

**ABALONE RESOURCE OF
WESTERN AUSTRALIA
DRAFT HARVEST STRATEGY
2016 – 2021**

DRAFT

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1 INTRODUCTION

Harvest strategies for aquatic resources managed by the Western Australian Department of Fisheries (the Department) are formal documents prepared to support the decision-making processes required to ensure the management of these resources are consistent with the principles of Ecologically Sustainable Development (ESD). The objectives of ESD are reflected in the objects of the *Fish Resources Management Act 1994* (FRMA), Section 3, and the draft *Aquatic Resources Management Bill 2015*, Clause 9, which will replace the FRMA once enacted.

The publication of these strategies is intended to make the decision-making considerations and processes for the management of specified aquatic resources publicly transparent and provide a basis for informed dialogue on management actions with resource users and other stakeholders.

These strategies provide guidance for decision-makers, but do not derogate from or limit the exercise of discretion required for independent decision-making under the FRMA by either the Minister for Fisheries, the Chief Executive Officer of the Department of Fisheries or other delegated decision-makers in order to meet the objects of the FRMA.

Harvest strategies make explicit the objectives, performance indicators, reference levels, and harvest control rules for each defined ecological asset taken into consideration by the Department when preparing advice for the Minister for Fisheries. They also indicate the scope of management actions required in relation to the status of each resource in order to meet the specific long- and short-term management objectives for the resource and the broader goals of the ESD strategy.

1.1 Review Process

It is recognised that fisheries change over time and that a review period should be built into each harvest strategy to ensure that it remains relevant. This harvest strategy will remain in place for a period of five (5) years, after which time it will be fully reviewed; however, the document may be subject to further review and amended as appropriate within the five year period.

2 SCOPE

This harvest strategy relates to the abalone resource of Western Australia and the fishing activities that impact this resource. Three species; Roe's abalone (*Haliotis roei*), Greenlip abalone (*H. laevigata*) and Brownlip abalone (*H. conicopora*), are targeted by recreational and commercial fishers through hand collection by wading and diving in shallow waters off the south-western and southern coasts of Western Australia. Although the commercial Abalone Managed Fishery, which is divided into eight spatial management areas, covers all coastal state waters between the Northern Territory and the South Australian borders, fishing

effort is currently focused in areas south of Moore River (Figure 1). The abalone recreational fishery is divided into three zones (Figure 2), with the majority of fishing effort focused on Roe's abalone in the Perth metropolitan area (Zone 1).



Figure 1. Boundaries and management areas of the commercial Abalone Managed Fishery in Western Australia. The Greenlip/Brownlip fishery operates in Areas 1-4 and the Roe's fishery operates in Areas 1, 2, 5, 6, 7 and 8



Figure 2. Boundaries of the three zones within the abalone recreational fishery in Western Australia; the Western Zone (Zone 1), the Northern Zone (Zone 2) and the Southern Zone (Zone 3).

This strategy has been developed in line with the Department's over-arching *Harvest Strategy Policy for Aquatic Resources* (Department of Fisheries 2015a) and relevant national policies / strategies (ESD Steering Committee 1992) and guidelines (e.g. Sloan et al. 2014). In addition to considering fishing impacts on the target species (i.e. Roe's, Greenlip and Brownlip abalone), it also considers bycatch¹, endangered, threatened and protected (ETP) species, habitats and other ecological components to ensure any risks to these elements are managed effectively.

This document has been developed via a consultative process with industry members and has been approved by the Director General of the Department of Fisheries and the Minister for Fisheries.

2.1 Environmental Context

Abalone occur along the south-western and south coast of Western Australia, from Shark Bay to the South Australian border, although the different species are not uniformly distributed throughout this range. Roe's abalone are targeted in the West Coast and South Coast Bioregions, whilst Greenlip and Brownlip abalone are most abundant in the South Coast Bioregion. Both bioregions have a Mediterranean climate, with most rainfall occurring during the winter months and relatively warm water temperatures due to the influence of the southward-flowing Leeuwin Current. From a global perspective, the coastal waters of these regions are characterised by low levels of nutrients and high species diversity, including a large number of endemic species.

The West Coast Bioregion is characterised by exposed sandy beaches and a limestone reef system that creates surface and subsurface reef lines, typically around five kilometres off the coast. The South Coast Bioregion is a high energy environment, heavily influenced by large swells generated in the Southern Ocean. The marine habitats of the South Coast Bioregion are characterised by fine, clear sand seafloors interspersed with granite outcrops, limestone shoreline platforms and subsurface reefs.

2.2 Target Species – Roe's, Greenlip and Brownlip Abalone

Abalone are shelled marine gastropods of the family Haliotidae, which occur on intertidal reef platforms and adjoining subtidal reefs in waters down to 40 m depth. Roe's abalone are most abundant on the south-western coast of Western Australia and grow to around 70-100 mm, whilst Greenlip and Brownlip abalone occur mainly off the southern coast of the state and grow to a much larger size of 160-200 mm.

Abalone are broadcast spawners and each species comprise small, spatially disaggregated populations within a broader overall meta-population structure. There is large spatial

¹ *Bycatch* is described as the part of the catch which is returned to the sea (usually referred to as non-retained or discarded) either because it has no commercial value or because legislative requirements preclude it being retained.

heterogeneity in the growth of abalone, which is accounted for in the harvest strategy for this resource.

2.3 Fishing Activities

2.3.1 Governance

Abalone in Western Australia are targeted by commercial, recreational and customary fishing sectors. These fishing sectors are managed by the Department of Fisheries under the following legislation:

- *Fish Resources Management Act 1994* (FRMA, will be replaced by Aquatic Resources Management Bill once enacted);
- *Fish Resources Management Regulations 1995* (FRMR);
- FRMA Part 6 — *Abalone Managed Fishery Management Plan 1992*; and
- FRMA Section 43 Order — *Prohibition on Taking Abalone (North of Moore River) Order 2011*.

Fishers must also comply with the requirements of the:

- Commonwealth EPBC Act;
- *Western Australian Marine Act 1982*;
- *Western Australian Wildlife Conservation Act 1950*; and
- *Western Australian Conservation and Land Management Act 1984*.

2.3.2 Commercial Fishing

A commercial hand collection fishery for abalone has been operating in Western Australia since the 1960s and it is one of the most valuable fisheries in the state. Roe's, Greenlip and Brownlip abalone are caught in the Abalone Managed Fishery by divers operating from small vessels, generally less than nine metres in length, and using surface supplied breathing apparatus (hookah). Divers use a hand-held abalone 'iron' to prise individual abalone off the substrate.

The commercial fishery is managed primarily through output controls in the form of annual quotas for each of the management areas in the fishery (see Figure 1). Annual commercial catches of Greenlip and Brownlip abalone have remained relatively stable at around 170 and 30 tonnes, respectively, since the 1990s. The annual commercial catch of Roe's abalone has typically fluctuated around 100 tonnes over the history of the fishery, although recent catches have been lower since a marine heatwave in 2011 caused large-scale mortalities of this species in the northern parts of its geographical range.

Due to the highly selective nature of the fishing method, bycatch and interactions with endangered, threatened and protected species are negligible. Any impacts on habitats through anchoring or divers are also considered negligible risk.

