

**APPLICATION TO ENVIRONMENT AUSTRALIA  
ON THE  
ABALONE MANAGED FISHERY**

*Against the Guidelines for the Ecologically  
Sustainable Management of Fisheries*

For Continued Listing on Section 303DB of the  
*Environment Protection and Biodiversity  
Conservation Act 1999*

NOVEMBER 2002



**Department of Fisheries**  
Government of Western Australia



*Fish for the future*

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# 1. INTRODUCTION TO THE APPLICATION

## 1.1 DESCRIPTION OF INFORMATION PROVIDED

This is an application to Environment Australia (EA) to assess the Western Australian Abalone Managed Fishery (Abalone Fishery) against the Commonwealth guidelines for sustainable fisheries. The submission of a successful application against these guidelines is now needed to meet the requirements under Part 13 A of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC), to enable the greenlip abalone (*Haliotis laevis*), brownlip abalone (*Haliotis conicopora*) and Roe's abalone (*Haliotis roei*) to remain on the section 303DB list of species exempt from export regulations (previously Schedule 4 of the Wildlife Protection (*Regulation of Exports and Imports*) Act, 1982) past December 2003.

The information provided in this application covers all the elements specified in the Guidelines for the Ecologically Sustainable Management of Fisheries (located on the EA website [www.ea.gov.au/coasts/fisheries/assessment/guidelines.html](http://www.ea.gov.au/coasts/fisheries/assessment/guidelines.html)) along with other information (at a variety of levels of complexity) considered relevant to those who wish to gain an understanding of the management of this fishery. The application includes:

- Comprehensive background information on the history of the Abalone Fishery and a description of the management arrangements, which provides the context for assessing this application and the biology of the primary abalone species caught (see Section 2 for details).
- A description of the National Ecologically Sustainable Development (ESD) Reporting Framework and methodology, which was used to generate the information that is presented in the application (see Section 3 for summary and [www.fisheries-esd.com](http://www.fisheries-esd.com) for full details).
- Specific supporting statements relevant to each of the criteria within the Commonwealth Guidelines. These criteria include the “General Requirements”, which cover many of the governance aspects related to the management of the Abalone Fishery, plus each of the objectives listed under “Principle 1” (target species issues) and “Principle 2” (broader ecosystem issues) of the Guidelines (see Section 4).
- Section 4 also has, where appropriate, specific links and references to the detailed ESD component reports contained in Section 5. Referral to this additional information is facilitated by the incorporation of appropriately placed hyperlinks (electronic version only).
- At the end of Section 4 there is an [OVERVIEW TABLE](#) that outlines for each issue, which EA Guidelines are relevant; if there is an operational objective, the availability of suitable data for the indicators, whether the current performance against the limit/measure chosen is acceptable, and a summary of what (if any) future actions are required.
- Section 5 includes a comprehensive account of the risk assessment outcomes and current performance of the Abalone fishery, presented in the National ESD Reporting format, covering each of the environmental and governance issues

relevant to this application for the Abalone fishery. These reports cover each of the issues in a comprehensive manner and include either; the explicit objectives, indicators, performance measures, current and future management responses and justification for each major component; or a full justification for why specific management of this issue within the Fishery is not required.

## **1.2 OVERVIEW OF APPLICATION**

Greenlip, brownlip and Roe's abalone are the three major species targeted by the commercial Abalone Fishery. Collectively these species comprise an annual catch of approximately 330 tonnes that had a landed value in 2000/2001 of approximately \$19 million. This is one of Australia's smaller Abalone Fishery in terms of the tonnage harvested, the gross value of production and the number of licence holders.

The fishery has operated under a detailed management regime since the 1990s with catches ranging from 133 to 229 tonnes per year for greenlip and brownlip abalone collectively, and 108 to 122 tonnes per year for Roe's abalone over the past 10 years. The management regime uses a comprehensive set of regulations that include limited entry licensing, unitised access arrangements (with minimum unit holdings), stock partitioning, area closures, quotas for each diver and total allowable catches (TACs) for each zone, along with a variety of biological controls. Each of these has been refined through time, and is subject to regular reviews to achieve the overall aim of successful management.

The *Fish Resources Management Act, 1994* (FRMA) provides the legislative framework to implement the management arrangements for this fishery. The FRMA, the regulations in the *Fish Resources Management Regulations, 1995* (FRMR) and the specific management plan for this fishery, adheres to arrangements established under relevant Australian laws with reference to international agreements as documented in Section 5.4.2.

The combination of having a large amount of relevant and accurate information on the biology and stock status of the abalone species, the sophisticated suite of management arrangements in place and the proactive management used in the Abalone Fishery have resulted in the maintenance of abalone stocks as well as the successful continuation of the fishery. The Department of Fisheries, in collaboration with industry, is continually improving upon the management of the fishery, particularly in the areas of compliance and monitoring stock status. Currently, the Department is attempting to implement a National Docketing System for abalone to improve the compliance in the fishery as well as developing an industry-based video monitoring program for greenlip and Roe's abalone stocks.

Due to the highly selective fishing technique used to take abalone, no by-product species are caught by this fishery and incidental take of other species is minimal (only piggy-back species are involved). The tonnage removed is very small and, moreover, research has shown that the abalone species captured in the WA fishery feed on drift algae and therefore play a minimal role in the broader functioning of the ecosystem.

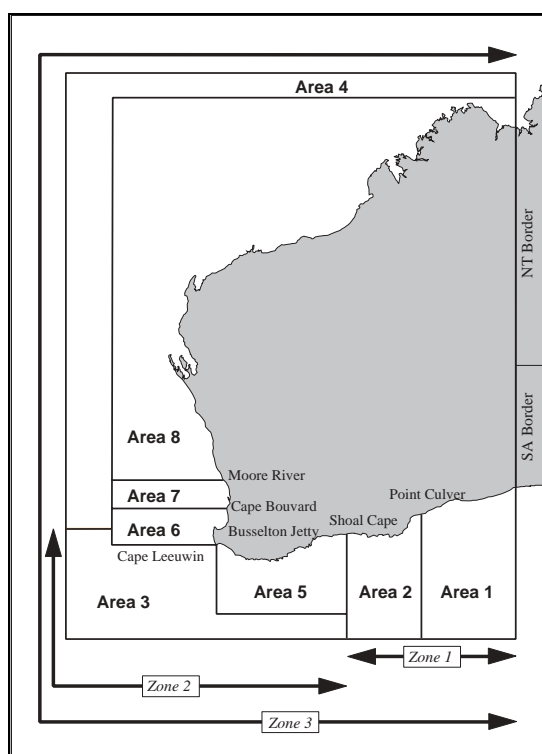
Consequently, the management regime for the Abalone Fishery should meet the Guidelines for the Ecologically Sustainable Management of Fisheries. Detailed justification for this conclusion is documented within the remainder of this application.

## 2. BACKGROUND ON THE ABALONE FISHERY

### 2.1 DESCRIPTION OF THE FISHERY

#### *The Commercial fishery*

The commercial managed fishery for abalone in Western Australia (Abalone Fishery) is one of the smaller abalone fisheries in Australia (with a total catch of around 330 tonnes). The legal area of the fishery includes all coastal waters of the Southern Ocean, Indian Ocean and Timor Sea between the Western Australian/Northern Territory Border and the Western Australian/South Australian border (i.e. all the waters of the state)(Figure 1).



**Figure 1. Current management areas and historical zones in the Abalone Fishery.**

Although the existing area description of the fishery gives the impression of an extensive fishery, only a small portion of the licence area forms the functional fishery. In practice, abalone are only commercially harvested in the coastal areas in regions as far north as the Zuytdorp cliffs near Shark Bay, as this is the northern limit of the range of *Haliotis roei*, the most northerly distributed of the three quota species (Figure 3).

The fishery for abalone in WA began in the 1960s when Roe's abalone (*Haliotis roei*) made up the majority of abalone harvested in WA. Since 1970, the catch composition for the Fishery has expanded to include greenlip abalone (*Haliotis laevigata*) and

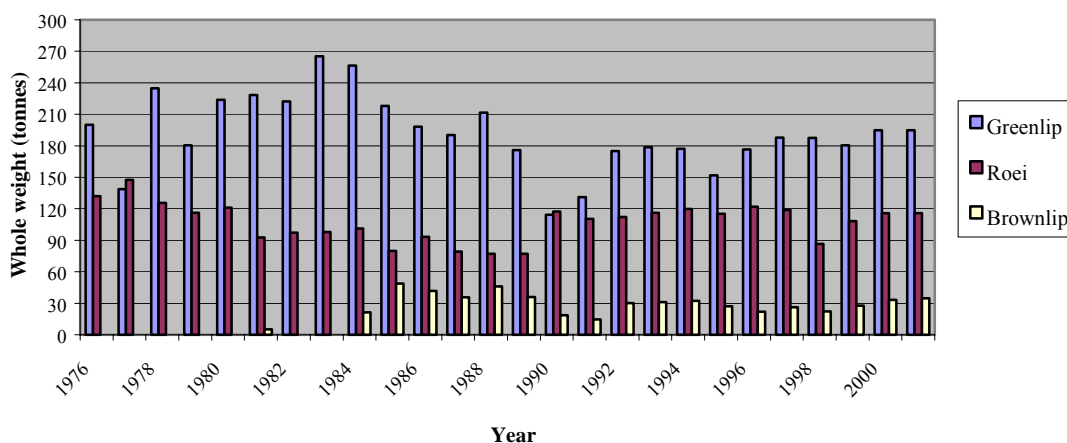
brownlip abalone (*Haliotis conicopora*). In 1971 the fishery was subject to limited entry management, and although the number of licence holders has reduced over the years since the fishery's inception, the catch of abalone in the state has remained reasonably consistent (Figure 2).

The history of the fishery is outlined in Prince & Shepherd (1992) and paraphrased here. Fishing began in 1964 but remained at relatively low levels, due to the isolated parts of the coast where abalone are found in WA, until 1969 when an influx of divers from other states caused a rapid expansion.

To control the expansion of the fishery, in 1971 the number of licences was restricted to 36 participants. These licences were initially non-transferable so that by 1975 this number had been reduced to 26. At this time, the fishery was divided into 3 zones, two on the south coast and one on the west coast (see figure above). There were 6, 8 and 12 divers respectively in these zones.

Size and weight limits were imposed for each of the species, which in some cases also varied among zones. In addition, individual transferable quotas (ITQs) were imposed in 1985-86 to reduce competition amongst divers. These quotas were progressively reduced until 1990 (see Figure 2) after which they have been relatively stable.

Catch statistics have been collected since 1964 for the commercial Abalone Fishery. Records since 1976 when the exploratory phase finished show that the catches during this period have ranged from 115 – 260 tonnes for greenlip abalone, 75 to 150 tonnes for Roe's abalone and (since the mid 1980s) 10 to 40 tonnes for brownlip abalone (Figure 2). Consequently, the catch history in the Abalone Fishery indicates that the yield levels for each of the three species has been relatively stable over the past 25 years and mostly vary according to the effort levels expended towards these species. The catch in 2000 was 331.7 tonnes (223.37 tonnes for greenlip and brownlip abalone and 107.7 tonnes for Roe's abalone) with a total value of \$16 million.



**Figure 2. The commercial catch of abalone by species, 1976 – 2001.**

Prior to 1999, the fishery was divided into three zones (see Figure 1). Fishers that operated in Zones 1 and 2, harvested greenlip and brownlip abalone (and a small quantity of Roe's abalone) while those operating in Zone 3 (the entire State) primarily harvested Roe's abalone.

In March 1999, management changes resulted in the State being divided into 8 specific areas. These management areas allow better monitoring and management of the specific abalone stocks found along the coast of WA.

Under the new management, Roe's abalone unit entitlements were also split from Zone 1 & 2 greenlip/brownlip unit entitlements and as a result the total number of managed fishery licenses in the fishery increased to 42. However, the number of operators in the fishery did not increase.

### ***Recreational Fishery***

Recreational fishing activity for abalone occurs in the southern half of WA where the commercial fishery operates. The easily accessible Roe's abalone is the prime target for recreational fishers and this occurs in two main areas:

1. The Perth Metropolitan fishery from Cape Bouvard (near Mandurah) to the northern tip of Wedge Island (near Lancelin).
2. The Greenough fishery, extending from the mouth of the Greenough River south to the Flatrocks car park near Geraldton.

Some of the commercial management arrangements for Roe's abalone fishing in these areas are structured to accommodate the recreational abalone fishing activity (e.g. a restriction on commercial fishing operations during the recreational season). Recreational fishing for greenlip and brownlip abalone in south and south west regions tends to be restricted to holiday sites and times (FWA, 1998). There have been a variety of changes to the closed seasons, minimum sizes, bag and boat limits for the recreational sector.

### ***Fishing Methods***

The only method of fishing used in the Abalone fishery is hand collection involving diving. Fishing operations are heavily weather dependent due to the small vessels used and the potentially hazardous conditions (waves, swells etc) encountered, particularly off the south coast. Prevailing south-westerly winds in the south of the State reduce the number of possible fishing days, however, when the weather is very good, there are some areas where fishers can access abalone by entering the water from the beach or a cliff face (i.e. no need to use a boat). Off the west coast, Roe's abalone generally live in very shallow areas with high wave action, therefore access to these animals is also highly weather dependent.

Fishing is largely confined to daylight hours and is usually completed close to shore (or offshore islands) as abalone tend to inhabit shallow water (1m – 20m). Typically, fishermen will travel up to 20 nautical miles in a day, and return to a land based camp at night. Fishers don't remain overnight on board a vessel, as each day's catch must be weighed and recorded in a catch and disposal record (CDR).

When working from a boat, the diving location is selected and the surface supplied air hoses and other diving equipment is lowered into the water. The compressor is then started, as the diver puts on their gear. Air is supplied through an air hose; the diver

descends and begins to harvest abalone from the substrate using a small lever to pry the animals from the reef. The collected animals are then stored in large catch bags.

The deckhand on board the vessel watches the rising air bubbles from the diver, and manoeuvres the vessel to keep the air-hose slack (i.e. a loose length of hose is maintained near the diver enabling the diver to move freely without reaching the end of the hose – the length of the hose is about 120ft). On jet-propelled vessels, the vessel can drive over the hose without severing it. On propeller driven vessels, the deckhand must take more care to ensure that the propeller does not sever the air hose.

When the catch bag is full of abalone, or the maximum bottom time for the diver has been reached (to avoid risk of “the bends”), the diver fills a “lift bag” on his equipment with air and the unit rises to the surface. A pulley system is used to hoist the catch and equipment onto the vessel and the abalone are counted and measured.

The preferred compliance position would be for all abalone to be kept whole until an opportunity for compliance checks is provided. However, for practical purposes, greenlip and brownlip abalone may be shucked (i.e. animals are removed from the shell and the gut removed and discarded) at sea and packed into saltwater filled containers (e.g. eskies). The Department does, however, require that the shell from these animals is stored in bags and available for inspection until the meat arrives at an approved processor.

Upon arrival at shore, the weight of the catch is determined, and catch and disposal records are completed for research and compliance purposes. The meats (or whole animals in the case of Roe’s abalone) are transported to the processor for weighing, cleaning, and packaging.

### ***Management***

The current management plan for the Abalone Fishery is a formal statutory document, the Abalone Fishery Management Plan 1992 (the Abalone Plan) that specifies the management measures for the fishery. The Abalone Management Advisory Committee (AbMAC) assists with the cooperative management for this fishery through the provision of advice. The advice provided allows for the management to be better tailored for achieving the maximum economic return from the abalone resource as well as maintaining the sustainability of the fishery and ensuring cost effective management.

The management of the Fishery includes a series of management controls, including limited entry licensing, minimum legal shell sizes, seasonal and area closures and individual quotas for each licence holder generated from the total allowable commercial catch for each zone. These management arrangements help to sustain all of the stocks of abalone while maintaining the supporting environment and ensuring that the abalone caught are greater than the set minimum size. A summary of the significant elements of the Abalone Plan in terms of environmental management is as follows:

*Limited number of licences.* There are forty-two current managed fishery licences in the Abalone Fishery (27 licences endorsed to take Roe’s abalone and 15 licences

endorsed to take greenlip/brownlip abalone) in one or more of the 8 specific areas. This is due to the separation of Roe's entitlements from greenlip/brownlip entitlements. In total there is currently only twenty-three persons holding these licences.

*Small numbers of operators and a unitized fishery with minimum unit holdings.* There are a limited number of units of entitlement in the fishery. To gain/retain a licence, a person must hold a minimum number of units for a particular species. In the Roe's fishery, the minimum number of units is 800 while in the greenlip/brownlip fishery the minimum number of units is 450.

*Stock partitioning.* Whilst recreational fishers taking Roe's abalone must abide by a minimum legal size of 60mm, commercial abalone fishers must ensure that Roe's abalone taken in the metropolitan area (Area 7) are at least 70mm in length, and are at least 75mm in length in Area 1. The difference in the size limits amongst sectors within the metropolitan area enables recreational fishers to collect sufficient sized abalone during their 9-hour yearly season (1.5 hours each Sunday for 6 consecutive Sundays). The increased minimum size in Area 1 was implemented at the request of industry members fishing for Roe's abalone in that area.

*Seasonal Closures.* The commercial Abalone Fishery potentially operates all year in most regions with the new quota season beginning each year on 1 April.

Under current arrangements, commercial divers fishing in the metropolitan area must cease fishing two weeks prior to the commencement of the recreational abalone fishing season and must not fish at all during the weeks that span the recreational fishing season. Commercial fishing can recommence on the Monday following the closure of the recreational fishing season. Fishing on weekends and public holidays in the metropolitan area remains prohibited.

The recreational fishery in the Metropolitan area has very short season (see above), but is open for the whole year outside of this region, with the exception of a small fishery at Greenough, south of Geraldton, which operates on the same rules as the Metropolitan area.

*Area Closures.* Commercial divers for Roe's abalone in the Metropolitan region of Area 7 are not permitted to operate in the intertidal region. This is to ensure that the stock levels on the shallow reef tops, which are the main sector fished by the recreational fishers, are not depleted.

At times there have been spatial closures in other regions to mitigate short term, small-scale issues.

*Compliance.* The Abalone Fishery has a compliance program, which involves:

- a) Inspections of commercial operators when landing catches;
- b) Covert surveillance of targeted commercial operators
- c) Checking that abalone catch and disposal records (CDRs) have been completed correctly and accurately
- d) The inspection of processing facilities.

- e) Inspections of recreational size limits and bag limits etc
- f) Covert surveillance to detect and apprehend illegal operators

The impact of illegal and unlicensed operators on abalone stocks is of great concern. A major part of the work of the Department of Fisheries Serious Offences Unit is concerned with the detection and prosecution of individuals and organisations involved with the illegal take and sale of abalone.

Abalone Fishery compliance is also a national concern. The Department of Fisheries is currently attempting to implement the National Docketing System for abalone that will bring the monitoring of abalone trade in the state under the same level of scrutiny as that in other States.

### ***Management Objectives and Issues for the Commercial fishery***

The Minister and the Department of Fisheries have a statutory obligation under section 3 of the FRMA to conserve, develop and share fish resources of the State for the benefit of present and future generations. These objectives are further amplified by the vision and mission statements and objectives as specified in various Strategic and Business plans of the Department.

The following management objectives for the commercial Abalone Fishery sub-program were developed in consultation with AbMAC and published in the WA Fisheries Overview # 1 (FWA, 1998).

- Maintain sustainability of the States abalone stocks through maintenance of the breeding stock and habitat
- Maximise the economic return from the abalone resource to the community while maintaining sustainability of the stock and the habitat
- Ensure cost-effective management of the fishery, with special reference to developing systems in collaboration with clients to fully identify all costs of running the sub-program for cost recovery; and
- Encourage maximum commercial flexibility and administrative simplicity from industry participants.

### ***Target Species***

In general, Australia is one of the few nations where there is a long history of sustainable harvesting of wild stocks of abalone with well-established commercial and recreational fisheries management arrangements. Of the eleven abalone species found in WA waters, only three are considered sufficiently abundant to support commercial harvesting. These are the Roe's abalone, the greenlip abalone, and the brownlip abalone. Each species occupies an ecologically distinct habitat.

Greenlip abalone and brownlip abalone are predominantly found on the south coast of WA. Roe's abalone, whilst found on the south coast, are more abundant on the west coast and are harvested commercially as far north as the Zuytdorp Cliffs near Shark Bay (Figure 3).



**Figure 3. Roe's abalone distribution in Western Australia.**

In WA, assessment of stock status for the three target species is conducted annually, primarily through the examination of the research data provided as part of the quota monitoring system. Analysis of these data along with other research programs has lead research scientists to conclude that although abalone stocks in WA are fully exploited, the breeding stocks are still considered to be adequate.

Studies carried out by the WA Museum indicate that, in most areas, the size at maturity for each of these species is well below the legal minimum size and provides at least one to two breeding seasons before legal capture is possible. In areas where greenlip abalone are 'stunted' (i.e. growth rates are slower than elsewhere and sexually mature animals are often substantially smaller than the legal minimum size), the legal minimum size may take longer to be reached, providing a relatively large reservoir of spawning individuals.

Since the mid-to-late 1980s, commercial fishing has been managed by TACs for each abalone species collected. Industry members and the Agency Research Division provide advice to the Executive Director of the Department of Fisheries (ED) as to what they believe is appropriate TACs. The annual TACs are determined by the ED, in consultation with the AbMAC and after advice from the Research Division of the Fisheries Department prior to the commencement of each entitlement period.

The TACs for each species in each area is divided by the number of units of entitlement for that species in the area thus providing a "unit value". Each licence holder is entitled to fish for abalone up to the weight provided by multiplying the number of units they hold for a species of abalone in an area, multiplied by the unit value for that species in that area.

## **Data Requirements**

Research activities continue to focus on the status of the abalone stocks. Presently abalone stocks are assessed through analysing industry data from the daily catch records, information from processors, fisher's monthly returns and data collected during specific research projects. In the case of greenlip and brownlip abalone, the weight and number of individuals collected each day is provided by divers, thus allowing the catch and average meat weight to be calculated over any period of time from 10 by 10 nautical mile grid blocks.

In the case of Roe's abalone, the information to calculate average meat weight is currently not accessible, as the number of animals fished is not provided. In addition to regular monitoring of catch data the Research Division is involved in a number of different research activities, including the development of protocols for the fishing of stunted stocks of greenlip abalone and digital video tools for more effective in-water stock assessment.

A research strategic plan has been developed in consultation with industry members. In this plan the main areas of interest for future research are identified and prioritised. Project briefs are then developed which identify participants, objectives, methods and outcomes of the study.

## **2.2 BIOLOGY**

### **2.2.1 GENERAL**

Abalone are gastropods from the genus *Haliotis* (family Haliotidae; subclass Prosobranchia). All three commercial species of abalone in WA share similar life-history characteristics in that they are broadcast spawners, will separate sexes and external fertilisation. The female abalone are known to produce a large amount of eggs. The larvae are pelagic and lecithotrophic with a relatively brief larval life (Mottet, 1978).

After a planktonic stage of between five and 10 days, depending on water temperature, abalone juveniles settle out onto the same rocky habitats as the adult abalone, usually in association with crustose coralline algae (McShane and Smith, 1988). Post settlement abalone feed on diatoms and at approximately 5mm long, commence feeding on a macro-algal diet. Between 5 –10 mm this is largely comprised of crustose coralline algae.

The dispersal of abalone larvae is considered to be relatively localised due to the short duration and benthic nature of the larvae. This has led to the hypothesis that there is little intermixing of recruits amongst reefs (Prince et al., 1987) and genetically distinct populations may occur within a few km of each other (Shepherd and Brown, 1993).

There can be a high degree of variability of recruitment success both within and between years and regions (McShane, 1992). The natural mortality rates of abalone are highly size dependent. Mortality is very high for larvae and juvenile but decreases

as the animals grow. Predators of the large sized individuals include stingrays, fish, octopus, rock lobsters, starfish and predatory whelks.

Abalone are herbivorous marine molluscs with a large muscular foot (the edible part) which is used to anchor the animal to reefs. Abalone feed either by actively scraping algae from rocks or by capturing drift algae as it floats past. All three species taken in the WA fishery are almost exclusively drift algal feeders and prefer to consume red algae but may consume some brown algal species when red algae are less abundant (Shepherd & Steinberg, 1992). These feeding preferences were strongly correlated with the degree of algal toughness and their phenolic levels.

## 2.2.2 GREENLIP ABALONE

### *Distribution and Stock Structure*

The greenlip abalone, *Haliotis laevigata* has been reported from Cape Naturaliste in WA to Cape Liptrap, Victoria, and northern Tasmania (Edgar, 2000)(Figure 4). This species is widely considered the best-tasting of Australian abalone and targeted by commercial and recreational divers along the coasts of northern Tasmania, Victoria, South Australia (SA) and southern WA providing about 20% of the total Australian commercial abalone catch (Edgar, 2000).

*Haliotis laevigata* occurs primarily on granite rocks in depths of five to 40 meters, in areas with high wave action and water movement. Adults live on rock faces near the sand line where drift algae is readily available, juveniles prefer to reside in the cracks and crevices (Joll, 1996). The species prefers exposed areas on shallow, rocky reefs with water temperatures ranging from 12 – 22°C (Yearsley et al., 1999).



**Figure 4. Greenlip abalone distribution in Western Australia.**

### ***Life History***

In WA this species can grow to a maximum shell length of about 24 cm but are most commonly found in the 14 – 17 cm range although “stunted” populations of this species have been recognised at some locations on the south coast (Wells and Mulvay, 1992). *H. laevigata* become mature at 2.5 – 3 years of age around a size of 10-11 cm shell length although the gonadal development begins at 70 mm (Wells and Mulvay, 1995). The size at which gonadal development commences is the same for both “normal” and “stunted” areas.

Whilst clear differences in growth rates for stunted and non-stunted populations of *H. laevigata* have been reported elsewhere (Nash, 1992; Shepherd et al., 1992), Wells and Mulvay (1995) found only equivocal results amongst stocks in the Augusta region of WA. They concluded that greenlip attain the minimum legal size for capture in WA (140 mm) at around five to six years of age. Thus, they have at least two or more spawning seasons before they become vulnerable to the commercial fishery.

The main period of spawning for the greenlip abalone occurs in late spring and early autumn, peaking in December (Wells and Mulvay, 1995). This species appears to be largely dependent upon drift algae and rarely moves to graze attached algae (Freeman, 2001).

## **2.2.3 BROWNLIP ABALONE**

### ***Distribution and Stock Structure***

Brownlip abalone, *Haliotis conicopora*, are considered by some taxonomists to be a subspecies of blacklip abalone (*Haliotis rubra*) rather than a distinct species. The morphological and elctrophenetic characteristics of the western populations indidcate that *H. conicopora* may be at the western end of the clinal variation of *H. rubra*. More powerful methods may resolve this issue, but for the moment and for the purposes of this report, *H. conicopora* is regarded as separate from *H. rubra*. Therefore, this species is currently recorded as being distributed from Fremantle to the WA border with SA (Figure 5).

*Haliotis conicopora* is characterised as a ‘calm water’ species preferring areas of reduced wave action, including caves and fissures in rock crevices. Brownlip abalone occur in coastal waters to a depth of 30m mostly on granite (occasionally limestone) and favours water temperatures ranging from 12 – 22°C (Yearsley et al., 1999).

### ***Life History***

This species can grow to a maximum shell length of about 22 cm but are commonly about 14 – 16 cm in size. Similar to greenlip, brownlip abalone becomes mature at three to four years of age at shell lengths between 11 and 13 cm. As a result, the brownlip abalone reaches the legal size (14 cm or 140 mm) at around four to six years of age, which is at least a year after reaching maturity (Wells and Mulvay, 1992).

The main spawning season for brownlip abalone occurs in late spring and early autumn, peaking in December. Mature brownlip abalone feed mainly on drift red algae and graze on seagrass in areas where drift algae is scarce (Wells and Mulvey, 1992). Shepherd (1975), however, based upon gut contents, concluded that they may prefer to eat kelp species.



Figure 5. Brownlip abalone distribution in Western Australia.

