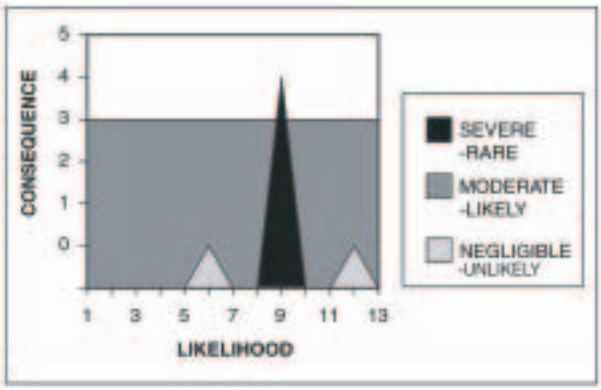


Figure 15. Pictorial representation of the differences between consequence and likelihood. The height (y axis) represents the relative level of consequence of an "incident", with the frequency of the incident shown on the x axis for each of three examples.

Appendix 2: The case study fisheries- Background

Qld East Coast Trawl Fishery

Primary species life history and ecology

The Queensland East Coast Trawl Fishery catches a variety of prawns including bay prawns, eastern king prawns, tiger prawns, red spot king prawns and other prawn species, bugs, squid and scallops. Generally speaking many prawn species have short lifecycles of a few years, can breed within one to two years and are highly fecund producing 150, 000 to 1.5 million eggs. Many prawns can spawn throughout the year but most species have spawning peaks and fishing often targets spawning aggregations or movements (eastern king prawns are known to migrate up to 1000km). Prawns tend to spend the first few weeks in the plankton before settling in 'nursery areas' that are often shallow inshore areas and estuaries. Adults usually move into deeper water although there are some exceptions (eg bay prawns). Prawn diets are variable with some species being carnivores (eating molluscs, crustaceans and polychaete worms), some omnivores and some detritivores, and diets often change as prawns mature. Prawns are eaten by squid, cuttlefish and a variety of finfish, from bonyfish to skates and rays.

The Bugs mainly caught by the fishery are Moreton Bay bugs (*Thenus* species), such as mud bugs and reef bugs, and Balmain bugs (*Ibacus* species). Moreton Bay bugs are mature in about a year and can live for 7 years. They are active mainly at night and can travel large distances. Juveniles feed on small benthic animals while adults feed on fish, crustaceans and molluscs, preferring bivalve molluscs. Predators are mainly benthic fish including rays.

Scallops caught by fishing are mud scallops and saucer scallops with the former being byproduct in the trawl fishery (40t) and the latter targeted (~1500t). Saucer scallops spend a few weeks in the plankton and then settle onto the ocean floor, they have a fast growth rate and are mature at 9-12 months and not many live past three years. Mud scallops are assumed to be similar.

Pencil squid (mainly *Photololigo* species) are caught as byproduct in this fishery with 150-200t per year. Squid growth is fast with a short lifespan of a year. The squid live in schools but spawning grounds are yet to be determined for the Pencil squid. Squid are most vulnerable to being caught in the day when they settle on the ocean floor but at night, when most trawling occurs, squid are off the seafloor. Diet is not well known, but probably prawns and fish.

Other species that are permitted to be caught by the Fishery include finfish such as whiting, whiptails, goatfish, pinkies, syngnathids, and sharks, as well as crustaceans such as barking crays, mantis shrimps and blue swimmer crabs, and molluscs for example cuttlefish and octopus. The list of species permitted to be taken is under review. At certain times and in certain areas stott whiting can be a large proportion of the catch.

The fishery also catches unwanted fish, turtles and seasnakes and trawl catch that is not retained (sometimes called bycatch) is estimated at from 65-95% of the total catch

depending on area, season and other factors. The introduction of Bycatch Reduction Devices (BRDs) and Turtle Excluder Devices (TEDs) should reduce these catches substantially, with BRDs estimated to reduce non retained catch by 40% or more. BRDs and TEDs are now compulsory throughout the otter trawl fishery.

History of the fishery

Limited entry for the Qld East Coast Trawl Fishery was introduced in 1979 and under these arrangements no new vessel licences are to be issued. To enter the fishery you must purchase an existing vessel licensed as a Queensland Commercial Fishing Vessel. Fishing is now licensed under the *Queensland Fisheries Act 1994*.

Area of the fishery

The Qld East Coast Trawl Fishery occurs from Cape York to the NSW border. Trawling occurs in bays, rivers and inlets, along the coast and out to the Great Barrier Reef.

Fishing Methods

There are three main fishing methods used, river and inshore beam trawl with 161 licenses and 100 active boats, prawn otter trawl and scallop otter trawl with 565 boats in 2001 (versus over 1400 licenses vessels in 1980). The beam trawl catches only 5% of the catch. The otter trawl fishing may be broken down into different regions, with the northern region occurring in the Great Barrier Reef Lagoon (ie between the reef and the Queensland coast), the southern region and the Moreton Bay region.

The northern boats catch tiger, red spot king and endeavour prawns, the southern trawlers catch eastern king prawns and saucer scallops and the Morton Bay sector catches bay and eastern king prawns, blue swimmer crabs and squid. Banana prawns are caught by all three and bugs are caught along the coast. Trawling does not occur in areas with coral and rock, canyons or steep slopes and trawling is estimated to occur over less than 15% of the east coast.

Management of the fishery

The Qld East Coast Trawl Fishery is managed by the Queensland Fisheries Service and was previously managed by the Queensland Fisheries Management Authority. The fishery is worth over $100m, has nearly 800 boats, and is estimated to employ about 10,000 people directly and indirectly. It is managed by limited entry, boat and net restrictions, area and time closures and effort restrictions on boats. The Great Barrier Reef Marine Park Authority also imposes measures on the fishery where fishing occurs in the marine park, the main management measures being area closures. Since the end of 2000 restrictions to the number of days the trawler could operate as well as increases in area and time closures have been implemented.

Vessel Monitoring Systems (VMSs) are on trawl boats and may be used to track where fishing is occurring as well as infringements of area closures. Bycatch Reduction Devices (BRDs) are compulsory and Turtle Excluder Devices (TEDs) will soon be compulsory.

Research

More active management has resulted in the introduction of VMS on all boats which should provide much more information on effort, area and time of fishing. Research into the composition of bycatch, effects of trawling on benthic habitat and mapping of seafloor habitat as well as surveying seagrass beds are taking place.

References

In addition to the ESD workshop report this overview was written using:

Williams, L. E. (ed) (2002) *Queensland's fisheries resources: Current condition and recent trends 1988-2000, Information series Q102012*. Department of Primary Industries, Queensland, Brisbane.