2.3.3 Recreational Fishing

Recreational fishers in Western Australia catch abalone through wading, snorkelling and diving. The main focus for the recreational abalone fishery is the Perth metropolitan stocks of Roe's abalone (Zone 1, see Figure 2), with recreational fishers landing around 41 % of the total catch of this species in Western Australia in 2014 (15-25 tonnes in the metropolitan area and 14 tonnes in the remainder of the state) (Hart et al. 2015a). The recreational take of Greenlip and Brownlip abalone off the southern coast is much smaller at around 8 tonnes, which represents approximately 3 – 4 % of the total catch of these two species (Hart et al. 2015b).

The recreational abalone fishery in Western Australia is managed under a mix of input and output controls, including bag and size limits. Recreational abalone fishers are required to hold a current recreational abalone fishing licence, with more than 16,000 issued for the 2014 fishing season (Hart et al. 2015a, b). To control catches of Roe's abalone in the densely populated Perth metropolitan area, the recreational abalone fishing season in this region is open for a total of only 5 hours each year, and is subject to a series of catch limiting rules including bag limits. An in-season harvest control rule currently limits catch to a pre-defined level based on sustainability assessments; this level was 20 tonnes for the 2015 season.

2.3.4 Customary Fishing

Although there is no quantitative information available on the customary catch of abalone in Western Australia, there is evidence available that indicates Indigenous people have traditionally taken abalone for food and continue to do so (Department of Fisheries 2005). Based on available data on the Indigenous proportion of the population inhabiting coastal areas in the south-western regions of the state, however, customary catches of abalone are likely to be negligible.

2.4 Catch-Share Allocations

Historically, the abalone resource of Western Australia has been fished by commercial and recreational sectors without any explicit catch share allocation between sectors. In 2005, a formal sectoral allocation process known as Integrated Fisheries Management (IFM) was initiated to define and assign long-term sectoral shares of the permitted catch of abalone (Department of Fisheries 2005). Based on historical data on commercial and recreational catches, the Integrated Fisheries Allocation Advisory Committee (IFAAC) recommended that sectoral allocations for the abalone resource should consider only Roe's abalone in the Perth metropolitan area due to its high relative importance within the overall recreational abalone fishery and the availability of recreational catch information from this area (IFAAC 2009).

As part of the typical IFM process, an overall sustainable harvest level (SHL) for the resource is set annually and used to recommend catch levels for each sector based on the proportional allocations of the recommended total catch level for the year. However, due to a limited understanding of the relationship between abalone on the platform habitats (targeted by recreational fishers) and the sub-tidal habitats (targeted mainly by commercial fishers), IFAAC did not recommend an immediate introduction of proportional management of Roe's abalone within an overall SHL (IFAAC 2009).

In the absence of proportional allocations, the recreational catch of Roe's abalone in the Perth metropolitan area (Zone 1) has been managed to an average annual catch target of 40 tonnes in conjunction with the commercial long-term SHL of 36 tonnes (see Section 3.4.1). Subject to recent concerns over environmental impacts on Roe's abalone stocks in this area, daily bag limits were reduced in 2014 so that metropolitan recreational catches are now managed to a catch target of 20 tonnes, which is controlled by an in-season catch prediction model. If the model predicts that catch is > 14 tonnes after the first three hours of the five-hour recreational fishing season, the season will be shortened by one hour to ensure the 20 tonne target is met.

3 HARVEST STRATEGY

3.1 Long-term Objectives

In addition to ensuring the biological sustainability of all captured aquatic resources, this harvest strategy includes broader ecological objectives for each relevant ecosystem component, as well as social and economic objectives for each fishery as a whole. It is important to note that the social and economic objectives are applied within the context of ESD.

3.1.1 Ecological Sustainability

- 1) To maintain spawning stock biomass of each target species (i.e. Roe's, Greenlip and Brownlip abalone) at a level where the main factor affecting recruitment is the environment;
- 2) To ensure fishing impacts do not result in serious or irreversible harm² to bycatch species populations;
- 3) To ensure fishing impacts do not result in serious or irreversible harm to endangered, threatened and protected (ETP) species populations;
- 4) To ensure the effects of fishing do not result in serious or irreversible harm to habitat structure and function; and

² Serious or irreversible harm relates to a change caused by the fishery that fundamentally alters the capacity of the component to maintain its function or to recover from the impact.

- 5) To ensure the effects of fishing do not result in serious or irreversible harm to ecological processes.

3.1.2 Economic and Social Benefits

- 1) To provide flexible opportunities to ensure fishers can maintain or enhance their livelihood, within the constraints of ecological sustainability; and
- 2) To provide fishing participants with reasonable opportunities to maximise cultural, recreational and lifestyle benefits of fishing, within the constraints of ecological sustainability.

3.2 Operational Objectives

Long-term management objectives are typically operationalised as short-term (e.g. annual) fishery-specific objectives through one or more performance indicators that can be measured and assessed against pre-defined reference levels so as to ascertain actual performance. Thus, within the context of the long-term objectives provided above, each fishery (commercial and recreational) has operational objectives to maintain each resource / component above the threshold level (and, where relevant, close to the target level), or rebuild the resource if it has fallen below the threshold or the limit levels.

3.3 Harvesting and Management Approaches

The harvest strategy for the abalone resource of Western Australia is based on a *constant exploitation approach*, where the annual catch varies in proportion to variations in stock abundance. The overarching tool to implement this harvest strategy is a weight-of-evidence approach designed to ensure catches are at the appropriate level to maintain constant exploitation. In principle this approach requires the use of multiple lines of evidence to assess stock status. These lines of evidence can include trends in catch, catch distribution, catch rates, vulnerability assessments, size and/or age composition, fishing mortality, and fishery recruitment and abundance indices. In practice, a primary performance indicator is specified that can be assessed against reference levels and defined harvest control rules (see Section 3.4), and this is assisted by the various other lines of evidence, depending on the species and fishery.

In line with this approach, the commercial Abalone Managed Fishery is managed primarily through output controls in the form of Total Allowable Commercial Catches (TACCs), set annually for each management area (see Figure 1) and allocated to licence holders as Individually Transferable Quotas (ITQs). The TACCs are set each year based on the state of resource relative to species- and area-specific reference levels (see below for more detail).

Recreational fishing for abalone is managed under a mix of input and output controls, including bag and size limits, and temporal and spatial closures. Recreational abalone fishers are required to hold a current recreational abalone fishing licence. The recreational fishery for Roe's abalone in the Perth metropolitan area is currently managed to a Total Allowable Recreational Catch (TARC). Additionally, a catch prediction model that uses environmental

data and access point census information from recreational fishing surveys is used to manage the length of the abalone season in order to achieve the desired catch target. The desired catch target is currently 20 tonnes, and if the model predicts that catch is > 14 tonnes after the first three hours (of the five-hour recreational fishing season), the season will be shortened by one hour to ensure the current 20 tonne target is met.

3.4 Performance Indicators, Reference Levels and Control Rules

The commercial abalone fishery has been managed under performance indicators and control rules for since 2005 (Hart et al. 2009). Suitable indicators (e.g. species- and area-specific standardised catch rates) have been selected to describe performance of the abalone fishery in relation to each management objective, with a set of reference levels established to separate acceptable from unacceptable performance. Where relevant, these levels include:

- A target level (i.e. where you want the indicator to be);
- A threshold level (i.e. where you review your position); and
- A limit level (i.e. where you do not want the indicator to be).

The associated control rules define what management actions should occur in relation to the value of each indicator approaching or crossing the limit, threshold or target levels. A summary of the current management objectives, performance indicators, reference levels and control rules for the resource is provided in Table 3.