#### 2.2.4 ROE'S ABALONE

##### *Distribution and Stock Structure*

*Haliotis roei* (Roe's abalone) has a distribution from Shark Bay (WA) to western Victoria (Shepherd, 1973) (Figure 3). They inhabit areas of high wave action and are most abundant on inter-tidal and shallow sub-tidal limestone platforms on the west coast. This species is mainly found in depths of 0 to 3 metres and prefers water temperatures of 14 – 26°C (Yearsley et al., 1999).

##### *Life History*

Roe's abalone can grow to a maximum shell length of about 12 cm but individuals larger than 10 cm are rare. They grow relatively quickly, attaining approximately 40 mm shell length during their first year, 60 mm in their second year (which is the size that can be legally taken by amateur fishers) and reaching the legislated commercial size of 70 mm for Area 1 in their third year (Keesing and Wells, 1989).

*H. roei* begin to become sexually mature at around 40 mm (Wells and Keesing, 1989), which is at the end of their first year. Thus, most females get to have at least one spawning season before they become vulnerable to the recreational and commercial fisheries.

The fecundity of each individual is relatively high with large individuals (>90 mm) producing in excess of 3 million eggs, but smaller individuals (near 40 mm) only produce approximately 200,000 (Wells and Keesing, 1989). Spawning activity appears to occur at low levels throughout most of the year but with a peak during the winter months of July-August (Wells and Keesing, 1989).

Abalone larvae are known to settle out onto encrusting coralline algae (Shepherd, 1973; Morse and Morse, 1984). The juveniles (< 10 mm) of *H. roei* are mainly found on areas of encrusting coralline algae, which are most abundant on the seaward edge of intertidal platform reefs (Keesing and Wells, 1989). They remain on top of these platforms for the first two years of their life (where they are mostly vulnerable to the recreational fishery) and move to the deeper subtidal areas where the food availability is higher (and become vulnerable to the commercial fishery).

*H. roei* consumes a variety of macroalgae by trapping drift algae which is mostly done at night. They do not appear to be active grazers of algae in WA. The most widespread algae found in their guts is *Sargassum* (Wells and Keesing, 1989) but the diet for *H. roei* varies both amongst sites and amongst seasons, presumably due to the relative availability. Consequently, measurements of feeding have shown that the volumes of algae in the guts were lowest in January and highest in the winter months, which corresponds to the seasonal abundance of drift algae that accumulate during winter storms (Wells and Keesing, 1989). Limpets and chitons had a much greater effect on the abundance of attached algae in the barren intertidal zone in the Perth region than occurred from the presence or absence of Roe's abalone (Scheibling, 1994).

## **2.3 MAJOR ENVIRONMENTS**

### **2.3.1 PHYSICAL ENVIRONMENT**

Abalone only live on hard rocky reef structures in relatively shallow waters in clean marine waters. The specific types of reefs inhabited vary amongst the species dependent upon their individual preferences for level of exposure and substrate complexity (see 2.4 above for details).

In recent years, concern has been mounting over habitat degradation, as the Perth metropolitan human population spreads north towards Lancelin and south past Mandurah. Although most abalone are found on reefs well away from areas of human activity, which do not normally suffer problems of environmental degradation, there is still a need to address these concerns particularly in the Metropolitan area where Roe's abalone occur on the 'doorstep' of the suburban environment. Natural habitat modification, such as riverine outflows, can also make the habitat unsuitable for abalone, as any reduction in salinity through river out flow is generally fatal for the Western Australian species of abalone.

### **2.3.2 ECONOMIC ENVIRONMENT**

The major markets for all three abalone species include Japan and other Asian countries. The highest prices for greenlip abalone are gained in China, Hong Kong and Singapore because it is the preferred abalone species. Roe's abalone is exported frozen, whole in the shell to Japan and Southeast Asia. In 1999, the Fishery had an average annual value to fishers of around \$13 million (includes all three abalone species). The estimated average prices were about \$44/kg (whole weight) for greenlip and brownlip abalone or \$120/kg (meat weight) for greenlip and \$110/kg (meat weight) for brownlip. On the basis of the average prices, the greenlip and brownlip abalone fishery was worth approximately \$9.1 million in the 1999 season (Fisheries WA, 2001). The estimated average prices for Roe's abalone were about \$35/kg. This amounted to the Roe's abalone fishery being worth approximately \$3.8 million (based on average prices) in 1999. In 2000, the prices for greenlip and brownlip were significantly higher than 1999. The estimated average wholesale price was \$163/kg meat weight for greenlip and \$132.50/kg meat weight for brownlip abalone. This amounted to the greenlip and brownlip abalone fishery being worth \$13.38 million. In addition, the estimated average price for Roe's abalone was significantly higher than the previous year at \$55/kg whole weight. On the basis of the average price the Roe fishery was worth approximately \$5.9 million. As a result, the total worth of the Fishery was around \$19 million (includes all three abalone species) for the 2000 season.

### **2.3.3 SOCIAL ENVIRONMENT**

There are close to 30 vessels operating in the Abalone Fishery. Of these, 14 vessels fish for greenlip and brownlip abalone and 26 vessels fish for Roe's abalone. There are approximately 35 divers and deck hands employed by the greenlip and abalone fishers and 50 for the Roe's fishers. In addition, due to the dispersed nature of all three of the abalone species fished, small coastal towns from Busselton to the South Australian borders and from Kalbarri to Eucla receive income from the activity of divers.

### 3. METHODOLOGY

#### 3.1 SCOPE

This application is based upon the ESD report for the Abalone Fishery. The ESD report was generated by assessing “**the contribution of the Abalone Fishery to ESD**”. This assessment examined the benefits and the costs of the Abalone fishery across the major components of ESD (see Table 1). In doing so, it will eventually provide a report on the performance of the fishery for each of the relevant ecological, economic, social and governance issues associated with this fishery. Given the timeframes involved, only the criteria required for the “Guidelines for the Ecologically Sustainable Management of Fisheries”, which cover mainly the environmental elements of ESD (outlined below in Table 1) were generated for this application.

**Table 1. Main National ESD reporting framework components.**

*Nb:* Only those ESD components in bold\* are reported in this application.

#### National ESD Framework – ESD COMPONENTS

Contribution to Ecological Wellbeing

***Retained Species\****

***Non-Retained Species\****

***General Ecosystem\****

Contribution to Human Wellbeing

*Indigenous Community Issues*

*Community Issues*

*National Social and economic Issues*

Ability to Achieve

***Governance\****

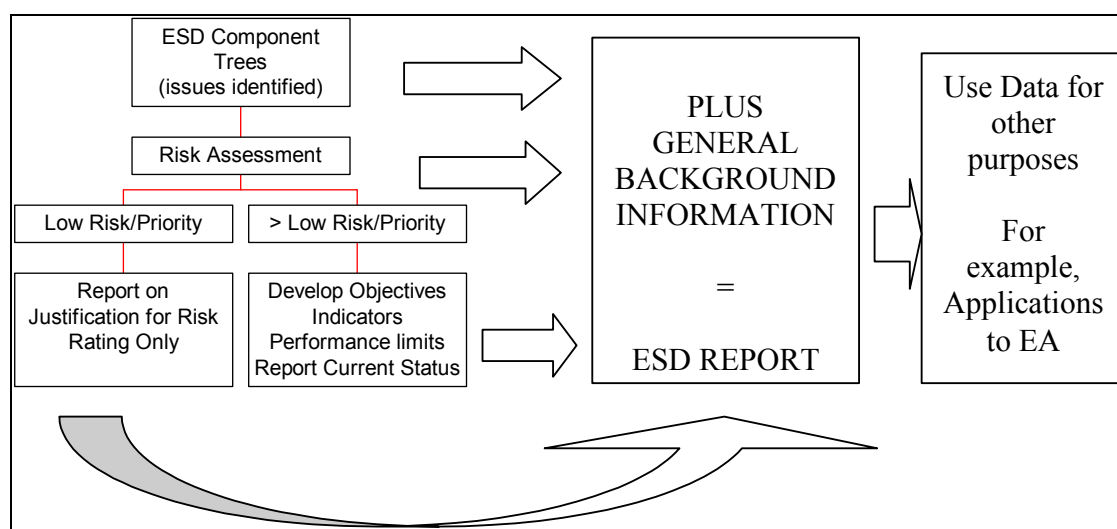
*Impact of the environment on the fishery*

#### 3.2 OVERVIEW

There were four steps involved in completing the ESD report for the Abalone Fishery. It was based upon using the National ESD Reporting Framework, which is outlined in detail in the WA ESD policy paper (Fletcher, 2002) and in the “*How to Guide*” (Fletcher et al., 2002) located on the website ([www.fisheries-esd.com](http://www.fisheries-esd.com)):

- The issues that needed to be addressed for this fishery were determined at a stakeholder workshop. This process was facilitated by adapting the set of “Generic ESD Component Trees” into a set of trees specific to the Abalone Fishery.

- A risk assessment/prioritisation process was completed that objectively determined, which of these identified issues was of sufficient significance to warrant specific management actions and hence a report on performance. The justifications for assigning low priority or low risk were, however, also recorded.
- An assessment of the performance for each of the issues of sufficient risk to require specific management actions was completed using a standard set of report headings where operational objectives, indicators and performance measures, management responses etc were specified.
- An overview assessment of the fishery was completed including an action plan for activities that will need to be undertaken to enable acceptable levels of performance to continue or, where necessary, improve the performance of the fishery.

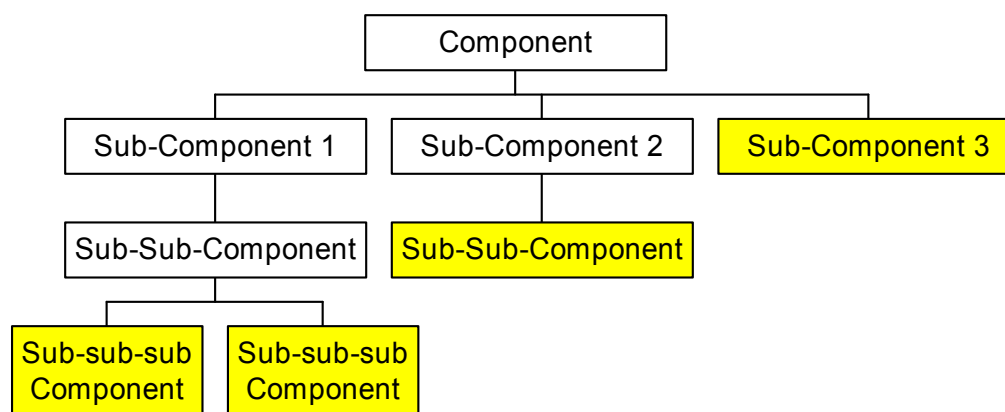


**Figure 6. Summary of the ESD reporting framework processes.**

### **3.3 ISSUE IDENTIFICATION (COMPONENT TREES)**

The National ESD Reporting Framework has eight major components, which fall into three categories of the “contributions to ecological wellbeing”, “contributions to human wellbeing” and the “ability to achieve the objectives” (Table 1). Each of the major components is broken down into more specific sub-components for which ultimately operational objectives can be developed.

To maximize the consistency of the approach amongst different fisheries, common issues within each of the components were identified by the SCFA and ESD reference groups within each of the major component areas and arranged into a series of “generic” component trees (See Fletcher (2002) and the [www.fisheries-esd.com](http://www.fisheries-esd.com) web site for a full description). These generic trees were used as the starting point for identifying the issues. These trees were subsequently adapted into trees specific to the Abalone Fishery during an open consultative process involving all stakeholder groups. This was achieved by expanding (splitting) or contracting (removing/lumping) the number of sub-components as required (see Fig. 7).



**Figure 7. Example of a component tree structure.**

The trees for the Abalone Fishery were developed at a meeting held in July 2001. The stakeholders present during this meeting covered the commercial industry, recreational fishers, environmental groups, local government, Environment Australia, WA Department of Environmental Protection, Department of Fisheries staff and an independent facilitator (full attendance list in Appendix 1).

### **3.4 RISK ASSESSMENT/PRIORITISATION PROCESS**

After the components/issues were identified, a process to prioritise each of these needs was completed using a formal risk assessment process. The risk assessment framework that was applied at the workshop was consistent with the Australian Standard AS/NZS 4360:1999 Risk Management, concentrating on the risk assessment components. The general Risk Assessment process is well documented but in summary, it considers the range of potential consequences of an issue/activity and how likely those consequences are to occur. The combination of the level of consequence and the likelihood is used to produce an estimated level of risk associated with the particular hazardous event/issue in question.

A realistic estimate of the consequence level for each issue was made by the group at the workshop. This level was from 0-5, with 0 being negligible and 5 being catastrophic/irreversible (see Appendix 2 for details of consequence tables). This assessment was based upon the combined judgement of the participants at the workshop, who collectively had considerable expertise in the areas examined.

The level of consequence was determined at the appropriate scale for the issue. Thus for target species the consequence of the Abalone Fishery was based at the population not at the individual level. Obviously catching one fish is always catastrophic for the individual but not always for the population. Similarly, when assessing possible ecosystem impacts this was done at the level of the whole ecosystem or at least in terms of the entire extent of the habitat, not at the level of an individual patch or individuals of non-target species.

The likelihood of a consequence occurring was assigned to one of six levels from remote to likely. In doing so, the workshop group again considered the likelihood of the “hazardous” event (consequence) actually occurring based upon their collective wisdom, which included an understanding of the scale of impact required.

From these two figures (consequence and likelihood), the overall risk value, which is the mathematical product of the consequence and likelihood levels (Risk = Consequence x Likelihood), was calculated. Finally, each issue was assigned a Risk Ranking within one of five categories: High, Moderate, Acceptable, Low and Negligible based on the risk value (see Table 2).

**Table 2. Risk ranking definitions.**

<b>RISK</b>	<b>Rank</b>	<b>Likely Management Response</b>	<b>Reporting</b>
Negligible	0	Nil	Short Justification Only
Low	1	None Specific	Full Justification needed
Moderate	2	Specific Management Needed	Full Performance Report
High	3	Possible increases to management activities	Full Performance Report needed
Extreme	4	Likely additional management activities	Full Performance Report needed

In general, only the issues of sufficient risk (Moderate, High & Extreme), - those that require specific management actions need to have a full performance reports completed. Nonetheless, the rationale for classifying issues as low risk or even negligible were also documented and formed part of the ESD report. This allows all stakeholders and interested parties to see why issues were accorded these ratings. This process is summarized in Figure 6 (above).

**It is important to note that the Risk Assessment involves the completion of reports that contain the completed justifications for the scores generated. Thus, the scores determined within the meeting alone are insufficient.**

### **3.5 COMPONENT REPORTS**

Only the issues of sufficient risk or priority that require specific management actions have a full performance report completed (which form section 5 of this application). Nonetheless, the rationale for classifying issues as low risk/priority were also documented and forms part of the report so that stakeholders can see where all the identified issues have finished.

For each of the lowest level sub-components (assessed as being of sufficient risk/priority to address), a detailed assessment of performance is generated. The SCFA Working Group in conjunction with the ESD Reference Group agreed upon a set of 10 standard headings each of which need to be addressed (Table 3). Added to this list a further heading, “**Rationale for Inclusion**”, has been added. This specific heading allows the issues raised within the risk assessment process to be explicitly recorded. A full description of each of these headings is located in the WA ESD policy (Fletcher, 2002), which is available on the WA Fisheries website.

**Table 3. The National ESD reporting framework headings used in this report.**

1. Rationale for Inclusion
2. Operational Objective (+ justification)
3. Indicator
4. Performance Measure (+ justification)
5. Data Requirements
6. Data Availability
7. Evaluation
8. Robustness
9. Fisheries Management Response
  - Current
  - Future
  - Actions if Performance limit is exceeded
10. Comments and Action
11. External Drivers

The completion of these component reports was initiated at the initial stakeholder workshop back in July 2001. Progress towards completing these reports was subsequently made by a variety of Departmental staff. Since the number of issues identified for this fishery was relatively few and their risks were relatively minor, a second full workshop was not held. Rather, the completed set of draft component reports was sent to all attendees of the initial workshop and any problems/concerns they had were communicated directly.

## **4. ASSESSMENT OF THE ABALONE MANAGEMENT REGIME AGAINST THE COMMONWEALTH (EA) GUIDELINES FOR ASSESSING THE ECOLOGICALLY SUSTAINABLE MANAGEMENT OF FISHERIES**

### **4.1 GENERAL REQUIREMENTS OF THE EA GUIDELINES**

The management arrangements must be:

#### **Documented, publicly available and transparent;**

As per the FRMA (1994) “*the Executive Director is to cause a copy of every order, regulation and management plan in force under this Act –*

- *To be kept at the head office of the Department; and*
- *To be available for inspection free of charge by members of the public at the office during normal office hours.”*

In addition to these legislative requirements, the current management regime, as documented in the formal set of management regulations, can be purchased by interested parties from the State Law Publisher.

Of more relevance, is that any discussion papers and proposals for modifications to these management arrangements are distributed widely to stakeholder groups automatically and other interested individuals by request in hard copy format. Where appropriate, they are now also available from the Departmental web site [www.fish.wa.gov.au](http://www.fish.wa.gov.au).

Finally, once completed, the full ESD Report on the Fishery will be made publicly available via publication and electronically from the Departmental website. This will provide increased transparency through explicitly stating objectives, indicators, performance measures, management arrangements for each issue and how the fishery is currently performing against these criteria.

There is also a proposal to formally publish the relevant objectives and performance measures for each fishery, including the Abalone Fishery, in a series of Ministerial Guidelines, which would form an adjunct to the management plan.

#### **Developed through a consultative process providing opportunity to all interested and affected parties, including the general public;**

S64 and S65 of the FRMA define the requirements for procedures that must be undertaken before determining or amending all management plans. More specifically, the management arrangements for the Abalone Fishery have been developed through formal consultation with industry and the general public, which includes the AbMAC, and also from requested submissions from industry groups (eg WA Fishing Industry

Council - WAFIC), other stakeholder groups (eg Recfishwest, Conservation Council of WA) and the general public.

The ESD Report for the Abalone Fishery was developed through a consultative process that included a wide variety of stakeholders including members of the Abalone industry, government (Departments of Fisheries and Environment), recreational groups (Recfishwest), non-government environmental groups (Conservation Council of WA and Marine and Coastal Community Network), Environment Australia and invited specialists (WA Museum, University of WA and Notre Dame University). Details of the methodology used to generate this report including how the issues were identified, how these identified issues were subjected to a risk assessment, and how the objectives etc were developed are described in [Section 3.5](#). Attendees at the workshops are listed in [Appendix 1](#).

**Ensure that a range of expertise and community interests are involved in individual fishery management committees and during the stock assessment process;**

The range of expertise and community interests that have been involved in the process of determining management and reviewing stock assessments is extensive. The groups that have been involved in the generation and review of the information contained in this application include:

- Department of Fisheries, WA;
- Department of Environmental Protection, WA;
- The abalone industry;
- Marine and Coastal Community Network;
- Western Australian Fishing Industry Council (WAFIC);
- Recfishwest;
- Aboriginal Lands Trust;
- Abalone Management Advisory Committee;
- Recreational Fishing Advisory Committee;
- Western Australian Abalone Industry Association;
- Conservation Council of WA;
- Museum of WA;
- The University of WA; and
- Notre Dame University.

The general consultation methods used for this fishery are summarised in the [Governance Section 5.4.3.1](#). The attendee list for the one meeting is listed in Appendix 1.

**Be strategic, containing objectives and performance criteria by which the effectiveness of the management arrangements is measured;**

The ESD Component Reports (see [Section 5](#)) contains the objectives, indicators and performance measures for determining the effectiveness of the management arrangements for the Abalone Fishery<sup>1</sup>. For some components, the objectives,

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<sup>1</sup> These will also be formally published in a set Ministerial Guidelines

indicators and performance measures are well established and the data are available to demonstrate levels of performance over time. For other components, the objectives, indicators and performance measures have only just been developed and/or the necessary data collection is only just being initiated. The status of this information is documented within each of the individual component reports within the ESD Reports in [Section 5](#).

**Be capable of controlling the level of harvest in the fishery using input and/or output controls;**

The FRMA, and specifically the management plan for the abalone fishery provides the legislative ability to control the level of harvest within this fishery. This is achieved through the use of a sophisticated and effective combination of input control measures based upon limiting the number of entitlements in the fishery, controlling the legal minimum size for abalone, along with a comprehensive set of TACs.

These arrangements have been modified during the past 30 years to ensure that management remains appropriate to achieve the sustainability objectives for the fishery. Thus there have been a series of reductions in the numbers of fishers allowed to operate; changes to compliance policing (eg introduction of National Docketing System); changes to spatial management arrangements (e.g. zonal management to areal management and increase of managed areas, 3 to 8); changes to the legal minimum sizes; changes to closures (no overlap of recreational and commercial fishing season) and changes to the TACs.

**Contain the means of enforcing critical aspects of the management arrangements;**

The Department employs a large number of operational staff to ensure compliance with the critical aspects of the management arrangements for the Abalone Fishery. This includes inspections of commercial operators when landing catches; covert surveillance of targeted commercial operators; unlicensed and illegal activities and inspection of processing facilities. In addition, divers and processors are required to provide daily CDRs with details of all abalone landed and consigned in WA to facilitate catch monitoring and enforcement. Processors are also required to lodge returns, which provide the Department of Fisheries with details of all the abalone received.

Given the value of the licences, fishers themselves are also a source of information on illegal activities. A full summary of these compliance activities and their effectiveness is provided in [Section 5.4.1.3](#).

**Provide for the periodic review of the performance of the fishery management arrangements and the management strategies, objectives and criteria;**

There is an annual review of the performance for the major aspects of the Fishery through the completion of the “State of the Fisheries” report. This is updated and published each year including periodic reviews by the Office of the Auditor General (OAG). It forms an essential supplement to the Department’s Annual Report to the

WA Parliament with the latest version located on the Departmental website [www.fish.wa.gov.au](http://www.fish.wa.gov.au).

The ESD Component Reports contain comprehensive performance evaluations of the Fishery based upon the framework described in the Fisheries ESD policy (Fletcher, 2002). This includes the development of objectives, indicators and performance measures for most aspects of this fishery and includes status reports for those components that are not subject to annual assessment. This full assessment, including an examination of the validity of the objectives and performance measures, is planned to be completed and reviewed externally every five years.

**Be capable of assessing, monitoring and avoiding, remedying or mitigating any adverse impacts on the wider marine ecosystem in which the target species lives and the fishery operates.;**

Capabilities for the assessment, monitoring and avoidance, remedying or mitigating any adverse impacts on the wider marine ecosystem are documented in “General Environment” [Section 5.3](#). This has been completed through a formal risk assessment analysis of the issues and, where necessary, the development of suitable monitoring programs. The Risk Assessment workshop was a critical part of the mechanisms to identify potential impacts of the Abalone Fishery on the wider marine ecosystems. This process did not identify and issues that posed greater than a minor risk and hence there are currently no needed to implement specific monitoring for such impacts.

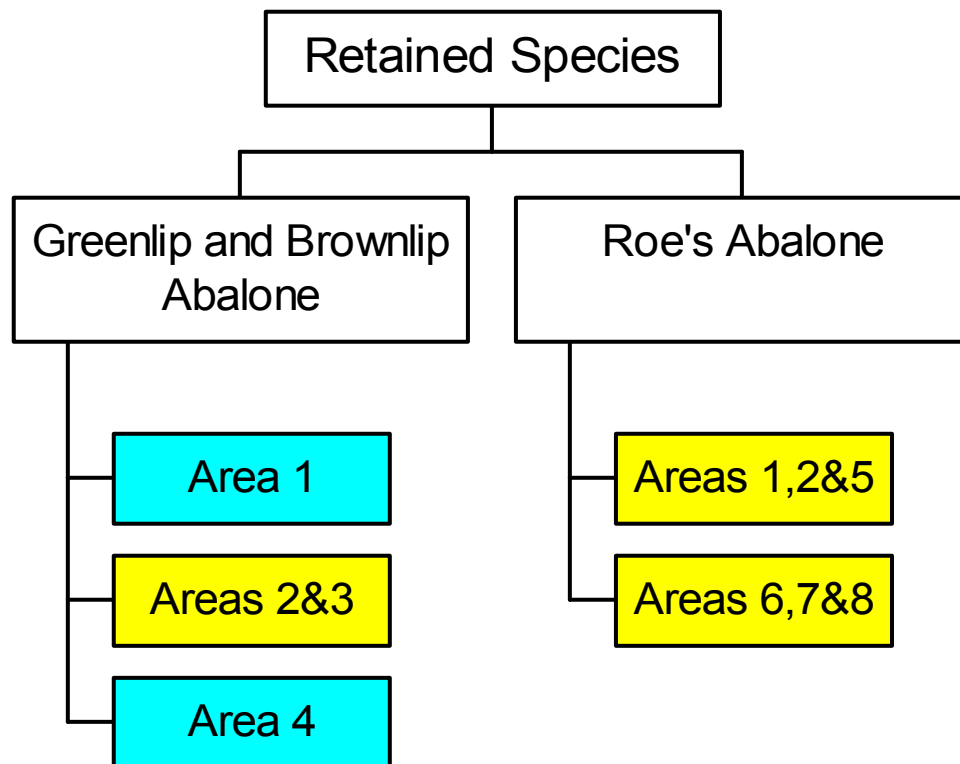
**Require compliance with relevant threat abatement plans, recovery plans, the National Policy on Fisheries Bycatch, and bycatch action strategies developed under that policy;**

The management regime for abalone complies with all the relevant threat abatement plans for species where there are significant interactions. Again, the Abalone Fishery essentially has no by-catch and negligible impacts on other elements of the ecosystem hence this is not a significant issue ([Section 5.2](#)).

## 4.2 PRINCIPLE 1 OF THE COMMONWEALTH GUIDELINES

### OBJECTIVE 1. MAINTAIN VIABLE STOCK LEVELS OF TARGET SPECIES

*A fishery shall be conducted at catch levels that maintain ecologically viable stock levels at an agreed point or range, with acceptable levels of probability.*



The component tree detailing the stocks of retained species relevant for this fishery is shown above. There are three target abalone species in this fishery, greenlip (*Haliotis laevis*), brownlip (*Haliotis conicopora*) and Roe's (*Haliotis roei*). The main stocks for each of these three species have been assessed with the appropriately detailed reports having been completed. The full reports are located in [Section 5.1](#).

The risk assessment workshop determined that the fishery was of Low or Negligible risk to greenlip abalone stocks and brownlip abalone stocks respectively in Area 1 because of the low exploitation that occurs in this region. The fishery is also having negligible risk to greenlip and brownlip abalone stocks in Area 4 because there is not quota or commercial activity within this Area. It was concluded that the fishery was of Moderate risk to greenlip abalone stocks in Areas 2 and 3 and brownlip abalone stocks in Areas 2 & 3. Roe's abalone stocks were also classified as being at Moderate risk in Areas 1, 2, 5, 6, 7 & 8.

Due to the similar biology, location and management strategies, greenlip and brownlip abalone stocks in Area 1 ([5.1.1.1](#)), Areas 2 and 3 ([5.1.1.2](#)) and Area 4 ([5.1.1.3](#)) were

assessed as three groups. Similarly, Roe's abalone in Areas 1,2 and 5 (5.1.1.4) were assessed together and likewise for Areas 6, 7, and 8 (5.1.1.5).

The management of the WA Abalone Fishery includes the use of explicit catch limits (TACs) for the commercial sector for each species in each zone of the fishery (Table 4 and 5).

Analysis of the current performance by the Abalone Fishery demonstrates that the greenlip, brownlip and Roe's abalone stocks are being maintained above levels necessary to maintain ecologically viable stock levels in each area. Thus, in summary:

- The catch and effort for each abalone stock within each area is set to maintain adequate catch rates within each area for each stock.
- There are no by-product species taken by this fishery.

Consequently, this fishery is meeting the requirements of Principle 1. The information relevant to this principle for these species is detailed below.