WA Aquarium Fishery

Primary species life history and ecology

This is a limited entry fishery with a small number of licensees. It is based upon the collection of individual fish for Australian and overseas markets to meet the large demand for marine aquarium fishes. The marine aquarium fishery targets over 250 species from a number of bio-zones from the Great Australian Bight through to the Kimberly coast. Many of the tropical fish species collected in the fishery also occur in Indonesia and the Philippines. Whereas a number of fish caught in the south and south west of Western Australia are endemic (occur only in these regions) and prices for these species is higher in overseas markets.

History and Management of the fishery

The WA Aquarium Fishery has been managed under special licensing arrangements since 1985. The fishery is managed in a precautionary manner and from 1985 to 1990 the number of endorsements was restricted to twenty fishers. The management of the fishery was reviewed in 1994 and a *Marine Aquarium Fish Management Plan* was introduced in 1995. The management plan has controls on the number of licences issued (there are now 13 licences issued), as well as restrictions on the size of boats (8m in length), on the permitted fishing gear and capture methods. In addition, specific size limits apply to some commercially exploited species and these limits are in place to stop operators collecting juvenile specimens. Some species that are covered by other management arrangements or management plans are not permitted to be taken by the WA Aquarium Fishery.

Area of the fishery

The fishery boundaries are the WA coastline out to the 200 n mile limit. There are also a number of area restrictions within these waters where collectors are not allowed to operate, including marine parks and some 'fish habitat protection zones'.

Fishing methods

Fish are caught by fishing gear as specified in the *Marine Aquarium Fish Management Plan 1995.* These methods include (but are not limited to) hand held scoop nets,

fence/barrier nets, haul nets throw nets, vacuum pumps and other hand collection methods. Fish collectors also use a wide variety of holding devices, including floating pens.

Research

Licensees must submit a monthly return that provides information on the numbers of each species and the statistical block where they were caught during the previous month.

References

In addition to the ESD workshop report this overview was written using:

Barrington, J. H. S. (1994) *Fisheries Management Paper No. 63: Management of the marine aquarium fish fishery*. Fisheries Department of Western Australia. East Perth.

WA Rock Lobster Fishery

Primary species life history and ecology

The western rock lobster (*Panulirus cygnus*) is a crustacean that can live for 20 years and grow up to 5.5kg, although under fished conditions they rarely exceed 3kg. They mature at 6-7 years and about 90mm carapace length in the south of their distribution, but mature earlier in the North, at about 70mm carapace length, at Abrolhos islands. During mating the male lobster attaches a packet of sperm to the female, and this is often called a tarspot, and when the female spawns her eggs she scratches the tarspot, and fertilises the eggs, which are then attached to a sticky part under her abdomen (the female is then called 'berried'). The eggs hatch in 5-8 weeks and the larvae are then swept into the currents. The larvae feed on plankton for 9-11 months in the ocean, and if they are lucky enough to survive, they settle on shallow inshore reefs at the puerulus stage where they grow into adults. The number that settle on reefs varies greatly depending on environmental factors, such as a strong Leeuwin Current and Westerly winds leads to more settlement.

The puerulus moult into juveniles that look more like lobsters, and these feed and grow in shallow inshore reefs for three to four years. After four years they moult, in synchrony, and migrate into deeper waters and reefs. Some migrate further in a Northerly direction along the continental shelf.

Western rock lobsters are omnivores, feeding on a wide range of foods, such as corraline algae, molluscs and other crustaceans, which probably have a high productivity and short life cycles. Juveniles rock lobsters have been found to have a wide range of diets and feeding strategies, depending on season and habitats. Diet is related to the abundance and size distribution of benthic macrofauna. When juvenile this species is eaten by numerous fish species and when adult are eaten by octopus and large fish. No predators feed solely on octopus.

History of the fishery

The fishery began in the 1940s and over the last 20 years has averaged about 10,000

tonnes per year, varying from 8000 to 14,000 tonnes. Catch in 1999/2000 was valued at $350 m, with each transferable lobster pot entitlement worth over $25,000. The fishery has been limited entry since the 1960s, with 830 boats, and this has been reduced to 594 boats by management measures to take into account increasing efficiency. Other management measures include limiting and reducing the total number of lobster pots and shortening the fishing season.

During the late 1980s the breeding stock had fallen to a level that might affect recruitment and so a reduction by 18% of commercial pot numbers and a prohibition on the taking of certain reproductive stages, to assist the survival of breeding females.

Area of the fishery

The western rock lobster occurs along the continental shelf on the west coast of Western Australia. Fishing for rock lobsters occurs from inshore areas in shallow water, to the edge of the continental shelf. Greater abundances of rock lobster occur off the mid west coast (Geraldton – Perth) than the northern and southern parts of the west coast although the commercial WRL fishery operates from all the ports between Denham and Bunbury. The fishery is split into two main zones, a North and Southern zone and the North zone is further subdivided. Recreational fishers fish the whole coast but are most concentrated around the main population centres of Perth and Geraldton.

Fishing Methods

The commercial fishery uses pots, which are traps of a batten design made from wood slats, or a behive design made from cane. Dimensions, escape gaps and neck sizes are specified by regulation. Pots are baited and set (released) into waters, often near reefs where lobsters live, or near areas thought to be migration routes. Information on this may be gained by depth sounders, GPS, and previous experience. Pots are left overnight to attract lobsters and pulled usually in the morning. Lobsters not of legal size, or reproducing (berried) are put back in the water. The lobsters that are kept are usually put in holding tanks and returned to processing facilities on-shore, with most being live-shipped to overseas markets.

The fishing season in coastal waters opens on 15 November and commercial and recreational fishers fish the reefs but when the migration starts most commercial fishers follow the lobsters into deeper waters. The abundance of legal sized lobsters is reduced by fishing over the summer but is reinvigorated by another peak of recently moulted lobsters by March.

Management of the fishery

The WA Rock Lobster Fishery is managed under the Fish Resources Management Act 1994. The fishery is management mainly by input controls, which limits things such as gear, entrance to the fishery, total number of pots in the fishery. Licenses have a number of pots associated with it and this limits the amount of gear fishers can use in a fishing season. The licenses and pot entitlements are transferable. Changes in harvesting rates may be made by varying the effort in the fishery, by changing the number of pots or the time or areas of operation. Minimum legal size limits for lobsters is another management measure, that means that lobsters are caught when

three or four years after settling as puerulus. Enforcement of the rules of commercial and recreational rock lobster fishing is carried out by patrol boats for at sea inspection, policing fishing zone boundaries and pot numbers, and shore based officers inspect the landed lobsters, particularly within processing plants for compliance with minimum sizes etc. There is currently a high level of cooperation from the industry and a high level of compliance with the regulations.