3.4.1 Target Species Stocks

The primary performance indicator used to evaluate the status of the abalone resource in Western Australia is a three-year moving average of standardised commercial catch rates of each target species (i.e. Roe's, Greenlip and Brownlip abalone) in their relevant management areas. In the absence of direct estimates of total biomass, these commercial catch rates are considered to represent adequate proxies for relative abundance of the stocks. The catch rate units differ among the three species due to the differences in the nature of their fisheries and the history of data collection.

Reference levels for each of the three abalone species in their relevant management areas have been determined based on specified reference periods of stability in the commercial fishery (see Table 1). For Roe's abalone in Area 7, reference levels have been calculated using an index of spawning biomass derived from fishery-independent surveys in this area during the reference period (1997-2010). Specifically, these (fishery-independent) data were used to calibrate the fishery-dependent performance indicator (i.e. the commercial catch rate) for Roe's abalone in all relevant management areas to unfished levels, based on data collected from marine protected areas during the same reference period (1997-2010). Area-specific target, threshold and limit reference levels that correspond to catch rates at 40%, 30% and 20% of unfished stock levels, respectively, were determined.

Table 1. Species-specific reference periods used for setting up appropriate harvest strategy reference levels for the abalone resource

Species	Reference period	Justification
Roe's abalone	1997-2010	Period prior to marine heatwave event for which fishery-independent survey data in Area 7 are available. Note that the same reference period is applied across all other management areas for Roe's abalone.
Greenlip abalone	1992-2006	As described by Hart et al. (2009).
Brownlip abalone	2000-2014	Period prior to TACC change in 2015 for which fishery-dependent data for this species are considered most reliable.

As fishery-independent data available for Greenlip and Brownlip abalone are less extensive than those for Roe's abalone, reference levels for these species have been determined from values of the commercial catch rates observed in each relevant management area during their reference periods (1992-2006 for Greenlip abalone and 2000-2014 for Brownlip abalone). Based on the data showing that the fisheries were operating at sustainable levels during these reference periods (i.e. recruitment was not impaired), threshold reference levels for each species have been set as the lowest catch rate observed in each management area (assuming this level corresponds to catch rates at 30% of unfished stock levels). Associated target (40%) and limit (20%) reference level were then determined.

For each of the three abalone species and their relevant management areas, a long-term commercial sustainable harvest level (SHL; also referred to as a sustainable TACC) has been calculated as the average catch of the species in that area over the reference period (Table 2). The long-term SHLs are applied in the annual process for recommending the harvest levels used for setting the TACC each year, in response to the status of the abalone resource relative to the specified reference points. As specified by the control rules in the abalone harvest strategy, an annual SHL for each target species and management area is determined as a percentage of the long-term SHL, based on the value of the performance indicator relative to the specified (target, threshold and limit) reference levels for that species/area (see Figure 3).

When the performance indicator in an area falls below the target reference level, the extent to which the SHL for the following year will be reduced is reflective of how far the indicator has fallen from the target level (see Figure 3). This allows for a precautionary approach to management, with reductions to catches addressed in a timely manner to minimise the risk of the indicator reaching the limit reference point. If an indicator falls below the limit level, a more stringent management response will be implemented, with the SHL set to 0 – 50% of the long-term SHL (i.e. potentially fully closing that area to fishing).

If the performance indicator increases beyond the target level, the control rule allows for an increase in SHL above the long-term SHL (Figure 3). The exact levels of the increase are usually determined via the weight-of-evidence approach for assessing species in each area, using all available information. As an example, in the particular case of the Area 7 Roe's

abalone fishery, extra evidence on future stock abundance is obtained from a stock prediction and TAC allocation model currently being developed (see Section 6.1). This model is usually applied when the performance indicator is above the target level, but as a consequence of its unique predictive capacity, it can also be used to inform decisions on sustainable harvest levels when performance indicators are below target and threshold levels. It uses evidence from annual recruitment surveys of Age 1+ animals, combined with the average summer sea surface temperature (i.e. January – March) during the four-year period in which the Age 1 cohort grows to harvest size, to predict the availability of harvest size stock (density of abalone ≥ 71 mm in length) in the target year. Such a model is only possible in Area 7 because it has a 20 year time series trend of fishery-independent survey data at both fished and unfished sites.

Table 2. Species- and area-specific long-term commercial sustainable harvest levels (SHLs) used within the harvest control rules for the abalone resource in Western Australia

Species	Area	Long-term SHL
Roe's abalone	2	19.8 tonnes (whole weight)
Roe's abalone	5	20 tonnes (whole weight)
Roe's abalone	6	12 tonnes (whole weight)
Roe's abalone	7	36 tonnes (whole weight)
Roe's abalone	8	12 tonnes (whole weight)
Greenlip abalone	2	30 tonnes (meat weight)
Greenlip abalone	3	35 tonnes (meat weight)
Brownlip abalone	2	7 tonnes (meat weight)
Brownlip abalone	3	6 tonnes (meat weight)

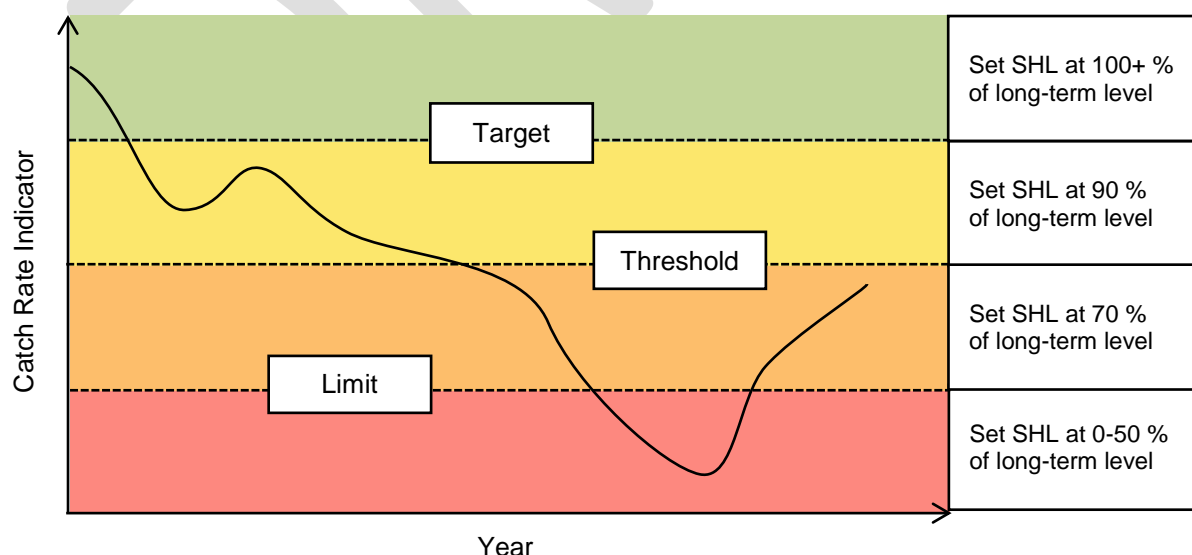


Figure 3. Schematic of how the harvest control rules are applied to managing the abalone resource of Western Australia.

3.4.1.1 Tolerance Levels

Given the highly dynamic nature of fisheries it is important to define the level of tolerance around performance indicators and/or control rules to minimise unnecessary management intervention (Department of Fisheries 2015a). Tolerance in the abalone harvest strategy is incorporated through the use of a three-year moving average of the standardised catch rate performance indicator for monitoring stock status. This enables a better estimate of the trend of the time series and removes the variation associated with annual variation that may be driven by environmental or other conditions (Hart et al. 2009).

