Ecological Risk Assessment of the Queensland Marine Specimen Shell Collection Fishery

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Introduction

The Queensland Marine Specimen Shell Collection Fishery (QMSSCF) is one of a range of harvest fisheries managed by Queensland Primary Industries and Fisheries (QPIF), part of the Department of Employment, Economic Development and Innovation (DEEDI). Specimen shells are marketed both domestically and internationally and are also collected recreationally.

The QMSSCF is based on the collection of a broad range of animals from the phylum Mollusca[*], using either hand or small shell dredges, for the purpose of display, collection, classification, enhancing scientific knowledge or sale. Specimen shell molluscs may be alive or dead at the time of collection. The QMSSCF includes the collection of beach-washed shells, but not the collection of fossilised shells. Specimen shells can not be retained in other commercial fisheries (e.g. the East Coast Trawl Fishery).

Specimen shells in Queensland can also be collected by recreational fishers; these collections are subject to possession limits and are likely to mainly target dead shells.

Species Groups 1–3[*] were developed in 1997 to better manage the sustainable harvest of specimens in the QMSSCF. They represent a hierarchy of increasingly conservative management measures with Group 1 being the lowest level and Group 3 the highest. The groups were classified based on a combination of information from Willan (1986), advice from the Malacological Society of Australia, and by using the following criteria;

- distribution,
- abundance,
- endemicity,
- conservation status,
- level of trade,
- biological features, such as form of reproduction, and
- specific habitat requirements.

Species with similar conservation and management requirements were classified into the following four groups:

Group 1 — Very common species and limited trading that are considered appropriately managed
Group 2 — Selected species identified as requiring greater management focus and catch monitoring
Group 3 — Rare, valuable or high demand species requiring greater management focus

Groups 2 and 3 are being monitored each year for changes in catch trends to determine if trade may be deleterious to stock sustainability. The conservative bag limit of 50 shells in possession (live or dead) remains in place across these groups while further investigations are conducted into new management controls. The *Fisheries Regulation 2008* provides a general exception to the possession limit, which allows for the possession of mollusc shells in genuine shell collections which are comprised of cleaned, preserved and labelled specimens.

Any changes in catch trends of Group 2 and 3 shells are assessed annually by QPIF with advice from Harvest MAC. QPIF collates the collection reports and presents it to Harvest MAC, members on the MAC review the data and if changes in catch trends are detected the MAC makes recommendations to QPIF for appropriate action.

[*] Does not include oysters, pearl oysters, trochus, giant clams, cephalopods and scallops. These are managed under separate arrangements.
[*] There is also a Group 4 – the collection of these species are prohibited under the *Fisheries Act 1994*

This risk assessment is designed to provide a more formal assessment of the impacts of the fishery on specimens from the special management Groups 1 to 3. As collection of specimens from Group 4 is prohibited they are not considered further in this document.

The QMSSCF was granted a five-year exemption from export controls of the *Environment Protection and Biodiversity Conservation Act 1999* on 1 December 2004. The exemption expires on 1 December 2009.

The Australia Government Department of the Environment, Water, Heritage and the Arts (DEWHA) made a number of recommendations that form conditions of the exemption. The recommendations are designed to address any risks or uncertainties that were identified during assessment of the fishery.

One of these recommendations relates to the harvest of specimens from Groups 1 to 3 in the fishery:

'By December 2005, QPIF to develop fishery specific objectives linked to performance indicators and performance measures for species representative of those listed in Groups 1-3 (Table 2 of the report Ecological Assessment of Queensland's Marine Specimen Shell Collection Fishery July 2004) including, but not necessarily limited to, most commonly caught species in the fishery.'

The recommendation is required to be implemented by the end of 2005. QPIF considers a more formal assessment of the species potentially at risk from this fishery must be made to better inform discussions about the development of performance measures.

This risk assessment is based on a workshop held on 13 December 2005 with key stakeholders. These included:

- Fishery managers
- QPIF assessment and monitoring staff
- Experienced commercial collector
- Experienced recreational collector/hobbyist
- Representative from DEWHA
- Representative from Great Barrier Reef Marine Park Authority (GBRMPA).

The list of attendees can be found in Appendix 1.

The objectives of the workshop were to:

- Determine the level of risk to the ecological sustainability of species representative of those listed in Groups 1-3 in the QMSSCF.
- Develop objectives, performance indicators and performance measures related to species representative of those listed in Groups 1-3 in the QMSSCF.

Process

Figure 1 provides an overview of the process that was followed in the workshop, highlighting the importance of justifying risks, and the linkage with development of performance measures. The risk analysis tool used in this process is based upon the AS/NZ Standard, but adapted for use within the fisheries context (Fletcher *et al*, 2002). It works by assigning a level of consequence (from negligible to catastrophic) and the likelihood of this consequence occurring (from remote to likely) for each issue/species. The overall level of risk assigned to each species is based on the group's assessment of the perceived consequence multiplied by the perceived likelihood. Further information on the process can be found in Fletcher *et al*, 2002.