There are a small number of recreational lobster fishers, who take from 3 to 6% of the commercial catch. A recreational license is necessary and there is a limit of two pots per fisher and a daily bag limit of 8 lobsters.

The management arrangements for the fishery can be summarised as follows:

- Closed season Winter to mid Spring
- Maximum Number of pots for the fishery
- Can only fish in the zone the fisher has been licenses for.
- Minimum carapace sizes.
- Illegal to retain setose females or those carrying eggs, or tarspot.
- Maximum size limits.
- Pot size and escape gaps are regulated.
- Pots may only be pulled during specified daylight hours.
- A licensee must have between 63 and 150 units of pot entitlement.

Research

Research and monitoring has occurred for over 50 years. Puerulus settlement is estimated by samples taken at a number of locations using artificial seaweed puerulus collectors. The puerulus can be used as an indication of the previous years spawning as well as to estimate the approximate size of the commercial sized lobsters in 3-4 years.

A spawning stock survey is undertaken each year by research staff on commercial and research vessels. About one third of the commercial fishermen assist with monitoring of breeding stock and other facets of the fishery by completing a detailed daily logbook. Finally, Department of Fisheries officers undertake sample monitoring of the fishery onboard commercial vessels where they collect information on the sizes of lobsters caught, noting the reproductive state of rock lobsters along with many other factors.

References

In addition to the ESD workshop report this overview was written using:

Department of Fisheries, WA (2001). *Application to Environment Australia on the Western rock lobster fishery against the Guidelines for the Ecologically Sustainable Management of Fisheries for Continued Listing on Section 303DB of the Environmental Protection and Biodiversity Conservation Act 1999.* Department of Fisheries, Western Australia, Perth. Pp 115.

Victorian Abalone Fishery

Primary species life history and ecology

Abalone are molluscs, and two main abalone species, the black lip abalone and greenlip abalone are caught by the Victorian Abalone Fishery. Abalone populations, like many molluscs, are affected greatly by environmental conditions. Often population numbers will track environmental changes and as a result, abalone numbers can be quite variable over space and time. The black lip abalone is a cryptic species that hides in reef crevices and is spread more consistently across the reef environment than most abalone species, which tend to have large aggregations concentrated in small areas. This means that black lip abalone are less likely to be totally removed from an area, and those abalone that escape fishing, can recolonise surrounding areas.

By contrast greenlip abalone is bigger, is less cryptic, occurs in denser populations but these are often isolated in patches far from each other. Greenlip abalone occur in different reef habitat to the black lip abalone, and this habitat is often isolated. This makes it harder for green lip abalone to recolonise suitable habitat if fished out of an area.

These species feed mainly on algae and seagrass and are eaten in turn by crabs, starfish, stingrays, some sharks, and possibly rock lobster. The may compete with urchins and snails.

History of the fishery

The Victorian Abalone Fishery started commercially in the early 1960s. Originally the fishery was managed by input controls but output controls were added in 1988, as TACs. There are currently 71 license holders for the 1400 t taken per year with the catch being processed by 18 processors. The landed catch is valued at about $70m per year.

Area of the fishery

This fishery, which occurs in Victorian waters, is divided into three zones, Western, Central and Eastern, to take into account variation in numbers between areas. The abalone occur on reefs and reef complexes.

Fishing Methods

Small boats are used in the fishery with the abalone being taken by diving. They are prized off rocks and reefs by the use of specialised flat knives.

Management of the fishery

The fishery was originally managed using input controls, such as legal minimum lengths, zonation, limited entry and possession limits. Output controls, being a total allowable catch (TAC) was introduced in 1988, and is set at 1440 t, and allocated across 1420 quota units. A Management plan is being developed for the fishery and is near completion.

Illegal fishing is a problem in this fishery.

Research

The fishery collects fishery dependent and independent data as well as tagging studies for information to estimate population parameters. Catches need to be reported at the level of reef complex, small bays and headlands, in the logbooks. In addition, MAFRI carries out commercial catch sampling for abalone size structure and reproductive status, and on board observer sampling for catch rates, diver depth and habitat characteristics. 150 fixed sites are also surveyed independently by MAFRI scientists and record information on abalone and other marine environment characteristics, such as algae, kelp and competitors and predators.

References

In addition to the ESD workshop report this overview was written using:

Victorian Department of Natural Resources and Environment (2001) *Submission to Environment Australia: Assessment of the Victorian Abalone Fishery against the Guidelines for the Ecologically Sustainable Management of fisheries: April 2001.* Victorian Department of Natural Resources and Environment, Melbourne. Pp 1-40

Fisheries Victoria (2002) *Victorian Abalone Fishery Management Plan.* Victorian Department of Natural Resources and Environment, Melbourne. Pp 1-52.

NSW Estuary General Fishery

Primary species life history and ecology

About 90 species are caught in the Estuary General fishery with the main species being yellowfin bream, sea mullet, sand mullet, fantail mullet, sand whiting, river eels, dusky flathead, luderick, silver biddy, and silver trevally. Nevertheless only a few species dominate the catches with about 90% of the catch being the above ten species and 97% of the catch consisting of only 27 species.

Yellowfin bream stocks are found in many estuaries and caught by many fishing methods, catches have remained within 400-600 tonnes per year for many years, peaking in late 1980s and declining since that time and this may have been due to reducing fishing effort and changing fishing methods rather than a significant decline in stock. The majority of fish caught are between 3-8 years of age and landed size composition has remained relatively constant over 50 years. Dusky flathead are mainly caught in estuaries by mesh nets and sometimes by haul nets with about 200t caught per year. The majority of commercial luderick is also caught in estuaries with about 400t per year and it is considered moderately fished. Sand whiting is caught in estuaries but are also caught on ocean beaches with haul nets tending to catch smaller fish and mesh nets catching larger fish, with about 130t per year. Silver trevally are caught in estuaries and inshore by a variety of methods with about 40t taken and are considered overfished across NSW with large declines over the past decade. Sea mullet is caught in estuaries and ocean beaches with about 2000-3000t caught per year and the stocks are assumed to be fully, to overfished. River eels are caught by traps in estuaries and freshwater rivers with about 200t taken per year.

All species mentioned above are estimated to be fully fished except for those

mentioned specifically. Apart from sea mullet and luderick it is expected that recreational fishers take as much as commercial fishers.

Ecological effects are not well known as it is difficult to tease apart other fisheries and agricultural and development effects on estuaries. Marine protected areas are being set up, as well as recreational-only estuaries and regions.