Whilst the commercial catch rates are used as the primary indicator to guide management, other available information (e.g. fishery-dependent and fishery-independent data on abalone size compositions and densities) incorporated into the overall weight-of-evidence assessment of the abalone resource (see Section 3.5.2.1) will also be considered in all decision making. Final research advice on harvest levels presents an integration of all relevant findings, including the outcomes of the harvest control rules, and the indications from the weight-of-evidence approach to stock assessments.

3.4.2 Risk Assessments

Other relevant ecological assets incorporated in this harvest strategy include bycatch, ETP species, habitats and ecosystem processes. The impacts of fishing activities on each of these assets varies by fishing sector, with separate performance indicators and reference levels determined for the commercial and recreational sectors, where required.

Due to a lack of reliable quantitative information, reference levels for these ecological assets have been set to differentiate acceptable fishery impacts from unacceptable fishery impacts according to the risk levels defined in Fletcher (2012).

3.4.3 Economic and Social Benefits

In line with the principles of ESD, this harvest strategy also includes objectives for the economic and social amenity benefits of fishing for the commercial and recreational fishing sectors. These objectives relate to the provision of opportunities to ensure (1) commercial fishers can maintain / enhance their livelihood and (2) that all fishers can maximise cultural, recreational and / or lifestyle benefits of fishing. It is important to note that management actions relating to these objectives are applied within the constraints of ecological sustainability.

The economic and social objectives for the commercial and recreational abalone fishery do not currently have explicit performance measures within the harvest strategy. Rather, it is through formal consultation processes that regulatory impediments to maintaining or enhancing economic return, and maximising social benefits of fishing, are discussed. Where possible, and in due consideration of ecological sustainability, fisheries management arrangements can be adjusted or reformed to help meet these objectives.

Once suitable and measurable indicators for monitoring performance against the economic and social objectives have been identified, these will be included in future revisions of this harvest strategy.

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Table 3. Harvest strategy reference levels and control rules for the abalone resource and associated assets that may be impacted by fishing activities undertaken by commercial and recreational fishing sectors while targeting abalone in Western Australia

Component	Management objectives	Resource / Asset	Performance Indicators	Reference Levels	Control Rules
Ecological					
Target Species	To maintain spawning stock biomass of each target species at a level where the main factor affecting recruitment is the environment.	Roe's abalone Greenlip abalone Brownlip abalone	Three-year moving average of the standardised catch rate in each relevant management area	<p>Target:</p> <p>Roe's abalone (kg whole weight/hr): Area 2- 13.3, Area 5- 11.8, Area 6- 11.8, Area 7 – 20.8, Area 8- 12.7</p> <p>Greenlip abalone (kg meat weight/hr): Area 2- 14.4, Area 3- 13.2</p> <p>Brownlip abalone (kg meat weight/day): Area 2- 19.4, Area 3- 9.8</p> <p>Threshold:</p> <p>Roe's abalone (kg whole weight/hr): Area 2- 10.0, Area 5- 8.9, Area 6- 8.9, Area 7 – 15.6, Area 8- 9.5</p> <p>Greenlip abalone (kg meat weight/hr): Area 2- 10.8, Area 3- 9.9</p> <p>Brownlip abalone (kg meat weight/day): Area 2- 14.6, Area 3- 7.3</p>	<p>1. If the performance indicator is \geq the Target, set SHL to long-term level (or above this level when indicator is well above the Target level).</p> <p>2. If the performance indicator is $<$ the Target and \geq the Threshold, set SHL at 90 % of long-term level.</p> <p>3. Area 7 Roe's abalone. Set SHL as a function of stock abundance using predictive model (see Section 6.1). This control rule is in the developmental stage, and is used in tandem with existing rules, rather than as a stand-alone rule.</p> <p>If the performance indicator is $<$ the Threshold and $>$ the Limit, set SHL at 70 % of long-term level.</p>

Component	Management objectives	Resource / Asset	Performance Indicators	Reference Levels	Control Rules
				<p>Limit:</p> <p>Roe's abalone (kg whole weight/hr): Area 2- 6.7, Area 5- 5.9, Area 6- 5.9, Area 7 – 10.4, Area 8- 6.3</p> <p>Greenlip abalone (kg meat weight/hr): Area 2- 7.2, Area 3- 6.6</p> <p>Brownlip abalone (kg meat weight/day): Area 2- 9.7, Area 3- 4.9</p>	If the performance indicator is ≤ the Limit, set SHL at 0-50 % of long-term level.
Bycatch (non-ETP) species	To ensure fishing impacts do not result in serious or irreversible harm to bycatch species populations.	All (non-ETP) bycatch species (i.e. piggyback species ³)	Periodic risk assessments incorporating current management arrangements, catch levels, species information and available research	<p>Target: Fishing impacts are considered to generate an acceptable level of risk to all bycatch species' populations, i.e. moderate risk or lower.</p> <p>Threshold: Fishing impacts are considered to generate an undesirable level of risk to any bycatch species' populations, i.e. high risk.</p>	<p>Maintain current management arrangements.</p> <p>A review is triggered to investigate the reasons for the variation. If sustainability is considered to be at risk, appropriate management action will be taken to reduce the risk to an acceptable level.</p>

³ Commensal organisms that use the shell of abalone as substrate, e.g. coralline algae, sponges and small invertebrates

Component	Management objectives	Resource / Asset	Performance Indicators	Reference Levels	Control Rules
				<p>Limit: Fishing impacts are considered to generate an unacceptable level of risk to any bycatch species' populations, i.e. severe risk</p>	<p>Implement management strategies to reduce the risk to an acceptable level.</p>
Endangered, threatened and protected (ETP) species	To ensure fishing impacts do not result in serious or irreversible harm to endangered, threatened and protected (ETP) species populations.	All ETP species	Periodic risk assessments incorporating current management arrangements, number of reported interactions, species information and available research	<p>Target: Fishing impacts expected to generate an acceptable risk level to ETP species' populations, i.e. moderate risk or lower.</p> <p>Threshold Fishing impacts are considered to generate an undesirable level of risk to any ETP species' populations, i.e. high risk.</p> <p>Limit: Fishing impacts are considered to generate an unacceptable level of risk to any ETP species' populations, i.e. severe risk.</p>	<p>Maintain current management arrangements</p> <p>A review is triggered to investigate the reasons for the variation. If sustainability is considered to be at risk, appropriate management action will be taken to reduce the risk to an acceptable level.</p> <p>Implement appropriate management strategies to reduce the risk to an acceptable level.</p>
Habitats	To ensure the effects of fishing do not result in serious or irreversible harm to habitat structure and function	Rocky reef Macroalgae Seagrass Sponge gardens	Periodic risk assessments incorporating current management arrangements, extent of fishing activities, habitat distribution and	Target: Fishing impacts are considered to generate an acceptable level of risk to all benthic habitats, i.e. moderate risk or lower.	Maintain current management arrangements.