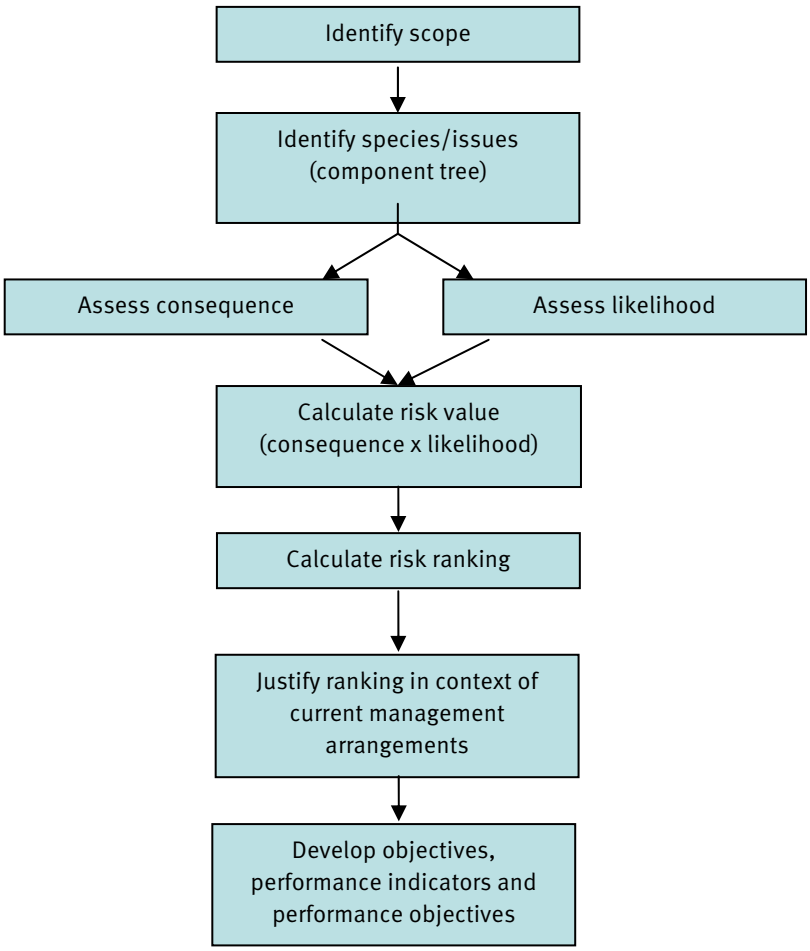


Figure 1. Risk assessment and performance measure development process

Much of the information necessary to make informed decisions in this risk assessment was already available or had already been compiled by other jurisdictions (see Willan 1986, Ponder & Grayson 1998, Enzer Marine Environmental Consulting 2002, Department of Fisheries Western Australia 2005). This information was used to establish the Scope, Issues and to calculate Risk Values before the workshop. The final values were validated and agreed to by all members of the workshop.

Scope

There was significant discussion at the beginning and throughout the workshop in regard to the scope of the assessment. This section provides a synthesis of these discussions.

Regional differences and species vulnerability listings

The Working Group considered whether any of the species collected in the fishery required special consideration or needed to be dealt with individually by this Risk Assessment.

It was noted that the list of species of specimen shell listed in Queensland as vulnerable in the report by Ponder and Grayson (1998) (Appendix 5) requires updating with regional information.

A distinction was made during the discussion that Group 1 species that are collected for bait and/or consumption should be considered separately when assessing the level of risk for this Group. There is also considerable more potential pressure on Group 2 Turban Shell species as their range is limited to southern Queensland where they could potentially be targeted as a food source.

Discussion within the Working Group resolved that no other single species within each group was considered more vulnerable than another, although it was noted that Volute shells are the most popular at present. The risk assessment therefore should consider impacts of the fishery on the remaining species in each Group as a whole. This view was supported by the Ponder & Grayson (1998) report.

Gear types and collection methods

The Working Group considered whether each of the methods used in the fishery need to be dealt with individually.

Specimen shells can be collected by hand or by the use of small towed dredges. Hand collection methods are essentially benign to the environment and allow a high degree of scrutiny over what is removed from the ecosystem.

The QMSSCF is a highly selective fishery that is driven by the rarity and value of the shell species. Grading of shells is paramount to the value of the shell and the diver/collector will preferentially select only the highest quality or unique specimens, leaving lower quality shells behind and relatively undisturbed.

Small shell dredges (max 600mm gape) are towed behind small dinghies in areas between reefs or in channels and usually used for collecting sand dwelling shell species. They are not generally used in areas with complex epibenthic habitat (e.g. reefs) as dredge loss can occur and the gear efficiency is much reduced due to fouling. Restrictions apply to the use of a hand dredge in the Great Barrier Reef (GBR) Marine Park and in State Marine Park waters. The use of a dredge is not permitted in Moreton Bay and in areas closed to collecting in the GBR Marine Park. Generally no more than five of any species is allowed to be harvested.