**Table 4 Greenlip and brownlip abalone catch and effort by quota period.**

Quota period	Greenlip TAC kg whole weight	Brownlip TAC kg whole weight	Greenlip caught kg whole weight	Brownlip caught kg whole weight	Combined catch kg whole weight	Diver days
1990	126,500	-	114,414	18,768	133,182	809
1991	148,500	-	131,266	14,660	145,926	1,145
1992	192,500	-	175,054	30,285	205,339	1,284
1993	197,450	-	178,794	31,155	209,949	1,347
1994	200,750	-	177,166	32,223	209,389	1,522
1995	187,264	-	151,863	27,263	179,126	1,327
1996	189,750	-	176,668	21,933	198,601	1,113
1997	207,350	-	187,993	26,298	214,291	1,259
1998	200,750	-	187,644	22,198	209,842	1,246
1999	189,750	28,000	180,620	27,673	208,293	1,121
2000	194,669	34,875	189,846	33,531	229,309	1,173

**Notes**

1. Data source: quota returns.
2. Standard conversion factors for meat weight to whole weight for greenlip abalone were 2.75 prior to 2000 and 2.667 for 2000. Brownlip abalone conversion factor for meat weight to whole weight was 2.5.
3. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar years.

**Table 5 Roe's abalone catch and effort by quota period.**

Quota period	Roe's TAC kg whole weight	Roe's caught kg whole weight	Diver days <sup>Δ</sup>
1990	105,000	117,558	1114
1991	101,000	110,334	1005
1992	105,000	112,275	942
1993	128,000	116,390	1058
1994	125,960	119,849	1146
1995	125,960	115,218	1206
1996	125,960	122,065	1176
1997	126,790	119,080	970
1998	93,960*	86,530	799
1999	119,900 <sup>+</sup>	108,278	757
2000	115,900 <sup>+</sup>	107,683	755

**Notes**

1. Data source: quota returns.
2. Standard conversion factors for meat weight to whole weight for Roe's abalone were 2.5 prior to 2000 and 3.0 in 2000.
3. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar year.

Δ Diver days from dedicated Roe's abalone divers only.

\* Reduced quota for a six-month season.

+ Industry-instigated voluntary 6 tonne reduction in quota for 1999 and voluntary 4 tonne reduction in quota for 2000 in response to concerns over the low abundance of legal-sized abalone.

## Information Requirements

### **1.1.1 There is a reliable information collection system in place appropriate to the scale of the fishery. The level of data collection should be based upon an appropriate mix of fishery independent and dependent research and monitoring.**

Data are collected through a combination of fishery dependent, and in the near future, fishery independent systems, the former having been in place for decades. These ongoing monitoring programs are supported by a number of research programs that have been conducted on the biology and ecology of abalone species along the west and south coast of WA.

Currently, the fishery dependent data collection systems in place to monitor the fishery are CPUE and average meat weight (greenlip and brownlip abalone only) as well as information from catch logbooks indicating where abalone is taken from, recorded on a grid basis (10 x 10 nm blocks). The Department of Fisheries recognises the need for more fishery independent data collection systems and thus has proposed studies for the coming years to investigate different fishery independent methods to analysis the abalone stocks and monitor the catch of abalone by the fishery.

There is a proposed FRDC (Fisheries Research and Development Corporation) funded study to examine the feasibility of in-water assessments using digital video to monitor changes in stock abundance and stock structure of greenlip and brownlip abalone populations. If successful, a longer-term program monitoring the status of the stocks will be implemented.

Since 1997, the Department of Fisheries has been conducting fishery independent surveys of the Roe's abalone stocks near Perth (Area 7). These surveys were initiated by the Department of Fisheries because of the higher likelihood of overfishing around the Metropolitan area as a result of the relatively easy accessibility to the abalone stocks from recreational and illegal fishers. The size distributions and densities of Roe's abalone were measured from each of six reef platforms between Penguin Island and Burns Beach. These surveys were conducted in January and February (post-season) to assess the effects of recreational fishing and to get an indication of the stock levels available for subsequent seasons ([Section 5.1.1.5](#)).

The specific data requirements needed to assess performance for each of the relevant objectives are detailed in the relevant sections of the ESD report, which is in [Section 5.1. Retained Species](#). These requirements are summarised as follows:

Monitoring Program	Information Collected	Robustness
Daily Catch and Disposal Records (CDR's)	Areas of operation on a grid basis (10x 10 nm blocks); Day of operation; Daily catch weight and number of individuals caught per day (greenlip and brownlip abalone only).	Moderate
Fishery independent surveys (Roe's abalone)	Size distributions and densities of Roe's abalone in Metropolitan region.	High
Climatic data	Rainfall data; Wind data; and Swell Height conditions.	High

## Assessments

**1.1.2 There is a robust assessment of the dynamics and status of the species/fishery and periodic review of the process and the data collected. Assessment should include a process to identify any reduction in biological diversity and/or reproductive capacity. Review should ideally take place at regular intervals but at least every three years.**

There are three main target species for the Fishery, greenlip abalone, brownlip abalone and Roe's abalone. They are managed in 8 separate areas, which allows for the management arrangements (i.e. assessments, performance measures) to be further tailored accordingly to the differences (i.e. environmental conditions, stock abundances and variabilities) between each of the areas. There is also the scope to assess data at a finer scale within these areas. For all the areas, if the effort increases

beyond the ranges provided for each area or the catch rates decline below the average value range, or in the areas where it is assessed, if there is a decline in the annual average meat weight below the long term average range, a series of management responses is set in motion. This currently involves a re-setting of the quota within the region; area access and variations in the minimum capture size in collaboration with stakeholders. The assessments for the areas are detailed in [Section 5- Performance Reports](#).

All of these stocks are classified as fully exploited and a review of the performance for the fishery is conducted annually.

## **Greenlip Abalone and Brownlip Abalone**

### *Area 1*

The risk rating was 'Low' for stocks in this area as a result of the catch of greenlip abalone being relatively low (allocated quota is 3 tonnes meat weight) plus the inaccessibility of the stocks in the area. Therefore, only a brief justification was provided ([5.1.1.1](#)).

The risk to the stocks of brownlip abalone from commercial fishing in this area was ranked as a 'Negligible' risk. The risk to brownlip was considered lower than greenlip because the allocated catch for brownlip in Area 1 is extremely low (30kg meat weight) and the abundant limestone crevices in this region ensure that the brownlip are well protected. Only a brief justification was provided ([5.1.1.1](#)).

Only the catch of both species is assessed annually to determine if exploitation is remaining at these low levels.

### *Areas 2 and 3*

The seasonal effort (in days) to take greenlip and brownlip catch is monitored against a five year average effort range (1994-1998) of 1,110-1,520 diver days in Area 2 and 681-1110 days in Area 3.

The seasons catch rates (kg per day) for greenlip and brownlip abalone are also monitored against the 5-year (1994-1998) historical mean catch rate per diver per day of 65.1 in Area 2 and 53.5 in Area 3.

The average individual meat weight of each species are monitored and assessed against the six-year (1995-2000) average. For greenlip abalone the average is currently 179.7g in Area 2 and 223.5 in Area 3. For brownlip abalone the six-year average is 261.3g for in Area 2 and 272.4 in Area 3.

The total catches, average catch rates and average meat weights are also examined for four sections within each of these Areas. These analyses are completed using the patterns from the previous year to determine if any significant differences have occurred. This is done to make sure that there are no localised effects from the commercial fishery. The full performance report is located in [Section 5.1.1.2](#).

## **Roe's Abalone**

### *Areas 1,2 &5*

The acceptable effort range in diver days to take the quota of Roe's abalone in each of the three Areas is (based on pro rata effort range for current quota):

- 23 - 77 days in Area 1,
- 163 - 211 days in Area 2, and
- 168 - 240 days in Area 5.

Although effort, in terms of the number of days fished, may vary due to variations in total catch and management controls of catch, the projected seasons catch rate (kg per day) is monitored against the historical average achieved in the fishery. The mean ( $\pm$ SD) catch rate within the 5-year range (1994-1998) for the following areas is:

- $147.7 \pm 34.3$  for Area 1 (minimum size is larger),
- $96.1 \pm 9.3$  Area 2, and
- $98.8 \pm 13.9$  Area 5.

Exceptional spatial movements of the fishery away from regular diving locations are also used as a potential indicator of local depletion of abalone. If there is a major shift in the sector within these Areas where the abalone are collected (in the order of 20% or more) amongst seasons and/or on a trend basis, this would also trigger a review. The full performance report is located in [Section 5.1.1.4](#).

### *Areas 6,7, & 8*

Total catch and effort is monitored against a 5-year (1994-1998) sustainable historical range (based on pro rata effort range for current quota- 2000). Diver days for each area are as follows:

- 60 - 89 diver days in Area 6,
- 162-170 diver days in Area 7 (first 2 seasons of new controls), and
- 122 - 182 diver days in Area 8.

In addition, there is a long time series of catch and effort data for this fishery (since 1989) against which current levels of effort can be compared. Although effort in number of days fished may vary due to variations in total catch the projected seasons catch rate (kg per day) is monitored against the historical average achieved in this fishery. As has been highlighted, this is not the case for Area 7, which has only had unrestricted daily fishing (within quota) since 1999. The mean ( $\pm$ SD) catch rate within the 5-year range (1994-1998) for Area 6 and 8 are:

- $158.3 \pm 25.6$ kg Area 6, and
- $127.4 \pm 24.4$ kg Area 8.

In Area 7 the catch rate in the 1999 and 2000 seasons has averaged 219 kg per diver day. The full performance report is located in [Section 5.1.1.5](#).

**1.1.3 The distribution and spatial structure of the stock(s) has been established and factored into management responses.**

The distribution for all three abalone species is well documented (see Section 2 for details and Figures 3, 4 and 5). The greenlip abalone occurs from Cape Naturaliste, Western Australia to Cape Liptrap, Victoria, and northern Tasmania. The brownlip abalone is found from Fremantle, Western Australia to the border of western South Australia. Lastly, Roe’s abalone occurs from Shark Bay, Western Australia to western Victoria.

The population structure for Roe’s abalone was assessed through genetic analysis in Western Australia. Results demonstrated moderate levels of connection between populations throughout the species distribution. This occurs despite mixing within each generation occurring on a scale of < 13 km. This means that although the majority of recruitment occurs as a local event on continuous reef complexes, there is sufficient gene flow between areas to allow Roe’s abalone to be dealt with on a State scale. While the management of Roe’s abalone can be managed on a state level, most fisheries management and research occurs on a smaller scale (10’s of km’s).

Additionally, the proposed study to begin in-water assessments using digital video will have the potential to monitor changes in stock abundance and stock structure of abalone populations and give the Department a better understanding of the abalone stock structures along the coast of WA.

**1.1.4 There are reliable estimates of all removals, including commercial (landings and discards), recreational and indigenous, from the fished stock. These estimates have been factored into stock assessments and target species catch levels.**

Within the list of monitoring programs outlined above for the Abalone Fishery, data covering each of these sources of removal are outlined. In most cases, these data are collected annually or at least on a sufficiently frequent basis to ensure robust estimates are available.

Sector	Catch Data Collected	Frequency
Commercial	Catch Disposal Records	Daily
Recreational	Telephone and field surveys	Annual
Indigenous	N/A included in the recreational data collection systems	Annual
Illegal	Estimated from compliance data.	Annually

While Indigenous people are not required to hold recreational licenses their take falls under the recreational management and therefore is accounted for under the data collection systems in place for the recreational fishery. Based upon the recreational telephone surveys, recreational fishing accounts for approximately 20% of the combined catch of commercial and recreational catch of greenlip and brownlip

abalone. Recreational fishing comprises 30% of the commercial and recreational catch of Roe's abalone.

The Department of Fisheries is currently attempting to implement a National Docketing System for abalone that will bring the monitoring of abalone trade in the state under the same level of scrutiny as that in other States.

### **1.1.5 There is a sound estimate of the potential productivity of the fished stock/s and the proportion that could be harvested.**

The long history of this fishery (in excess of 20 years) combined with the extensive catch and effort data and research that has been collected has enabled a very reliable estimate of the sustainable yield to be calculated for the Fishery within the fished areas. These have been translated into the annual TACs for each of the regions and species in the fishery.

The management of this fishery is adaptive and tailored to each zone and each species of abalone to allow for the variability in abalone recruitment and abundances in each area. Therefore the management this fishery uses a variety of indicators to assess the sustainability of the abalone stocks in each area.

As previously stated, seasonal effort, catch and meat weights over different time periods for each species in each area are used to assess the abalone abundance for each species within each area. In addition, Areas 2 and 3 are further broken down into sectors to determine if there are any localised effects on the greenlip and brownlip abalone stocks within the areas. In Areas 1, 2 and 5 local depletion is also analysed for Roe's abalone stocks by examining the spatial movement of the fishery away from regular diving locations.

In addition, the proposed in-water video monitoring will provide the Department of Fisheries with additional fishery independent data to utilise when managing the take of abalone by the fishery by providing information on abalone stock abundance and structure.

## **Management Responses**

### **1.1.6 There are reference points (target and/or limit), that trigger management actions including a biological bottom line and/or a catch or effort upper limit beyond which the stock should not be taken.**

#### **Greenlip and Brownlip Abalone**

As previously stated, the greenlip and brownlip abalone stocks in the Abalone Fishery are monitored by assessing the catch rate, seasonal effort and average meat weights for each season. Furthermore, there are minimum shell length restrictions in place to also control the take of abalone by commercial and recreational fishers. If successful, the in-water monitoring research project will provide the Department of Fisheries with more information on abalone stock abundances and structure, which will then be incorporated into future management strategies for the fishery.

## *Area 2*

The effort range for the greenlip and brownlip stocks in Area 2 is based on the 5-year (1994-1998) average effort average of 1,110-1,520 diver days. For catch rates, the reference point for greenlip and brownlip abalone stocks in Area 2 is based on the 5-year (1994-1998) historical mean catch rate of  $65.1 \pm 4.2$  kg meat weight per diver per day. The reference point for the annual average meat weight is based on the 6-year (1995-2000) average of 179.7g per annual for greenlip and 261.3g for brownlip abalone per annual.

If there was an increase in effort or decrease in the catch rate or meat weight from the reference range or points than a renegotiation of the quota within the area, access to the area and variations in the minimum capture size in collaboration with the stakeholders would be initiated. These management actions could be implemented mid-season (for exceptional circumstances) or prior to the beginning of the following season (see [Section 5.1.1.2](#) for more information).

## *Area 3*

The effort range for greenlip and brownlip abalone stocks in Areas 3 is based on a 5-year (1994-1998) average effort average of 681-1,110 diver days. For catch rates, the reference point is based on a 5-year (1994-1998) historical mean catch rate of  $53.5 \pm 11.5$  kg meat weight per diver per day. The reference point the annual average meat weight is based on the 6-year (1995-2000) average of 223.5 g per annual for greenlip and 272.4 g for brownlip abalone per annual.

If there was an increase in effort or decrease in the catch rate or meat weight from the reference range or points then a renegotiation of the quota within the area, access to the area and variations in the minimum capture size in collaboration with the stakeholders. These management actions could be implemented mid-season (for exceptional circumstances) or prior to the beginning of the following season (see [Section 5.1.1.2](#) for more information).

## **Roe's Abalone**

The Department of Fisheries uses the combination of seasonal effort and total catch of Roe's abalone as an indicator of stock abundance. In conjunction with the Department of Fisheries reviewing the CPUE, the movement of catch and effort within a 10x10 nautical mile grid reporting system is also assessed to monitor stock abundance and structure for Roe's abalone. If there is an exceptional spatial movement of the fishery away from regular diving locations (in the order of 20% or more) amongst seasons and/or on a trend basis, this would trigger a review.

As with greenlip and brownlip abalone, the Department of Fisheries will be investigating the use of in-water assessments of Roe's abalone using digital video to monitor changes in stock abundance and structure. Furthermore, the Department is currently working with industry to institute the development of a system for Roe's

abalone, which will be able to monitor changes in the average meat weight or grade of catch from particular locations. This measure will be made with the cooperation of abalone processors.

#### *Areas 1,2 and 5*

Roe's abalone catch rates in these areas are monitored against a 5-year (1994-1998) range of  $147.7 \pm 34.3$  kg whole weight per day of for Area 1,  $96.1 \pm 9.3$  kg whole weight per day for Area 2, and  $98.8 \pm 13.9$  kg whole weight per day for Area 5. If catch rates in an Area in any one-year is lower than the range for that area, this would trigger one of a number of additional management actions such as reducing the quota allocations, additional area and temporal closures or increase in minimum size ([Section 5.1.1.4](#)). These additional management actions can be implemented mid-season (in exceptional circumstances) or prior to the beginning of the following season.

#### *Areas 6,7 and 8*

Roe's abalone catch rates in Areas 6 and 8 are monitored against a 5-year (1994-1998) range of  $158.3 \pm 25.6$  kg whole weight per day of for Area 6 and  $127.4 \pm 24.4$  kg whole weight per day for Area 8. This is not the case for Area 7, which has only had unrestricted fishing since 1999. In Area 7 the catch rate is measured against the average from the 1999 and 2000 seasons, which is 219 kg per diver day. If catch rates in an Area in any one-year is lower than the average for that area, this would trigger one of a number of additional management actions such as reducing the quota allocations, additional area and temporal closures or increase in minimum size ([Section 5.1.1.5](#)). These additional management actions can be implemented mid-season (in exceptional circumstances) or prior to the beginning of the following season.

Furthermore, the Department of Fisheries is currently developing a performance measure for the fishery independent surveys conducted post-recreational season in the Perth area fishery for Roe's abalone. Size distributions and densities of Roe's abalone are measured from six platforms between Penguin Island and Burns Beach to assess the effects of recreational fishing and to get an indication of the stock levels available for subsequent seasons. Since the surveys have just begun recently, a performance measure has not been determined but once it is determined it will also be used in the management of Roe's abalone stocks.

### **1.1.7 There are management strategies in place capable of controlling the level of take.**

A full description of the management arrangements for the commercial fishery is located in the attached management plan. A full discussion of the main regulations and their justifications are located in Section 2.2. The following is a summary of the management arrangements for all Areas in the Fishery:

#### ***Commercial***

- a) The commercial fishery is managed through output controls (individual and area quotas generated from an annual TACs).
- b) The use of a minimum size limit that ensures sufficient spawning stock remains on the reefs and that they have at least 1 spawning season before being vulnerable to the commercial fishery.
- c) The annual fishing season has a fixed quota that is reassessed on an annual basis. Closures and quota limitations can be made mid-season, either at the request of licensees or by the Department of Fisheries, to account for exceptional events.
- d) Any significant declines in the breeding population either from environmental effects or due to fishing are observed in time to implement appropriate risk management interventions.
- e) Compliance policing monitors both abalone fishers and abalone processors.

#### ***Recreational***

- (a) A daily bag limit of 20 Roe's abalone and a combined limit of 10 greenlip and brownlip abalone.
- (b) There is a daily boat limit of twice the daily bag limit if more than one licence holder is fishing.
- (c) There are minimum legal sizes for recreational fishers of 60 mm for Roe's abalone and 140 mm for greenlip and brownlip.
- (d) In the Perth region (area 7), access for recreational fishers is only allowed between 700am and 830am on 6 Sundays per year (between November –December; a total of only 9 hours).

#### ***Compliance***

Significant effort is put into ensuring adequate compliance with these regulations. The Department of Fisheries ensures compliance within the fishery by monitoring both the abalone fishers and abalone processors. The Fishery's compliance program includes inspections of commercial operators when landing catches; covert surveillance of targeted commercial operators; and inspection of processing facilities. In addition, the Fisheries Officers check that abalone catch and disposal records have been completed correctly and accurately. Since the impact of illegal and unlicensed operators on abalone stocks is of great concern a major part of the work of the Department of Fisheries Serious Offences Unit is concentrated on the detection and prosecution of any individuals and organisations involved with the illegal take and sale of abalone.

In addition, compliance within the Fishery is also a national concern. As such, the Department of Fisheries is currently reviewing the implementation of the National

Docketing System for abalone that will bring the monitoring of abalone trade in the state under the same level of scrutiny as that in other States.

**1.1.8 Fishing is conducted in a manner that does not threaten stocks of by-product species.**

There are no by-product species caught in this fishery.

**1.1.9 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.**

Management actions taken over the past 20 years have been extremely effective and there is, therefore, an extremely high probability that they will continue to achieve the main objective of maintaining the spawning stock/biomass for all abalone species retained in the Abalone Fishery. The management responses that are currently in place for the Abalone Fishery are very detailed, both for current actions, future actions and if the performance limits are reached/approached (see [Sections 5.1.1.1 – 5.1.1.5](#)).

The Fishery utilises area management, which enables the fishery to use limit reference catch rates for each abalone species in each area. This allows for the annual management arrangements to be tailored to the expected abundance of each abalone species in each area and therefore ensures the sustainability of this fishery within each area and overall. As previously outlined above in 1.1.6, the Department of Fisheries monitors the stocks of greenlip and brownlip abalone through the seasonal effort, catch rate, average meat weights and, in the future, in-water digital video monitoring of stock structures and abundances. The Roe's abalone stocks are monitored by the Department of Fisheries through the combination of seasonal effort, total catch, spatial movement of fishery and in the future, meat weights or catch grade and in-water digital video monitoring of stock abundance and structure. If the probability of these performance limits being reached is increased, management arrangements could be implemented mid-season or by the beginning of the following season.

Strategies available to offer further protection to the spawning stock for each abalone species in each area, if required, would include:

- a) Reduce quota allocations, either for the following season or mid season.
- b) Additional area closures.
- c) Increase minimum size.

The ability to implement these strategies is provided for within the FRMA, FRMR and Abalone Plan.

## **OBJECTIVE 2. RECOVERY OF STOCKS**

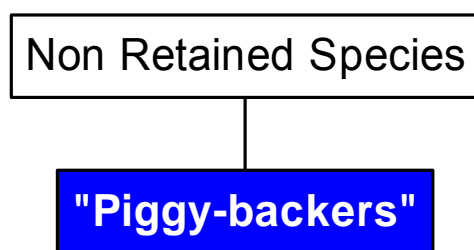
*Where the fished stocks are below a defined reference point, the fishery will be managed to promote recovery to ecologically viable stock levels within nominated timeframes.*

There are no stocks within the Fishery that are currently below defined reference points/limits.

## **4.3 PRINCIPLE 2 OF THE COMMONWEALTH GUIDELINES**

### **OBJECTIVE 1. BYCATCH**

*The fishery is conducted in a manner that does not threaten bycatch species.*



The take of non-retained species in this fishery is minor. This is due to the fact that fishing for abalone is highly selective (i.e. fishers dive and remove individual abalones). Only one group of species, 'piggy-backers' was identified as a possible non-retained species. This category of species includes commensal organisms such as other small invertebrates, which use the shell of the abalone as substrate. The risk to the bycatch species of 'piggy-backers' identified by the component tree was rated as Low.

A comprehensive report on the bycatch species is presented in [Section 5.2 Non-Retained Species](#). This assessment indicates that the performance of the Abalone Fishery is currently adequate in not threatening the bycatch (non-retained) species and is therefore meeting Objectives 1 and 2 of Principle 2.

### **Information Requirements**

#### **2.1.1 Reliable information, appropriate to the scale of the fishery, is collected on the composition and abundance of bycatch.**

Due to the highly selective method of fishing in the Fishery, there is little to none bycatch species caught. Since the management of the abalone stock results in a high proportion of abalone stocks not being affected by the fishery, the level of bycatch is too small to warrant ongoing monitoring.

## **Assessments**

### **2.1.2 There is a risk analysis of the bycatch with respect to its vulnerability to fishing.**

A formal risk assessment for the identified non-retained/bycatch species was completed (see Section 3.4 for details). This assessment concluded that the Fishery was of minor risk to any 'piggy-back' species.

#### **Piggy-back Species – Summary ERA Risk Rating Summary (C1 L3 LOW)**

The shell of abalone is encrusted with fouling commensal organisms including other small invertebrates, which use the shell of the abalone as substrate. These organisms are harvested with the abalone on which they reside and are scraped off and discarded (returned to the water mostly dead). The management arrangements for the abalone stock itself which is to ensure a sustainable harvest also ensures that a large percentage of the population remains. This would in turn ensure that adequate habitat for sessile invertebrates remains.

## **Management Responses**

### **2.1.3 Measures are in place to avoid capture and mortality of bycatch species unless it is determined that the level of catch is sustainable (except in relation to endangered, threatened or protected species). Steps must be taken to develop suitable technology if none is available.**

Not applicable.

### **2.1.4 An indicator group of bycatch species is monitored.**

Not applicable.

### **2.1.5 There are decision rules that trigger additional management measures when there are significant perturbations in the indicator species numbers.**

Not applicable.

### **2.1.6 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.**

Given the relatively low levels of interactions of the Fishery with non-retained species and the selective method of fishing used in the fishery it is likely that the level of interaction will continue to be only minimal and acceptable levels of impact will occur.

## **OBJECTIVE 2. PROTECTED, THREATENED AND ENDANGERED SPECIES**

*The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities.*

### **Information Requirements**

#### **2.2.1 Reliable information is collected on the interaction with endangered, threatened or protected species and threatened ecological communities.**

The Abalone Fishery does not interact with any endangered, threatened or protected species and threatened ecological communities.

### **Assessments**

#### **2.2.2 There is an assessment of the impact of the fishery on endangered, threatened or protected species.**

There are no endangered, threatened or protected species caught by this fishery.

#### **2.2.3 There is an assessment of the impact of the fishery on threatened ecological communities.**

There are no threatened ecological communities associated with the Fishery.

### **Management Responses**

#### **2.2.4 There are measures in place to avoid capture and/or mortality of endangered, threatened or protected species.**

Not applicable.

#### **2.2.5 There are measures in place to avoid impact on threatened ecological communities.**

Not applicable.

#### **2.2.6 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.**

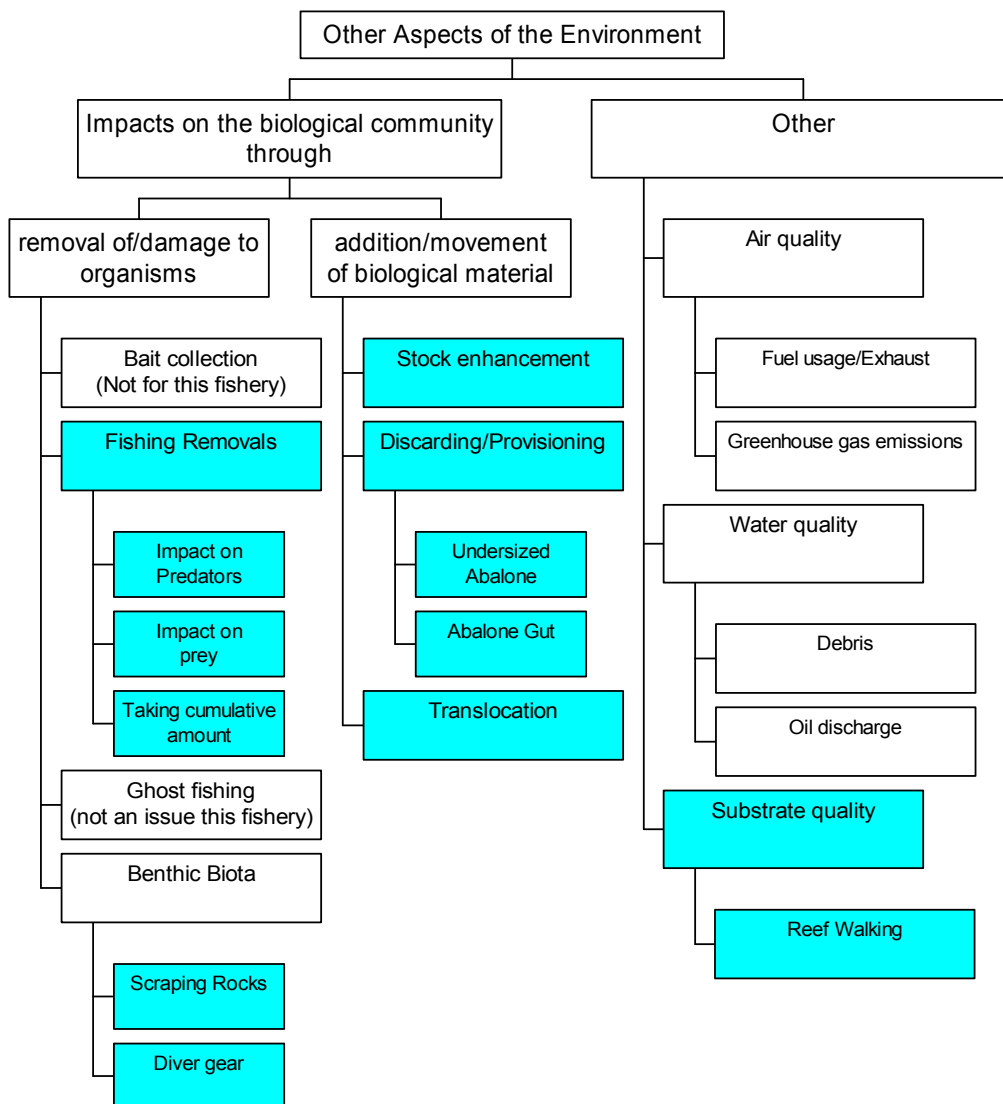
There are no endangered, threatened or protected species or threatened ecological communities impacted by this fishery.