Component	Management objectives	Resource / Asset	Performance Indicators	Reference Levels	Control Rules
		Corals	available research.	<p>Threshold: Fishing impacts are considered to generate an undesirable level of risk to any benthic habitats, i.e. high risk.</p> <p>Limit: Fishing impacts are considered to generate an unacceptable level of risk to any benthic habitats, i.e. severe risk.</p>	<p>A review is triggered to investigate the reasons for the variation. If sustainability is considered to be at risk, appropriate management action will be taken to reduce the risk to an acceptable level.</p> <p>Implement management strategies to reduce the risk to an acceptable level.</p>
Ecosystem	To ensure the effects of fishing do not result in serious or irreversible harm to ecological processes	Trophic interactions Community structure	Periodic risk assessments incorporating current management arrangements, catch levels, extent of fishing activities, ecosystem information and available research.	<p>Target: Fishing impacts are considered to generate an acceptable level of risk to ecological processes within the ecosystem, i.e. moderate risk or lower.</p> <p>Threshold: Fishing impacts are considered to generate an undesirable level of risk to any ecological processes within the ecosystem, i.e. high risk.</p>	<p>Maintain current management arrangements.</p> <p>A review is triggered to investigate the reasons for the variation. If sustainability is considered to be at risk, appropriate management action will be taken to reduce the risk to an acceptable level.</p>

Component	Management objectives	Resource / Asset	Performance Indicators	Reference Levels	Control Rules
				<p>Limit: Fishing impacts are considered to generate an unacceptable level of risk to any ecological processes within the ecosystem, i.e. severe risk.</p>	<p>Implement management strategies to reduce the risk to an acceptable level.</p>

3.5 Monitoring and Assessment Procedures

3.5.1 Information and Monitoring

3.5.1.1 Commercial Fishing Information

3.5.1.1.1 Commercial Catch and Effort Reporting

There is a statutory obligation for fishers in the Abalone Managed Fishery to provide records of catch and effort information by 10 x 10 mile statistical reporting blocks in a daily logbook. Information recorded includes species catches (weight and numbers), effort (dive hours or minutes fished), statistical reporting block, and location of fishing. As a result of the constraints of diving to avoid decompression illness, the estimates of effort derived from the daily catch and effort logbook are highly accurate as they are dependent on pre-determined depth / time profiles which are consistent between divers and from year to year. These catch and effort data provide the basis for calculating the standardised catch rates that are used to inform the annual assessment of the abalone resource in Western Australia.

3.5.1.2 Recreational Fishing Information

3.5.1.2.1 Recreational Fishing Surveys

Estimates of recreational catch and effort for Roe's abalone are available from within the Perth metropolitan fishery, where field surveys are undertaken each year during the 5-hour fishing season. These estimates are based on information collected on average catch (weight and numbers), catch rates (derived from 1,000+ interviews), and fisher counts from shoreline vantage points and aerial surveys (Hancock and Caputi 2006).

A number of phone diary surveys of recreational abalone fisher licence holders have been undertaken (in 2004, 2006 and 2007) to provide estimates of fishing effort and the catches of Roe's, Greenlip and Brownlip abalone on a state-wide basis. More recently, surveys of all boat-based recreational fishing have been undertaken biennially in Western Australia to provide bioregional estimates of recreational catches, which include abalone. The information from these surveys complement the catch and effort data obtained in the annual Perth metropolitan surveys for Roe's abalone.

3.5.1.3 Fishery-Independent Information

3.5.1.3.1 Population Surveys

Fishery-independent population surveys are undertaken regularly in the different areas of the fishery to collect data on the size and density of abalone. These data provide information on recruitment, estimates of mortality and independent measures of abundance to compare to fishery-dependent catch rates for the different species.

Population surveys of Roe's abalone are undertaken annually at 13 indicator sites in the Perth metropolitan area; eleven that are fished and two that are located in areas where no fishing is

permitted. Surveys are carried out on two habitats, the reef platform and the sub-tidal habitat, which generally correspond to the recreational and commercial fisheries, respectively.

Surveys of Greenlip and Brownlip abalone along the southern coast are undertaken periodically at fixed sites throughout the fishery (86 sites in Area 2 and 131 sites in Area 3). Survey sites were selected on the basis of known stock distributions and range broadly in the level of productivity. Two main sub-areas (Arid in Area 2 and Augusta in Area 3) are surveyed annually (71 sites), while other areas are visited once every 2 - 3 years.

3.5.2 Assessment Procedures

3.5.2.1 Roe's, Greenlip and Brownlip Abalone

The stock status of Roe's, Greenlip and Brownlip abalone in Western Australia is assessed using a weight-of-evidence approach that considers all of the available (fishery-dependent and fishery-independent) information for this resource. This annual assessment of the abalone resource is primarily based on monitoring of standardised fishery-dependent catch rates of each species in their relevant management areas in the fishery.

Commercial catch rates for each species in their relevant management areas are calculated from the daily catch and effort data reported by commercial fishers in the daily logbooks. The catch rates are standardised using a generalised linear modelling (GLM) approach to account for the variables that influence the catching efficiency and abundance of abalone. To reduce the effects of annual fluctuations in abundance resulting from natural annual recruitment variability and account for one-off anomalous influences that may cause sharp turns in catch rate trajectories, a three-year moving average of the standardised catch rate index is used as the performance indicator. This is compared against the species- and area-specific reference points to determine the annual SHLs in accordance with the harvest control rules.

3.5.2.2 Risk Assessments

The Department uses a risk-based Ecosystem Based Fisheries Management (EBFM) framework to assess the impacts of fishing on all parts of the marine environment, including the sustainability risks of target species, bycatch, ETP species, habitats and the ecosystem. This framework has led the development of the periodic risk assessment process for the commercial and recreational abalone fishery in Western Australia, which is used to prioritise research, data collection, monitoring needs and management actions for these fisheries and to ensure that fishing activities in the state are managed both sustainably and efficiently.

In December 2015, an ecological risk assessment (ERA) workshop was held to assess the impacts of the commercial and recreational abalone fisheries in Western Australia. The workshop participants included representatives from the Abalone Industry Association of Western Australia (AIAWA), the Western Australian Fishing Industry Council (WAFIC), environmental groups, and the Department of Fisheries. The risk assessment framework applied during the workshop was based on the global standard for risk assessment and risk

management (AS/NZS ISO 31000), which has been adopted for use in a fisheries context (see Fletcher et al. 2002).

Four aspects were considered for the risk assessment: ecological sustainability, community well-being, external factors and governance (note only ecological sustainability is currently considered as part of this harvest strategy). Ecological components and associated issues were identified and scored for risk for both the commercial and recreational abalone fisheries (Webster et al. in prep.). The potential effects of the abalone fishing on bycatch, ETP species, habitat and ecosystem processes were all scored as negligible risk.

Risk assessments will be undertaken periodically (e.g. every 5 years) to reassess any current or new issues that may arise in the fishery; however, a new risk assessment can also be triggered if there are significant changes identified in fishery operations or management activities or controls that are likely to result in a change to current risk levels.

3.5.3 Reports and Publications

Information on the current status of Western Australian fisheries and aquatic resources is reported annually in the Department's *Status Reports of the Fisheries and Aquatic Resources of Western Australia: the State of the Fisheries* (e.g. Fletcher and Santoro 2015). Other comprehensive information on fisheries management and the findings and recommendations from research and monitoring activities are also regularly compiled and published in a number of publically-available documents¹, including:

- The Department's *Annual Report* to Parliament;
- The *Research, Monitoring, Assessment and Development Plan* (e.g. Department of Fisheries 2015b); and
- Fisheries Research Reports (FRRs), Fisheries Management Papers (FMPs), Fisheries Occasional Papers (FOPs) and peer-reviewed scientific journal articles. Examples for abalone include:
 - FRR No. 185: Performance indicators, biological reference points, and decisions rules for Western Australian abalone fisheries (*Haliotis sp.*): (1) Standardised catch per unit effort (Hart et al. 2009);
 - FMP No. 243: Future management of the metropolitan recreational Roe's abalone fishery (Department of Fisheries 2010);
 - FRR No. 241: Biology, history, and assessment of Western Australian abalone fisheries (Hart et al. 2013a); and
 - Stock enhancement in Greenlip abalone Part 1: long-term growth and survival (Hart et al. 2013b).