The use of dredges is considered to be of low impact on the broader ecosystem due to its small size, limited use and limitation on habitats where it can be used.

Recreational and Indigenous harvest

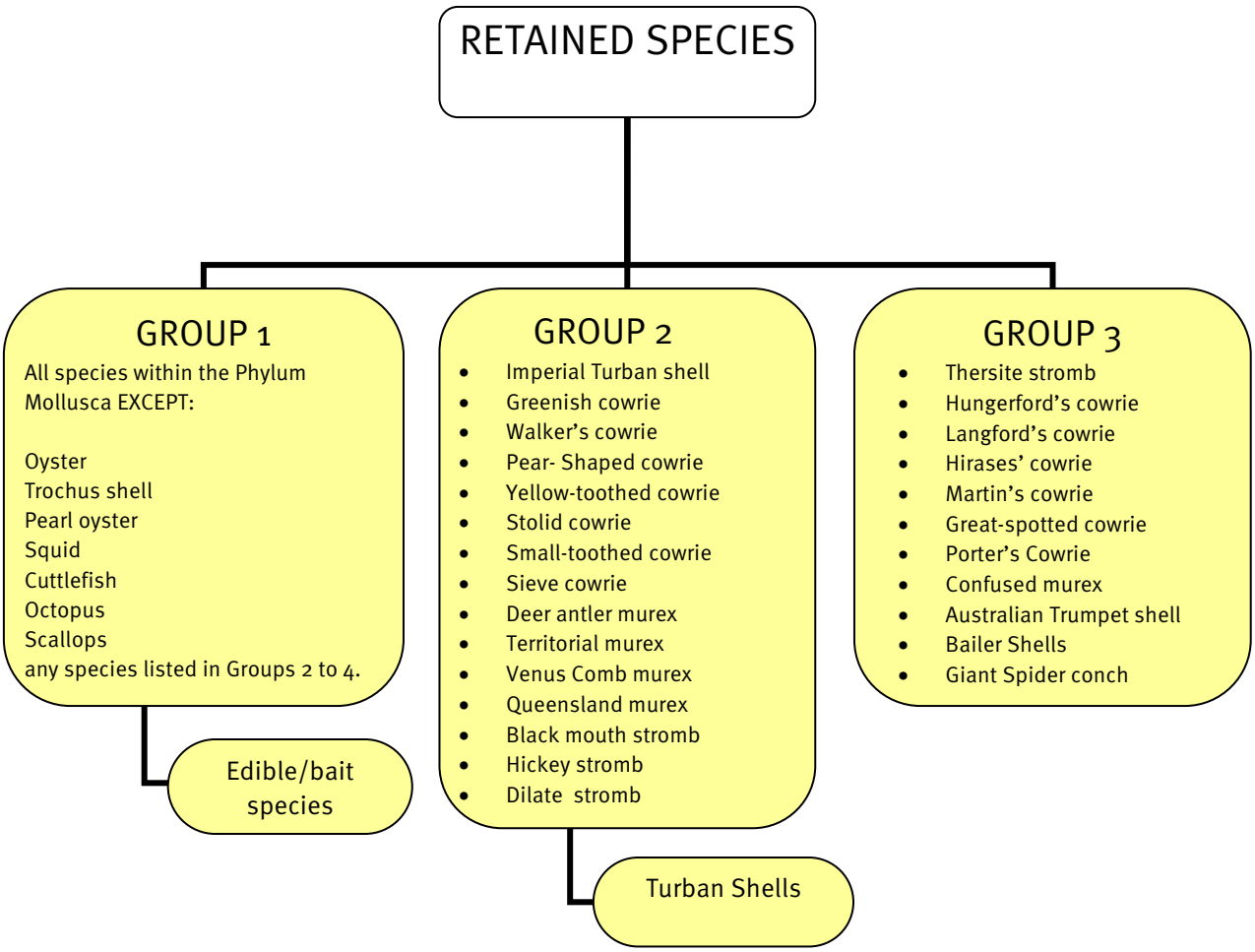
The take of shells by Indigenous people for cultural purposes is recognised to occur near coastal Indigenous communities and it is considered that this harvest has been occurring in a similar fashion for a very long time. There is likely to be little overlap between species of shell collected by Indigenous groups and recreational/commercial collectors. It was considered unlikely the level of harvest by this group would be a threat to the sustainability of the shell species that are collected. It was recognised that the level of information available on this harvesting sector can be improved to better inform monitoring in the future.