### OBJECTIVE 3. GENERAL ECOSYSTEM

*The fishery is conducted, in a manner that minimises the impact of fishing operations on the ecosystem generally.*

The issues that relate to the broader ecosystem, which were identified for this fishery are shown below in the component tree. A formal risk assessment process subsequently assessed each of these issues with the information relating to each issue detailed in [Section 5.3](#).

Of the twelve issues identified, five were rated as Low risks, the remaining issues were rated as Negligible risks. The three issues associated with the impacts on the environment from removing organisms in this fishery were assessed in one full management report. Consequently, the Fishery’s current performance is meeting Objective 3 and this acceptable performance is likely to at least continue or improve in the future due to the implementation of further management arrangements.



## Information Requirements

### 2.3.1 Information appropriate for the analysis in 2.3.2 is collated and/or collected covering the fisheries impact on the ecosystem and environment generally.

Appropriate levels of information have been obtained for most of the issues identified, which has allowed for a sensible assessment of the level of risk to be determined. This information includes data collected directly related to the Fishery – in terms of the stock assessment and status of abalone stocks and levels of catch and effort. There are also a number of research publications that provide valuable information on the biology of abalone as well as prey and predator species populations. This information has been critical in the development of appropriate management responses.

In addition, future research projects are already identified and proposed to commence in the coming years to gain more information in all areas of the Fishery. A summary of the abalone research strategic plan is located in Appendix 3.

## Assessments

### 2.3.2 Information is collected and a risk analysis, appropriate to the scale of the fishery and its potential impacts, is conducted into the susceptibility of each of the following ecosystem components to the fishery.

A formal risk assessment was completed (see [Section 5.3](#) for details) on each of the identified issues relevant to the Fishery (see component tree for issues). The identified issues that were assessed and a summary of the outcomes are located in Table 6- complete justification are located in the performance reports in [Section 5.3](#).

**Table 6. Summary of risk assessment outcomes for environmental issues related to the Abalone Fishery.**

ISSUE	RISK	SUMMARY JUSTIFICATION	FULL DETAILS
<b>Impact of removing organisms from the environment:</b>			
Impact on predators of abalone	Low	No predator that exclusively feeds on abalone. Anecdotal reports from fished and unfished areas suggests that there does not seem to be much difference between these areas in terms of presence of predator species. No measurable effects of removing abalone on predator populations with abalone fisheries around the world which are managed at harvest levels higher than the WA Abalone Fishery.	<a href="#">5.3.1.1</a>
Impact on prey of abalone	Low	Abalone are one of several benthic herbivore groups in these communities. They are drift algal feeders, not active grazers hence they have few structuring effects on the algal communities	<a href="#">5.3.1.1</a>
Impact of removing	Low	The management of abalone stocks ensures	<a href="#">5.3.1.1</a>

piggy-back species		that a large percentage of the population remain, which would continue to provide habitat for sessile invertebrates. Most species probably do not use the shell of the abalone exclusively as a substratum. The high-energy environments, which abalone inhabit are harsh and unfavourable for settling invertebrates	
Impact of removing the cumulative amount of biological material	Low	There is little overall tonnage removed by this fishery. Only 300t over a distance of 2000 km.	<a href="#">5.3.1.1</a>
<b>Addition of material:</b>			
Discarding undersized abalone	Negligible	The quantity of discarded abalone is extremely low (less than 1% discarded) because: <ul style="list-style-type: none"> <li>- abalone fishing is very selective,</li> <li>- divers are very experienced at estimating the size of abalone before removing them, and</li> <li>- legal size is 140mm (greenlip/brownlip), industry does not usually target individuals smaller than 150mm.</li> </ul>	<a href="#">5.3.2.1</a>
Discarding Abalone Gut	Negligible	Only greenlip and brownlip abalone are shucked at sea. Approx. one-third of the animal is gut. Approx. 76 tonnes of gut are spread across approx. 1800km of coastline over approx. 1500 fishing days.	<a href="#">5.3.2.2</a>
Non-native and Disease Introductions (Translocation)	Low	Since the vessels are rarely stationary while in the water and their duration of immersion is relatively short the ability for serious attachment of fouling organisms is unlikely. The vessels are removed from the water and left to dry overnight, which likely kills any marine organisms attached to the hull.	<a href="#">5.3.2.3</a>
Stock Enhancement	N/a	Currently, no abalone stock enhancement projects operating in Western Australia.	<a href="#">5.3.2.4</a>
<b>Impact to Substrate Quality from:</b>			
Scraping abalone from rocks	Negligible	Substrate not physically damaged in the process of lifting the abalone off. Area of disturbance is limited to the site of abalone attachment.	<a href="#">5.3.3.1</a>
Interaction of diver gear and bottom	Negligible	Divers operate about a metre above the substrate. Diver equipment have floats attached so that they are held above the substrate and do not drag along the bottom.	<a href="#">5.3.3.2</a>
Reef Walking	Negligible	Commercial divers rarely walk on the intertidal areas. This habitat is generally in high-energy zones that contain species capable of withstanding physical impacts then in less disturbed areas. Additionally, disturbance is a natural event in these areas and therefore this is unlikely to be detectable against the natural level of impact, Amount of area accessed is very low, not widespread impact.	<a href="#">5.3.3.3</a>
Indirect Interactions	Negligible	No known interactions between abalone	<a href="#">5.3.3.4</a>

	fishers and wildlife.	
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Thus, all of these issues were rated as negligible or low risk.

### **Management Responses**

#### **2.3.3 Management actions are in place to ensure significant damage to ecosystems does not arise from the impacts described in 2.3.1.**

The most important management methods required to ensure that there is minimal impact on the broader ecosystem are ensuring there is sufficient stock/biomass levels of abalone are maintained. In most cases this serves to achieve both objectives (eg a sustainable fishery and minimal impacts on any trophic interactions). Additionally, since this fishery uses a very selective means of fishing, this helps to preclude any damage to the surrounding habitat and environment (eg by-product and bycatch species are minimal). Other management measures such as limiting the number of fishers, setting minimum legal catch sizes, spatial and seasonal closures, areal management of abalone stocks, and future research also further minimise the potential for impacts. Moreover, abalone species captured in the WA fishery feed on drift algae and therefore play a minimal role in the broader functioning of the ecosystem.

#### **2.3.4 There are decision rules that trigger further management responses when monitoring detects impacts on selected ecosystem indicators beyond a predetermined level, or where action is indicated by application of the precautionary approach.**

None of the issues were of sufficient risk to require specific target levels as they are effectively covered by the other management arrangements and trigger points (eg – stock levels of abalone).

#### **2.3.5 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.**

Given that the risk assessment identified that under current management arrangements there have been minimal or negligible impacts from the Fishery on the broader ecosystem even after around 30 years of fishing, it is highly likely that the fishery will continue to meet the objectives of having only acceptable levels of impacts.

## OVERVIEW TABLE

The following table provides a summary of the material presented in the report.

Issue	Objective Developed	Indicator Measured	Performance Measure	Current Performance	Robustness	EA Guidelines Covered	Actions
<b>RETAINED SPECIES (Component Tree)</b>						1.1	
<a href="#">5.1.1.1 Greenlip/Brownlip Abalone Area 1</a>	No- Low and Negligible Risk					1.1.1-1.1.7	Review risk at next major assessment
<a href="#">5.1.1.2 Greenlip/Brownlip Abalone Area 2</a>	Yes	Catch Rate and Average meat weight	Effort range- 1,110-1,520 diver days. Catch rate- 65.1±4.2kg meat weight per diver day. Avg. meat weight- greenlip- 179.7g per annual; brownlip- 261.3g per annual.	Acceptable	Moderate	1.1.1-1.1.7	Continue current monitoring, management and assessment arrangements.
<a href="#">5.1.1.2 Greenlip/Brownlip Abalone Area 3</a>	Yes	Catch Rate and Average meat weight	Effort range- 681-1,110 diver days. Catch rate- 53.5±11.5kg meat weight per diver day. Avg. meat weight- greenlip- 223.3g per annual; brownlip- 272.4g per annual.	Acceptable	Moderate	1.1.1-1.1.7	Continue current monitoring, management and assessment arrangements.

Issue	Objective Developed	Indicator Measured	Performance Measure	Current Performance	Robustness	EA Guidelines Covered	Actions
<b>RETAINED SPECIES (Continued)</b>							
<a href="#">5.1.1.3 Abalone in Area 4</a>	No						
<a href="#">5.1.1.4 Roe's Abalone Area 1</a>	Yes	Catch Rate	Effort range-23-77 diver days; Catch Rate-147.7± 34.3kg whole weight per diver day.	Acceptable	Medium	1.1.1-1.1.7	Continue current monitoring, management and assessment arrangements.
<a href="#">5.1.1.4 Roe's Abalone Area 2</a>	Yes	Catch Rate	Effort range-163-211 diver days; Catch Rate-96.1± 9.3kg whole weight per diver day.	Acceptable	Medium	1.1.1-1.1.7	Continue current monitoring, management and assessment arrangements.
<a href="#">5.1.1.4 Roe's Abalone Area 5</a>	Yes	Catch Rate	Effort range-168-240 diver days; Catch Rate-98.8± 13.9kg whole weight per diver day.	Acceptable	Medium	1.1.1-1.1.7	Continue current monitoring, management and assessment arrangements.
<a href="#">5.1.1.5 Roe's Abalone Area 6</a>	Yes	Catch Rate	Effort range-60-80 diver days; Catch Rate-158.3± 25.6kg whole weight per diver day.	Acceptable	Medium	1.1.1-1.1.7	Continue current monitoring, management and assessment arrangements.
<a href="#">5.1.1.5 Roe's Abalone Area 7</a>	Yes	Catch Rate	Effort range-162-170 diver days; Catch Rate-219kg per diver day.	Acceptable	Medium	1.1.1-1.1.7	Continue current monitoring, management and assessment arrangements.

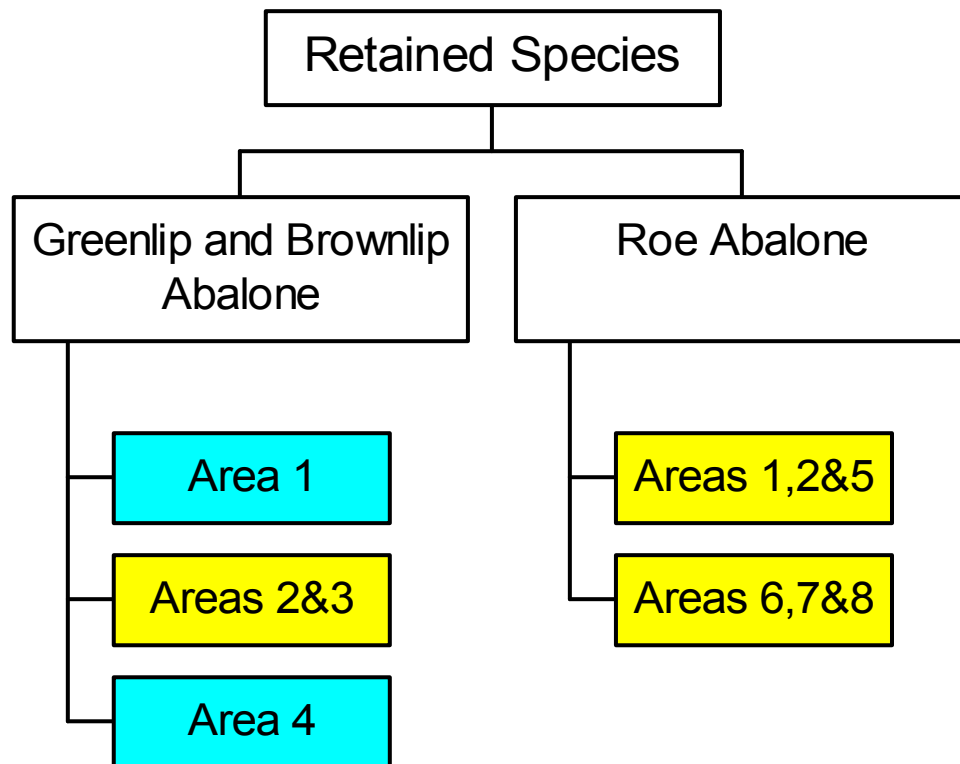
Issue	Objective Developed	Indicator Measured	Performance Measure	Current Performance	Robustness	EA Guidelines Covered	Actions
<b>RETAINED SPECIES (Continued)</b>							
<a href="#">5.1.1.5 Roe's Abalone Area 8</a>	Yes	Catch Rate	Effort range-122-182 diver days; Catch Rate-127.4± 24.4kg whole weight per diver day.	Acceptable	Medium	1.1.1-1.1.7	Continue current monitoring, management and assessment arrangements.
<b>NON-RETAINED SPECIES (Component Tree)</b>						2.1,2.2	
<a href="#">5.2.1.1 Piggy-back Species</a>	No					2.1	Review at next major assessment.
<b>GENERAL ENVIRONMENT (Component Tree)</b>						2.3	
<a href="#">5.3.1.1 Impact of removing all organisms</a>	No					2.3.1-2.3.5	Review at next major assessment.
<a href="#">5.3.2.1 Discarding undersized abalone</a>	No					2.3.1-2.3.5	Review at next major assessment.
<a href="#">5.3.2.2 Discarding abalone gut</a>	No					2.3.1-2.3.5	Review at next major assessment.
<a href="#">5.3.2.3 Non-native and disease introductions</a>	No					2.3.1-2.3.5	Review at next major assessment.
<a href="#">5.3.2.4 Stock Enhancement</a>	No					2.3.1-2.3.5	Review at next major assessment.
<a href="#">5.3.3.1 Scraping abalone from rocks</a>	No					2.3.1-2.3.5	Review at next major assessment.

Issue	Objective Developed	Indicator Measured	Performance Measure	Current Performance	Robustness	EA Guidelines Covered	Actions
<b>GENERAL ENVIRONMENT (Continued)</b>						2.3	
<a href="#">5.3.3.2 Interaction between diver/diver gear and the bottom</a>	No					2.3.1-2.3.5	Review at next major assessment.
<a href="#">5.3.3.3 Reef Walking</a>	No					2.3.1-2.3.5	Review at next major assessment.
<a href="#">5.3.3.4 Indirect interactions</a>	No					2.3.1-2.3.5	Review at next major assessment.

## 5. PERFORMANCE REPORTS

### 5.1 RETAINED SPECIES

#### COMPONENT TREE FOR THE RETAINED SPECIES IN THE ABALONE FISHERY



**Figure 8. Component tree for the retained species.**

**Yellow boxes** indicate that the issue was considered high enough risk at the July 2001 Risk Assessment workshop to warrant having a full report on performance. **Blue boxes** indicate the issue was rated as a low risk and no specific management is required - generally only the justification is presented.

#### 5.1.1 PRIMARY SPECIES

##### 5.1.1.1 GREENLIP AND BROWNLIP ABALONE STOCKS IN AREA 1

###### Rationale for Inclusion:

Greenlip and brownlip abalone are commercially fished in Area 1.

###### ERA Risk Rating: Impact on breeding stocks in Area 1:

Greenlip Abalone (C1 L4 LOW)

Brownlip Abalone (C0 L3 NEGLIGIBLE)

**Greenlip:** The risk to greenlip abalone breeding stocks from commercial fishing in this region was ranked as a 'low' risk. The risk was considered 'low' because the allocated quota for greenlip abalone in Area 1 is small (3 tonne meat weight) relative to the available abalone habitat (275km coastline) in Area 1. Since 1994, the catch (<200kg taken annually) and effort in this location has been limited for a variety of reasons. So, the consequence of taking even the full quota level would only have a minimal impact on these stocks and the past activities of the fishery suggest that this does not occur every year

As with all Western Australian greenlip abalone, breeding stocks are safeguarded by the legislation of a minimum size limit, which increases the likelihood that abalone have a minimum of one spawning season before they are eligible to be taken by commercial fishers. Although fishing occurred prior to the 1993-1994 season in Area 1, catches declined substantially after this season because minimum size limits (140 mm shell length) were introduced into a predominantly 'stunted' stock (i.e. relatively few individuals ever exceed the legal size).

In addition to the effect of the introduction of a new minimum legal size on catches, only a small percentage of the fishing grounds in this Area are accessed due to the remoteness of the Area and generally unfavourable fishing conditions. Many abalone patches in this Area are not commercially viable as the densities of abalone are low, making fishing of such stocks uneconomic.

An increase in the fishing effort for greenlip abalone is not likely within this remote fishing Area if the present size limit remains in place. Exploratory surveys carried out by industry divers and Fisheries staff in 1979, 1994 and 2001 to determine the distribution and density of the stocks within this region found that less than 5% of the stocks were of legal size (140mm) and the stocks of legal size were located in small localised areas.

The shell and meat condition of abalone fished in Area 1 is generally poor. However, checks by the Fish Health section of the Department of Fisheries have found no ubiquitous pest or parasitic infection (samples checked in 2001). The poor condition of abalone found here may be related to the shallow depth of water that these colonies of abalone inhabit. It is possible that they may be negatively impacted from significant variations in water temperature and the decomposition of seaweed and seagrass, which is characteristic of this fishing location.

**Brownlip:** The risk to brownlip abalone stocks from commercial fishing was ranked 'negligible'. The risk was considered this small because the allocated catch for brownlip abalone in Area 1 is extremely low (30 kg meat weight) and the abundant limestone crevices in this region ensure that the cryptic brownlip abalone present in the Area are well protected. Consequently, the amount that could be taken would not be measurable against any background variation in stock abundance.

The risk of either species being targeted by illegal operators (poachers) is unlikely as aggregations are small and low in density. Although the remoteness of Area 1 could be advantageous to illegal operators, the fishing conditions are very challenging.

Unless there is a change to the minimum legal sizes (140 mm) or observations of the commercial divers suggest a significant change in relative abundance, only the annual catch of each species will be monitored.

### **5.1.1.2 GREENLIP AND BROWNLIP ABALONE STOCKS IN AREAS 2 & 3**

#### **Rationale for Inclusion:**

Greenlip and brownlip abalone are commercially fished in Area 2.

#### **ERA Risk Rating: Impact on breeding stocks in Area 2**

**Greenlip (C3 L3 MODERATE)**

**Brownlip (C2 L5 MODERATE)**

#### **ERA Risk Rating: Impact on breeding stocks in Area 3**

**Greenlip (C3 L4 MODERATE)**

**Brownlip (C3 L4 MODERATE)**

#### ***Area 2***

The risk to the breeding stocks of both greenlip and brownlip abalone from commercial fishing were rated as 'Moderate'. For brownlip abalone, the fishery was assessed as only occasionally being able to fully exploit the stocks within Area 2 because of the generally cryptic nature of much of the stock and the relative inaccessibility to non-commercial divers.

Current-fishing practices for greenlip abalone could only have an unwanted level of impact on breeding stocks (ie a 'severe' consequence) if the spawning cycle was in some way interrupted for a significant number of years. The likelihood of this occurring was considered unlikely for greenlip because of the significant management safeguards already in place to minimise this chance. The impact of other users of this resource (recreational and illegal fishers) was also considered to be relatively low in Area 2.

#### ***Area 3***

The risk ratings for greenlip and brownlip abalone breeding stocks from the commercial fishery in this region whilst higher were still only ranked as 'Moderate'. Thus, the potential for a 'severe' consequence on the breeding stocks for both species was considered 'possible' in this region because there is a greater presence of both recreational and illegal fishers in Area 3 than in Area 2, and because there has been evidence of localised stock depletions for both species since the start of the commercial fishery.

#### **Operational Objective**

To ensure there is sufficient breeding stock across the entire area (Zones 2 and 3) to continue recruitment at levels that will replenish what is taken by fishing, predation

and other environmental factors by maintaining the spawning stock of greenlip and brownlip abalone at or above a level that minimises the risk of recruitment overfishing.

***Justification:***

*The operational objective is in place to meet the environmental and commercial objectives of sustaining abalone populations. Greenlip and brownlip abalone can suffer recruitment overfishing. It is important, therefore, to ensure a significant proportion of abalone of spawning size remain protected on all abalone reefs in case of sporadic recruitment deficiencies because once reefs have few adults this may negatively impact on ongoing recruitment.*

**Indicators**

***Areas 2 and 3:***

**Catch Rate – (Total Fishing Effort used to take entitlement)**

The total number of fishing days taken to achieve the catch entitlement, and the daily catch per unit effort (CPUE) is used as an indicator of stock abundance. The catch rate is monitored on a number of levels (by species and spatially). Compulsory catch logbooks are filled in by fishers indicating where abalone were taken, recorded on a grid basis (10 x 10 mile blocks). In addition to the annual catch rate for the entire area being calculated, the annual catch rate for a number of sectors within this region, and where necessary on a grid block by grid block basis are also calculated.

**Average meat weight**

The daily catch of abalone is shucked (removed from the shell) by the operator and counted. This provides data on the total weight of abalone (meat weight or whole weight) and number of abalone caught (by species) at that location. From this the annual average meat weight of abalone caught for the entire Area and Sectors within this area can be calculated.

**Performance Measures**

***Area 2 & 3***

The seasonal effort (in days) to take greenlip and brownlip catch is currently monitored against the five-year average effort range (1994-1998) of 1,110-1,520 diver days in Area 2 and 681-1110 days in Area 3.

The seasons catch rates (kg per day) for greenlip and brownlip abalone are also monitored against the five-year (1994-1998) historical mean catch rate per diver per day of 65.1 in Area 2 and 53.5 in Area 3.

The average individual meat weight of each species are monitored and assessed against the six-year (1995-2000) average. For greenlip abalone, the average is

currently 179.7g in Area 2 and 223.5g in Area 3. For brownlip abalone, the six-year average is 261.3g in Area 2 and 272.4g in Area 3.

The total catches, average catch rates and average meat weights are also examined for sections within each of these Areas (Area 2 -West, Esperance, Pt Malcolm, Israelite Bay), (Areas 3 - Augusta, Hopetoun & Windy Harbour) using the patterns from previous years to determine if significant differences have occurred. This is done to make sure that there are no localised effects from the commercial fishery.

If effort increases beyond these ranges or the catch rates decline below the average values, or if there is a decline in the annual average meat weight below the long-term average, a series of management responses is set in motion (see later for details). This currently involves a re-setting of the quota within the region; area access and variations in the minimum capture size in collaboration with stakeholders.

***Justification:***

*The historical effort range and average catch rate (kg/day) against which the status of the breeding stocks is assessed is based on the range of catch and effort values that have been observed during the long time series of catch and effort data available for this fishery (30 years). During this period the catch rate has remained reasonably high and there are no signs of adverse affects on the levels of recruiting juvenile abalone entering the fishery. Consequently, it is assumed that these catch rates are consistent with the breeding stock being sufficient to maintain adequate recruitment. The finer scale analyses completed at the intra-Area (sector) level are completed to ensure that there are no serial depletion problems affecting the stocks in these areas. For example, movements of fishing activity within the fishery away from regular diving locations can indicate potential problems in abundance of abalone in the fishery.*

*Variations in the annual average meat weights of both species are also examined at the level of the entire Area, within 4 main sectors and various sub-sectors. A fall in average meat weight below the long term average can indicate that stocks are being accessed at a smaller size (age) or are becoming scarcer causing the fishing effort to be extended into the time of year when meat condition is less robust (resulting in greater "bleed-out"). The movements in the fishing location away from the faster growing grounds, which support larger abalone may also result in a decline in the average meat weights caught during a season.*

*Falls in average meat weights are approached from a precautionary perspective and management decisions are made accordingly. A series of decision rules based on the extent and duration of changes in meat weight are currently being developed.*

## Data Requirement for Indicator

### *Areas 2 and 3*

Data Required	Availability
Catch rate utilising commercial catch and effort information provided through compulsory catch disposal returns (CDR) completed daily by 100% of the fishers	Yes; available on an annual basis since the late 1980's
Average abalone meat weights calculated from the CDRs	Yes; available on a daily basis since the late 1980's
Location fished to 10km <sup>2</sup> grid from the CDRs'	Yes; available on a daily basis since the late 1980's

### Evaluation

**Summary: The current and historical catch and effort figures indicate a high level of stability in the time needed to take the catch, the average catch rate and average meat weight for greenlip and brownlip Abalone Fishery of Area 2 and 3 during the past decade. Consequently, the current performance of the fishery is maintaining a sufficient level of spawning biomass and is therefore meeting the agreed objective.**

### *Area 2*

#### *General*

For greenlip and brownlip abalone, the catches and effort expended to take the quota have generally been within the acceptable range for this fishery for the last decade (Table 7). Catch allocations and catch rates have remained stable, without the need to impose exceptional fluctuations in quotas or other measures.

Assessment of the catch and effort for the 2000 season reveals a catch rate of 75.68kg/day for greenlip and brownlip (total catch 37,236.4kg) which shows no sign of decline against the longer term (1994-98) average of 65.1kg/day. This result has been obtained despite a marginal increase in the level of take of brownlip abalone during the last decade. Observations on the levels of stock and recruitment are consistent with there being sufficient breeding stock to continue recruitment at levels that will replenish what is taken by fishing, predation and other environmental factors. Small irregular fluctuations in indicators are likely to result from environmental variations and not from a decrease in the abundance of the spawning stock due to fishing.

**Table 7. Area 2 abalone catch and effort by quota period.**

Quota period	Greenlip Brownlip combined TAC kg	Maximum allowable Greenlip TAC kg	Greenlip abalone total meat wt (kg)	Brownlip abalone TAC kg	Brownlip abalone total meat wt (kg)	Greenlip Brownlip Dive days	Greenlip Brownlip abalone kg meat weight per day	Greenlip ave meat weight (kg)	Brownlip ave meat weight (kg)
1990	36,000	*30,000	29,140	*6,000	5,903	500	70.09	191.2**	244.0**
1991	12,000	*10,000	7,888	*2,000	2,191	177	56.94	175.2**	229.1**
1992	36,000	*30,000	31,361	*6,000	6,692	476	79.94	187.5**	238.6**
1993	36,000	*30,000	29,564	*6,000	6,626	422	85.76	180.2**	243.9**
1994	37,200	*30,000	29,928	*7,200	7,245	551	67.46	183.5**	248.3**
1995	37,200	*30,000	29,319	*7,200	7,872	631	58.94	178.4	256.0
1996	37,200	*30,000	29,541	*7,200	7,651	577	64.46	180.7	261.2
1997	40,320	*32,400	31,838	*7,900	8,403	574	70.11	175.2	263.5
1998	37,320	*30,000	30,062	*7,200	7,195	577	64.57	177.5	258.1
1999	37,320	30,000	29,772	7,200	7,163	421	87.73	188.8	268.1
2000 <sup>#</sup>		30,000	29,457	7,920	7,779	492	75.68	177.2	259.4

**Notes**

1. Data source: quota returns.
2. Standard conversion factors for meat to whole (live) weight where used are 2.666 for greenlip and 0.4 for brownlip abalone.
3. The quota period length has varied with management changes. For simplicity it has been recorded against calendar years.
4. 1991 was a 4-month season.
5. \* Brownlip TAC up to minimum value. Equals combined greenlip/brownlip quota minus actual greenlip catch.
6. \*\* Average meat weights are available prior to 1995 but there is some argument over the accuracy of abalone counts prior to 1995.
7. <sup>#</sup> Some variation from data presented in State of the Fisheries document due to changes following transfer of database between regional offices and a central entry and checking point in Perth.