¹ Departmental reports are available at <http://www.fish.wa.gov.au/About-Us/Publications/Pages/default.aspx>

4 MANAGEMENT MEASURES AND IMPLEMENTATION

There are a number of management measures in place for the commercial Abalone Managed Fishery (Table 4) and the abalone recreational fishery (Table 5), which are currently used to implement the harvest strategy. If a performance indicator breaches a threshold or limit level and the control rules specify that management action is necessary, these controls can be amended as needed to ensure the fishery is achieving the management objectives; however, these do not preclude the consideration of other options.

4.1 Implementing Changes to the Management Arrangements

Decision-making processes can be triggered following the identification of new or potential issues as part of a risk assessment (generally reviewed every 3 – 5 years), results of research, management or compliance projects or investigations, monitoring or assessment outcomes (including those assessed as part of the harvest strategy) and / or expert workshops and peer review of aspects of research and management.

There are two main processes for making decisions about the implementation of management measures and strategies for the Abalone Managed Fishery:

- Annual decision-making processes that may result in measures to meet the short-term fishery objectives (driven by the control rules); and
- Longer-term decision-making processes that result in new measures and / or strategies to achieve the long-term fishery objectives (i.e. changes to the management system).

However, if there is an urgent issue, consultation with stakeholders may be undertaken to discuss the issue and determine appropriate management action, as needed.

4.1.1 Consultation

Management changes are generally given effect through amendments to legislation, such as the commercial fishery management plan, regulations and orders. These changes generally require the approval of the Minister for Fisheries. In making decisions relevant to fisheries, the Minister for Fisheries may choose to receive advice from any source, but has indicated that:

- 1) The Department is the primary source of management advice; and
- 2) Peak Bodies (WAFIC and Recfishwest) are the primary source of industry advice and representation.

The peak bodies are funded by Government under Service Level Agreements (SLA) to undertake their representation / advisory and consultation roles.

Table 4. Management measures and instrument of implementation for the commercial Abalone Managed Fishery in Western Australia

Measure	Description	Instrument
Licence Requirements	Operators must hold a Managed Fishery Licence to undertake commercial abalone fishing in WA. Licences are renewed annually.	Abalone Managed Fishery Management Plan
Species Restrictions	The Abalone Managed Fishery is limited to the collection of Roe's, Greenlip and Brownlip abalone.	Abalone Managed Fishery Management Plan FRMR
Size Limits	Minimum size for Roe's abalone is a shell length of 75 mm in Area 1, 70 mm in Area 7 and 60 mm in all other areas of the fishery.	Abalone Managed Fishery Management Plan FRMR
	Minimum size for Greenlip and Brownlip abalone is a shell width of 140 mm.	FRMR
Quota System	<p>The Fishery is divided into eight management areas.</p> <p>The Abalone Managed Fishery is managed via output controls in the form of a total allowable commercial catch (TACC), which is divided into individually transferable quota units for Roe's, Greenlip and Brownlip abalone within each management area on Abalone Managed Fishery Licences.</p> <p>Abalone quota units are currently distributed across areas 1-2 and 5-8 for Roe's abalone, and areas 1-4 for Greenlip and Brownlip abalone.</p> <p>The total number of permanent units for Roe's abalone is: Area 1 – 1980 units, Area 2 – 3600 units, Area 5 – 4000 units, Area 6 – 2400 units, Area 7 – 7200 units, and Area 8 – 6000 units.</p> <p>The total number of permanent units for Greenlip abalone is: Area 1 – 600 units, Area 2 – 6000 units, Area 3 – 7200 units, and Area 4 – 0 units.</p> <p>The total number of permanent units for Brownlip abalone is: Area 1 – 60 units, Area 2 – 1440 units, Area 3 – 800 units, and Area 4 – 0 units.</p>	Abalone Managed Fishery Management Plan
Temporal Restrictions	Roe's abalone fishing is prohibited in Area 7 on Saturday's, Sunday's and Public Holidays.	Abalone Managed Fishery Management Plan
Spatial Closures	Commercial fishing for Roe's abalone is not permitted between the North Mole at Fremantle and Trigg Island at any time.	Abalone Managed Fishery Management Plan
	Commercial fishing for Roe's abalone is not permitted on reef tops between Hillarys Boat Harbour and Cape Bouvard.	
	Western Australian waters north of Moore River are currently closed to fishing for Roe's abalone indefinitely.	<i>Prohibition on Taking Abalone (North of Moore River) Order 2011</i>

Table 5. Management measures and instrument of implementation for the abalone recreational fishery in Western Australia

Measure	Description	Instrument
Licence Requirements	Recreational abalone fishers in WA must hold a Recreational Abalone Licence to undertake recreational fishing for abalone in WA. Licences are able to be renewed annually.	FRMR
Species Restrictions	Recreational Abalone Licence holders are only permitted to collect Roe's, Greenlip and Brownlip abalone, and sea urchins.	FRMR
Size Limits	Minimum size for Roe's abalone is a shell width of 60 mm. Minimum size for Greenlip and Brownlip abalone is a shell width of 140 mm.	FRMR
Bag limits	The daily bag limits for recreationally caught abalone in WA are: - 15 Roe's abalone in Zone 1; - 20 Roe's abalone in Zones 2 and 3; and - 5 Greenlip and Brownlip abalone (combined).	FRMR
Temporal Closures	Recreational abalone fishing is open in Zone 1 between 0700 hours and 0800 hours on the first Sunday in January, February, March, November and December in any year. Recreational abalone fishing is open in Zones 2 and 3 between 1 October and 15 May.	FRMR
Spatial Closures	Abalone may not be taken from between the main Cottesloe Groyne and Rous Head, within 800 m of seaward and 200 m landward of high water mark. Western Australian waters north of Moore River are currently closed to fishing for Roe's abalone indefinitely.	FRMR <i>Prohibition on Taking Abalone (North of Moore River) Order 2011</i>

4.1.1.1 Commercial Sector Consultation

Under its SLA with the Department, WAFIC has been funded to undertake statutory consultation functions related to fisheries management plans and the facilitation of annual management meetings for licensed fisheries.

The FRMA requires the Minister to consult with affected parties when changes to a Part 6 management plan are being considered. In the case of the Abalone Managed Fishery, this includes all licence holders. Annual Management Meetings (AMM) between the Department, WAFIC and licence holders are generally held pre-season (end of January) and are used as the main forum to consult with stakeholders and licence holders on the management of the fishery. During these meetings, current and future management issues that may have arisen during the previous fishing season, and any proposed changes to the management plan, are discussed. Follow-up meetings may be held as required.

The Department also consults directly with the AIAWA and the West Coast Abalone Divers Association on specific commercial abalone management and operational issues.

4.1.1.1.1 TACC Setting Process

Monitoring and research results are presented to the AIAWA in briefings conducted by Departmental research staff during the season. These briefings provide the AIAWA with information such as current state of the stocks, abalone meat condition, etc. which is fed back to industry meetings whereby co-management can occur.