History of the fishery

The Estuary General fishery started in the mid 1800s and was first regulated under the Fisheries Act 1865. By the end of the 19th century controls over type, size and use of fishing nets and fishing closures and licensing of boats were in place. NSW Fisheries has records of estuarine catches for the past 50 years with the overall amount of fish taken remaining relatively stable. The fishery mainly occurs in 24 of the 130 major estuaries in NSW. About half of NSW commercial fishing businesses are permitted to fish in the NSW Estuary General fishery. In 1998/99 the fishery took 5,500 t of fish valued at about $20m at farm gate.

Area of the fishery

This fishery operates within the estuaries of NSW. Estuaries are water bodies that are enclosed to some extent by land and represent the zone where the ocean meets the land, where salt water is mixed with freshwater. As a result estuaries can be greatly affected by river flows, wind, rain, waves and this can vary across estuaries and within estuaries. Most NSW estuaries are also surrounded by urban areas and agriculture and have modified freshwater inflows.

The estuary general fishery competes with a number of other fisheries, such as other commercial, recreational and indigenous fishing as well as competing with other non-fishing uses.

Fishing Methods

More than 15 types of fishing gear are used in the Estuary General Fishery with the most common fishing methods being meshing and hauling nets. There are also trapping for crabs, eels and finfish and some handlining and hand gathering. Collection of pipis and beachworms on ocean beaches is also included because handgathering also occurs in estuaries. Fishing is mainly by small fishing boats mostly in 24 of NSW's 130 major estuaries.

Studies on discards by different fishing gear are taking place and gear has been modified and tested, for example one study found that adding larger mesh panels into the bunt of the haul nets reduced catches of unwanted animals and improved size selectivity of sand whiting. Other tests found that manipulating haul net mesh sizes could reduce the number of fish below the minimum legal length.

Management of the fishery

Access has been limited to those fishers who have a demonstrated history in the fishery and fishers have been endorsed to fish in one or more of 9 method categories. The fishery is managed by gear limitations and specifications for minimum net mesh sizes, time limitations, closed areas and seasons, and minimum fish size limitations.

Research

Although fishing catch has been recorded for 50 years fishing effort has only accurately been recorded for the past 15 years or so. Landing records, fish size data and surveys are used to cross check catch and effort trends. Recent research has examined the eel fishery looking at reproduction, age and growth as well as looking at glass eels, their recruitment and potential for aquaculture. Other research into fish discarding by different fishing methods has assessed levels of discards and investigated changing fishing gear to improve (decrease) the discarding of fish.

References

In addition to the ESD workshop report this overview was written using:

NSW Fisheries (2001). *Estuary General Fishery: Environmental impact statement*. NSW Fisheries, Cronulla. Pp 1- 384.

NSW Fisheries (1999). *1999 Estuary General Fishery Report*. NSW Fisheries, Cronulla.

NT Barramundi Recreational Fishery

Primary species life history and ecology

The primary species caught in this recreational fishery is Barramundi. It was estimated that in 1999 300t of Barramundi were caught by the recreational sector and 800t by the commercial sector (Kelly and Griffin, . Barramundi breed from December to March in the Northern Territory. Young males move downstream and meet up with the larger females (fish change sex as they get larger) in the estuaries. They usually spawn in aggregations on the full moon or new moon, at the beginning of an incoming tide. This allows eggs to be carried into estuaries as embryonic development is best in brackish water. Juveniles live in freshwater swamps and creeks. The fish tend to mature at 1 to 5 years and breed as males for a couple of years before changing into females, although this varies between individuals. The males turn into females at about 80- 95 cm in length or 4 to 8 years and the females can grow to 180cm in length. Juvenile and larval barramundi feed on plankton, while adults eat crustaceans (such as prawns) and fish (including juvenile Barramundi) (Kailola, et al. 1993).

History of the fishery

The fishery as a whole (including commercial) began in the 1960s. After a major increase in fishing effort in the 1970s, restrictions were put in place and the catch rate for the recreational sector improved, doubling the catch per hour between 1986 and 1995. Since 1994 there has been a trebling of Fishing Tour Operators in the fishery as well as a large increase in fishing lodges, safari camps and tours.

Area of the fishery

The fishery occurs across Northern Territory coastal and freshwaters, but particularly around Darwin, such as Mary River and Daly Rivers, Kakadu, and also Victoria, Roper and McArthur Rivers in the South.

Fishing Methods

Fishing is mainly from boats (often specifically designed for Barramundi) in freshwater and marine waters. Anglers use light rods, fly fishing gear or handlines and they cast or troll using lures or bait. Fish caught in rivers are mainly one to four years old.

Management of the fishery

The fishery is managed through input and output controls, such as possession and size limits, gear restrictions and seasonal area closures. Fishing is managed under the Barramundi Fishery Management Plan (1998).

Research

Research includes such things as fishing competitions, with Barramundi Classic tag and release tournament having data since 1982. The Fisheries division carried out a survey on catch, effort and expenditure in the recreational sector in 1993, and FISHCOUNT, a general survey of the human population was carried out in 1994 to 96. Research into fish recruitment and abundance of this species is relevant to both the commercial and recreational sectors.

References

In addition to the ESD workshop report this overview was written using:

Kelly, M. and Griffin, R. (2000) Barramundi Fishery Status Report 1999, Pp 11- 18. *NT Fishery Status Reports 1999, Fishery Report No. 55*. Department of Primary Industry and Fisheries, Darwin.

Commonwealth Eastern Tuna and Billfish Fishery

Primary species life history and ecology

The primary species caught by this fishery are tuna and billfish. These species are large predatory fish that may range over substantial areas, with the primary species being found across the South West Pacific. The primary species include yellowfin tuna, bigeye tuna, broadbill swordfish and skipjack tuna. Yellowfin tuna mature at 2 years of age but may grow to 180cm in length and weigh over 100kg when 6 years old, although fish caught in Australia tend to be about 30kg. Bigeye tuna are similar to yellow fin, although grow slower, maturing at about 3 years old and can reach 200cm and weigh over 180kg when 8 years old or older. Those caught in Australia average 35kg. Bigeye tend to live lower in the water column than yellowfin, from 150m to 300m deep. Adult bigeye and yellowfin tend to be solitary, but when juvenile they form aggregations. Swordfish similarly have a large distribution, they can grow to 550kg and grow rapidly for the first two years. Half of the female swordfish are mature at 4 years and weigh 50-60kg, while half of males are mature at 2 years at about 20kg. Australian fishers catch swordfish between 20 and 90kg. Swordfish can live at much deeper depths than the above tunas, down to 600m, but all three species may move towards the surface at night.