Recreational harvest can be broken down into two categories; enthusiasts (i.e., malacological societies) and opportunists (i.e., beachcombers, tourists). Enthusiasts are more likely to collect fewer specimens than opportunists and they are likely to be very selective in the shells they collect. All recreational collectors are restricted by an in-possession limit of 50 specimens. At this level, recreational collectors are unlikely to be having a major effect on the sustainability of specimen shells collected for display purposes, however shells collected for consumption or bait may be impacted on at a greater level. The collection of bait and edible shells for Groups 1 and Turban Shells in Group 2 was decided to be dealt with separately by this assessment.

Overall assessment of scope

Based on the points raised above, it was identified that the scope of the assessment should:

- Assess Group 1 edible/bait species separately
- Assess Group 2 Turban Shell species separately
- Assess all other species representative of those listed within Groups 1-3 as a whole;
- The impacts of hand collection and the use of hand dredge will be considered together when assessing risk.



Blue boxes indicate negligible risk
Yellow boxes indicate low risk
Green boxes indicate moderate risk
Orange boxes indicate high risk
Red boxes indicate extreme risk

Figure 2. Component tree for retained species in the Marine Specimen Shell Collection Fishery (box shading indicates risk level)

Issue identification (component trees)

Issue identification is an important step in any risk assessment process. The purpose of developing component trees is to assist the process of issue identification by moving through each of the ecological components of Ecological Sustainable Development in a comprehensive and structured manner, maximising consistency and minimising the chances of missing issues.

Issues and species were discussed by the Working Group and subsequently added/deleted to the generic component tree.

The final component tree is included above in Figure 2.

Risk assessment

The risk analysis tool used in this process is based upon the AS/NZ Standard, but adapted for use within the fisheries context. It works by assigning a level of consequence (from negligible to catastrophic) and the likelihood of this consequence occurring (from remote to likely) for each issue/species. The overall level of risk assigned to each species is based on the group's assessment of the perceived consequence multiplied by the perceived likelihood.

A realistic estimate was made by the group, based upon the combined judgment of the participants, who have significant expertise or experience in the fishery.

When considering the level of consequence or likelihood, participants made an assessment in context of what existing control measures and management arrangements are already in place. When assessing consequence, participants noted the consequence on a population or region, not an individual animal. The consequence and likelihood tables can be found in Appendix 2.

A risk ranking was given, based on the risk value (see Table 4 and 5 in Appendix 2). The risk ranking dictates the amount of justification required and also the extent of management likely to be needed to address the risk.

Justification of the risk values and ratings are provided below. A summary table can also be found in Appendix 3.

Background information and data that was used to make an assessment has been included in Appendix 4–5.

Retained species

Group 1 species (except edible/bait species)

Risk ranking: Low
Risk value: 1

Group 1 species (not including edible/bait species) are common and generally not desirable to enthusiasts. Their life histories are such that they have widespread population reserves with high reproductive potential. There are no rare or highly desirable species within this group. The risk of the fishery on the sustainability of Group 1 species was considered to be negligible.

Proposed Management Actions:

The species were assessed as requiring little management emphasis, at this stage, either because they are very common or are not traded. It is considered that trends and information indicating a need to move certain species from Group 1 to the more vulnerable Groups 2 and 3 are available through analysis of commercial logbook data trends, general consultations with collectors, traders, museum staff and other interested parties as well as through export records.

No further management action is considered necessary.

Group 1 edible/bait species

Risk ranking: Low
Risk value: 4

The harvest of edible/bait Group 1 species was not considered to be a 'normal' specimen shell collection activity and therefore required separate treatment in this risk assessment. They are being assessed at the workshop because species collected for consumption (e.g., razor clams) and bait (e.g., pipis) still fall under the specimen shell collection fishery suite of management controls. Harvest of this group of shell species was considered an area specific issue confined to Queensland sites that are close to high population centres. Another identified risk was to species that have not been harvested historically, but which may become increasingly important for food for other cultures as Queensland's population grows through immigration. These risks have the potential to lead to localised depletion where a species is targeted.

Proposed Management Actions:

As these species are targeted for bait and food, workshop participants felt this group could be subject to better defined 'in possession' limit, or the harvest of the species could be managed under a separate bait fishery. These suggestions will be considered by QPIF.

Group 2 species (except Turban Shells)

Risk ranking: Low
Risk value: 2

Group 2 species comprise species of Volutes, Cowries and Strombs. Group 2 species were considered to be more at risk from collection activities than Group 1 species due to the rarity, higher desirability in the shell trade, and because their life history strategies may not be as robust in recovering from harvesting pressure. Harvesting trends are likely to relieve the potential for over-harvesting as shell collectors are highly selective, only collecting large and perfect specimens ('gem' quality = highest prices/demand), leaving behind the smaller, younger and/or imperfect individuals to breed. The numbers of shells collected from these groups is extremely low. The highest yearly take for any one species was 14 for the Dotted Volute, *Cymbiola pulchra peristicta.*

The threat of the fishery on Group 2 species was considered to be low. The workshop considered external environmental factors on the shells habitats to have a greater potential influence on the vulnerability of populations than collecting.