The annual TACC for the Abalone Managed Fishery is determined by the Director General (DG) of the Department through a consultative process that occurs at the end of the abalone fishing season from November to March each year (see Figure 4). Based on results from the annual assessments of Roe's, Greenlip and Brownlip abalone, preliminary advice on the recommended SHLs (for each species in their relevant management areas), and an industry consultation form, are developed by Departmental research staff and sent to abalone licence holders, the AIAWA and WAFIC for consultation. Following the receipt of this preliminary advice, AIAWA holds an industry meeting to discuss the research summary and determine the industry' view on the recommended SHLs for the coming season. Following this industry meeting, AIAWA advises the Department in writing of their recommended SHLs and any additional feedback as required. The Department's SHL recommendations are considered by the AIAWA and abalone industry more broadly at the AMM, along with co-management arrangements such as voluntary size limits and any fish-down arrangements.

Final recommendations on the SHL (from the Department's research division), along with the AMM and AIAWA positions on the recommendations, are then provided to the DG of the Department for consideration and a final determination. Once the final determination is made, the DG notifies AIAWA in writing through publication of a Notice of Determination¹, and licence renewals and season arrangements for the following year commence.

¹ <http://www.slp.wa.gov.au/statutes/subsiduary.nsf/Fisheriestexec?openpage>

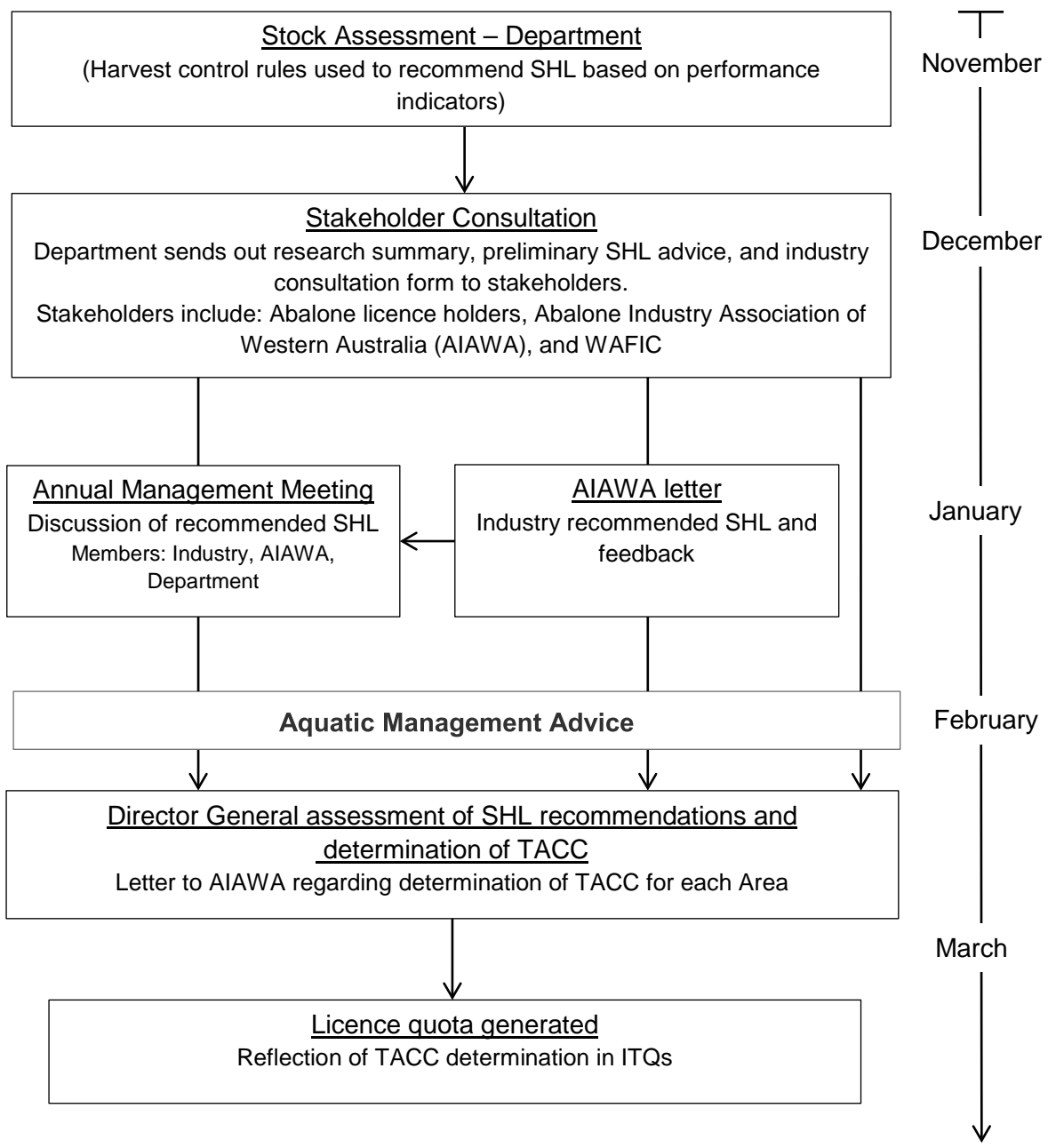


Figure 4. Annual TACC setting process for the commercial Abalone Managed Fishery

4.1.1.2 Recreational Sector Consultation

Under the SLA with Recfishwest, the Department is required to consult with Recfishwest as the recognised peak body for recreational fishing in Western Australia. Recfishwest is required to engage and consult with recreational fishers as necessary in order to meet its obligations.

4.1.1.3 Consultation with Other Groups

Consultation with non-fisher stakeholders including Government agencies, conservation sector Non-Government Organisations, customary fishers, statutory advisory committees and other affected / interested parties is undertaken by the Department in accordance with the

recently finalised departmental *Stakeholder Engagement Guideline* (in preparation for publication). The Department's approach to stakeholder engagement is based on a framework designed to assist with selecting the appropriate level of engagement for different stakeholder groups and includes collaborating with and involving key stakeholders, seeking input from interested parties through a public consultation process and keeping all parties fully informed through the provision of balanced, objective and accurate information. Key fishery-specific documents such as harvest strategies, recovery plans and bycatch action plans are subjected to both formal key stakeholder consultation and public consultation processes.

4.2 Compliance and Enforcement

The primary objective of the Department regarding compliance is to encourage voluntary compliance through education, awareness and consultation activities.

4.2.1 Operational Compliance Plans

Management arrangements (Table 4 and Table 5) are enforced under Operational Compliance Plans (OCP) with a specific plan developed for the Abalone Managed Fishery and a more general plan for the recreational fisheries. An OCP is informed and underpinned by a compliance risk assessment conducted for each fishery. The Abalone Managed Fishery OCP has the following objectives:

- To provide clear and un-ambiguous direction and guidance to Fisheries and Marine Officers for the yearly delivery of compliance in the fishery;
- To protect the fisheries' environmental values, while providing fair and sustainable access to the fishery's commercial and social values;
- To encourage voluntary compliance through education, awareness and consultation activities; and
- To provide processes which ensure that the fisheries are commercially viable in the international market yet environmentally sustainable in the local context.

The OCP is reviewed every 1-2 years.

