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Abalone Resource of Western Australia: Harvest Strategy: 2021-2026 : Version 2.2

Department of Primary Industries and Regional Development, Western Australia

Department of
**Primary Industries and
Regional Development**

GOVERNMENT OF
WESTERN AUSTRALIA

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Western Australia.*

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**Abalone Resource of
Western Australia
Harvest Strategy**

2021-2026

Version 2.2

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Version Control

Version	Publication Series Title	Change Description	Date
1.0	Fisheries Management Paper No. 283	First published harvest strategy for WA abalone resource	January 2017
2.0	Fisheries Management Paper No. 283	Updated after first five-yearly review. Key changes include. Some structural changes and revised wording in the generic sections to ensure consistency with other harvest strategies.	September 2023
2.2	Fisheries Management Paper No. 283	Updated reference to the customary sector allocation of 500 kgs of Roe's abalone in the Perth metropolitan fishery, Minor administrative amendments.	October 2023

Contents

List of Acronyms

AIAWA	Abalone Industry Association of Western Australia
AMF	Abalone Managed Fishery
AMM	Annual Management Meeting
ARMA	*Aquatic Resources Management Act 2016*
CEO	Chief Executive Officer
DBCA	Department of Biodiversity, Conservation and Attractions
DG	Director General
DPIRD	Department of Primary Industries and Regional Development
EBFM	Ecosystem Based Fisheries Management
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
ERA	Ecological Risk Assessment
ESD	Ecologically Sustainable Development
ETP	Endangered, Threatened and Protected (species)
FRMA	*Fish Resources Management Act 1994*
FRMR	*Fish Resources Management Regulations 1995*
HCR	Harvest Control Rule
IFAAC	Integrated Fisheries Allocation Advisory Committee
IFM	Integrated Fisheries Management
ITQ	Individually Transferable Quota
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
NGO	Non-Government Organisation
OCP	Operational Compliance Plan
RECR	Recreational Effort Control Rule
RFBL	Recreational Fishing from Boat Licence
RRL	Recreational Reference Level
SA	South Australia
SCPUE	Standardised Catch Per Unit Effort
SHL	Sustainable Harvest Level
SST	Sea Surface Temperature
TAC	Total Allowable Catch
TACC	Total Allowable Commercial Catch

TARC	Total Allowable Recreational Catch
VFAS	Voluntary Fishery Adjustment Scheme
WA	Western Australia
WAFIC	Western Australian Fishing Industry Council
WARAF	WA Recreational Abalone Fishery
WCADA	West Coast Abalone Divers Association

1.0   Introduction

Harvest strategies for aquatic resources in Western Australia (WA) that are managed by the Department of Primary Industries and Regional Development (DPIRD, the Department) are formal documents that support decision-making processes and ensure these are consistent with the principles of Ecologically Sustainable Development (ESD; Fletcher 2002) and Ecosystem Based Fisheries Management (EBFM; Fletcher et al. 2012). The objectives of ESD are reflected in the objects of the *Fish Resources Management Act 1994* (FRMA) and the *Aquatic Resources Management Act 2016* (ARMA), which will replace the FRMA once enacted.

This harvest strategy has been developed and revised in line with the Department's Harvest Strategy Policy for Aquatic Resources (Department of Fisheries 2015) and is consistent with relevant national harvest strategy policies and guidelines (e.g. Sloan et al. 2014; Department of Agriculture and Water Resources 2018a, b). It makes explicit the performance indicators, reference levels, and harvest control rules designed to achieve the specific long- and short-term management objectives for the resource, and the broader goals of ESD and EBFM.

The publication of this harvest strategy 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 (Department of Fisheries 2015). The strategy provides guidance for decision-makers, but do not derogate from or limit the exercise of discretion required for independent decision-making by the Minister for Fisheries, the Chief Executive Officer (CEO) of DPIRD, or other delegated decision-makers in order to meet the objects of the FRMA or ARMA.

Consistent with the Department's Stakeholder Engagement Guideline (Department of Fisheries 2016), this harvest strategy has been subjected to informal and formal stakeholder consultation with industry members and peak commercial and recreational fishing sector bodies, as well as public consultation processes. It has been approved by the Minister for Fisheries.