Proposed Management Actions:

Group 2 species (except Turban Shells) are well managed and no further management actions are considered necessary at this stage.

Group 2 species (Turban Shells)

Risk ranking: Low
Risk value: 4

Turban shells (*Turbo militaris*) are targeted as a food source in New South Wales (NSW) where localised depletions may have occurred. The distribution of Turban Shells in Queensland is confined to coastal areas from the Queensland/NSW border north to about Caloundra. As this distribution is within major population centres, there is potential for Turban Shells collected for food to increase.

The threat of the fishery on Turban Shells was considered to be low however the situation requires greater monitoring emphasis.

Proposed Management Actions:

Improvements in the level of information gathered for the recreational harvest of Turban Shells may need to be considered to monitor this collection activity.

Group 3 species

Risk ranking: Low
Risk value: 1

The harvest levels for Group 3 species are small. Group 3 species are naturally rare (occurring mostly in deep water) and their collection is dependent on market demand. Historically the species have only been opportunistically collected by trawlers using approved dredges. The workshop considered the level of protection from harvest was high given the large areas closed to collection in the Great Barrier Reef Marine Park. Such small harvest levels and large spatial closures indicate the fishery is likely to have minimal impact on the ecological sustainability of these shell specimens or on the broader ecosystem. The threat of the fishery on Group 3 species was considered to be low.

Proposed Management Actions:

Group 3 species are well managed and no further management actions are considered necessary at this stage.

Non-retained species

There are no known non-retained species harvested in the QMSSCF.

Preliminary performance measurement

The development of fishery specific objectives, performance indicators and performance measures is becoming increasingly important in fisheries management. Such a system can help provide clear goals for industry and management, and through performance measures, can assess the effectiveness of those management arrangements. Triggers can be put in place to help ensure major undesirable shifts in catches etc are dealt with through appropriate management responses and in appropriate timeframes.

Objectives

Objectives are an important part of performance measurement in that there needs to be an overall goal that management works towards.

Examples of objectives used in other fisheries / jurisdictions:

- Ensure ecological sustainability of species taken in the fishery
- To improve protection for vulnerable/threatened species
- Protect endangered species
- **WA Fisheries** - To maintain sufficient spawning stock, at or above a level that minimises the risk of recruitment overfishing, to ensure recruitment at levels will replenish what is taken by fishing, predation and other environmental factors.
- **SA Fisheries** – 3 part biological objective

1. To prevent localised depletion of populations of specimen shells and maintain harvesting at a level that provides for a sustainable fishery.
2. Harvest specimen shells at a level which will provide for adequate levels of recruitment.
3. Maintain biodiversity across the range of marine shellfish collection areas.

Performance indicators

Indicators should be simple, meaningful and relatively easily monitored. There is little point identifying indicators that require a costly new monitoring regime which cannot be supported by the industry.

Examples of indicators used in other fisheries / jurisdictions:

- Data from commercial logbook returns (harvest numbers, CPUE, spatial information etc)
- Compliance with reporting
- **WA Fisheries** - The catch is recorded in detail by number of shells for each species in each area.
- **SA Fisheries** - Changes in the number of species taken, and changes in fishing patterns.

Performance measures

Performance measures can be in the form of a target level, a limit, or a trigger for some form of review or action.

Examples of measures used in other fisheries/ jurisdictions:

- **WA Fisheries** - The preliminary acceptable catch range is from 10,000 to 25,000 shells.
- **SA Fisheries** – The basis for measuring this indicator is the assessment of the time spent diving (i.e. searching and collecting) and the number of fish taken at the available level of spatial resolution. It should be remembered that the number of specimens suitable for collecting may have no direct reflection on the size of the population. And

Evidence of changes in fishing patterns, particularly when targeted at a specific species, may indicate localised depletion of suitable specimens.

Management responses

Management responses should not be too rigid to restrict the capacity to deal with the issue. However, they should ensure that appropriate management action is taken when a performance measure is triggered.

Examples of management responses used in other fisheries/ jurisdictions:

- Stakeholders to review the fishery and make recommendations to ……
- Amended arrangements to be implemented within XX months of trigger value being exceeded.
- Within three months of becoming aware that a review has been triggered, QPIF to finalise a timetable for the implementation of appropriate management responses.

WA Fisheries - **Current**: To ensure the maintenance of the breeding stock the following measures are employed:

• The fishery is managed through input controls (limited entry, maximum number of divers, maximum boat size); and

• The fishers provide monthly returns under the statutory CAES.

Future: The Department of Fisheries recognises the need to increase the robustness of the data used to monitor the status of stocks by obtaining better data on catch (e.g. isolating the catch by species) and effort (validating crew days; accounting for visibility and other conditions).