4.2.1.1 Compliance Strategies for the Abalone Managed Fishery

Compliance strategies and activities that are used in the Abalone Managed Fishery include:

- Land and sea patrols;
- Inspections of abalone wholesale and retail outlets;
- Undertaking covert operations and observations;
- Inspections at abalone processing facilities;
- Inspection in port;
- At-sea inspection of fishing boats;

- Quota management;
- Aerial surveillance; and
- Intelligence gathering and investigations.

Inspections may involve:

- Inspection all compartments on board vessels;
- Inspection of all authorizations;
- Inspection of CDR book and associated paperwork; and
- Inspection of catch.

4.2.1.2 Compliance Strategies for the Abalone Recreational Fishery

Compliance strategies and activities that are used in the abalone recreational fishery include:

- Land and sea patrols (including inspections of vessels, catch and licences);
- Undertaking covert operations and observations; and
- Intelligence gathering and investigations.

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6 APPENDICES

6.1 Appendix 1. Harvest control rules for the Area 7 Roe's abalone commercial fishery

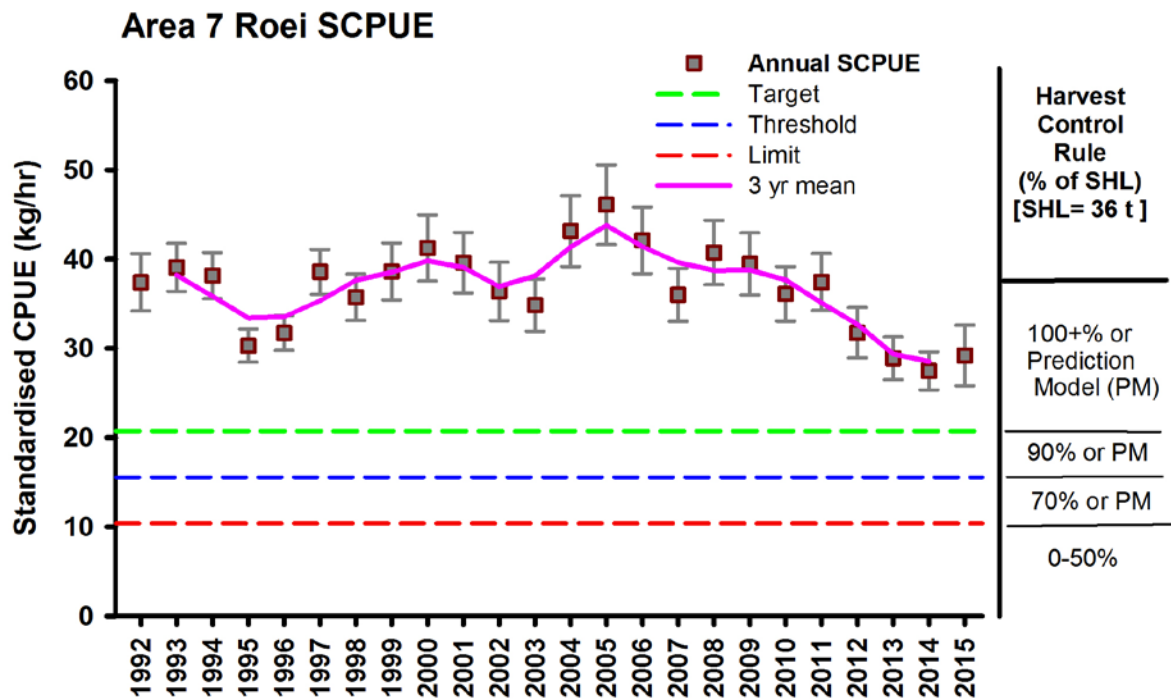


Figure 5. Harvest control rule for Roe's abalone in Area 7 of the Abalone Managed Fishery. SHL – Sustainable Harvest Level

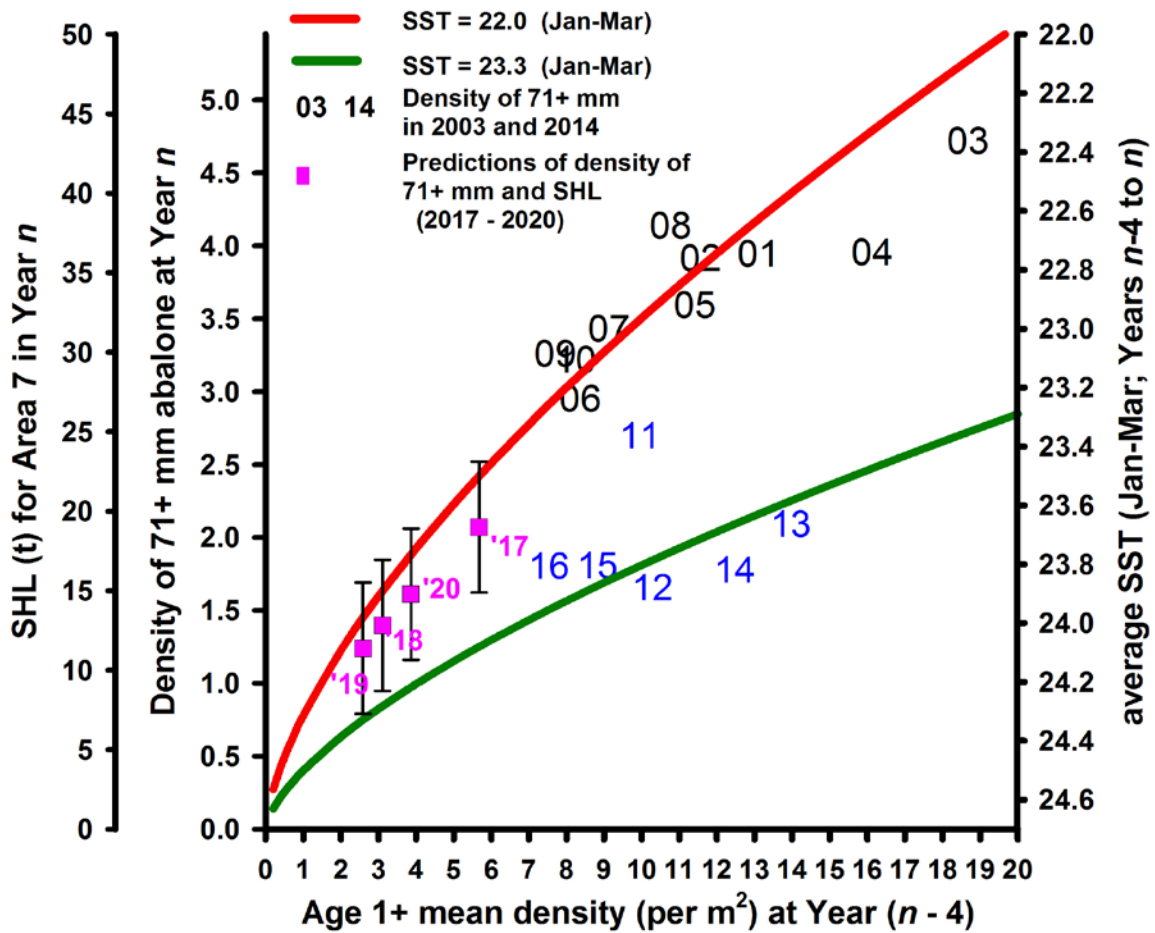


Figure 6. Prediction model and developmental harvest control rule for Roe's abalone in Area 7 of the Abalone Managed Fishery. This prediction model used in tandem with the main harvest control rule, as it is still being developed. It requires some years of accurate forecasts before being adopted as the primary rule. SHL – Sustainable Harvest Level, SST – sea surface temperature