1.1   Review Process

The WA Harvest Strategy Policy recognises that fisheries change over time and that a review period should be built into each harvest strategy to ensure that it remains relevant (Department of Fisheries 2015). This document replaces the first version of the harvest strategy for the WA abalone resource, which was successfully certified as sustainable by the globally recognised Marine Stewardship Council (MSC) in 2017. The strategy will remain in place for a period of five years, after which time it will again be fully reviewed.

- *This five-year period of this current document is 2021-2026.*

If required, however, this document may be subject to review and amended within this five-year period.

2.0 Scope

This harvest strategy relates to the abalone resource of WA 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 WA.

Although the commercial Abalone Managed Fishery (AMF), which is divided into eight spatial management areas, covers all coastal state waters between the Northern Territory and the South Australian (SA) borders, fishing effort is currently focused in areas south of Moore River (Figure 1). The WA Recreational Abalone Fishery (WARAF) is divided into three zones (Figure 2), with the majority of fishing effort focused on Roe's abalone in the Western Zone (Zone 1).

In addition to considering fishing impacts on the target species (i.e. Roe's, Greenlip and Brownlip abalone), this harvest strategy also covers impacts on any other retained, bycatch[1], endangered, threatened and protected (ETP) species, habitats and other ecological components, to ensure any risks to these elements are managed effectively. Note, that this harvest strategy currently only considers the impact on these ecological components by commercial fishing activities in the MSC certified AMF. Although this fishery is highly selective for the target species, some piggyback species attached to the shells of the abalone may be retained in small quantities (and discarded later).

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

Figure 1. Boundaries and management areas of the commercial Abalone Managed Fishery in WA. The fishery for Greenlip and Brownlip abalone operates in Areas 1 to 4 and the Roe's abalone fishery operates in Areas 1, 2, 5, 6, 7 and 8.

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

2.1   Environmental Context

Abalone occur along the south-west and south coast of WA, from Shark Bay to the SA 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 (Hart et al. 2017). 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 (Gaughan and Santoro 2021). 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 (Gaughan and Santoro 2021).

2.2   Target Species

Abalone are shelled marine gastropods of the family Haliotidae, which occur on intertidal reef platforms and adjoining subtidal reefs in coastal waters down to 40 m depth. Roe's abalone are most abundant on the south-western coast of WA and grow to around 70-100 mm in shell length, 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 (Hart et al. 2017). There is large spatial heterogeneity in the growth of abalone, which is accounted for by the harvest strategy through monitoring and assessing populations within each key management area.

Abalone are broadcast spawners and each species comprise small, spatially disaggregated populations within a broader overall meta-population structure. Recent genetic evidence indicates the existence of one single Greenlip abalone population along the WA coast but with five differentiated adaptive population clusters (Sandoval-Castillo et al. 2018), while for Roe's abalone a single meta-population (across the species distribution) with three differentiated adaptive population clusters (Sandoval-Castillo et al. 2015). These genetic studies have not been conducted on Brownlip abalone, however there is evidence to suggest this species is genetically similar to, and potentially considered conspecific with, Blacklip abalone (*Haliotis rubra*) (Brown and Murray 1992), which are distributed east from WA/SA border to northern New South Wales and Tasmania.

2.3   Fishing Activities

2.3.1 *Governance*

The abalone resource in WA is utilised by the commercial, recreational and customary fishing sectors, as well as the aquaculture sector. Although not an exhaustive list, these sectors are managed by the Department under the following key legislation:

- *Fish Resources Management Act 1994* (FRMA, will be replaced by the ARMA once enacted);

- *Fish Resources Management Regulations 1995* (FRMR);

- *Abalone Managed Fishery Management Plan 1992*; and

- *Prohibition on Taking Abalone (North of Moore River) Order 2011*.

Fishers must also comply with the requirements of:

- The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC);

- *Marine Safety (Domestic Commercial Vessel) National Law Act 2012*;

- Western Australian *Marine Act 1982*;

- Western Australian *Biodiversity Conservation Act 2016*;

- Western Australian *Conservation and Land Management Act 1984*; and

- Any other legislation governing the use of the marine environment in which fishing activities occur.