*Greenlip*

The Area 2 catch rate for greenlip abalone was 59.51 kg/day in 2000. Catch rates decreased by 12 kg/day in 2000 from the 1999 catch rate since there was 10% more abalone fishing (by weight) from “traditional” stocks compared to 1999. The temporary increase seen in average meat weights compared to the traditional greenlip stocks (non-stunted) recorded in 1999 was not sustained in 2000/2001. In 2000 the average greenlip meat weight reverted to 177g, a decrease of just over 10g from the previous season’s average when controlled harvesting of stunted stocks relieved fishing pressure (and effort) from traditionally fished stocks. This is still above the 6-year average for greenlip meat weights of 175.2g. The small upward and downward seasonal fluctuations in average meat weights appear to be more related to environmental influences on recruitment and growth, and trigger points currently under development take into account inconsistent marginal fluctuations in average meat weights before controls are introduced

*Brownlip*

The CPUE for brownlip in this area is generally not a good indicator of abundance because brownlip are fished as incidental catch to the more common greenlip. The discovery of new local clusters of commercial size brownlip can increase the CPUE considerably, whereas moderate harvesting of brownlip in a range of greenlip locations can lower the catch rate with no overall change to stock health. The Area 2

catch rate for brownlip abalone was 19.4 kg/day in 2000 compared to 19.3 kg/day in 1999 (Table 8).

The average meat weight for brownlip in Area 2 was 259.3 g this is only 2 grams lower than the 6-year average (1995-2000 seasons inclusive) for brownlip meat weights in Area 2 and does not indicate any present cause for concern.

**Table 8. Area 3 abalone catch and effort by quota period.**

Quota period	Greenlip TAC kg	Greenlip abalone kg meat wt	Brownlip TAC kg	Brownlip abalone kg meat wt	Diver days	Greenlip Brownlip abalone kg meat weight per day	Greenlip ave meat weight (kg)	Brownlip ave meat weight (kg)
1990	*16,000	9,567	*	1,604	272	41.07	209.4	298.1
1991	*44,000	36,620	*	3,673	917	43.94	204.1	238.7
1992	*40,000	32,046	*	5,422	800	46.84	197.7	285.5
1993	*40,000	33,936	*	5,836	893	44.54	199.1	279.3
1994	*40,000	34,309	*	5,644	964	41.45	201.5	267.6
1995	*35,096	25,887	*	3,032	691	41.85	213.6	329.0
1996	*36,000	34,546	*	1,122	528	67.55	228.3	222.5
1997	*40,000	36,437	*	2,111	678	56.86	226.4	263.4
1998	*40,000	38,158	*	1,684	665	59.91	217.2	273.3
1999	36,000	35,871	4,000	3,906	649	61.29	229.2	260.5
2000	40,000	40,290	6,000	5,436	583	78.43	231.0	273.4

**Notes**

1. Data source: quota returns.
2. Standard conversion factors for meat to whole (live) weight where used are 2.75 for greenlip and 2.5 for brownlip abalone.
3. The quota period length has varied with management changes. For simplicity it has been recorded against calendar years.
4. 1991 was a 4 month season.
5. \* Brownlip TAC up to minimum value. Equals combined greenlip/brownlip quota minus actual greenlip catch. \* Indicates that only a global quota for both greenlip and brownlip was set. Individual quotas have been implemented since 1999.

**Area 3**

*General*

For greenlip and brownlip abalone in this area, catch and effort have been within the acceptable range for this fishery for the last decade (Table 7). Quota allocations and catch rates have remained stable, with no exceptional fluctuations in quotas or the daily catch rate. This area has utilised a combination of temporary quota reductions and closures/openings of the most productive locations in the recent past as controls to direct effort. Assessment of the current effort levels against historical ranges reveals a decline in the time taken to catch the quota despite a marginal increase in the take of brownlip abalone. In addition there has been a noticeable increase in daily catch rates (kg) from those seen in the last decade from approximately 40 kg/day in the mid 1990s to the current rate of 78 kg/day. This is much greater than the 5 yr (1994-1998) average ( $\pm$ SD) of  $53.5 \pm 11.5$  kg per day.

In addition, raising minimum size limits by a millimetre a year (which occurred by industry agreement) has increased the average meat weight of greenlip abalone substantially since 1997. Although the legislated minimum size limit is set at 140 mm shell length, industry only begins to access the stocks at lengths between 149 and

153mm shell length (depending on whether the sector being fished is slower or faster growing). In 2000, the average meat weight for greenlip abalone was 231g, the highest average recorded since 1990 (see Table 8). During the 2001/2002 season the catch of greenlip from traditionally fished grounds decreased 3.75% by fishing 1.5 tonnes of ‘stunted stock’ east of Hopetoun.

### *Brownlip*

Information on brownlip abalone stocks in Area 3 is less extensive as divers have in the past primarily targeted greenlip abalone. The quota for brownlip abalone in Area 3 was increased by 2 tonnes for the 2000 season, partially as an incentive to get divers to target new areas for brownlip abalone. Diver catch records and average meat weights indicate that this approach has been partially effective. Anecdotal information has revealed that divers allocated more brownlip quota have been forced to adopt a different fishing style (brownlip are more cryptic) in order to fill their brownlip allocation, and the change in style of diving has allowed divers to find more brownlip without an extensive search being required. There is still a push to get divers to spread their search for brownlip abalone. The average meat weight for brownlip abalone in 2000 was 273.4g, the highest since 1995.

### **Robustness**

#### **Low (Brownlip) – Moderate (Greenlip)**

Assessment of both daily catch records (catch and effort and through the analysis of processor weights and counts of abalone, average meat weights) was until the end of 2000 entered by Regional Services at regional Fisheries Offices along the south and west coast of Western Australia. Fisheries Officers and office staff at these offices concentrated efforts on tallying quota, and discrepancies crept into the records system when the general data was collated into a central database. This problem has been recognised and rectified by the Department of Fisheries and entry and checking of all daily catch records has now been centralised. From the start of the 2001 season, all daily catch records have been collated and entered at one central office in the Metropolitan area where one qualified officer from Regional Services manages the entry of all information, checking for inaccuracies and contacting fishers to query uncertainties. In the past, the Mollusc Research Division has corrected mistakes found in the database as the data is being analysed. Such changes can result in small variation to the overall figures and averages presented in the State of the Fisheries report. This should occur less frequently from 2001 onwards, due to the new centralised management system for the catch database.

The indicators of abundance and stock status (catch rates, mean size) are considered sufficiently robust for the current risk because:

- There is a suitable minimum size limit, good compliance and the positive move by fishers to voluntarily increase their minimum size limit beyond the legislated minimum (to 145 mm), which ensures that the breeding stock is better safeguarded.
- The Department of Fisheries has a long time-series of catch and effort information provided by 100% of the commercial fishers through compulsory daily logbooks, which provides a suitable basis to make comparisons on current performance.

- Through the use of a combination of the catch and effort data and an analysis of average meat weights at spatial scales (with a potential resolution of 10 x 10 nautical miles) is considered to be an adequate indicator of relative abundance of greenlip and to a lesser extent brownlip abalone.
- This formal monitoring information is supplemented by observations made by the research group whilst conducting experimental studies in the region. In addition, there is a high level of feedback from industry on the status of stocks in the sectors in this area which has at times lead to increased management actions including temporary reductions in quota).

## **Fisheries Management Response**

**Current:** To ensure maintenance of the required level of breeding stock the following measures are employed:

- a) There is an annual TACs that limits the catch for each area, in 2000 for Area 2 and Area 3 this was 30 t and 40 t for greenlip and 7.9 t and 6 t for brownlip respectively.
- b) The TACs are divided amongst the licence holders through each licence holder having an ITQ.
- c) These TACs are reassessed on an annual basis. Area closures and quota limitations can be made mid-season by the Department of Fisheries or at the request of licensees to account for exceptional events.
- d) Greenlip abalone have been shown to mature at 70-110mm shell length (Wells and Mulvay, 1995) whereas brownlip abalone mature at a slightly larger size of between 110-130mm. Despite growth varying markedly between fast growing and stunted stocks in WA, the minimum legal size limit of 140 mm is considered adequate to ensure that these abalone have a minimum of 1 spawning season before becoming accessible to commercial fishing.
- e) The breeding stock for both species is further protected, as industry sets self imposed length limits in excess of the minimum legal limits. In Area 2, there is a general 145mm minimum shell length across the fishing grounds (other than stunted stocks). Abalone in Area 3 are fished at 149 - 153mm and above, which is a minimum of 9mm above the legislated minimum size limit of 140mm shell length. The hand selection of product allows fishers to gauge abalone before they are harvested.
- f) The potential for area closures as well as the current output controls (an annual maximum catch, minimum legal size limits). Any significant declines in the breeding population either from environmental effects or due to fishing are observed in time to implement appropriate risk management interventions.
- g) Compliance policing monitors both abalone fishers, illegal fishers and abalone processors.
- h) There are also a set of management arrangements for the recreational sector including bag and boat limits plus minimum sizes (see section 2 above for details)

## **Future:**

- a) To increase the robustness of the data used to monitor the status of stocks and provide additional advice on the likely changes in stock abundance through having data on abundance for individuals below commercial sizes, it is

proposed to begin in-water assessments using digital video to monitor changes in stock abundance and stock structure of abalone populations (Friedman, 2001). Videos have been shown to provide a good record of habitat and can allow monitoring of changes in other factors in addition to abalone stock eg. algal cover, numbers of other benthic species and changes in habitat. Although it is unlikely that these videos will give a comprehensive index of recruitment strength across all of Area 2, the extensive monitoring of undersize year classes, especially of greenlip abalone will add markedly to information assessed when quotas are examined.

- b) It is also proposed to obtain a better understanding of the dynamics of stunted colonies of greenlip abalone within Area 2, which are generally excluded from the fishable stock due to their small shell size, to allow for a more comprehensive management of the Abalone Managed Fishery.

**Series of Actions if Performance Triggers Points are Reached:** The following approach is used when the either the catch rates or meat weights fall beyond the thresholds indicated:

1. Determine why the acceptable effort range or meat weight averages have not been met. Evaluate if there has been a shift in the targeting of abalone through market forces or a different explanation that could explain the variation. If variation is due to verifiable explanations, which do not indicate a shift in stocks, then no action will be taken.
2. If indicators highlight an increase or decrease in available stock, quotas can be increased or further protection can be given to the breeding stock. Options for further protecting breeding stock include:
  - a) Reduce quota allocations, either for the following season or mid season (in exceptional circumstances).
  - b) Additional area or temporal closures.
  - c) Increase the minimum size.

The ability to implement these strategies is provided for within the Fish Resources Management Act, 1994, Fish Resources Management Regulations, 1995 and the Abalone Management Plan, 1992.

### **Comments and Action**

There is a process of continual improvement in the ongoing development and refinement of methods used to determine breeding stock estimates. This relates to both the collection of information in the field (eg. length frequencies and growth data) and the involvement of fishers in supplying further information (eg shell measures) to the Research Department through the use of new technologies.

A new industry catch reporting system, which is on a finer and more relevant scale than previous systems, has been initiated by the Department of Fisheries for all greenlip/brownlip abalone fishing areas in the 2000 season. This data will enable more efficient and effective assessment of these increasingly valuable stocks, and will improve the reliability of management in the future.

Further assessment and supervised fishing of stunted stocks are planned for 2002. In addition, the Department of Fisheries in collaboration with the industry is developing new techniques for greenlip abalone stock surveys using underwater digital video camera equipment. A FRDC application has been obtained to develop the use of these video techniques.

### **External Driver Check List**

In the last few years there has been a change in the normal operating procedure of the fishery, away from owner-operators to lease divers. This change resulted in an increased pressure on cost minimisation when fishing and a greater potential for overfishing easily accessible stocks that are close to boat launching points. This change also impacts on the assessment of effort in the fishery. In some locations in the Abalone Fishery there has also been an increase in the prevalence of divers targeting deeper-water stocks (> 30 m) that historically have contributed little to general catch. At present fishing depth is not recorded on the daily catch record.

Environmental factors such as climatic changes, ocean currents, winter storms and sea temperatures are known to affect the productivity (spawning and growth) of abalone stocks. Similarly, weather conditions can affect the level of access fishers have to stocks. If winter weather is such that divers cannot work, a greater percentage of stock needs to be taken later in the season when water temperatures are greater and greenlip and brownlip abalone are more prone to 'bleeding', which results in a lower meat recovery per weight of abalone caught.

#### **5.1.1.3 TAKING ABALONE IN AREA 4**

There is no quota or commercial activity in Area 4 therefore the issue was rated as a **Negligible Risk**.

#### **5.1.1.4 ROE'S ABALONE STOCKS IN AREA 1, 2 AND 5**

##### **Rationale for Inclusion:**

Roe's abalone are commercially fished in Areas 1, 2 and 5, the south coast area of the fishery.

**ERA Risk Rating: Impact on Roe's Abalone breeding stock in  
Area 1 (C2 L5 MODERATE)  
Area 2 (C3 L3 MODERATE)  
Area 5 (C3 L3 MODERATE)**

The risk of commercial fishing on Roe's abalone stocks was ranked 'Moderate' in Areas 1, 2, & 5. Conditions for fishing in Area 1 are difficult as abalone are only found on narrow platforms at the base of shore cliffs. In Area 1, fishing is not conducted unless reefs hold a significant abundance of Roe's abalone as fishing at lower densities is uneconomic in this remote fishing location. Size limits have recently been increased to 75 mm (larger than in any other Western Australian fishing location) in the Abalone Management Plan to discourage localised overfishing in the few localised sections of the reef protected from predominant swells. Although a

'Moderate' risk ranking was given for Roe's abalone stocks in Area 1, the level of fishing for the area has remained relatively stable for the last decade.

Commercial aggregations of Roe's abalone in Areas 2 and 5 are easier to access, with numerous aggregations in close proximity to launch areas. Even so, the risk to breeding stocks was still only considered Moderate as the level of fishing for Roe's abalone in Area's 2 and 5 (and effort in diver days) has remained relatively stable for the last decade.

### **Operational Objective**

To ensure there is sufficient breeding stock over the entire region, to continue recruitment at levels that will replenish what is taken by fishing, predation and other environmental factors by maintaining the spawning stock of Roe's abalone at or above a level that minimises the risk of overfishing.

#### ***Justification:***

*The operational objective is in place to meet the environmental and commercial objectives of sustaining abalone populations. The population structure has now been assessed (Hancock, 2000). Results demonstrate moderate levels of connection (gene flow) between populations throughout the species distribution. Although there is gene flow across the complete range of Roe's abalone, the majority of recruitment occurs as a local event on continuous reef complexes; therefore most fisheries management and research occurs on a smaller scale (10's of km's).*

*Roe's abalone can suffer recruitment overfishing. It is important to ensure a proportion of abalone of spawning size class remain protected on reefs across the entire region. Biomass estimates for the entire species cannot guard against localised depletion and therefore management assesses catch and effort down to a relatively small scale (grid block) to ensure serial depletion is not occurring.*

### **Indicators**

#### **Catch Rate (Using total effort to capture the quota)**

In general, assessment of Roe's stocks using daily catch records is limited to reviewing CPUE and movement of catch and effort within the 10 x 10 nautical mile grid reporting system.

The season's effort (days fished) and catch rate (kg per day) for each area is monitored against the sustainable 5-year historical average for that Area. Compulsory catch logbooks are filled in by fishers indicating the weight of abalone caught on a daily basis (numbers are not recorded for Roe's abalone due to accuracy limitations related to the higher catch numbers) and where abalone were fished (within a 10 x 10 nautical mile block). Total catch, taking into account the number of fishing days taken to achieve the catch is used as an indicator of stock abundance.

## Performance Measures

The acceptable effort range in diver days to take the quota of Roe's Abalone in each of the three Areas is (based on pro rata effort range for current quota):

- 23 - 77 diver days in Area 1,
- 163 - 211 diver days in Area 2, and
- 168 - 240 diver days in Area 5.

Although effort in number of days fished may vary due to variations in total catch and management controls of catch, the projected seasons catch rate (kg per day) is monitored against the historical average achieved in the fishery. The mean ( $\pm$ SD) catch rate within the 5-year range (1994-1998) for the following areas is:

- $147.7 \pm 34.3$  kg for Area 1,
- $96.1 \pm 9.3$  kg for Area 2, and
- $98.8 \pm 13.9$  kg for Area 5.

If the catch rates in an Area in any one-year is significantly lower than the average for that area, this would trigger one of a number of additional management actions (see below).

Exceptional spatial movements of the fishery away from regular diving locations is also used as a potential indicator of local depletion of abalone. If there is a major shift in the sector within these Areas where the abalone are collected (in the order of 20% or more) amongst seasons and/or on a trend basis, this would also triggers a review.

### **Justification:**

*The 5-year historical range of catch and effort selected to assess the current performance of the fishery was chosen because the stocks of Roe's Abalone were considered to be stable and acceptable in these areas over this period. This range is supported by a longer time series of catch and effort data for this fishery (since 1989) against which current levels of effort can also be compared. There has not been any evidence of major declines in recruitment of Roe's abalone in these regions during this longer time period. Consequently, if stocks continue to be kept at or above these levels there is minimal chance that recruitment failures will occur due to the impacts of fishing.*

*The rationale for examining shifts in the spatial arrangements of catches is to ensure that serial depletion within areas does not occur.*

### **Data Requirement for Indicator**

<b>Data Required</b>	<b>Availability</b>
Catch rate utilising commercial catch and effort information provided through compulsory daily logbooks completed by 100% of the fishers	Yes; available on an annual basis since the late 1980's
Location fished to 10km <sup>2</sup> grid	Yes; available on a daily basis since the late 1980's

## Evaluation

**Summary: Current and historical catch and effort trends indicate that there has been no significant decline in production levels for Roe's abalone in Area 1, 2 and 5 in the last decade. Consequently, the current performance of the fishery for maintaining a sufficient level of spawning biomass is meeting the agreed objective.**

In 1999 there was some concern at the condition of the commercial stocks at specific locations at the margins of the fishery. In Area 1 there was evidence of localised depletion of Roe's abalone in the vicinity of the launch area at Twilight Cove (first 10 km east of cliffs), which was more protected from prevailing wind and swell. This concern has been somewhat allayed by the increase in the legislated legal minimum size limit for this region from 60 mm to 75 mm shell length. Although the abundance of Roe's abalone is not of concern at other locations on the south coast, a portion of the quota consistently remains unfished in Area 1 due to the remoteness of the fishing locations and the unpredictable nature of the weather.

For this species, catch and effort have been within the acceptable range for the last decade (Table 9, 10 and 11). Quota allocations evolved prior to 1993 following a period of negotiation between Roe's fishers and greenlip brownlip fishers on the south coast (Area 1, 2 and 5). In the case of Area 1 there was initially a 15 tonne quota set. Previously no limit was set in Area 1. The initial setting of fifteen tonne was considered too high for this Area and was dropped to its current setting of just under 10 tonnes by 1995.

**Table 9. Area 1 Roe's abalone catch and effort by quota period.**

Quota period	Roe's TAC kg	Roe's abalone kg whole wt	Diver days Roe's	Roe's abalone kg/day
1990	n/a	8,228	83	
1991	n/a	5,788	78	
1992	n/a	6,093	43	
1993	15,000	9,102	68	133.8
1994	12,960	8,230	77	106.9
1995	9,960	5,378	27	199.2
1996	9,960	6,066	41	147.9
1997	10,290	7,131	55	129.6
1998	7,560	3,567	23	155.1
1999	9,900	5,019	20	250.9
2000	9,900	5,540	19	291.6

### Notes

1. Standard conversion factors for meat to whole (live) weight where used is 2.5 for Roe's abalone.
2. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar years.
3. Prior to the 1998 season the commencement of the quota period for ex-Zone 1 and Zone 3 Roe's abalone divers were not aligned.

**Table 10. Area 2 Roe's abalone catch and effort by quota period.**

Quota period	Roe's TAC kg	Roe's abalone kg whole wt	Diver days Roe's	Roe's abalone kg/day
1990	18,000	18,833	211	89.3
1991	14,000	9,574	124	77.2
1992	18,000	16,954	220	77.1
1993	18,000	19,607	222	88.3
1994	18,000	18,713	219	85.4
1995	18,000	17,917	162	110.6
1996	18,000	17,777	187	95.1
1997	18,500	16,478	180	91.5
1998	13,200	13,231	135	98.01
1999	18,000	15,987	135	118.4
2000	18,000	17,928	170	105.5

Extra Notes

1. 1991# was a 4 month season for Zone 1 divers only.

Assessment of the catch and effort data reveal that catch rates (kg per day) have remained stable or risen compared to the long term average catch rates recorded in the last decade. In Area 1, catch rates have increased markedly as fewer fishing days are accessed (5 year average  $147.7 \pm 34.3$  kg per day). Fishers are less numerous, despite large catches that can be made if the weather is suitable, as the costs of fishing in Area 1 are high and fishing weather is difficult to predict. The drive from Esperance (nearest major town) to the access point for fishing in Area 1 is in the region of 10 hours. In Areas 2 and 5, catch rates have fluctuated little around the 5-year (1994-1998) average ( $\pm$ SD). Area 2 averaged 105.5 kg per day in 2000 (5 yr average,  $96.1 \pm 9.3$  kg per day). Area 5 averaged 99.5 kg per day in 2000 (5 yr average,  $98.8 \pm 14.0$  kg per day).

**Table 11. Area 5 Roe's abalone catch and effort by quota period.**

Quota period	Roe's TAC kg	Roe's abalone kg whole wt	Diver days Roe's	Roe's abalone kg/day
1990	*12,000	13,729	174	78.9
1991	*12,000	12,217	151	80.9
1992	*12,000	12,173	154	79.0
1993	20,000	10,491	129	81.3
1994	20,000	17,388	209	83.2
1995	20,000	15,257	164	93.0
1996	20,000	18,401	199	92.5
1997	20,000	17,354	146	118.9
1998	13,200	12,890	121	106.5
1999	20,000	17,143	140	122.5
2000	20,000	17,715	178	99.5

Extra Notes

1. \* No quota allocated for Zone 2 divers.

Stock and recruitment studies indicate that Roe's stocks remain at a point, where current levels of exploitation do not affect recruitment. Small irregular fluctuations in catch rates are likely to result from environmental variations, not from a decrease in the abundance of the spawning stock.

## **Robustness Medium**

The indicators are considered robust as:

- The minimum size limit (60-75mm), good compliance and a positive move by fishers to voluntarily increase their size limit beyond the legislated minimum (abalone below 70 mm are less attractive to processors and the market), which ensures that the breeding stock is further safeguarded.
- The Department of Fisheries has a long time-series of accurate catch and effort information provided by 100% of commercial fishers through compulsory daily logbooks.
- A combination of catch and effort over spatial scales of 10 miles<sup>2</sup> is considered to provide indications of the relative abundance of Roe's abalone.

## **Fisheries Management Response**

**Current:** To ensure maintenance of the required level of breeding stock the following measures are employed:

- a) The fishery is managed through output controls (quotas, minimum legal size limits).
- b) The use of a minimum size limits (75mm in Area 1, 60mm in Area's 2 and 5) ensures sufficient spawning stock remains on reefs. Roe's abalone have been shown to mature at 40mm shell length and abalone fished at 60 mm would have a minimum of 1 spawning season before becoming accessible to the commercial fishery (Wells and Kessing, 1986; Wells et al., 1986; Kessing and Wells, 1989).
- c) The annual fishing season has a fixed quota that is reassessed on an annual basis. Closures and quota limitations can be made mid-season at the request of licensees or the Department of Fisheries to account for exceptional events.
- d) Any significant declines in the breeding population either from environmental effects or due to fishing are observed in time to implement appropriate risk management strategies.
- e) Compliance policing monitors both abalone fishers and abalone processors.

**Future:** In 2001/2002 Department of Fisheries will be working with industry to institute the development of a system which is able to monitor changes in the average meat weight or grade of catch (canning details) from particular locations. This measure will be made with the cooperation of abalone processors.

**Series of Actions if Performance Triggers Points are Reached:** The following approach is used when the catch rates or meat weights fall beyond the thresholds indicated:

1. Determine why the acceptable catch range has not been met. Evaluate if there has been a shift in the targeting of abalone through market forces or "other" factors, which could explain the variation. If variation is due to verifiable explanation, then no action to be taken.

2. If indicators highlight a significant increase or decrease in available stock, quotas can be increased or further protection can be given to the breeding stock. Options for further protecting breeding stock include:
  - (a) Reduce quota allocations, either for the following season or mid season (in exceptional circumstances).
  - (b) Additional area or temporal closures.
  - (c) Increase minimum sizes.

The ability to implement these strategies is provided for within the FRMA, FRMR and Abalone Management Plan 1992.

### **Comments and Action**

There is a process of continual improvement in the ongoing development and refinement of methods used to determine breeding stock estimates. This relates to both the collection of information in the field (eg. length frequencies and growth data) and the involvement of fishers in supplying further information (eg shell measures) to the Research Department for analysis.

### **External Driver Check List**

Environmental factors such as: climatic changes, ocean currents, sand movements, winter storms and sea temperatures are known to affect the productivity (spawning and growth) of abalone stocks. Similarly, weather conditions can affect the level of access fishers have to stocks.

#### **5.1.1.5 TAKING ROE'S ABALONE IN AREA 6, 7 AND 8 (WEST COAST)**

##### **Rationale for Inclusion:**

Roe's abalone are commercially fished in Areas 6, 7 and 8.

**ERA Risk Rating: Impact on Roe's abalone stocks in**  
**Area 6 (C3 L3 MODERATE)**  
**Area 7 (C3 L4 MODERATE)**  
**Area 8 (C3 L3 MODERATE)**

The risk to stocks of Roe's abalone in Areas 6, 7 and 8 was ranked 'moderate'. In Area 7, which includes Metropolitan Perth, the likelihood of overfishing was higher than in the other two Areas, as recreational and illegal fishers can easily access stocks due to the location of abalone and time of the year the fishery is open. Although the time of year open to recreational fishing is climatically favourable for abalone fishing, and there are ready markets for stock, which is taken illegally, there is a high level of vigilance by the Department, Volunteer Liaison Officers and the general public to monitor and ensure the reefs are not being stripped. Even though a higher likelihood was given to Area 7 than to Areas 6 and 8, the overall risk rating for Area 7 was 'Moderate'.

Fishing locations in Areas 6 and 8, although relatively close to towns when compared to Area 1, are less actively targeted by recreational and "other" fishing groups.

Although these areas were given a 'Moderate' risk rating, commercial catches from these areas are well controlled and breeding stocks are well protected.

In addition, it was noted that it would be hard to cause an extinction of Roe's abalone in any particular location as their distribution compared to the area of fishing, and cryptic nature will ensure a part of the spawning stock is not accessible to fishing.

### **Operational Objective**

To ensure there is sufficient breeding stock over the entire region, to continue recruitment at levels that will replenish what is taken by fishing, predation and other environmental factors by maintaining the spawning stock of Roe's abalone at or above a level that minimises the risk of overfishing.

#### ***Justification:***

*The operation objective is in place to meet the environmental and commercial objectives of sustaining abalone populations. The population structure has now been assessed (Hancock, 2000). Results demonstrate moderate levels of connection (gene flow) between populations throughout the species distribution. Although there is gene flow across the complete range of Roe's abalone, the majority of recruitment occurs as a local event on continuous reef complexes; therefore most fisheries management and research occurs on a smaller scale (10's of km's).*

*Roe's abalone can suffer recruitment overfishing. It is important to ensure a proportion of abalone of spawning size class remain protected on reefs across the entire region. Biomass estimates for the entire species cannot guard against localised depletion and therefore management assesses catch and effort down to a relatively small scale (grid block) to ensure serial depletion is not occurring.*

### **Indicators**

#### **Catch Rate (Using total effort to capture the quota)**

In general, assessment of Roe's stocks using daily catch records is limited to reviewing CPUE and movement of catch and effort within the 10 x 10 mile grid reporting system.

The season's effort (days fished) and catch rate (kg per day) for each area is monitored against the sustainable 5-year historical average for that Area. Compulsory catch logbooks are filled in by fishers indicating the weight of abalone caught on a daily basis (numbers are not currently recorded) and where abalone were fished (within a 10 x 10 nautical mile block). Total catch, taking into account the number of fishing days taken to achieve the catch is used as an indicator of stock abundance.

#### **Fishery Independent Monitoring**

For the Perth fishery, size distributions and densities of Roe's abalone were measured from each of six reef platforms between Penguin Island and Burns Beach. Reef areas

surveyed were Burns Beach, Beaumaris, Waterman's reserve, Mettams Pool, Bailey Street and Penguin Island. Surveys were conducted using quadrats placed at repeated positions along fixed transects oriented perpendicular to the shore across the reef platform. All abalone seen within a quadrat were counted and measured. These surveys were conducted in January and February 2001 (post-recreational season) to assess the effects of recreational fishing and to get an indication of the stock levels available for subsequent seasons.