SA Fisheries – Management action on reaching a target reference point

Where target reference points have been described above, and one or more of the reference points is reached or exceeded, the management committee will undertake the following actions:

1. notify the Minister for Primary Industries and participants in the fishery as appropriate.
2. undertake an examination of the causes and implications of 'triggering' a reference point.
3. consult with the specimen shell fishing sector and PISA Fisheries on the need for alternative management strategies or actions.

Table 1. Draft performance measurement system for target species

	Objective	Performance Indicator	Performance measure	Management response
All species	Ensure ecological sustainability of species or groups of live specimen shells harvested in the fishery To prevent localised depletion of populations of specimen shells.	Data on numbers harvested, effort levels and areas where harvesting occurs	Monthly logbook returns are completed. Total annual commercial harvest of live shells does not exceed 400 specimens. Total annual commercial effort does not exceed 50 fishing days and is distributed among collection areas Changes in spatial distribution of the commercial fishery Change in the relative proportion of catch between each species group (1-3)	Within three months of becoming aware that a review has been triggered, QPIF to undertake a review of the causes and implications of 'triggering' a reference point. Pending the outcome of that review QPIF to finalise a timetable for the implementation of appropriate management responses. This would include consultation with the Harvest MAC on the need for alternative management strategies or actions.
	Maintain specimen shell fishery at a level that provides for economic benefits to licence holders	The individual market prices for valuable species	Change in the individual species market price in the fishery	QPIF to review catch composition in light of market changes. Review the possible need for management intervention.
	Ensure compliance with current management arrangements for the fishery	Compliance figures.	Increase in non-compliance.	Presentation of compliance figures to Harvest MAC Review of compliance strategy for the fishery.

	Objective	Performance Indicator	Performance measure	Management response
Recreational harvest of specimen shells	Ensuring recreational amenity. Ensure the recreational and indigenous value of shell collecting is equitably maintained.	Information on the recreational and Indigenous involvement with specimen shell collection	Participation in surveys. Changes in estimates of recreational and Indigenous harvest.	As above and presentation of that information to Harvest MAC
Edible / bait species (NB *Turbo militaris* has the potential to become exploited as a food source)	Ensure ecological sustainability of species of edible/bait shells harvested in the fishery	Information on the recreational and indigenous involvement with edible/bait species collection. Community concern regarding the level of exploitation	Increase in the use of these species for food or bait purposes. Increased level of community concern regarding the levels of take	Review current management arrangements and "end use" of product.

Appendix 1 – List of workshop attendees

Thora Whitehead	Specimen Shell Fishery representative on Harvest MAC
Don Peverill	Commercial fisher and processor (north) with 25 years Spanish mackerel fishing experience
Randal Owens	Great Barrier Reef Marine Park Authority.
Melissa Maly	DEWHA
Stephanie Slade	Harvest management, QPIF
Tara Smith	Harvest management, QPIF
Anthony Roelofs	Assessment and Monitoring Unit, QPIF
Natalie Snape	Assessment and Monitoring Unit, QPIF

Apologies[1]:

Peter Doherty	Australian Institute of Marine Science
Jesse Lowe	Queensland Parks and Wildlife Service

[1] Note that those people who were unable to attend where still provided with the opportunity to comment on the justifications for risk rankings.

Appendix 2 – Consequence and likelihood tables

Table 2 Detail of consequence table for target species or species groups

Level	Ecological sustainability of target species
Negligible (0)	Insignificant impacts to populations. Not measurable against background variability for this population. Target Stock – not detectable for this population
Minor (1)	Detectable, but minimal impact on population size and none on dynamics (eg recruitment).
Moderate (2)	Full exploitation rate, but long-term recruitment/dynamics not adversely impacted.
Severe (3)	Affecting recruitment levels of stocks/or their capacity to increase.
Major (4)	Will cause local extinctions, if continued in longer term (i.e. probably requiring listing of species in an appropriate category of the endangered species list (eg IUCN category).
Catastrophic (5)	Local extinctions are imminent/immediate

Table 3 Detail of likelihood table for target species or species groups

Level	Descriptor
Likely (5)	Is expected to occur often
Occasional (4)	Is expected to occur moderately
Unlikely (3)	Is expected to occur only infrequently
Possible (2)	Unlikely, but has been known to occur elsewhere
Rare (1)	Happens only very rarely
Remote (0)	Never heard of, but not impossible

Table 4 Risk matrix – numbers in cells indicate risk value, the colours/shades indicate risk rankings (see Table 5 for details). Adapted from Fletcher *et al.* 2002.