2.3.2 *Commercial Fishing*

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

The commercial AMF is managed primarily through output controls in the form of Total Allowable Commercial Catches (TACCs) set annually for each key species and relevant management areas in the fishery (see Figure 1). The annual commercial catch of Roe's abalone had fluctuated around 100 tonnes historically. Although catches have been lower since a marine heatwave in 2011 caused large-scale mortalities in the northern distribution of this species and commercial fishers have caught under the TACCs on the south coast, driven by economic reasons (low value of catch and few viable markets), high cost of accessing these areas and prevailing weather conditions (Strain et al. 2021a). Recovery of the Perth metropolitan Roe's

abalone fishery (Area 7 of the AMF and Zone 1 of WARAF) from historically low levels due to the heatwave was considered complete in 2019 (Strain et al. 2021a).

Annual commercial catches of Greenlip and Brownlip abalone were relatively stable at around 170 and 30 tonnes, respectively, between the 1990s and mid-2010's (Strain et al. 2021b). However, since then indicators for Greenlip abalone in Area 2 and 3 and Brownlip abalone in Area 2 have declined, therefore reductions in TACCs have occurred (Strain et al. 2021b).

2.3.3 *Recreational Fishing*

Recreational fishers in WA catch abalone through wading, snorkelling and diving. The focus for the WARAF is Roe's abalone in Zone 1 (see Figure 2, also referred to as the Perth metropolitan Roe's abalone fishery). In recent times, around 40 to 46 % of the total catch of this species in WA has been landed by the recreational sector (Strain et al. 2021a). The recreational take of Greenlip and Brownlip abalone off the southern coast is much smaller at around 8 tonnes, which historically represents approximately 3 – 4 % of the total catch of these two species (Strain et al. 2021b).

The WARAF 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, with more than 16,300 issued in 2019 (Strain et al. 2021a). To control catches of Roe's abalone in Zone 1, the recreational abalone fishing season in this region is open for a specific number of 1-hour sessions (generally between 4 – 5 hours annually), and is subject to a series of catch limiting rules including a Total Allowable Recreational Catch (TARC).

2.3.4 *Customary Fishing*

Although there is no quantitative information available on the customary catch of abalone in WA, 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, customary catches of abalone are likely to be negligible.

2.3.5 *Aquaculture*

In 2021, there were three abalone aquaculture farms currently operating on the south coast of WA: two marine-based and one land-based. These farms source broodstock from the commercial fishery. Production of cultured abalone from these farms is continuing to grow. Abalone aquaculture production has more than doubled in the past few years and future growth is expected with the expansion of existing farms and identification and development of additional sites.

2.4   Catch-Share Allocations

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 the availability of commercial and recreational catch information, the Integrated Fisheries

Allocation Advisory Committee (IFAAC) recommended that sectoral allocations for the abalone resource should consider only the Perth metropolitan Roe's abalone fishery (Area 7 of the AMF and Zone 1 of WARAF). Due to limited information on the relationship between Roe's abalone on the platform (targeted by recreational fishers) and the sub-tidal habitats (targeted mainly by commercial fishers), proportional allocations of catch to the two sectors within the Perth metropolitan area could not be achieved at that time (IFAAC 2009). As part of this process a formal allocation to the Customary sector of 500 kgs of Roe's abalone in the Perth Metropolitan fishery was included.

Since 2016, the proportional allocation of annual Roe's abalone catch between the commercial and recreational fishing sectors in the Perth metropolitan Roe's abalone fishery has been based on an improved understanding of the spatial distribution of biomass and fishing effort between habitats. It has been estimated that around 60% of spawning biomass resides in the subtidal zone, where all commercial fishing effort and approximately 17% of recreational fishing effort occurs. In contrast, the platform habitat contains 40% of the spawning biomass, which is targeted by 83% of recreational fishing effort.

In approving this Harvest Strategy, it is confirmed by the Department and the Minister for Fisheries that this is the appropriate method to allocate catch between the commercial and recreational fishing sectors in the Perth metropolitan Roe's abalone fishery into the future.

The current process for setting the annual TACC and TARC for Roe's abalone in Area 7 of the AMF and Zone 1 of the WARAF, respectively, is described in more detail in Section 3.4.2.2.