## **Performance Measure**

### **Catch Rate**

Total catch and effort is monitored against a 5-year (1994 to 1998) sustainable historical range (based on pro rata effort range for current quota- 2000). Diver days for each area are as follows:

- 60 - 89 diver days for Roe's abalone in Area 6,
- 162-170 diver days for Roe's abalone in Area 7 (first 2 seasons of new controls), and
- 122 - 182 diver days for Roe's abalone in Area 8.

In addition, there is a long time series of catch and effort data for this fishery (since 1989) against which current levels of effort can be compared. Although effort in number of days fished may vary due to variations in total catch the projected seasons catch rate (kg per day) is monitored against the historical average achieved in this fishery. As has been highlighted, this is not the case for Area 7, which has only had unrestricted daily fishing (within quota) since 1999. The mean ( $\pm$ SD) catch rate within the 5-year range (1994 to 1998) for Area 6 and 8 are:

- $158.3 \pm 25.6$  in Area 6, and
- $127.4 \pm 24.4$  in Area 8.
- 219 in Area 7 (first two seasons)

### **Fishery Independent Surveys**

These surveys have only begun recently and the performance measure will be determined within the next year.

### ***Justification:***

*The 5-year historical range of catch and effort selected to assess the current performance of the fishery was chosen because the stocks of Roe's Abalone were considered to be stable and acceptable in these areas over this period. This range is supported by a longer time series of catch and effort data for this fishery (since 1989) against which current levels of effort can also be compared. There has not been any evidence of major declines in recruitment of Roe's abalone in these regions during this longer time period. Consequently, if stocks continue to be kept at or above these levels there is minimal chance that recruitment failures will occur due to the impacts of fishing.*

The rationale for examining shifts in the spatial arrangements of catches is to ensure that serial depletion within areas does not occur.

### Data Requirement for Indicator

Data Required	Availability
Catch rate utilising commercial catch and effort information provided through compulsory daily logbooks completed by 100% of the fishers	Yes; available on an annual basis since the late 1980's
Location fished to 10km grid	Yes; available on a daily basis since the late 1980's
In-water fishery independent survey of Area 7	Last 4 years
Recreational Catch	Annual for past 3 years

### Evaluation

**Summary: Historical catch and effort trends indicate that there has been no decline in production levels for Roe's abalone in Areas 6, 7 and 8 in the last decade. Consequently, the current performance of the fishery for maintaining a sufficient level of spawning biomass is meeting the agreed objective.**

Catch and effort of this species has been within the acceptable range for this fishery for the last decade (Table 12, 13 and 14). Quota allocations and catch rates have remained stable within the 3 Areas without exceptional fluctuations in quotas or the daily catch rate.

**Table 12. Area 6 Roe's abalone catch and effort by quota period.**

Quota period	Roe's abalone TAC kg	Roe's abalone kg whole wt	Diver days	Roe's abalone kg/day
1990	*	10,418	79	131.9
1991	*	6,221	56	111.1
1992	*	6,897	37	186.4
1993	*	10,416	83	125.5
1994	*	15,903	108	147.3
1995	*	11,914	73	163.2
1996	*	13,372	99	135.1
1997	14,000	13,677	68	201.1
1998	12,000	11,750	81	145.1
1999	12,000	11,748	76	154.6
2000	12,000	11,997	82	146.3

#### Notes

1. Data source: quota returns.
2. Standard conversion factors for meat to whole (live) weight where used 2.5 for Roe's abalone.
3. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar years.
4. \* Formally part of West Coast quota combined with Areas 7 & 8. TAC 1990 to 1994 of 75 tonne, TAC 1995 to 1998 of 78 tonne.

Stock and recruitment studies indicate that Roe's stocks remain at a level where the recruitment is not affected by the current levels of exploitation. Small irregular fluctuations in catch rates are likely to result from environmental variations, not from a decrease in the abundance of the spawning stock.

As a consequence of management changes in 1999, such as the removal of the daily catch limits in Area 7, the historical effort data set from the metropolitan area (Area 7) is no longer comparable with present-day effort recordings. A new estimation of the acceptable effort range for Area 7 has been calculated for this report by varying the average 1999 and 2000 catch rate (first two years of new management arrangements) by the mean annual variation of catch rate recorded within other areas of the fishery between 1994 and 1998 ( $\pm 16.5\%$ ). Although effort in number of days fished may vary due to variations in total catch, the season's mean kg/day catch rates for Area 7 should not fall significantly below 219 kg whole weight Roe's abalone per diver day.

Preliminary estimates of post-season densities after the 2000 recreational season were highest at Burns Beach with 155 abalone/m<sup>2</sup>, with the other locations ranging from 87 to 97 abalone/m<sup>2</sup>. At sites north of Penguin Island, these figures have remained fairly stable during the last three years, with fluctuations in total densities being influenced by the strength of post-settlement recruitment. These densities can be compared to an average figure of 95 abalone/m<sup>2</sup> in Waterman's reserve, an unfished site, however the variation between transects indicates that the changes over time at a site are more informative. The mean densities of legal-sized abalone at the end of the fishing season vary among sites (Recreational Abalone Table 3) but most sites had good abundance of legal-sized abalone during the 2001 survey compared to previous years.

**Table 13. Area 7 Roe's abalone catch and effort by quota period.**

Quota period	Roe's abalone TAC kg	Roe's abalone kg whole wt	Diver days	Roe's abalone kg/day#
1990	*	36,564	382	95.7
1991	*	41,308	392	105.4
1992	*	24,427	243	100.5
1993	*	39,306	366	107.4
1994	*	34,312	353	97.2
1995	*	41,731	574	72.7
1996	*	48,098	483	99.6
1997	36,000	38,797	365	106.3
1998	24,000	24,976	257	97.2
1999	36,000	35,174	170 <sup>#</sup>	206.9
2000	36,000	36,509	158 <sup>#</sup>	231.1

Notes

1. # 100 kg daily limit and restricted 2 month fishing removed at start of 1999 season.

In Area 8, the most northerly margin of the fishery, observations from divers suggested that the quota setting for 1999 and 2000 was too high, despite a reduction in quota in 2000. The abundance of legal-sized Roe's abalone in this area has declined due to the combination of localised depletion of abalone caused by inappropriate distribution of fishing effort by less experienced fishers (on a spatial scale smaller than previously reported) and natural losses. Some natural losses have occurred in this Area as a result of environmental factors outside of the control of the commercial

fishery, for example in shallow water areas where unusually hot weather coincided with extreme low tides. In 1999, fishers in Area 8 instituted a voluntary reduction of 6 tonnes from their 30 tonne TACs. A voluntary reduction was necessary as, at the time, the management plan did not have provision for quota variation within a quota period. Whilst an area closure could have been introduced under the plan it would have pushed effort into other areas and been inequitable in its effect. The voluntary reduction indicates a responsible approach by industry to sustainability issues. However, the plan has since been amended to provide for quota reductions during the period of a quota. Despite arguing for a 20 tonne TACs for 2000, fishers again instituted a voluntary reduction of 4 tonnes during the season following concerns that the quota was still too high.

For the 2001 season, a further reduction in quota is planned to improve the abundance of legal-sized abalone, there is a spatial closure within Area 8, and industry operators have traded quota units to ensure that only divers experienced in fishing these remote colonies operate in the north of Area 8. Recent stock assessments (2001 and 2002) for Area 8 show that the area is recovering.

**Table 14. Area 8 Roe's abalone catch and effort by quota period.**

Quota period	Roe's abalone TAC kg	Roe's abalone kg whole wt	Diver days	Roe's abalone kg/day
1990	*	29,786	185	161.0
1991	*	35,226	204	172.7
1992	*	45,731	245	186.7
1993	*	27,468	190	144.6
1994	*	25,303	180	140.6
1995	*	23,021	206	111.8
1996	*	18,351	167	109.9
1997	28,000	25,643	156	164.4
1998	24,000	20,116	182	110.5
1999	24,000	23,326	182	128.2
2000	#20,000	15,991	144	111.0

Notes

1. # Voluntary reduction from 20,000 kg to 16,000 kg whole weight Roe's abalone.

**Robustness**

**Medium**

The indicators are considered robust as:

- The minimum size limit (60-70 mm), good compliance and a positive move by fishers to voluntarily increase their size limit beyond the legislated minimum (little taken below 70), which ensures that the breeding stock is safeguarded.
- The Department of Fisheries has a long time-series of accurate catch and effort information provided by 100% of commercial fishers through compulsory daily logbooks.
- A combination of catch and effort over spatial scales of 10 miles<sup>2</sup> is considered to be a good indicator of relative abundance of Roe's abalone. At specific locations

of importance (some reef areas in the Metropolitan –Area 7) there is finer scale reporting and feedback to industry on take and effort at these sub-grid scales.

- Abalone stocks within the Perth Roe's Abalone Fishery are assessed annually using measurements from quadrats on fixed transects at six indicator sites. Changes in density and length frequency composition at each indicator site are examined for abalone of >5mm length, to indicate recruitment and relative changes of the fished stock through time.
- Recreational catch, effort and catch weights are monitored each day of the Perth recreational Roe's Abalone Fishery. Monitoring is conducted with the assistance of a large number of volunteers (VFLO's) as well as research staff. The information collected indicate trends in the distribution of effort, catch in number of abalone, and the mean weight of abalone taken by the recreational fishers for each 10 nautical mile (10 minutes of latitude) section of the Perth fishery. This data provide a comparison of catch share between the commercial and recreational fisheries, on a spatial scale of 10 nm and give a further insight into the state of Metro stocks.

## **Fisheries Management Response**

**Current:** To ensure maintenance of the required level of breeding stock the following measures are employed:

- a) The fishery is managed through output controls (quotas, minimum legal size limits).
- b) Research has shown that the size at sexual maturity (50% of animals mature) of Roe's abalone in the Perth metropolitan area is 40mm (approximately 2.5 years of age). Preliminary growth data for these same metropolitan Roe's abalone indicate that they have a minimum of one year's spawning before reaching 60mm, the minimum legal size at which Roe's abalone are harvested anywhere in Western Australia. This is considered to provide adequate protection for the breeding stock, especially since the commercial fishery's legal minimum size in Area 7 (the metropolitan area) is 70mm, 10mm larger than that used by the recreational sector.
- c) The annual fishing season has a fixed quota that is reassessed on an annual basis. Closures and quota limitations can be made mid-season at the request of licensees or by the Department of Fisheries to account for exceptional events.
- d) Any significant declines in the breeding population either from environmental effects or due to fishing are observed in time to implement appropriate risk management interventions.
- e) Compliance policing monitors both abalone fishers and abalone processors.

**Future:** In 2001/2002 Department of Fisheries will be working with industry to institute the development of a system which, if successful, will monitor changes in the average meat weight or grade of catch (canning details) from particular locations. This measure will be made with the cooperation of abalone processors.

In-water assessments using digital video have the potential to monitor changes in stock abundance and stock structure of abalone populations. The video provides a good record of abalone present and allows monitoring of changes in habitat factors eg. algal cover, numbers of other benthic species and movement of sand. Although it is unlikely that these videos will give a comprehensive index of recruitment strength

across all Areas, the monitoring of undersized year classes will add markedly to the information assessed when quota's are examined.

**Series of Actions if Performance Triggers Points are Reached:** The following approach is used when the catch rates fall beyond the thresholds indicated:

1. Determine why the acceptable catch range has not been met. Evaluate if there has been a shift in the targeting of abalone through market forces or "other" which could explain the variation. If variation is due to a verifiable explanation, then no action will be taken.
2. If indicators highlight a significant increase or decrease in available stock, quotas can be changed (increased or decreased) to provide further protection to the breeding stock. Options for further protecting breeding stock include:
  - a) Reduce quota allocations, either for the following season or mid season (in exceptional circumstances).
  - b) Additional area closures.
  - c) Increase minimum sizes.

The ability to implement these strategies is provided for within the FRMA, FRMR and Abalone Management Plan 1992.

### **Comments and Action**

There is a process of continual improvement in the ongoing development and refinement of methods used to determine breeding stock estimates. This relates to both the collection of information in the field (eg. length frequencies and growth data) and the involvement of fishers in supplying further information (eg shell measures) to the Research Department for analysis.

The 1999 quota period saw several major management changes within the metropolitan area (Area 7). The 100 kg maximum daily limit was removed, along with the restricted two-month fishing season; subsequently effort was greatly reduced due to larger daily catch rates and decreased diver days in the water. A new catch reporting system, which is on a more relevant scale than previous systems, has been initiated by the Department of Fisheries, with industry support, for all Roe's abalone fishing areas in the 2000 season. This will permit improved monitoring of the exploitation rates in the fishery.

Examination of the density of different year classes of Roe's abalone from the independent surveys may permit the assessment of annual variation in settlement, and the strength of cohorts reaching legal size in subsequent seasons. This projection requires a sound knowledge of the growth of sub-legal size classes, which is currently being analysed.

### **External Driver Check List**

Environmental factors such as: climatic changes, ocean currents, sand movements, winter storms and sea temperatures are known to affect the productivity (spawning

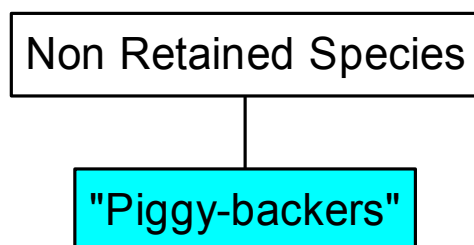
and growth) of abalone stocks. Similarly, weather conditions can affect the level of access fishers have to stocks.

### **5.1.2 BY-PRODUCT SPECIES**

The Abalone Fishery is based on catching 100% abalone. No other species are collected and retained for commercial use.

## 5.2 NON-RETAINED SPECIES

### COMPONENT TREE FOR NON-RETAINED SPECIES



**Figure 8. Component tree for the non-retained species.**

**Yellow boxes** indicate that the issue was considered high enough risk at the July 2001 Risk Assessment workshop to warrant having a full report on performance. **Blue boxes** indicate the issue was rated as a low risk and no specific management is required- generally only the justification is presented.

#### 5.2.1.1 'PIGGY-BACK' SPECIES

##### **Rationale for Inclusion:**

The shell of the abalone is encrusted with fouling commensal organisms including other small invertebrates, which use as a substrate. Adult abalone are often infested by the predatory sponges, boring annelids, gastropods and algae. These organisms are harvested together with the abalone on which they reside and are then scraped off and discarded. It would be highly unlikely that these species survive this experience.

##### **ERA Risk Rating: Impact on breeding stock (C1 L3 LOW)**

It was determined that the potential environmental risk to commensal species using abalone shell as a substrate would vary between locations and abalone species. The overall consequence on the populations of these encrusting organisms is likely to be 'minor' at most (i.e. possibly detectable but no impact on population size or dynamics), due to the following:

- Adult abalone live in high-energy environments making this a harsh, unfavourable habitat for settling invertebrates. McShane and Naylor (1995) showed that post settlement abalone on wave exposed reef habitat have low survival rate because currents dislodge recruits from the substrata. This indicates the unfavourable nature of this environment for settlement, even for abalone that have a relatively strong foot. Adult abalone only move to more exposed areas, where their food is more accessible, once they have developed the strong muscular foot capable of maintaining the grip to the substrata. This would indicate that the abalone shell is unlikely to be used exclusively by other species for habitat purposes (*Dr. K. Friedman<sup>2</sup>, pers. comm.*).

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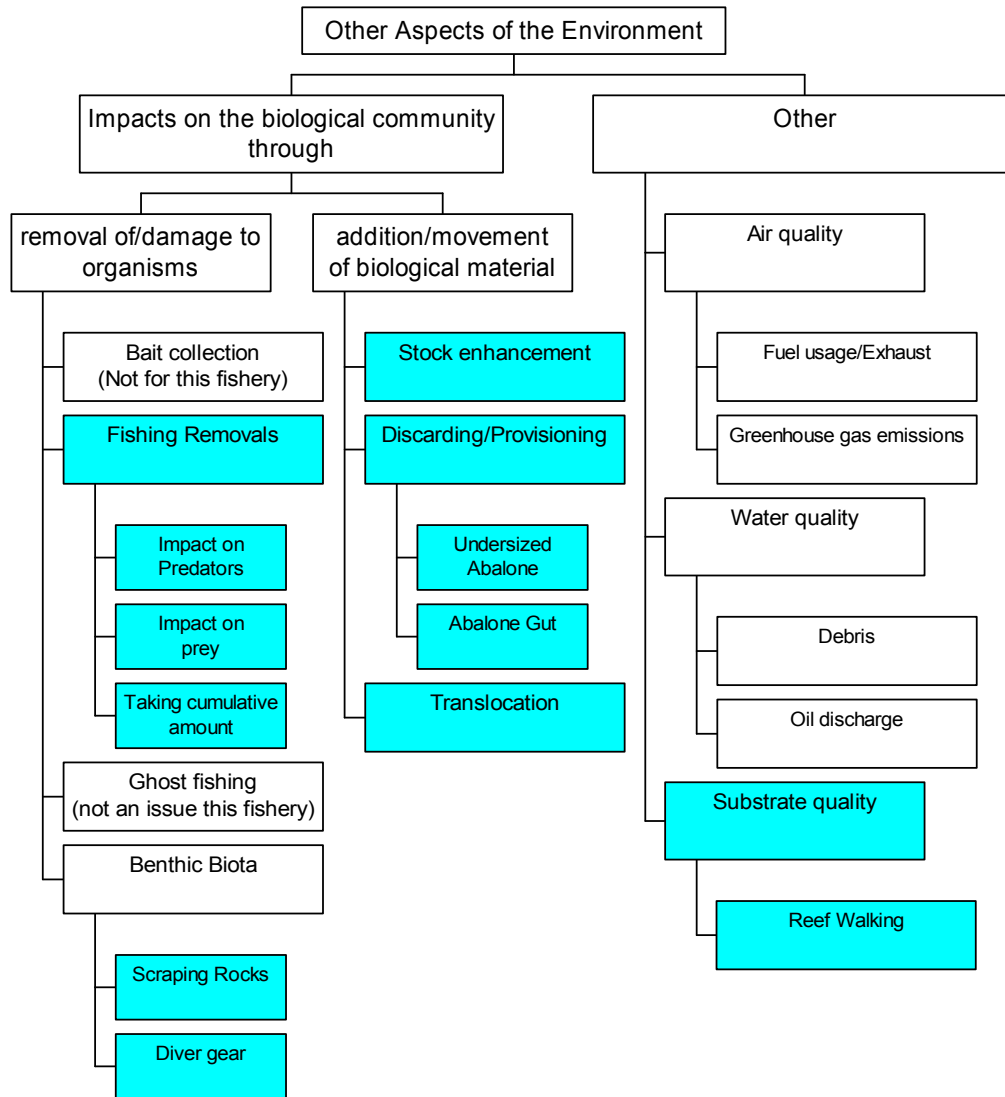
<sup>2</sup> *Dr. Kim Friedman, formerly of Department of Fisheries- Research.*

- It has been identified that the limpet, *Patelloida nigrosulcata* lives only on the shells of a very limited number of gastropods, which live in shallow water, primarily *Haliotis roei* and *Patella laticostata* (Wells et al., 1986; Wells and Keesing, 1989; and Scheibling et al., 1990). Additionally the limpet, *Patelloida nigrosulcata* occurs only from Esperance to Geraldton (Wells and Bryce, 1990). While the fishery does result in the take of these species, it is unlikely that the fishery is endangering the species since the limpet does not use the abalone shell exclusively.
- The management of the abalone stock itself, to ensure a sustainable harvest, ensure that a large percentage of the population remain, which would continue to provide habitat for sessile invertebrates.
- It was suggested that there was data on a limpet, which is being studied and occurs on blacklip and brownlip abalone.
- As previously mentioned, of the limited species that do settle on the shell of abalone, most probably do not use the abalone shell exclusively as a substratum. As such, the fishery only affects a very small proportion of these organisms total habitat. An exception to this is the report of the predatory whelk *Haustrum bailey anum* found subtidally associated with *Haliotis rubra* and *Haliotis laevigata* (Thomas and Day, 1995). In studies undertaken on this whelk and its association, there have been no reports on *H. bailey anum* drilling holes in other species. Even though *H. bailey anum* does not occur in Western Australia it will be addressed under the section that relates to the impact of abalone fishing on predator/prey relationships of abalone.

The likelihood of having a ‘minor’ impact is considered ‘unlikely’ at most, since management of the abalone stock results in a high proportion of abalone stocks not being affected by the fishery. This results in an overall ‘low’ risk to the piggyback species of abalone.

### 5.3 GENERAL ENVIRONMENT

#### COMPONENT TREE FOR THE GENERAL ENVIRONMENT



**Figure 9. Component tree for the general environment.**

Yellow boxes indicate that the issue was considered high enough risk at the Month 2001 Risk Assessment workshop to warrant having a full report on performance. Blue boxes indicate the issue was rates as a low risk and no specific management is required – generally only the justification is presented.

### **5.3.1 IMPACT OF REMOVING ORGANISMS FROM THE ENVIRONMENT**

#### **5.3.1.1 REMOVAL OF ALL ORGANISMS**

##### **Rationale for inclusion:**

The risk assessment determined that there are three issues associated with the impacts on the environment as a result of removing organism in the Abalone Fishery:

- Impact of removing ‘piggyback’ species (i.e. sessile organisms, which reside on abalone shell);
- Impact on predators of abalone; and
- Impact on prey of abalone (i.e. level of herbivory).

None of these issues was determined to be of high enough risk rating to justify a full management report (including objectives and performance measures) or to be assessed individually. It was considered that the most efficient method for examining the appropriateness of current management arrangements to address any impacts should cover all three issues in a holistic manner. As such these three issues have been brought together in this management report.

##### **ERA Risk Rating: Removal of Abalone and Piggyback species on the Ecosystem (C1 L4 LOW)**

The removal of the abalone themselves and the species, which ‘piggyback’ on the abalone shell potentially results in a reduced number of abalone and ‘piggyback’ species being available as food to their predators. It may also result in a lower level of herbivory by abalone, due to the removal of a portion of these herbivores from the system. This component examines whether the effects of the removal of abalone, and ‘piggyback’ species will have an effect on their predator or prey (algae), are likely to result in any significant effects on the trophic structure of the south coast bioregion.

There are three phases of the benthic portion of the abalone lifecycle, each of which have different groups of predators due to the habitats that they live in – crustose coralline habitat of newly settled abalone; the crevice or under-boulder habitat of cryptic juveniles or small abalone and; the cave or open habitat of large or adult abalone. As the juveniles are not harvested and the levels of recruitment are not impacted then the predators of these phases are not being affected at all.

There are two classes of “predators” of adult abalone (abalone caught in the commercial fishery)– the boring gastropods, annelids and sponge, which also use the abalone as a substrate (Naylor and McShane, 1997; Thomas and Day, 1995); and more motile predators such as octopuses, sea-stars, large fish including eels, rays and sharks, mammals such as sea otters and seals, and shore-feeding birds.

The impact of taking abalone on the food source of abalone predators was considered ‘minor’ (i.e. the abalone are not keystone species; would result in only minor changes in relative abundance of other constituents). The total tonnage that is removed by the fishery is very small – 330 tonnes across 1400 km of coastline. Knowledge of the

predation levels on abalone suggests that in general there are no predators that exclusively feed on abalone, thereby being vulnerable to a reduction of that food source through harvesting of abalone (Dr. K. Friedman<sup>3</sup>, pers. comm.). Seastars are generalist predators that capture emergent abalone or scavenge stressed or moribund individuals. Large fish, rays and small sharks capture abalone by variously ramming and fracturing the shell, crushing the shell with the teeth or prising the animal from the substratum (Shepherd, 1973). These groups of predators are all general carnivores that would prey on a range of other bivalve invertebrates in the same manner.

There are a few examples of possibly stronger links between abalone and their predators in other parts of the world. The predatory whelk *Haustrum baileyannum* is one example of a predator with stronger links to their prey. The whelk drills over the muscle of *Haliotis rubra* and *Haliotis laevigata*, but this has not been reported drilling holes in any other species.

With limited opportunity for any species to potentially be affected, anecdotal reports from fished and unfished areas supports that there does not seem to be any difference between these areas in terms of presence of predator species (Dr. K. Friedman, pers comm.). In other abalone fisheries around the world, some of which have harvest levels much higher than the WA Abalone Fishery, there have still been no measurable effects of removing abalone on their predators.

In a recent Tasmanian study (Edgar and Barrett, 1999), which assessed abalone abundance inside and outside of reserves, individual abalone inside the reserves were larger but less abundant than in similar habitats outside the reserve. This gives some insight into the changes in stock structure that can occur when abalone stocks are not fished. In WA, studies have shown that the density and mean size of *H. roei* are substantially greater inside the Waterman reserve than at Trigg Island to the south (Wells and Keesing, 1989; Wells et al., 1986; Wells and Keesing, 1989). Although the recruitment of small (<20 mm) individuals is similar on the two reefs. Each of these are only population effects, not ecosystem effects and there are no apparent difference in the types of ecosystems in the two locations indicative of major indirect effects such as on the algal communities.

It is known that abalone begin to feed after settlement (Wood, 1993) initially consuming benthic diatoms (Tutschute and Connell, 1988; Shepherd and Steinberg, 1992; Wood, 1993; McShane et al., 1994). Stepto and Cook (1996) experimentally determined that juvenile South African abalone *Haliotis midae*, showed preference for specific algal species, therefore concluding that food value was of greatest importance to their selectivity. Jensen (1983) suggested that food preferences would affect growth rates. He observed that, in general, herbivores grew better on their preferred foods.

Pre-adult and adult abalone feed primarily on dislodged and broken pieces of macroalgae (drift algae) and probably have little effect on attached plants (Lowry and Pearse, 1973). All three species of abalone in WA are primarily drift algal feeders (see Section 2 for details). Never travelling far from the place where they first settled, abalone usually prefer to dwell in places on the seabed where drift weed is

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<sup>3</sup> Dr. Kim Friedman, formerly of Department of Fisheries- Research.

conveniently carried along by currents. This association seems very strong, to the extent that in some cases, abalone have been reported to starve rather than move to attached vegetation when drift components are not available (Leighton et al. 1996; MacGinite and MacGinite, 1966).

In some locations in the world, a reduction in abalone has been associated with an increase in algal cover, which has effectively altered the community structure of the abalone habitat. For the WA Abalone Fishery, it was determined that the consequence of removing abalone in relation to impact on algal community, would be minor. That is, they do not directly affect the abundance or composition of algal communities in the regions where they reside. Consequently, experimental studies on the impacts of grazers on the algal composition off the west coast of WA found that limpets and chitons had a much greater role in determining role than the presence/absence of Roe's abalone (Shiebling, 1994).

In some other abalone fisheries (e.g. NSW), there has also been a reported association between urchin and abalone with urchins, being very efficient at removing algal matter from substrate, creating what are known as 'urchin barrens' when their numbers are sufficiently large (Fletcher, 1987). The reduction in numbers of their natural competitor, abalone, has been associated with an increase in urchin numbers, in turn resulting in the creation of urchin barren areas (Andrew et al., 1998). This species of urchin (*Centrostephanus rodgersii*) does not occur in WA and therefore there is no potential for such an interaction to take place.

The potential consequence of taking abalone on the algal community of the bioregion on which they feed was considered 'minor' (i.e. captured species are not keystone species; would result in only minor changes in relative abundance of other constituents). Moreover, the assessment of risk concluded that there was only an occasional likelihood that even a 'Minor' impact would occur on the algal community. Therefore the risk to the ecosystem was **LOW**.

## **5.3 2 ADDITION OF MATERIAL TO ENVIRONMENT**

### **5.3.2.1 DISCARDING UNDERSIZED ABALONE**

#### **Rationale for Inclusion:**

The discarding of by-catch of no commercial value has, if large quantities are involved, the potential to cause environmental impacts through making these organisms available to be fed on by guilds and trophic levels that would not normally have this opportunity – or by elevating the level of that food source availability. This is particularly an issue for fisheries that use indiscriminatory methods of fishing and as a result catch and discard a high proportion of bycatch, e.g. trawl fisheries.