Skipjack tuna are substantially smaller and can mature within their first year, their growth rates are variable and they can reach 1.5kg or 40cm within their first year and greater than 20kg in 4 years. They spawn all year round, near the equator but only in summer at lower latitudes, and they do not spawn in NSW or Tasmania where most Australian catches are taken. Like the other tunas they can move over large distances.

Other species caught include a number of sharks, and like tunas these species feed on small and medium sized pelagic fish as well as squid. Tunas and billfish do not have many predators, although killer whales and sharks have been known to take caught tuna before they reach the boat deck. Seabirds can be caught when diving for bait on long lines.

History of the fishery

The Eastern Tuna and Billfish Fishery occurs from North Queensland to Tasmania. Japan began fishing in the 1950s and catches have ranged up to 400t for yellowfin, 750t for bigeye and 100t for swordfish. In 1997 Japan was excluded from Australian waters. Australians also fished in this fishery from the 1950s mainly selling to canneries, although from 1984 fish were air freighted to Japan to the high value market. In 1988 many boats left the fishery due to variable catch rates. In the late 1990s after Japan was excluded many Australian boats re-entered the fishery and expanded fishing into Northern Queensland. The fishery is focussed o exports with biqeye and yellowfin being sent to Japan, and swordfish to the USA. There are presently about 150 boats in the fishery.

The skipjack purse seine fishery started in the 1950s and until the 1980s mainly caught fish off Southern NSW after the Southern Bluefin Tuna fishing season. Fishing for SBT changed and skipjack is presently the main species caught for canning in Australia.

Area of the fishery

This fishery occurs in Commonwealth waters from Cape York, along the eastern coast of Australia, including waters around Norfolk Island, to the border between Victoria and South Australia, . Fishing sometimes occursout to the 200nm boundary of Australia's fishing zone and boats may concentrate on seamounts. Purse seine skipjack tuna fishing mainly occurs in the south, off Tasmania and southern NSW.

Fishing Methods

There are three main sub fisheries, or methods of fishing, within the Eastern Tuna and Billfish Fishery, with longlining, purse seine and other methods (poling, rod and reel, handlining and trolling).

Most Australian Eastern Tuna and Billfish longliners are between 15 and 30m and they set between 200 and 1200 hooks at night on long monofilament lines. Northern Queensland boats tend to set less hooks but make several sets each day. Australian boats store catch in an ice slurry or brine spray systems and trips can be three to seven days. Japanese longliners are bigger, set more hooks and stay at sea longer. Light sticks are attached near the hooks and are used to attract the fish.

The purse seine part of the fishery catches mainly skipjack tuna, using purse seine nets, where they surround a school of fish with a large net and then draw it together, like a purse at the bottom, and these schools are often located by spotter aircraft. Catches are highly variable between years, from 50-800t before 1990, but reached 7000t in 1991/92, and this is thought to be the result of oceanographic events.

The other fishing methods catch less than 5% of the catch. Poling boats will sometimes work with purse seine boats to catch skipjack tuna. Poling boats use burly to attract the tuna and then use poles to hook fish and pull them out of the water.

Management of the fishery

Input controls such as limited entry and boat specifications are the main management measures. Bilateral agreements with Japan were past management measures but these were withdrawn in the late 1990s.

Research

Information was gathered by scientific observers on Japanese boats from 1979 to 1997, collecting information on the fishery and biology of the species caught. Australian boats have a logbook but no observers and data is not verified when landed. Recent research has focussed on determining whether Australian species are distinct stocks or whether they are part of a continuous SW Pacific stock as this has large implications for estimates of abundance. Tagging studies and otolith measurement are being carried out to assess growth characteristics of the main species. Past observers and CSIRO projects have recorded about 35 to 40 other species being landed, such as other tunas and billfish, other teleost fish and sharks, as well as recording at least 40 discarded species or interactions, including sharks, birds and other species.

References

In addition to the ESD workshop report this overview was written using:

AFMA (2000) *Australian Fisheries Management Authority annual report 1999-2000*. Australian Fisheries Management Authority, Canberra.

Campbell, R. A. (ed) (1999) *Fishery Assessment Report 1999: Eastern Tuna and Billfish Fishery.* Australian Fisheries Management Authority, Canberra. 67pp.

Harris, A. and Ward, P. (1999) *Non-target species in Australia's Commonwealth fisheries: A critical review.* Bureau of Rural Sciences, Canberra. Tuna Fisheries Bycatch Action Plan Working Group. (2001) *Australia's Tuna and Billfish Fisheries Bycatch Action Plan.* Australian Fisheries Management Authority, Canberra.

Ward, P., Hampton, J., Campbell, R., Elscot, S. and Gunn, J. (2000) *Eastern Tuna and Billfish Fishery- yellowfin, bigeye and swordfish,* pp 97-109. In: Fishery Status Reports 1999: Resource assessments of Australian Commonwealth Fisheries, Caton, A. and McLoughlin, K. (eds) Bureau of Rural Sciences, Canberra.

Ward, P., Hampton, J., and Gunn, J. (2000) *Eastern Tuna and Billfish Fishery-skipjack*, pp 111-117. In: Fishery Status Reports 1999: Resource assessments of Australian Commonwealth Fisheries, Caton, A. and McLoughlin, K. (eds) Bureau of Rural Sciences, Canberra.

SA Lakes and Coorong Fishery

Primary species life history and ecology

The major species caught in the freshwater lakes, Lake Albert and Lake Alexandrina (and the Murray river) are callop, bony bream, carp, redfin, and yabbies, while in the Coorong estuary the main species are yellow eyed mullet, mulloway, black bream and flounder, and cockles are caught on the ocean beaches (as are Mulloway).

The lower River Murray has been significantly affected by humans since European settlement with large changes in flow regimes, water quality as well as more refugia during droughts. Callop and bony bream as well as exotic carp and redfin have benefited from these changes to the environment, as did yabbies initially after empounding the two Lakes which turned them into freshwater. In contrast other species have been disadvantaged such as Murray Cod and most Coorong estuary fish. Total fish production for the area is substantially below past production, since the Lakes were changed from estuary to freshwater. Stock abundance of most commercial species are linked to not only fishing, but also water quality and water flow making assessments of stock status difficult. Carp is suspected to have had a negative impact upon Murray cod and yabbies and possibly other species and commercial fishing of carp may restore a more natural balance to the ecosystems.

Other species potentially affected by the fishery include tortoises in the rivers and Lakes, birds and potentially cetaceans (although the risk for the latter would be minimal). The Lakes and Coorong is a very important area for birds, for both feeding and nesting, and large nesting colonies are found in the Coorong and surrounding areas. The fishery operates within the boundaries of the Coorong National Park. The wetland habitat within the National Park has been recognised as having international importance, and has been listed under the Ramsar Convention.