Consequence							
Likelihood		**Negligible**	**Minor**	**Moderate**	**Severe**	**Major**	**Catastrophic**
		0	1	2	3	4	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

Table 5 Risk ranking definitions

RISK		**Reporting**	**Management Response**
Negligible	0	Short justification only	Nil
Low	1–6	Full justification needed	None specific
Moderate	7–12	Full Performance Report	Continue current management arrangements
High	13–18	Full Performance Report	Changes to management required
Extreme	19–30	Full Performance Report	Substantial additional management needed urgently

Appendix 3 - Risk ratings

Species	Consequence	Likelihood	Risk value	Risk ranking	Justification and workshop comments
Retained species					
Group 1 species	1	1	1	low	Distinction between collection shell and those taken for food or bait. Indigenous harvest overlap in area and spp take likely to have been consistent over time, unlikely to be a sustainability threat. Most people do not collect Group 1 shells as they are common and not desirable or sought after. Group 1 species are widely distributed.
Group 1 spp edible/bait	2	2	4	low	Area specific issues. High pop areas. Not a "collector" activity. NB: more targeted for food/bait, "in possession" limit may be appropriate; participants thought this could be considered by management (note there is an in possession limit of 50). Likelihood of 2 due to stock decline known in other states.
Group 2 species	1	2	2	low	Some species are hard to find/cryptic spp mainly in Group 2 for desirability. Naturally rarer than Group 1. Chance of opportunistic take is low due to these factors. External factors on habitat are more influential on population than collection. Turban shells potentially higher risk due to being targeted for eating- separate out. Likelihood of 2 due to desirability
Group 2 Turban Shells *Turbo millitaris*	2	2	4	low	Targeted as food source in NSW=potential localised depletion. Limited range in Queensland - Caloundra south. Distribution is within major southern pop centres and the consequence depends on the species being targeted as food source.
Group 3 species	1	1	1	low	Collection dependant on supply and demand, market rare /valuable, less accessible- historically collected by trawl only. Spp not generally endemic. High level of protection through spatial closures under RAP etc. Accidental take in most instances, not able to target. no real biological characteristics that put spp in this group.
Non-retained species					
There are no known non-retained species in the fishery					

Appendix 4 – information sourced from compulsory commercial logbooks

Marine Specimen Shell Species Groups

Group 1 Species:	All species within the Phylum Mollusca	
excepting	oyster	*Ostreidae*
	Trochus shell	*Trochus niloticus*
	Pearl oysters	*Pteriidae*
	squid	
	cuttlefish	
	octopus	(coleoid cephalopods)
	scallops	*Amusium spp*
and	any species listed within Groups 2 to 4 below	
Group 2 Species:	Imperial Turban shell	*Turbo imperialis*
	Greenish cowrie	*Cypraea subviridis*
	Walker's cowrie	*Cypraea walkeri*
	Pear-shaped cowrie	*Cypraea pyriformis*
	Yellow-toothed cowrie	*Cypraea xanthodon*
	Stolid cowrie	*Cypraea stolida*
	Small-toothed cowrie	*Cypraea brevidentata*
	Sieve cowrie	*Cypraeacribraria,*variety *melwardi*
	Deer-antler murex	*Chicoreus cervicornis*
	Territorial murex	*Chicoreus territus*
	Venus Comb murex	*Murex pecten*
	Queensland murex	*Murex queenslandicus*
	Black mouth stromb	*Strombus aratrum*
	Hickey stromb	*Strombus hickeyi*
	Dilate stromb	*Strombus dilatatus*
	Textile cone	*Conus textile*
	Volutes	*Volutidae* (Excluding *Melo* spp)
Group 3 Species:	Thersite stromb	*Strombus thersites*
	Hungerford's cowrie	*Cypraea hungerfordi*
	Langford's cowrie	*Cypraea langfordi moretonensis*
	Hirases' cowrie	*Cypraea hirasei queenslandica*
	Martin's cowrie	*Cypraea martini*
	Musume's cowrie	*Cypraea musumea*
	Great-spotted cowrie	*Cypraea guttata*
	Porter's cowrie	*Cypraea porteri*
	Confused murex	*Chicoreus akritos*
	Australian Trumpet shell	*Syrinx aruanus*
	Bailer shells	*Melo* spp
	Giant spider conch	*Lambis truncata*
	Gouty spider shell	*Lambis chiragra*
Group 4 species:	Trumpet shell	*Charonia tritonis*
	Giant clams	*Tridacnidae*
	Helmet shell	*Cassis cornuta*

Appendix 5 – Ecological and other factors relating to each species identified

Retained species

Many of the ecological factors relating to each species in the QMSSCF have been used to develop vulnerability assessments of shell fisheries for Australia. This assessment is based largely on the vulnerability rankings done by Ponder and Grayson (1998). The rankings were based on the following four criteria (the numbers relate to the scores used in the assessment):

1. Distribution:
    1. Very restricted (found only in a small area within a State or Territory and not elsewhere unless near a border and the species has a very restricted distribution on the other side of the border)
    2. Restricted (found in part of a State or Territory and not elsewhere unless near a border and the species has a restricted distribution on the other side of the border)
    4. Margin of range (a restricted or very restricted distribution within a state or territory when the species is found elsewhere)
    5. Spread (widespread in the state or territory).