Abalone divers have the unusual capacity to identify and measure individual animals before they are removed from the substrate. Because of this, very few abalone are removed from the substrate at a smaller size than is desired, and the negligible number that do get removed in this way can be promptly replaced on their home scar.

Furthermore, no other major<sup>4</sup> species are directly affected – i.e. there are no other species captured that are subsequently discarded except for those on the shells of the abalone and these are mostly microscopic.

Abalone that are replaced back on the substrate immediately take very little time to re-attach to the substratum. In the time taken for re-attachment, or even if some unseen damage had been inflicted on the abalone in its initial removal, there would be more scope for predation. As it is a rare occurrence for abalone to be taken and returned to reef this effect is not significant.

### **ERA Risk Rating: Impact on environment from discards (C0 L1 NEGLIGIBLE)**

The impact of providing this food source to groups that would not normally have this available to them is considered to be negligible as the quantity of discarded abalone is extremely low. Nearly all abalone collected are considerably larger than the minimum legal size, so the frequency of undersized animals being taken is extremely low, in the order of <0.01% of the total catch. The low proportion of discards is attributed to the following:

- Abalone fishing, by nature of the method of collection, is very selective;
- It is common practice for abalone divers to measure abalone before removing them from the substrate to ensure that they are of legal sized; and
- Although the regulated legal size of abalone is 60 mm (Roe's), 140 mm (greenlip and brownlip abalone), industry generally does not target Roe's < 65 mm, or greenlip and brownlip <145 mm (east) or <153 mm (west). In this case, even if the divers misjudge the size, the abalone is still well above the legal size limit.

#### **5.3.2.2 DISCARDING ABALONE GUT**

##### **Rationale for Inclusion:**

In the greenlip/ brownlip Abalone Fishery, the gut is usually discarded at sea after the abalone is shucked (removed from its shell). The discarding of this biological material to the environment provides a food source to other animals that would not naturally have the opportunity to feed on. The impact of discarding abalone gut on the trophic structure of the community is considered here.

In the Roe's Abalone Fishery, the animals are usually shucked on land at a fish processing facility – hence this is not an issue at all.

##### **ERA Risk Rating: Impact on trophic structure (C0 L2 NEGLIGIBLE)**

The potential environmental risk to the trophic structure of discarding gut was considered 'rare' to have even a 'negligible' impact, due to the following evidence:

- Approximately one-third (32.5%) of abalone by whole weight is the gut of the animal. Given this, it is estimated that approximately 74 tonnes of abalone gut is

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<sup>4</sup> In terms of size/weight (which is the important value for this issue)

discarded in Western Australia each year. This 74 tonnes of gut are spread across a wide geographical area, approximately 1400 km over approximately 1000+ fishing days.

- Fish and rays, in particular, are known to eat the abalone gut as it falls from the surface to the substrate. The impact of providing this additional food source to those animals that would not normally have access to it is extremely low, as the events are isolated, dispersed, and not repeated in the same area for many years.

### **5.3.2.3 NON-NATIVE AND DISEASE INTRODUCTIONS**

#### **Rationale for Inclusion:**

The movement of non-native organisms and disease through the movement of vessels around the marine environment is a serious issue that could lead to long term, or catastrophic impacts. The role that abalone fishing vessels may play in the movements of organisms beyond their natural range, and the introduction of disease, is considered here.

#### **ERA Risk Rating: Impact of translocation of organisms on vessel hulls (C4 L0 NEGLIGIBLE)**

The potential consequence of the introduction of non-native organism or disease is considered to be major, potentially resulting in a non-native species out-competing a native species, or a disease causing ill effects to marine species. The likelihood of this occurring is considered 'remote' due to the following:

- Abalone fishing vessels are typically less than 10 m in length and are removed from the water after each day of fishing. Vessels are usually launched early in the morning and will remain in the water for the day while the operator is working (diving). The vessels are rarely stationary while in the water as the deckhand is constantly following the diver to ensure an adequate length of air hose is available. At the completion of a day of fishing, vessels are removed from the water and left to dry overnight. As such, there is little opportunity for marine organisms to attach to the hull of the vessel and be transported between fishing locations.
- If any organisms were to attach, the process of removing the vessel from the water and the drying period overnight is likely to kill any marine organisms attached to the hull. As a result, it is thought that the risk of any non-native species being transported on the hulls of vessels used in the capture of abalone is negligible.

The overall risk ranking for this issue is therefore 'negligible'.

### **5.3.2.4 STOCK ENHANCEMENT (INTRODUCTION OF DISEASE, FOREIGN GENES, AND THE ALTERATION OF NATURAL DISTRIBUTION OF ABALONE)**

#### **Rationale for Inclusion:**

There has been some recent interest expressed from aquaculture organisations to enhance stocks of *Haliotis scalaris* on some reefs in Western Australia with a view to

harvesting these stocks at some future time. However, at this stage, there are no abalone stock enhancement projects operating in Western Australia.

Issues such as the introduction of disease, foreign genes and the alteration of natural distribution of abalone will be fully considered prior to any final decision being made relating to the above-mentioned aquaculture proposals. There is certainly a risk that the *Perkinsus* parasite may be introduced into an area via stock enhancement.

There is very little information available concerning changes in trophic structure following the addition of abalone to an area. A requirement to research such information would most likely be a part of any approved operation to introduce abalone to an area.

The risk associated with this activity would need to be considered once more operational details on any potential stocking exercise were determined.

### **5.3.3 DAMAGE TO HABITATS**

#### **5.3.3.1 SCRAPING ABALONE FROM ROCKS**

##### **Rationale for Inclusion:**

Abalone are removed from the substrate using a small tool to pry the animals from the reef. The collected animals are then stored in large catch bags. The tool is a broad, flat bladed level with a slight bend near the end to provide a leverage point, used to remove abalone from the substrate. The impact on the benthic habitat from the process of abalone removal is assessed here.

##### **ERA Risk Rating: Impact from scraping abalone off rocks (C0 L1 NEGLIGIBLE)**

The impact to the environment, through damage to the habitat from prizing abalone from the substrate was considered to be at most a 'rare' possibility of causing a 'negligible' impact. This was since the abalone is lifted off the substrate and the substrate is not physically damaged in the process. Furthermore, the area of disturbance when carrying out this activity is limited to part of the site where an abalone is attached.

#### **5.3.3.2 INTERACTION BETWEEN DIVER/DIVER GEAR AND THE BOTTOM**

##### **Rationale for Inclusion:**

Abalone divers carry with them several pieces of equipment for safety and abalone collection purposes. This includes the underwater breathing apparatus (such as surface supplied air units), battery powered "shark pod" units that emit an electrical pulse thus deterring marine predators, on occasion a lightweight aluminium pneumatically propelled cages for additional protection from predators, battery powered or pneumatically powered "scooters" for propulsion underwater, and a large mesh bag for storage of the catch (with a capacity of between 100 and 200 live animals). The

impact on the benthic habitat from interaction of the diver, and the diver's equipment is assessed here.

**ERA Risk Rating: Impact of interaction between diver gear and habitat  
(C0 L1 NEGLIGIBLE)**

The impact to the environment, through damage to the habitat impact of the diver and diver equipment was considered to be at most a 'rare' possibility of causing a 'negligible' impact. This was since it is known that divers operate above the substrate, not making contact with the bottom. This is to their advantage as contact with the bottom may cause turbidity reducing visibility and therefore their ability to locate abalone. Also, diver equipment such as cage and catch bag are generally only slightly negatively buoyant. Divers use air reservoirs on cages and lift bags on catch bags to manipulate buoyancy. This ensures that contact with the substrate does not damage equipment and abalone product, and in turn, the substrate is not negatively impacted.

**5.3.3.3 REEF WALKING**

**Rationale for Inclusion:**

There are some areas where fishers can access abalone by walking over a reef-flat from the beach or a cliff face (i.e. no need to use a boat). Reef walking has the potential to impact on sensitive benthic organisms that occupy this zone.

**ERA Risk Rating: Impact of reef walking (C0 L1 NEGLIGIBLE)**

The impact to the environment, through damage to the habitat from reef walking is considered to be at most a 'rare' possibility of causing a 'negligible' impact. This is due to the following:

- The habitat walked on is generally in high-energy zones.
- Species occurring in high-energy environments are generally low-lying encrusting and generally physically robust. This is a necessity for them to survive in this harsh environment. As such, although reef walking may cause some local harm, these robust species are likely to repair themselves relatively quickly.
- The amount of area that is accessed by reef walking is very low so this impact is not widespread.
- In these high-energy environments, disturbance is a natural event. The disturbance from reef walking is unlikely to be detectable against this natural background level of impact.

#### **5.3.3.4 INDIRECT INTERACTIONS**

##### **Rationale for Inclusion:**

The potential impacts of abalone fishing operations through other indirect interactions with wildlife should be considered.

##### **ERA Risk Rating: Impact on other wildlife (C0 L1 NEGLIGIBLE)**

The indirect effect of the abalone fishing on other forms of wildlife was considered at the risk assessment workshop. There were no known indirect interactions as a result of the fishery. Therefore this issue was considered a 'negligible' risk.

## 5.4 GOVERNANCE

### COMPONENT TREE FOR THE GOVERNANCE OF THE ABALONE FISHERY

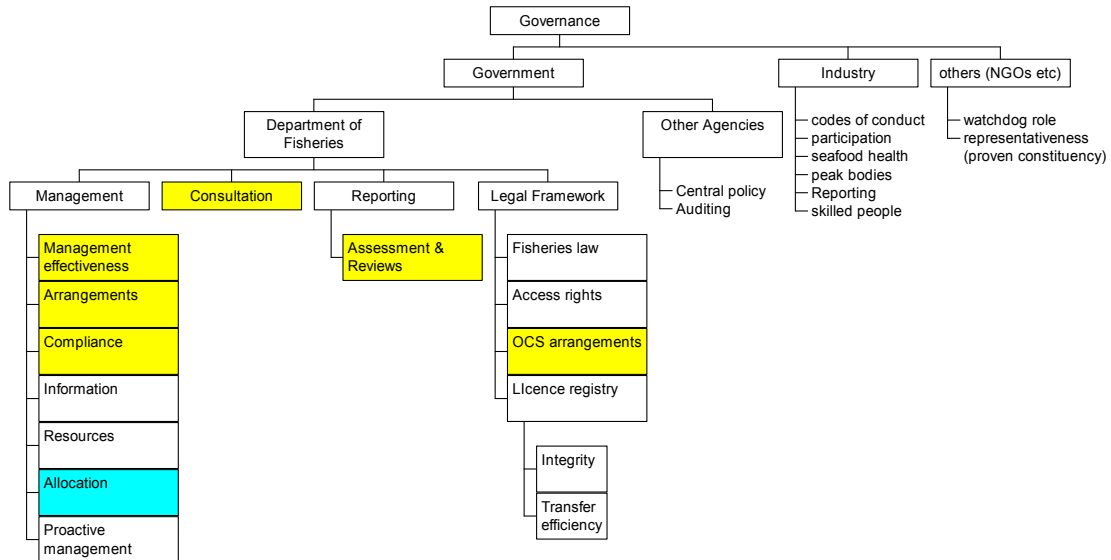


Figure 10. Component tree for governance of the Abalone Fishery.

Nb- no generic components have been removed from the tree but only those boxes that are blue or yellow will be reported in this application.

#### 5.4 1 DEPARTMENT OF FISHERIES – MANAGEMENT

##### 5.4.1.1 MANAGEMENT EFFECTIVENESS (OUTCOMES)

The effectiveness of management activities should ultimately be reflected by the extent to which each area in the commercial Abalone Fishery continues to produce expected outcomes. The annual average commercial catch of abalone has been about 330 tonnes (whole weight) with an expectation that variations in annual catch will only result from changes in environmental conditions, variable recruitment, or planned changes to the management of the level of commercial and recreational catch. Any large unexplained variation in catch, particularly any significant and unexpected reduction in catch, may be a reflection of a lack of management effectiveness and would be investigated. Given the relatively high level of community intelligence about the vulnerability of the abalone resource to overfishing, any significant unexplained reduction in catch may also raise interest/concern within the general community.

#### Operational Objective

The actual catch is maintained within an acceptable range of the total allowable commercial catch of abalone.

**Justification:**

*If effective management arrangements are operational in the fishery (including the setting of the total allowable catches and compliance and research standards of operation) then the actual total catch should be very close to the total allowable catch. Any variation outside of the acceptable totals allowable catch range would elicit the need to explain the cause of this deviation and potentially result in changes to management arrangements.*

**Indicator**

The weight of the total commercial abalone catch compared to specified total allowable catches of abalone for a given area in any one year.

**Performance measure**

The total acceptable catch range for this fishery is up to 10% below the annual Total Allowable Catch.

**Justification:**

*The annual catch for all species has typically been between 5% and 10% below the total allowable catch. Any significant variations outside of this range should be explained/explored. In addition, small fluctuations occur that are due to practical difficulties when fishing of taking an exact weight of catch (i.e. any uncaught “quota”) and/or minor clerical errors made by industry members or the Department that result in licensees inadvertently fishing over their allocated quota unit value. An administrative system is being developed with industry to counter any advantages gained by these errors and provide a disincentive to licensees.*

**Data requirements for indicator**

The following data is required for this indicator:

Data Requirement	Data Availability
Annual catch.	Yes - reliable estimates easily obtained.
Historical catch levels.	Yes - records available and accessible.
Annual total allowable catch.	Yes – set annually.
Historical catch.	Yes – data available and accessible.
Level of fishing effort	Yes – number of hours and days dived readily available.
Environmental indicators	Yes – key environmental indicators readily available.

## Evaluation

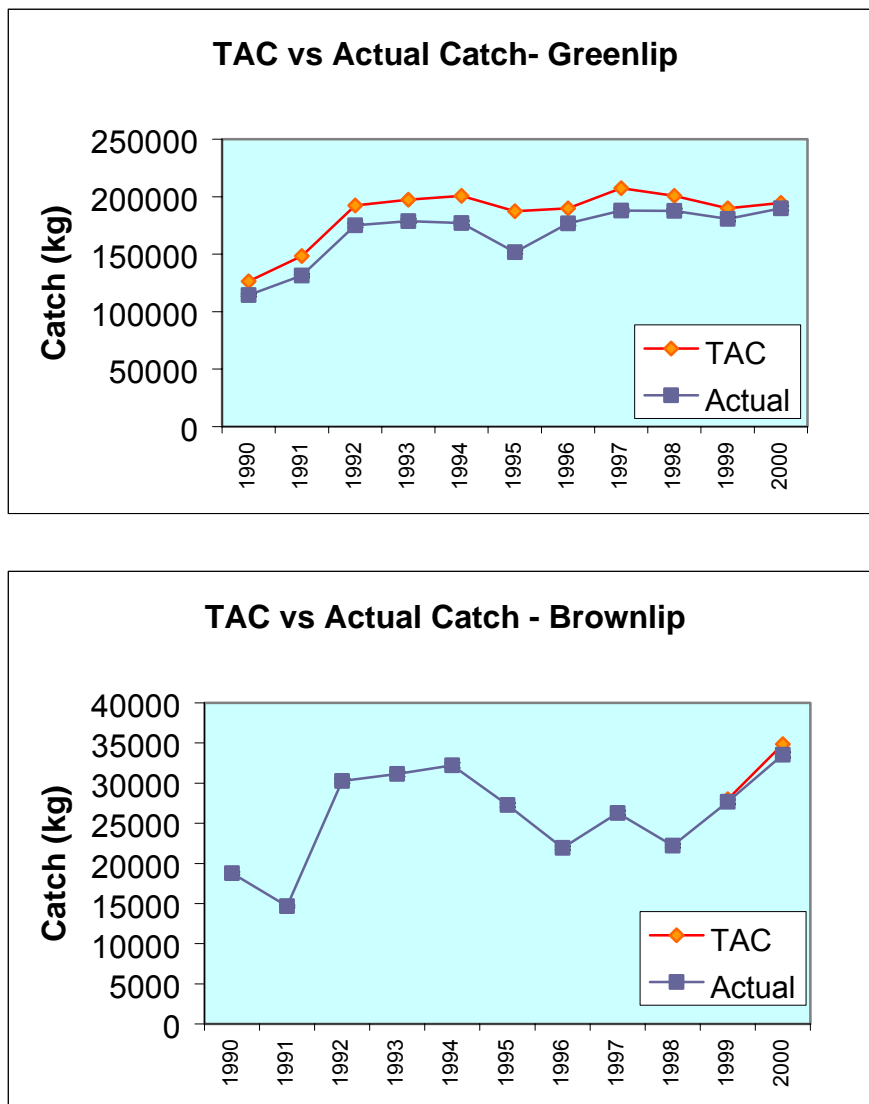
### Summary

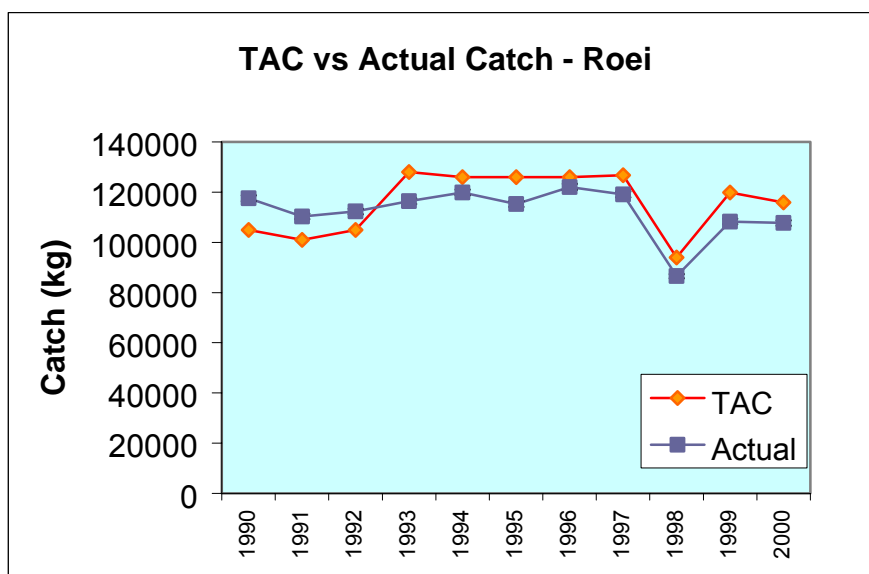
Using the above “management effectiveness” performance measure, the acceptable catch range and actual catch for the 2000 season was:

- Greenlip abalone range: 175,000kg – 204,500kg. Catch: 189,846kg.
- 31,400kg – 36,600kg for brownlip abalone. Catch: 33,531kg
- 104,300kg – 121,700kg for Roe’s abalone. Catch: 107,683kg

Therefore, the performance measure has not been triggered and current management strategies appear to be effective in achieving the overall objectives for the fishery (Figure 11).

**Figure 11. Comparison of TACs and the actual catch (whole weight) for the three abalone species.**





### Commercial Catch

The catch of Roe's abalone in the 2000 season across all areas was less than the total allowable catch.

Continuing a trend of TACs reductions in Area 8 due to industry motivated stock health concerns, a TACs of 12 tonnes (whole weight) was applied to Area 8 at the start of the fishing season. A Memorandum of Understanding (MOU) was established between the Department and Industry, which specified that only 6 tonnes of the 12 tonne TACs would be taken in Area 8. Following this, the MOU specified that a Research Scientist from the Department would carefully assess stocks in the Area, and the Research Officer would make a recommendation concerning the collection of the other 6 tonnes of TACs in the Area. The take of the "second" 6 tonnes was permitted, but was not completely taken due to an industry self-imposed catch reduction arrangement that was initiated during the previous season.

### Fishing effort

The nominal fishing effort for 2000 was:

Greenlip and brownlip abalone: 1,173 diver days

Roe's abalone: 755 diver days

The combined greenlip/brownlip catch rate increased from 185.8 kg per day (whole weight) in the 1999 season to 195.5 kg (whole weight) per day in 2000.

## **Stock Assessment**

### ***Greenlip/Brownlip***

Presently greenlip and brownlip abalone stocks are assessed by analysing industry data from the daily catch records, information from processors, fishers' monthly returns and data collected during specific research projects.

Industry has collaborated with the Department of Fisheries to develop strategies for the sustainable harvesting of stunted populations of abalone. In Area 1 there are extensive, isolated populations of stunted greenlip abalone. The generally small size of these abalone (surveyed in 1974, 1994 and 2000) has limited catches from this part of the fishery, with less than 200 kg fished annually since 1994. In 2000, industry divers and Department researchers carried out exploratory fishing at Twilight Cove to determine the distribution and density of the stocks and obtain data needed for the development of a new strategy for sustainable fishing of these particular stocks. The survey revealed that less than 5% of stocks were of legal size (140 mm+) and that stocks reaching legal size were localised to small areas.

In Area 2, the recent improvement in average meat weights of non-stunted greenlip stocks recorded in 1999 was not sustained in the 2000. In 2000 the average greenlip meat weight reverted to 177 g, a decrease of just over 10 g from the previous season's average when controlled harvesting of stunted stocks relieved fishing pressure (and effort) from traditionally fished stocks. The Area 2 catch rate for greenlip abalone was 54.63 kg/day (meat weight) in 2000. In addition to decreasing average meat weights, fishing 10% more abalone (by weight) from traditional stocks than in 1999 also saw catch rates decrease by 9 kg/day. Although lower than last season by 4 g, the generally consistent average meat weight of brownlip abalone in Area 2 does not indicate any present cause for concern.

Area 3 has utilised a combination of temporary quota reductions and closures/openings of the most productive locations in the recent past as controls to direct effort. In addition, raising minimum size limits (by industry agreement) has increased the average meat weight of greenlip abalone substantially since 1997. In 2000, the average meat weight for greenlip abalone was 231 g, the highest average recorded in the 1990s. During the season the catch of greenlip from traditionally fished grounds was decreased 3.75% by fishing 1.5 tonnes of 'stunted stock' east of Hopetoun. Information on brownlip abalone stocks in this area is limited, as divers have in the past primarily targeted greenlip abalone. The quota for brownlip abalone in Area 3 was increased by 2 tonnes for the 2000 season to allow divers to target new areas for brownlip abalone. Average meat weights and diver catch records indicate that this approach has been partially effective. The average meat weight for brownlip abalone in 2000 was 274.5 g, the highest since 1995.

### ***Roe's***

Presently stocks of Roe's abalone are assessed by analysing industry data from the daily catch records, information from processors, fishers' monthly returns and data collected during specific research projects. Unlike greenlip and brownlip abalone,

Roe's abalone are not counted by divers, so there is no process for assessing average meat weights within this fishery.

The population structure has now been assessed through genetic analysis (gel electrophoresis). Results demonstrate moderate levels of connection (gene flow) between populations throughout the species distribution; hence Roe's stocks can be examined on a State scale. Statewide connection occurs despite mixing within each generation occurring on a smaller scale of < 13 km. This means that, although there is gene flow across the complete range of Roe's abalone, the majority of recruitment occurs as a local event on continuous reef complexes; therefore most fisheries management and research occurs on a smaller scale by Area.

In general, assessment of Roe's stocks using daily catch records is limited to reviewing catch per unit effort (CPUE) and movement of catch and effort within the 10 x 10 mile grid reporting system. In general these catch statistics describe a well-managed stock, as the catch was fished in two less days than was the case last year and within the acceptable catch and effort range projected last season. However, comparative assessments of changes in catches from particular locations beyond gross catch weight, e.g. by assessing changes in average meat weight, are needed to be able to monitor fluctuations in catches prior to any critical change in stock health.

The Department is currently working with industry to institute the development of a system that is able to monitor changes in the average meat weight or grade of catch from particular locations. In 1999 there was some concern at the condition of the commercial stocks at specific locations at the margins of the fishery. In Area 1 there was evidence of localized depletion of Roe's abalone in the vicinity of the launch area at Twilight Cove (first 10 km east of cliffs). This concern has been somewhat allayed by an increase in the legal minimum size limit for Area 1 from 60 mm to 75 mm shell length. Although the abundance of Roe's abalone is not of concern at other locations on the south coast, a portion of the quota consistently remains unfished due to the remoteness of the fishing locations and the unpredictable nature of the weather.

In Area 8, the most northerly margin of the fishery, observations from divers suggested that the quota setting for 1999 and 2000 was too high, despite a reduction in quota in 2000. The abundance of legal-sized Roe's abalone in this area has declined due to localised depletion of abalone caused by inappropriate distribution of fishing effort by less experienced fishers (on a spatial scale smaller than previously reported). In addition, some natural losses have occurred as a result of environmental factors outside of the control of the commercial fishery, for example in shallow water areas where unusually hot weather coincided with extreme low tides. In 1999, fishers in Area 8 instituted a voluntary reduction of 6 tonnes from their 30 tonnes TACs. Despite arguing over 20 tonnes TACs for 2000, fishers again instituted a voluntary reduction of 4 tonnes during the season following concerns that the quota was still too high. For the 2001 season, industry operators have traded units to ensure that only divers experienced in fishing these remote colonies operate in the northern parts of Area 8.

## **Robustness**

### **High**

The data required for the indicator in most cases is readily available and setting of annual TACs is done in close consultation with industry. Changes in diving efficiency through time may reduce the robustness of this indicator.

## **Fisheries Management Response**

### **Past:**

The management measures imposed to achieve the objective for the spawning stock (see above) also serve to achieve the objective related to the exploitable stock.

Historically, variations in catch below the range expected have been due to industry self-imposed catch restrictions due to stock health concerns, variations in catch above the expected ranges have been due to diver and or Department administrative errors.

### **Future:**

The Department is doing further work to both improve the measurement of fishing efficiency and understand the relationship between environmental factors and catch.

The Department recently introduced measures that permit the alteration of total allowable catches during an entitlement period. Any necessary future changes to TACs because of stock issues will result in a corresponding change to the total allowable catch. As a result, future total catch figures should more closely reflect the total allowable catch, and nearly all (if not slightly more than) the total allowable catch should be taken.

### **Response if Performance Limit is Triggered:**

In previous years, if the catch were outside of the range of expected values then a review of the causes would have been undertaken. In the case of the full TACs not being taken, the review would examine if the likely cause was due to environmental conditions (such as weather conditions) or if industry had agreed to not take the total allowable catch for some alternate reason.

In the case of an overfishing event, an investigation with a view to prosecution would occur. In addition, when setting the total area catch for the following season, the quantum of overfishing in that area from the previous year would be taken into account.

## **Comments and Action**

The Department is currently negotiating a system with industry that, if implemented, would specify that any minor overfishing of entitlement would be dealt with in one of two ways. Any overfishing up to and including 20kg over an individual licence holder's TACs in an area would require (as a disincentive to overfish) the payment of

the commercial value of any overfished catch to a Fisheries Research and Development Fund. Any overfishing of more than 20kg would require the suspension of units in the following two seasons.

This system, if implemented, should be in place before 1 April 2003.

### **External Driver Check List**

Environmental factors such as climatic changes, ocean currents, sea-surface temperatures and ENSO events may impact upon recruitment and hence the size of the exploitable biomass and consequent catch. Further research is required to determine the range of possible causes of variable recruitment in this fishery.

Increased levels of recreational fishing in the more geographically isolated parts of the fishery may also have an unforeseen impact on the catch of abalone. The long-term impact of conservation measures and possible population increases of predatory molluscs, stingrays and some fish may also have an impact on the catch available to commercial fishers.

Gradual refinements in fishing and diving and related technology (e.g. improved accuracy of Global Position Satellite navigation aids, use of Nitrox) may also lead to an increase in fishing efficiency.

### **5.4.1.2 MANAGEMENT ARRANGEMENTS**

#### **Rationale for Inclusion:**

In Western Australia, a number of instruments are used to articulate the management arrangements for fisheries. The FRMA has elements that affect all fisheries; in addition there are Management Plans, Orders, Regulations, Ministerial Guidelines and Policy Statements. In cases where current management arrangements were developed under the previous Act (as was the case for the Abalone), the powers from the previous Act have been transferred under various sections of the Transitional Provisions of the FRMA (**S 266** Savings and transitional provisions - Schedule 3 parts 8-12, 15-19).