History of the fishery

The commercial fishery dates back to the 1840s (although the area was fished by Aboriginals prior to this time). A series of barrages built in the Goolwa region in 1940 separated the Murray estuary into freshwater lakes and the salt water Coorong estuary. In addition to direct changes to the Lakes and Coorong river system, substantial changes upstream have also had flow on (or lack of flow on) effects on the Lakes and Coorong fish species. The lakes and Coorong fishery mainly supplies Adelaide, whereas a lot of the River Murray fish catch is marketed in Melbourne. The Lakes and Coorong region is important for recreational fishers as well as commercial sectors and many thousands of recreational fishers spend time in the area. The fishery currently has recreational and commercial sectors with different species targeted in different areas of the region, ie Lakes, estuary and ocean.

Area of the fishery

The Lakes and Coorong Fishery comprises the lower River Murray lakes of Lake Albert and Lake Alexandrina, the Coorong estuary system, as well as the Sir Richard and Younghusband Peninsula next to the mouth of the Murray.

Fishing Methods and Management methods

The Lakes and Coorong Fishery is a multi-species, multi-method fishery, which allows fishers to tailor fishing practices and harvesting levels to the seasonal variation in abundance in different target species, changing weather patterns and market prices. This approach allows for effort to be transferred between species and avoids focussed fishing pressure on individual fish stocks. Callop and a number of other species are taken in freshwater river and lakes by mesh nets during low flow periods and by drum nets (Fyke nets) at all times and effort is controlled by limited entry, gear limits and restrictions to specified areas. Recreational fishers catch mainly by rod and reel although there are also mesh net entitlements. Other freshwater species taken by the above methods include bony bream, carp, redfin and rarely Murray Cod. Yabbies are also caught in the River and Lakes particularly after floods but are currently in low numbers. Mullet nets are mesh nets of a particular size used to catch Yellow eyed mullet in the Coorong, limited access to the fishery and net units for commercial and recreational are the main management controls. Species specific size limits are also in place for all species. Some mullet are taken by rods/lines. Mulloway are taken inside the Coorong mainly by mesh nets, but on the beach they are caught using swinger nets. Flounder are taken commercially by mesh nets and recreationally mainly by hand spears. Cockles are caught on the ocean beach with cockle rakes, with restrictions being a seven month season and minimum size limits for both recreational and commercial fisheries. A recreational bag limit of 600 cockles per day is in place for the recreational sector.

The Lakes and Coorong sub fisheries are mainly managed by limited entry, gear limitations and size limits, and area restrictions for commercial sectors. Whereas recreational fishers are mainly managed by gear limits, size limits, and bag limits.

PIRSA Fisheries has commenced a process to finalise the development of a formal Management Plan for the fishery, which will address the National ESD reporting framework. A strategic research plan for the fishery is being developed as part of this process.

Research

A fish stock assessment program is in place through the SARDI Aquatic Sciences Inland Fisheries Research Program. Species which have been assigned a high priority for assessment include: mulloway, yellow eye mullet, callop, black bream and flounder. Research collects information on catch and effort, by gear type and also by relating to environmental features, such as water flow and quality and drought. For a number of species the abundance of juvenile fish is also monitored and in addition assessments of habitat and non target species also take place. For some species genetic studies are being, or have been, carried out to determine whether fish stocks are all one population or are distinct populations, for example for callop, Murray cod and yabbies. The commercial fishers are also carrying out research into efficiency of boat motors as well as pollution and garbage surveys, as a part of their Environmental Management Plan. Sporadic recreational fishing surveys are also carried out to estimate this sectors fishing catch and effort. The Industry production sector is also pursuing MSC accreditation.

References

In addition to the ESD workshop report this overview was written using:

Unpublished material provided at the workshop.

SARDI (1999) *SARDI aquatic sciences: Research Report 1999.* South Australian Research and Development Institute, Adelaide.

Southern Fishermen's Association (1998) *Wild fisheries with a future! Environmental Management Plan of the Southern Fishermen's Association,* Baker, D. and Pierce, B. (eds), The Southern Fishermen's Association, Meningie.

Appendix 3: Power Point Presentation

(also available from the website www.fisheries-esd.com)

ESD REPORTING
and Meeting EA Guidelines

Presentation to ESD Workshops

Dr Rick Fletcher

Ecologically Sustainable Development
Catching Sustainably

Department of Fisheries
Government of Western Australia

FISHERIES RESEARCH & DEVELOPMENT CORPORATION

OUTLINE OF TALK

- Why are we doing this?
- Brief Overall Description of National ESD Reporting Framework
- How does this fit with applications to EA for export approval
- Later talks will detail each of the 4 steps

What is ESD?

NSESD (1992)

"using, conserving and enhancing the communityís resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased"

Incorporates the 5 major issues of interest:
Target Species, Ecosystem, Social, Economic and Governance

See page 15 of How To Guide (HTG)

Issues and Needs

- Fisheries Legislative Requirements (all have ESD in their Acts in some form)
- Other Government Requirements e.g. EPBC (Used to be Schedule 4). Various state-based agencies want environment issues addressed (EPA, Councils etc).
- Market Leverage/Access Marine Stewardship Council
- Develop one reporting process that gathers the information to meets most of these needs
- Urgent need to respond to the EPBC requirements to enable exports past 2003

See pages 16 – 17 of HTG

ESD Measurement and Reporting

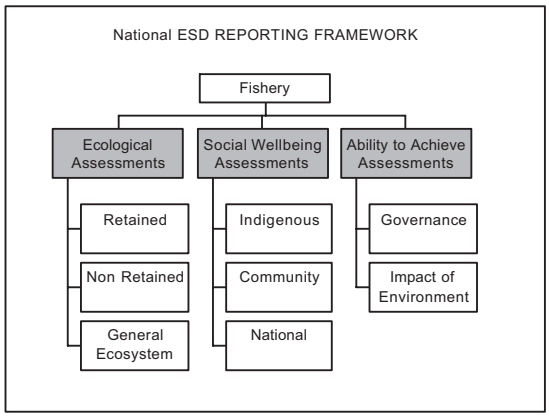
- **Many previous attempts have failed**
- **One size does not fit all**
- **Requires a process to systematically identify issues, develop operational objectives and then work out what indicators need to be measured.**
- **The objectives and acceptable range needs to be developed with all stakeholders**
- **Level of information presented needs to be appropriate to the issue**

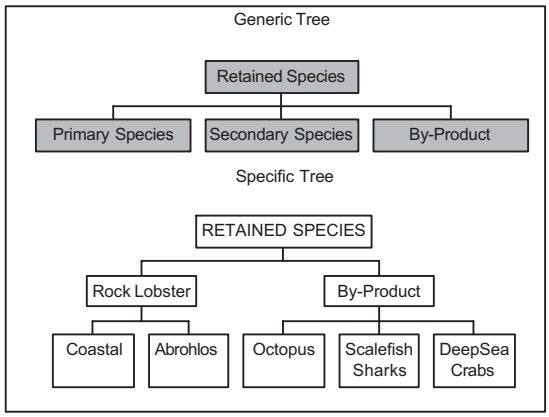
How does the National ESD Process Work? - Part 1

Identify specific issues for each fishery by adapting the set of generic component trees

(Initial drafts completed, circulated before meeting and confirmed later today)

See pages 23 – 24 of HTG





Why use generic component trees?