2. Development:
    1. Direct (develops directly from the egg or from incubation to a benthic juvenile)
    3. Lecithotrophic (has a [usually short] larval stage which feeds on yolk reserves)
    5. Planktotrophic (has a larval stage that feeds in the plankton).

3. Accessability:
    1. Intertidal (very readily accessible)
    2. Shallow subtidal (accessible – snorkel depth)
    3. Subtidal (moderately accessible – SCUBA depth)
    4. Continental Shelf (difficult – trawling and dredging)
    5. Very deep water (very difficult – deepsea trawling)

    (When a range of scores was available the highest and lowest values were averaged).

4. Market value:
    1. More than $1000
    2. $500-1000
    3. $100-500
    4. $20-100
    5. Less than $20

    (When a range of values was available the average of the highest and lowest values was used)

Overall Score for Threat Category

The scores for the four criteria used in the assessment were summed and the criteria assigned as follows:-

A. Less than 8
B. Greater than 8 to 9.5
C. Greater than 9.5 to 11.5
D. Greater than 11.5 to 13.5
E. Greater than 13.5

The following table is adapted from the Ponder and Grayson (1998) assessment of the vulnerable shell species in Queensland.

FAMILY	GENUS	SPECIES/SUBSPECIES	RANGE	STATE SCORE	NATIONAL SCORE
Volutidae	*Notovoluta*	*hokensae* Poppe, 1992	Very Restricted	A	A
	Athleta (Ternivoluta)	*insperata* Darragh, 1979	Very Restricted	A	A
	Cymbiola	*perplicata* (Hedley, 1902)	Very Restricted	A	A
	Nannamoria	*ranya* Willan, 1995	Restricted	A	A
	Cymbiola	*thatcheri* (McCoy, 1868)	Very Restricted	A	A
	Amoria	*maculata* (Swainson, 1822)	Restricted	B	C
	Amoria	*necopinata* Darragh, 1983	Very Restricted	B	B
	Amoria	*volva* (Gmelin, 1791)	Restricted	B	B
	Cymbiola	*intruderi* (Poppe, 1985)	Very Restricted	B	B
	Cymbiola	*pulchra* (Sowerby , 1825)	Restricted	B	B
	Cymbiola	*rutila* (Broderip, 1826)	Restricted	B	B
	Nannamoria	*inopinata* Darragh, 1979	Very Restricted	B	B
	Volutoconus	*grossi mcmichaeli* Habe and Kosuge, 1966	Very Restricted	B	B
	Chicoreus (Chicoreus)	*cornucervi* (Roding, 1798)	Margin of range	C	
Conidae	*Conus*	*papilliferus* Sowerby, 1834	Restricted	C	
Haliotidae	*Haliotis*	*ethologus* (Iredale, 1927)	Very Restricted	C	
Cypraeidae	*Cypraea (Schilderia)*	*hirasei queenslandica* Schilder, 1965	Very Restricted	C	
	Cypraea (Umbilia)	*capricornica* Lorenz, 1989	Restricted	C	
Cassidae	*Galeodea (Galeodea)*	*maccamleyi* Ponder, 1983	Restricted	C	
Volutidae	*Amoria*	*canaliculata* (McCoy, 1869)	Restricted	C	
	Amoria	*guttata* McMichael, 1964	Restricted	C	
	Amoria	*turneri* (Gray in Griffith and Pidgeon, 1834)	Margin of range	C	
	Athleta (Ternivoluta)	*studeri* (von Martens, 1897)	Very Restricted	C	
	Cymbiola	*sophia* (Gray, 1846)	Margin of range	C	
	Lyria	*deliciosa howensis* Iredale, 1937	Margin of range	C	
	Melo (Melocorona)	*amphora* (Lightfoot, 1786)	Spread	C	C
	Nannamoria	*gotoi* Poppe, 1992	Restricted	C	
	Nannamoria	*parabola* Garrard, 1960	Very Restricted	C	
	Notovoluta	*gardneri* Darragh, 1983	Restricted	C	
	Volutoconus	*grossi grossi* (Iredale, 1927)	Restricted	C	
	Volutoconus	*bednalli* (Brazier, 1878)	Margin of Range	C	C

FAMILY	GENUS	SPECIES/SUBSPECIES	RANGE	STATE SCORE	NATIONAL SCORE
Volutidae cont.	*Murex*	*kerslakae* Ponder and Vokes, 1988	Restricted	C	
	Murex	*queenslandicus* Ponder and Vokes, 1988	Very Restricted	C	
	Pterynotus (Pterochelus)	*acanthopterus* (Lamarck, 1816)	Margin of range	C	
	Pterynotus (Pterochelus)	*duffusi* (Iredale, 1936)	Margin of range	C	
	Columbarium	*harrisae* Harasewych, 1983	Very Restricted	C	
	Columbarium	*hystriculum* Darragh, 1987	Restricted	C	

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