The “Abalone Fishery Management Plan” (the Abalone Plan) in effect, is a set of rules as to how the fishery will operate. The Plan obtains its power from the FRMA and, in conjunction with the FRMR and relevant Ministerial Policy Guideline, is the vehicle through which the fishery is managed. The Plan and the associated documentation (which includes the ESD report) should include all information expected to be in a “Best Practice” set of management arrangements (as defined in the Department’s ESD Policy - Fletcher 2001).

These arrangements should contain:

1. An explicit description of the management unit.
2. The issues addressed by the plan.
3. Descriptions of the stocks, their habitat and the fishing activities.

4. Clear operational (measurable) objectives and their associated performance measures and indicators.
5. Clearly defined rules, including what actions are to be taken if performance measures are triggered.
6. Economic and social characteristics of the groups involved in the fishery.
7. Management and regulatory details for the implementation of the actual management plan.
8. The reporting and assessment arrangements.
9. How and when reviews of the plan will occur (including consultation mechanisms).
10. A synopsis of how each of the ESD issues are being addressed.

These arrangements includes the criteria to operate in the fishery, the manner of fishing, the fishing season, fishing areas, licence renewals, transfers, temporary transfers and cancellations, fishing unit entitlements, labelling of containers, offences and major provisions, process for amending the plan and the minimum number of units that must be endorsed on a licence.

### **Operational Objective**

In consultation with the AbMAC and other stakeholders, periodically review the management plan, related legislation, regulations and arrangements to ensure it remains relevant and aligned with the fishery's management objectives and that collectively they cover the 10 main principles.

*Justification:*

*To have an effective and understandable plan for the management of this fishery with all of the 10 principles covered within the suite of arrangements developed for the fishery.*

### **Indicator**

The extent to which the management plan and supporting documentation addresses each of the issues and has appropriate objectives, indicators and performance measures, along with the planned management responses

### **Performance Measure**

This should be 100%.

### **Evaluation**

As an over-arching sub-component, the performance of the management arrangements are evaluated on two levels – the micro level, i.e. the relevance of individual clauses and the role they play and on the macro level, i.e. the relevance of the plan as a whole and the role that it plays.

Current Performance against each of the areas required within the “plan”<sup>5</sup>:

1. **An explicit description of the management unit** – The management unit is explicitly described within the “Declaration of the Fishery” section of the Abalone Management Plan.
2. **The issues addressed by the plan** – The issues that need to be addressed by the Abalone plan have been examined thoroughly and are documented within the 8 ESD component trees and their reports.
3. **Descriptions of the stocks, their habitat and the fishing activities** – the Abalone stock is well described in Section 2.1 and the fishing activities are described in Section 2.2.
4. **Clear operational (measurable) objectives and their associated performance measures and indicators** – These are now located in Section 5 for each of the major issues.
5. **Clearly defined rules, including what actions are to be taken if performance measures are triggered** – For each of these major issues, the management actions that are planned to be taken if performance limits were exceeded are now articulated in Section 5.
6. **Economic and social characteristics of the groups involved in the fishery** – A brief articulation of the economic and social characteristics is located in Section 3.3 and there is to be a greater level of detail accumulated during the process of completing the remainder of the ESD components.
7. **Management and regulatory details for the implementation of the actual management plan** – The regulations relating to the Abalone Fishery are located in both the Abalone Plan and Abalone Ministerial Policy Guidelines.
8. **The reporting and assessment arrangements** – These arrangements are documented in Section 5.8.4.1 and include annual reporting against current agreed performance limits and targets and a five yearly review of these arrangements and assumptions.
9. **How and when reviews of the plan will occur (including consultation mechanisms)**. – The FRMA clearly sets out how the process for the review of any management plan must occur.
10. **A synopsis of how each of the ESD issues are being addressed** – A synopsis of ESD issues has been compiled within the Overview Table of this report.

## **Robustness**

### **Medium**

The management plan and related legislation represent a comprehensive set of fisheries management legislation. The fact that the management arrangements are contained within legislation provides a reasonably high degree of stability with respect to how the fishery is managed. However, it should be noted that following the development of the initial plan in 1992, there have been 36 amendments to the plan. Many of the amendments were annual administrative requirements, but there have been significant management changes in the fishery, including a major amendment to the plan in 1999.

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<sup>5</sup> “Plan” – includes all management arrangements

This said, the processes for achieving management plan changes are well understood by the majority of stakeholders in the fishery, and system is flexible enough so that the management process can respond to change within a reasonable timeframe.

### **Fisheries Management Response**

The Department of Fisheries has successfully administered the management plan and related legislation to achieve and pursue the stated objectives. Changes have occurred regularly to address key concerns or issues, and the management plan will continue to evolve over time through the established processes.

### **Comments and Action**

The fishery is managed in a dynamic and consultative way. While most fishermen have a reasonable degree of confidence in the Department's research activities and results, some industry members remain concerned about the type of information research is collecting, and believe that better indicators of stock status are available at minimal cost. As a result of these discussions an FRDC project is now underway to utilise underwater digital video to obtain independent information in regard to abalone size, density and abundance.

Industry remain concerned at the long term funding of compliance activities related to unlicensed operators in the fishery. These costs are attributed to the commercial fishing sector under the cost recovery model, however, the current Minister has agreed to subsidise these costs for the 2000-2004 term of Government. This key issue needs to be resolved over the longer term.

### **External Driver Check List**

- Level of support by commercial fishers of Department initiated management arrangements.

#### **5.4.1.3 COMPLIANCE**

##### **Rationale for Inclusion:**

Effective compliance is vital to achieve the management objectives of any fishery. The Department spends around \$750,000 in enforcement and compliance monitoring in the Abalone Fishery each year. This involves a mix of land patrols, aerial surveillance, processing factory inspections and covert surveillance.

##### **Operational Objective**

To have sufficiently high levels of compliance with the FRMA, FRMR and the abalone managed fishery management plan.

##### ***Justification:***

*The activities of the participants in the fishery need to be sufficiently consistent with the management framework and legislation to make it likely that the expected outcomes and objectives of the fishery will be achieved.*

## **Indicators**

The levels of compliance with the legislation, including the estimated level of illegal landings.

Degree of understanding and acceptance of rules governing operation of the Abalone Fishery by licensees and the broader fishing community.

## **Performance Measure**

Aiming for 5% inspection of landed catches.

Aiming for 2% factory inspections.

## **Data Collection Requirements and Processes**

Random Inspections of Processors

Ongoing collection of data on illegal activities.

Comparative data on the relative effectiveness of certain compliance techniques.

## **Evaluation**

Sea and land patrols along with factory inspections only detected a low level of non-compliance with the management of this fishery during the 1999/2000 season. Fisheries Officers carried out licence and gear inspections and provided advice to industry during the season. A compliance risk assessment involving industry, management and compliance representation was held for the first time prior to the commencement of the 2001-2002 season. As a result, a review of operations led to a new field operations approach.

## **Robustness**

### **Low**

The difficulties in identifying all types of illegal activities will remain particularly when concentrating effort on the factory inspections.

## **Fisheries Management Response**

The Regional Services division of the Department continues to gather intelligence on suspected and known illegal activity within the fishery. In addition to this, dedicated close working relationships with fisheries enforcement Departments in other states, and a close working relationship with the Police Department in Western Australia are of great value.

## **Comments and Action**

The Department will continue to provide high standard compliance service to the Abalone Fishery. The Department recently negotiated a comprehensive compliance activity schedule, which clearly specifies the expected types of commercial abalone inspections for the fishery.

## **External Driver Check List**

- Changes to technology that may facilitate an increase the level of non-compliance.
- Changes to non-fisheries legislation (National Competition Policy) may impact upon the Department's ability to restrict activities in a way that assist compliance (e.g. processor receivals restrictions).

### **5.4.1.4 ALLOCATION AMONG USERS**

#### **Rationale for Inclusion:**

In addition to the commercial fishery there is also a significantly large recreational fishery for abalone in Western Australia, particularly in the Perth Metropolitan area. Regardless of the motivation for extractive fishing it should be noted that the sustainability parameters of the resource remain the same. It is therefore important that all extractive users are considered when implementing arrangements designed to secure the resource and ecological sustainability.

Furthermore there are other non-extractive (conservation) interests in the resource and its related ecosystem that also need to be considered within the management process.

#### **Operational Objective**

To ensure that adequate management processes are in place that allow for the integrated management of the Abalone Fishery as a means of facilitating debate on management arrangements that will achieve an appropriate allocation of the resource amongst the various extractive and non-extractive stakeholders.

#### **Indicator**

The percentage of catch taken by each sector (recreational and commercial).

The level of resource sharing conflict amongst user groups.

The level of participation of interested groups / parties in any focused resource sharing process.

The willingness of the various interest groups to participate in the resource sharing process and include other user-groups.

#### **Performance Measure**

To be determined as an outcome of the Toohey Committee (see below) report on Integrated Fisheries Management (IFM).

## **Data Requirements**

- Information on the catch by the recreational sector.
- Information on incidental mortality as a result of recreational fishing.
- Projected potential increases in recreational fishing effort for abalone.
- The costs associated with various management options and the identification of potential funding sources – particularly relevant for those measures targeted at the recreational sector.
- Appropriate advice and framework from the Toohey Committee on the question of resource allocation mechanisms across user groups.

## **Evaluation**

There are now reliable estimates of the total annual recreational catch (Hancock et al., 2001). In the 2000 fishing season an estimated 32 tonnes was taken of Roe's abalone from the Perth metro area. The total catch of Roe's abalone for the West coast and South coast areas was estimated at 11.2 tonnes and 8.3 tonnes (respectively) in 2000. This resulted in the recreational catch estimates for Roe's abalone in 2000 being approximately 32% of the total Roe's abalone catch. The recreational greenlip/brownlip catch was estimated at approximately 21% of the total greenlip/brownlip catch. This resulted from 15.5 tonnes of greenlip and 4.6 tonnes of brownlip abalone in the West Coast fishery and 31.5 tonnes and 7.4 tonnes (greenlip and brownlip, respectively) taken from the South Coast fishery. These figures were derived through two independent methods of estimation: telephone surveys covering all of the State, and field surveys for the Perth fishery only.

The Abalone Fishery is likely to move into a more explicit process to address resource-sharing issues, including resource allocation across user groups. The Western Australian Abalone Industry Association has initiated discussions with the Western Australian Peak Recreational Fishing body (Recfishwest) to discuss the issue. This issue is also being considered as part of the Integrated Fisheries Management Initiative with Justice Toohey, due to report in late 2002.

## **Robustness**

### **Medium**

Presently, whilst there is no specific allocation made to the recreational sector, both the overall catch is managed through a suite of input controls and the overall catch and percentage take by each sector is monitored annually.

If there was a significant increase in the percentage of catch from the recreational sector, this would prompt a reassessment of the current management arrangements, possibly for both sectors in line with the normal dynamic management approach that is used.

## **Fisheries Management Response**

**Current:**

The extensive consultative processes involved in managing both sectors of the fishery ensure that the rights of commercial and recreational fishers are considered.

The Department also attempted to form a group comprised of commercial fishers, recreational fishers and conservation representatives to identify the issues involved in resource sharing in the Abalone Fishery. Due to commercial sector concerns about conservation representation in the discussion group, the group did not meet, and the commercial sector is currently attempting to engage the recreational sector directly.

Recreational fishers interests are specifically catered for through the Recreational Fishing Advisory Committee process that advises the Minister for Fisheries on matters relating to recreational fishing, including recreational abalone fishing. In addition, the peak independent recreational fishing body Recfishwest is closely involved in the fishery consultative processes.

**Future:**

It should be noted that the Governments IFM initiative being lead by Justice Toohey will be reporting in late 2002. The IFM process is charged with determining a more explicit process of allocation amongst competing community sectors.

**Comments and Action**

Through the processes already established and underway, the Department will continue to promote the integration of fisheries management across user groups. To this end the Department has a number of initiatives related to improving the governance of allocation and reallocation. An IFM policy was released in early 2000. This has been followed up by the formation of the "Toohey Committee" which will report to the Minister on the most appropriate framework to try and achieve these IFM objectives.

**External Driver Check List**

Resource sharing issues being raised with the Minister independently of the AbMAC, Recreational Fishing Advisory Committee or the Toohey Committee.

**5.4.2 DEPARTMENT OF FISHERIES - LEGAL ARRANGEMENTS**

**5.4.2.1 OCS ARRANGEMENTS**

**Rationale for Inclusion:**

The Offshore Constitutional Settlement (OCS) arrangements between Western Australia and the Commonwealth Government of 1988 established that it is the sole responsibility of the State of Western Australia to manage the Abalone Fishery. The OSC *"was developed to simplify legal arrangement for the management of fisheries operating in both State and Commonwealth waters"* (Anon., 1988).

This simplified the management of the fishery from the previous system where jurisdiction was split between WA within 3 nm of the coast and the Commonwealth, outside of this area.

Although the license area extends into Commonwealth waters, the functional fishing area is within State waters boundary.

### **5.4.3 DEPARTMENT OF FISHERIES – CONSULTATION**

#### **5.4.3.1 CONSULTATION**

##### **Rationale for Inclusion:**

The FRMA prescribes certain requirements with regard to consultation that must be undertaken in the course of managing fisheries. The management of the Abalone Fishery is based around a very extensive consultation and communication process.

There are sections in the FRMA that relate to the development of a management plan (Section 64) and to the amendment of a management plan (Section 65). Given that the Abalone Fishery already has a management plan, Section 65 is the most relevant.

This states that:

##### **S 65. Procedure before amending management plan**

- (1) A management plan must specify an advisory committee or advisory committees or a person or persons who are to be consulted before the plan is amended or revoked.*
- (2) Before amending or revoking a management plan the Minister must consult with the advisory committee or advisory committees or the person or persons specified for that purpose in the plan.*
- (3) Despite subsection (2), the Minister may amend a management plan without consulting in accordance with that subsection if, in the Ministers opinion, the amendment is –*
  - a) required urgently; or*
  - b) of a minor nature*
- (4) If –*
  - a) the Minister amends a management plan; and*
  - b) the amendment is made without consultation because it is, in the Minister’s opinion , required urgently,*

*the Minister must consult with the advisory committee or advisory committees or the person or persons specified for that purpose in the plan as soon as practicable after the plan has been amended.*

The persons which must be consulted prior to amending the abalone plan are specified in the management plan as the licence holders in the fishery.

Section 41 of the FRMA provides the head power for the establishment of the Abalone Management Advisory Committee and Section 42 allows the Minister to create an instrument that specifies the functions, identify the members of, and provide for any other matter that, in the Minister's opinion, is necessary for the operation of the committee.

### **Operational Objective**

To administer a consultation process that is in accordance with the requirements of the FRMA and allows for the best possible advice from all relevant stakeholders to be provided to the decision maker (Minister/ED) in a timely manner.

### **Indicators**

- The Minister (or the Department on his behalf), conforms to the consultation requirements of the FRMA.
- The level to which licensees consider that they are adequately and appropriately consulted.

### **Performance Measures**

Advice provided to the Minister following each AbMAC meeting.

Production and circulation of Chairman's reports to all stakeholders.  
Adherence to annual planning cycle.

Proper consultation procedures have been followed in any amendment of the management plan.

Direct contact with fishermen during annual "fishdown" operations and during the annual meeting for the fishery.

### **Data Requirements**

Views on the AbMAC and related consultation processes collected from the community and stakeholders at an annual Department/Industry meeting.  
Documentation of the formal consultation procedures followed when an amendment is made.

### **Evaluation**

Consultation on management of the Abalone Fishery is conducted in an open, accountable and inclusive environment where all sectors of the industry and the Departments managers collectively identify and discuss appropriate courses of action.

## **Robustness**

### **High**

The consultation process is well understood with relatively high levels of participation from the various stakeholder groups.

## **Fisheries Management Response**

The Department has strong links to the abalone industry through a formal process. The AbMAC has certain functions as defined by the Minister which are:-

- To identify issues that affect the Fishery;
- To advise the Minister on matters relating to the Management and protection of the Fishery; and
- To advise the Minister on matters relating to the Fishery on which the advice of the Advisory Committee is sought by the Minister.

Membership of the AbMAC comprises an independent Chairperson; a Department representative; one abalone processor; three commercial abalone licence holders or fishermen, one recreational abalone fisherman and one person with community experience. Terms of appointment vary, but are usually for two years.

To that end, they play an integral part in guiding the service delivery of the Department and setting priorities for management, research, enforcement and development.

In addition to the MAC process, industry has developed an independent Industry Association, the Western Australian Abalone Industry Association (WAAIA). This group is fully representative of licence holders in the Abalone Fishery. The Minister has agreed that appropriate “day-to-day” commercial fishery management matters will be dealt with directly between the Department and the WAAIA.

The Department does, however, also provide independent advice to the Minister on the implications of any proposal from AbMAC, the Western Australian Abalone Industry Association, or any other body.

## **Comments and Action**

The Department will continue to provide a dedicated Executive Officer whose primary role is to service the Abalone Fishery consultation process.

## **External Driver Check List**

Despite the existence of the AbMAC, the WAAIA, and other consultation processes used, disaffected parties still seek to use political avenues to further their cause.

## **5.4.4 DEPARTMENT OF FISHERIES - REPORTING**

### **5.4.4.1 ASSESSMENTS AND REVIEWS**

#### **Rationale for Inclusion:**

It is important that the outcomes of the fisheries management processes administered by the Department for the Abalone Fishery are available for review by external parties. It is also important that the community is sufficiently informed on the status of this fishery, given that it is utilising a community resource. The reports that are currently provided annually are: the State of the Fisheries Report, the Annual report to the Auditor General; and more irregular reports including the ESD report, and this application to Environment Australia. There is a longer-term plan to have the entire system of management audited by the WA Environmental Protection Authority.

#### **Operational Objective**

Current - To report annually to the Parliament and community on the status of the fishery

Future - To develop an independent audit process for the fishery at appropriate intervals.

#### **Indicators**

- The extent to which external bodies with knowledge on the management of fisheries resources have access to relevant material.
- Level of acceptance within the community.

#### **Performance Measure**

General acceptance of the management system by the community

#### **Data Requirements**

The majority of data required to generate reports is already collected in the course of pursuing resource management objectives. The Department conducts an annual survey of the community with respect to its opinion on the status of the State's fisheries and their attitudes to the performance of the Department.

#### **Evaluation**

The Department has implemented more than one process to report on the performance of this fishery and in doing so has ensured that the community has access to this information.

In addition to this base level reporting the development of a new process that will see the fishery undergo regular independent audits ensures this sub-component is well in hand.

The Department has been the recipient of a number of awards for excellence for its standard of reporting - Premiers Awards in 1998, 1999 for Public Service excellence, Category Awards in Annual Reporting in 1998, 1999, 2000; Lonnie Awards in 2000, 2001.

Current Reporting Arrangements for this fishery include:

### ***State of the Fisheries***

Annual reporting on the performance of the fishery against the agreed objectives within the State Of The Fishery Report. This document is available in hard copy format but is also available from the Department's web site in PDF format.

### ***Annual Report***

A summary of this report is presented within the Department's Annual Report and is used in some of the Performance Indicators that are reviewed annually by the Office of the Auditor General (OAG).

The OAG also periodically audits that the information (both the data and processes) used to generate these reports.

### ***ESD***

The Department is currently completing a full ESD report (of which the material presented in this application is a subset), which will cover not only the environmental aspects of the fishery but the full social and economic issues. Once completed this too will be available from the web site.

### ***Reports to Industry***

Each year, the status of the resource, upcoming and recently amended management arrangements and compliance updates are presented to fishers and other interested parties in a public meeting held in Perth. This is termed the abalone annual meeting.

### **Robustness**

**High**

### **Fisheries Management Response**

**Current:**

For many years the Department has produced substantial and high quality documents that report on the operation of the Department and the status of its fisheries (including the Abalone Fishery)– these reports are the Annual Report and the State of the Fisheries.

**Future:**

In line with the new Commonwealth Government requirements the Department of Fisheries is in the process of developing a tri-partite memorandum with the Western Australian Environmental Protection Authority and the Office of the Auditor General to conduct a regular audit of the fishery.

**Comments and Action**

The processes already established and those new external review processes that are all but established ensure that there will be many opportunities for appropriateness of the management regime and the importantly the results it produces to be reviewed.

**External Driver Check List**

The assessments provided by independent review bodies and the community.

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**APPENDIX 1 PARTICIPANTS AT RISK ASSESSMENT WORKSHOP**

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## **APPENDIX 2 ACRONYMS**

Abalone Fishery	Western Australia Abalone Managed Fishery
AbMAC	Abalone Management Advisory Committee
CDR	Catch and Disposal Record
ED	Executive Director of Department of Fisheries WA
ESD	Ecologically Sustainable Development
FRDC	Fisheries Research and Development Corporation
FRMA	Fish Resources Management Act, 1994
FRMR	Fish Resources Management Regulations, 1995
IFM	Integrated Fisheries Management
ITQ	Individual Transferable Quota
OAG	Office of Auditor General
TACs	Total allowable catches
The Plan	Abalone Management Plan 1992
WAAIA	Western Australian Abalone Industry Association

### APPENDIX 3 DETAILS OF CONSEQUENCE TABLES

Level	Ecological
<b>Negligible</b>	<p>General - Insignificant impacts to habitat or populations, Unlikely to be measurable against background variability</p> <p><b>Target Stock/Non-retained:</b> undetectable for this population</p> <p><b>Byproduct/Other Non-Retained:</b> Area where fishing occurs is negligible compared to where the relevant stock of these species reside (&lt; 1%)</p> <p><b>Protected Species:</b> Relatively few are impacted.</p> <p><b>Ecosystem:</b> Interactions may be occurring but it is unlikely that there would be any change outside of natural variation</p> <p><b>Habitat:</b> Affecting &lt; 1% of area of <b>original</b> habitat area</p> <p><i>No Recovery Time Needed</i></p>
<b>Minor</b>	<p><b>Target/Non-Retained:</b> Possibly detectable but little impact on population size but none on their dynamics.</p> <p><b>By-Product/Other non-retained:</b> Take in this fishery is small (&lt; 10% of total) compared to total take by all fisheries and these species are covered explicitly elsewhere.</p> <p>Take and area of capture by this fishery is small compared to known area of distribution (&lt; 20%).</p> <p><b>Protected Species:</b> Some are impacted but there is no impact on stock</p> <p><i>Ecosystem: Captured species do not play a keystone role – only minor changes in relative abundance of other constituents.</i></p> <p><b>Habitat:</b> Possibly localised affects &lt; 5% of total habitat area</p> <p><i>Rapid recovery would occur if stopped - measured in days to months.</i></p>
<b>Moderate</b>	<p><b>Target/Non Retained:</b> Full exploitation rate where long term recruitment/dynamics not adversely impacted</p> <p><b>ByProduct:</b> Relative area of, or susceptibility to capture is suspected to be less than 50% and species do not have vulnerable life history traits</p> <p><b>Protected Species:</b> Levels of impact are at the maximum acceptable level</p> <p><i>Ecosystem: measurable changes to the ecosystem components without there being a major change in function. (no loss of components)</i></p> <p><b>Habitat:</b> 5-30 % of habitat area is affected.</p> <p>or, if occurring over wider area, level of impact to habitat not major</p> <p>Recovery probably measured in months – years if activity stopped</p>
<b>Severe</b>	<p><b>Target/Non Retained:</b> Affecting recruitment levels of stocks/ or their capacity to increase</p> <p><i>ByProduct:Other Non-Retained: No information is available on the relative area or susceptibility to capture or on the vulnerability of life history traits of this type of species</i></p> <p><i>Relative levels of capture/susceptibility greater than 50% and species should be examined explicitly.</i></p> <p><i>Protected Species: Same as target species</i></p> <p><b>Ecosystem:</b> Ecosystem function altered measurably and some function or components are missing/declining/increasing outside of historical range</p>

	<p>&amp;/or allowed/facilitated new species to appear.</p> <p><b>Habitat:</b> 30- 60 % of habitat is affected/removed.  <i>Recovery measured in years if stopped</i></p>
<b>Major</b>	<p><b>Target/Non Retained:</b> Likely to cause local extinctions</p> <p><b>By-Product:Other non-retained:</b>N/A</p> <p><b>Protected Species:</b> same as target species</p> <p><b>Ecosystem:</b> A major change to ecosystem structure and function (different dynamics now occur with different species/groups now the major targets of capture)</p> <p>Habitat: 60 - 90% affected  <i>Recovery period measured in years to decades if stopped.</i></p>
<b>Catastrophic</b>	<p><b>Target/NonRetained:</b>Local extinctions are imminent/immediate</p> <p><b>By-Product/Other Non-retained</b> N/A</p> <p><b>Protected Species:</b> same as target</p> <p><b>Ecosystem:</b> Total collapse of ecosystem processes.</p> <p><b>Habitat:</b> &gt; 90% affected in a major way/removed  <i>Long-term recovery period will be greater than decades or never, even if stopped</i></p>

## APPENDIX 4 RESEARCH STRATEGIC PLAN

Project	Pre-2000	Gap		Res Group	00/01	01/02	02/03	03/04	04/05	Priority G/B	Roe's
<b>BIOLOGICAL</b>											
1. Growth rate of abalone – spatial, juveniles (hatchery)	*	*		FWA, I	■	■	■			M	M
2. Early juvenile life history and habitat, natural mortality and predation		*								L/M	M/H
3. Environmental effects on recruitment		*								M	M
4. Genetics	*	*		FWA, I Nick Elliot	■	■	■			L/M	L/M
5. Reproduction / Fecundity, spawning periodicity	*	*								H	H
<b>GENERAL STOCK ASSESSMENT</b>											
1. Catch statistics (wildstock)	*			FWA, I	■	■	■	■	■	n/a	n/a
2. Mapping of areas	*			FWA, I	■	■	■			H	H
3. Recruitment		*		FWA	■	■				M/H	M/H
4. Video monitoring sites –incl movement				FWA, I	□	□	■	■	■	H	M/H
5. Fishing efficiency		*								L	L
6. Tagging program – shell ID	*			FWA, I		■	■	■		H	H
7. Information management – digital systems				FWA, I		■	■	■		M/H	M/H
8. Recreational Impact	*			FWA, I	■	■	■			H	H

### Project Status Key

- ✓ Complete
- Committed
- Proposed but not approved/committed

### Research Group Key

- FWA WA Government
- AIMS Commonwealth Government
- CSIRO Commonwealth Government
- CRC Cooperative Research Centre (TAS)
- I WA Industry
- Y Yet to be determined

### Priority Key

- H = High
- M = Medium
- L = Low
- n/a

Project	Pre-2000	Gap	Res Group	00/01	01/02	02/03	03/04	04/05	Priority	
									G/B	Roe's
<b>INDUSTRY DEVELOPMENT</b>										
1. Relocation of stocks	*		FWA, I	■	■				H	M/H
2. Reseeding of stocks with juveniles		*							H	H
3. Setting appropriate fishing size controls	*								H	H
4. Diver safety/profiles	*								M	M
5. Compliance assistance	*		FWA, I						M/H	H
6. Historical record of industry development		*	D. Soremen	■	■				M/H	M/H
7. Timing of fishing		*							H	H
<b>ENVIRONMENT</b>										
1. Oceanography/shelf – bathymetric survey		*							H	M
2. Site survey/food availability/density		*							L	M/H
3. Environmental impact/monitoring ESD	*		FWA	■	■				H	H
4. Remote sensing		*							M/H	L
5. External Threats, pollution, bio-invasion, red tides, contaminants		*							L/M	M
<b>ABALONE HEALTH</b>										
1. Fish health and diagnostics		*	FWA	■	■	■	■	■	L/M	L/M
2. Disease survey/atlas									L/M	L/M
3. Translocation/protocol	*		FWA, I						L	L
4. Contingency plan		*	FWA, I						M	M

Project	Pre-2000	Gap		Res Group	00/01	01/02	02/03	03/04	04/05	Priority		
										G/B	Roe's	
<b>EDUCATION AND TRAINING</b>												
1. Public awareness / interest groups	*	*									M	M
2. Biological training / scientific methods		*									M	M
<b>MARKET</b>												
none												
<b>ASSOCIATED R &amp; D</b>												
none												

Project Status Key

- ✓ Complete
- Committed
- Proposed but not approved/committed

Research Group Key

- FWA WA Government
- AIMS Commonwealth Government
- CSIRO Commonwealth Government
- CRC Cooperative Research Centre (TAS)
- I WA Industry
- Y Yet to be determined

Priority Key

- H = High
- M = Medium
- L = Low
- n/a