- **Likely issues identified were developed into a generic tree for each component of ESD**
- **These generic trees are used as the starting point for all assessments**
- **Enhances consistency of approach**
- **Requires specification of what are NOT issues as much as determining what are issues.**
- **Minimises 'missing issues' at first pass**

FIRST TASK FOR TODAY

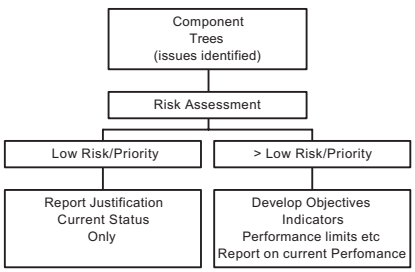
- **AGREE ON THE COMPONENT TREE STRUCTURE FOR THESE FISHERIES**
- **YOU CAN ADD ANY ISSUE YOU THINK HAS NOT BEEN INCLUDED**
- **WE WILL NOT DEBATE THEIR PRIORITY - THIS IS DONE IN THE NEXT STAGE**

How does the process work? Part 2

- Often many issues are identified, their importance varies and not all will require full reports and explicit management
- Conduct a Risk Assessment on each of the identified issues to determine appropriate level of response

See pages 24 – 25 of HTG

RISK ASSESSMENT



RISK ASSESSMENT PROCESS STARTED TODAY

Reporting Process Part 3

Complete Suitably Detailed Reports on Each Issue

- Can you justify that your management actions (or in inactions) are appropriate given the level of risk and the current level of knowledge available?
- Is your current performance acceptable given the levels chosen?

(REPORTS NOT COMPLETED TODAY)

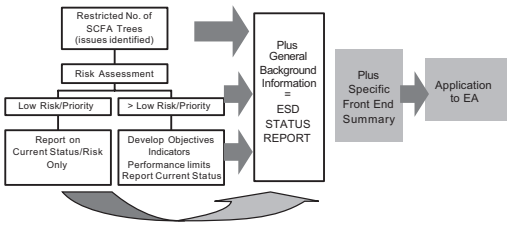
See pages 25 – 26 of HTG

How does the process work? Part 4

Complete Application to EA Using information in Component Reports

(Draft Completed following review of component reports)

Process of Reporting to EA



What Are We Doing Today??

TODAY

Completing the development of the 3 Environmental component trees for each fishery

Conducting the Risk Assessment on each of the identified components

Out of Session

Reports for each component will be drafted ñ the comprehensiveness and format GUIDED by the Risk Assessment

Next Meeting (if needed)

Go through each component report and get agreement on content.

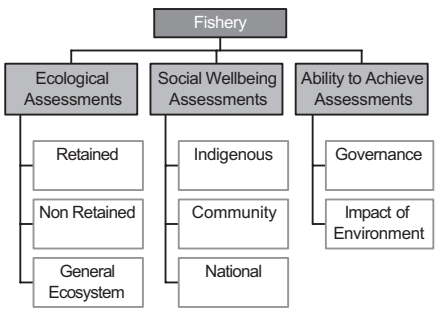
Following Review of Component Reports

Using agreed component reports, complete the application to EA.

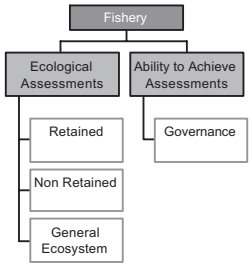
DETAILS ON COMPONENT TREES

See pages 29 – 54 and 55 – 57 of HTG

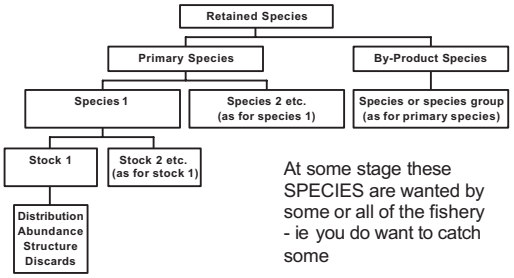
NATIONAL ESD REPORTING FRAMEWORK



NATIONAL ESD REPORTING FRAMEWORK EA VERSION



Retained Species



At some stage these SPECIES are wanted by some or all of the fishery - ie you do want to catch some

Pgs 33 –35

THREE BASIC CATEGORIES

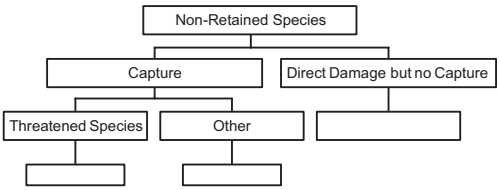
Target/Major ByProduct

1. Species by itself

Minor Byproduct

2. Species is mostly taken in another fishery, that fishery will deal with the species explicitly and comprehensively
3. Other ñ nobody, including this fishery takes a significant (relevant to the stock) amount

Non-Retained



These SPECIES are NEVER wanted to be caught - if possible eradicate all from catch

Pgs 35 – 37

THREE BASIC CATEGORIES

Major Non ñ Retained

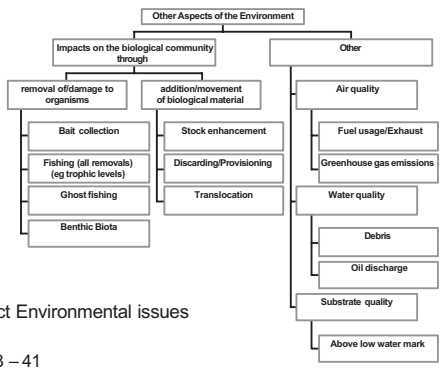
1. Species by itself

Protected/Threatened

1. Species by itself

Minor Non-retained (group)

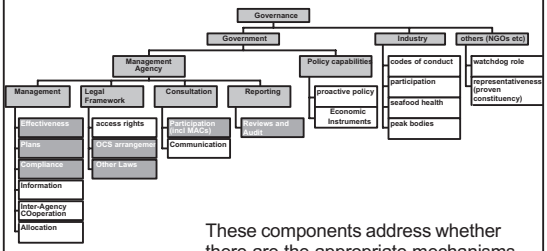
2. Group (minor - determined by a risk assessment for each species)



Indirect Environmental issues

Pgs 38 – 41

Governance



These components address whether there are the appropriate mechanisms to actually achieve the objectives listed in the previous 7 trees.

Pgs 51 – 53

Details On Risk Assessment Methodology

Pages 59 – 70 HTG

Risk Assessment

- **Risk is the chance of something happening that will have an impact on objectives**
- **Risk analysis involves consideration of the sources of risk, their consequences and the likelihood that those consequences may occur**
- **RISK = CONSEQUENCE x LIKELIHOOD**

Pg 62 – 64

CONSEQUENCE LEVEL

RETAINED SPECIES (ONE OF FIVE TABLES)

Negligible: **Unlikely to be measurable against background**

Minor: **Possibly detectable but no impact on population size or dynamics.**

Moderate: **Full exploitation rate where long term recruitment/dynamics not adversely impacted**

Severe: **Affecting recruitment levels of stocks/ or their capacity to increase**

Major: **Likely to cause local extinctions**

Catastrophic: **Local extinctions are imminent**

RETAINED SPECIES

Assessing the risk of having this fishery for each component should integrate/incorporate:

- **All removals, by all sectors (i.e. Commercial, Recreational, Indigenous, Illegal, discards)**
- **Species biological characteristics/dynamics**
- **The current knowledge and understanding available on these issues (including distribution v area fished)**
- **Current management arrangements - their effectiveness and problems**

Non - RETAINED SPECIES

Assessing the risk of having this fishery for each component should integrate/incorporate

- **Only the species affected by the fishery being examined**
- **The relative impact of this fishery compared to distribution of species and other impacts**
- **The biological characteristics and dynamics of the species captured**
- **The current knowledge and understanding available on these issues and current management arrangements**

GENERAL ECOSYSTEM

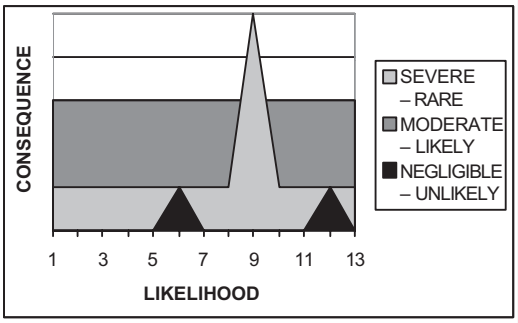
Assessing the risk for each of these components should:

- **isolate the relative impact of this fishery compared to the scope of the ecosystems and habitats involved.**
- **Assess the impact of current knowledge and understanding available on these issues and current management**

RISK ASSESSMENT

Likelihood		Negligible 0	Minor 1	Moderate 2	Severe 3	Major 4	Catastrophic 5
Remote	1	0	1	2	3	4	5
Rare	2	0	2	4	6	8	10
Unlikely	3	0	3	6	9	12	15
Possible	4	0	4	8	12	16	20
Occasional	5	0	5	10	15	20	25
Likely	6	0	6	12	18	24	30

RISK ASSESSMENT



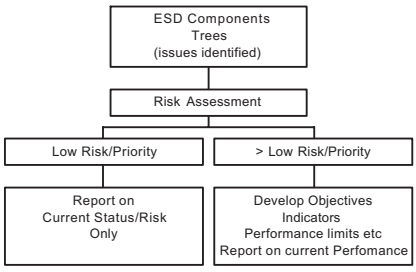
Pg 69 – 70

A fishery may be UNLIKELY to EVEN CAUSE a NEGLIGIBLE Consequence

RISK ASSESSMENT

Negligible			
Low			
Moderate			
High			
Extreme			

REPORTING PROCESS



RISK ASSESSMENT OUTCOMES

The actual risk assessment is not just the scores developed during todayís meeting (ie the risk category in the previous table) -

But, the full output reports backed up by the appropriate level of documentation/justification.

WORKSHOP REPORT

- The workshop report we send to you in a few days time may not have all the information needed to fully justify the assertions made today – it is just a report of todayís outcomes to ensure we have recorded everyoneís opinions accurately.
- All the information **MUST BE** in the component reports which you will receive in about 6 weeks from which you should be able to assess if the justifications for the decisions were appropriate

Details On Component Reports

Reporting Categories

- Operational Objectives *(+Justification)*
- Indicator
- Performance Measure *(+Justification)*
- Data Requirements
- Data Availability
- Evaluation
- Evaluation Reliability
- Management Response *(Current, Future and if Trigger is reached)*
- Summary of Actions and Conclusions
- External Drivers

Pg 71 – 79 HTG

Reporting Categories

Operational Objectives

- Each of the lowest level subcomponents requires an agreed operational objective.
- For this industry and this subcomponent, what do you wish to achieve?
- IT IS NOT HOW YOU ACHIEVE IT OR WHAT YOU WILL NEED TO ACHIEVE IT
- Needs a justification relating to the High Level Objectives
- You can have more than one objective for an issue.

Operational Objectives, Indicators and Performance Measures/Limits

- The operational objective, indicator and performance measure are a package.
- All three are needed before any one of them is useful.
- Indicators by themselves (as used in some reporting schemes) are of little value.
- Needs appropriate level of justification for the limits/triggers chosen

Reporting Categories

Reliability

- What is the reliability (robustness, precision etc) of the indicator, performance measure and the evaluation?
- Categories are being developed to distinguish the reliability for all indicators but are summarised as High, Medium and Low
- The level of reliability needs to be taken into account in determining what are the appropriate management responses and/or what future studies should be completed.

Reporting Categories

Management Response

- Current

- What are the current management arrangements responding to this objective, particularly noting the level of information available and reliability of the evaluation
  - Future
- Are there extra management arrangements proposed?
  - What is the response if performance limit is reached?
- This could include reviews, decision rules etc.

These Reports Allow

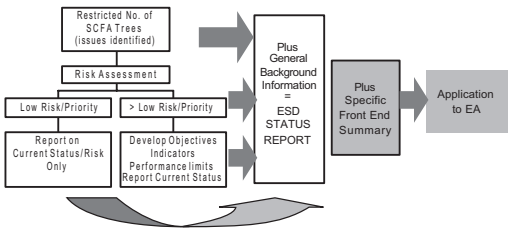
A direct comparison between:

- the level of understanding of an issue,
- the risks associated with proposed management actions
- the level of precaution currently being applied

Can you justify that the management actions are appropriate given the level of risk and current knowledge

THIS IS SPECIFICALLY WHAT EA WANTS TO SEE!

Process of Reporting to EA



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