3.0   Harvest Strategy

The procedures used within this harvest strategy involve two interrelated decision-making processes. The first constitutes the formal review of targeted stocks and other ecological assets against defined reference levels to determine performance against management objectives relating to ecological sustainability (Section 3.4). The second process involves an annual fishery-level review that determines whether the current catch/effort by each of the relevant fisheries/sectors is consistent with the levels expected when ecological objectives are met (Section 3.5).

This harvest strategy is structured to describe, hierarchically:

1) the high-level, long-term objectives of management (Section 3.1);

2) the short-term, operational objectives (Section 3.2); and

3) how these translate into the management approach for this resource (Section 3.3).

This is followed by a more detailed description of:

4) the processes for assessing ecological sustainability (Section 3.4);

5) the processes for assessing fishery performance (Section 3.5); and

6) the specific monitoring and assessment procedures used to ascertain if objectives are being met (Section 3.6).

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 high-level social and economic objectives for the sectors targeting this resource. It is important to note that the social and economic objectives are applied within the context of ESD and are considered once the ecological objectives have been met (Department of Fisheries 2015, see Section 3.5 for more information).

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 harm[2] to any other retained or bycatch species populations;

3) To ensure fishing impacts do not result in serious or irreversible harm to endangered, threatened and protected species populations;

4) To ensure the effects of fishing do not result in serious or irreversible harm to habitat structure and function; and

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.

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[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.

3.2   Operational Objectives

Long-term management objectives are typically operationalised as short-term (e.g. annual or periodic) objectives through one or more performance indicators that can be measured and assessed against pre-defined reference levels to ascertain actual performance. Within the context of the long-term ecological objectives provided above, operational objectives aim to maintain each resource 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 Approach

The abalone resource of WA is harvested using a constant exploitation approach, where the catches vary in proportion to variations in stock abundance.

In line with this approach, the commercial AMF is managed primarily through output controls in the form of TACCs, set annually for each species in the relevant management areas (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).

The WARAF 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 (Zone 1 of WARAF) is managed to a TARC, which is set annually by a catch prediction model based on fishery independent survey information and an environmental factor.

3.4   Ecological Sustainability

A formal, resource-level review process is undertaken by the Department to assess the status of relevant target stocks and performance in relation to each ecological objective. Suitable indicators have been selected to determine the status of the abalone resource of WA, and other ecological assets, against defined reference levels established to separate acceptable from unacceptable performance (Section 3.4.1). Where relevant, these reference 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).

Harvest Control Rules (HCRs) define the management actions that relate to the status of each indicator compared to the reference levels (Section 3.4.2). A summary of the management objectives, performance indicators, reference levels and HCRs is provided in Table 3.

3.4.1 *Performance Indicators and Reference Levels*

3.4.1.1 *Target Species*

The status of the WA abalone resource is assessed annually based on a weight-of-evidence approach that considers all available fishery-dependent and fishery-independent information for the three target species. With the exception of Roe's abalone in the Perth metropolitan area, the primary performance indicator used to assess each species in their relevant management areas is the annual standardised commercial catch rates (SCPUE). These are considered more responsive to changes in stock status compared to the three-year moving average of these standardised catch rates, as was used in the previous version of this harvest strategy.

In the Perth metropolitan Roe's abalone fishery (Area 7), future abundance of harvest sized stock is used as the primary performance indicator. This is obtained from a stock prediction model using fishery-independent survey information and an environmental factor (Section 3.4.2.2).

Reference levels for Roe's abalone (Area 2, 5, 6 and 8) have been calculated using an index of spawning biomass derived from fishery-independent surveys during the 1997-2010 reference period. Specifically, this (fishery-independent) data was used to calibrate the fishery-dependent performance indicator (i.e. the commercial catch rate) for this species in each relevant management area to unfished levels, based on data collected from areas closed to fishing during the same reference period. Area-specific target, threshold and limit reference levels that correspond to standardised catch rates at 50%, 40% and 30% of unfished stock levels, respectively, were determined.

Reference levels for Greenlip and Brownlip abalone (Area 2 and 3) have recently been updated based on outputs from model-based assessments that have provided estimates of biomass relative to the levels associated with Maximum Sustainable Yield (MSY), i.e. B_{MSY}. The target, threshold and limit reference levels for these species in each management area are now equivalent to the standardised catch rate corresponding to the estimated biomass at $1.2B_{MSY}$, B_{MSY} and $0.5B_{MSY}$, respectively (consistent with MSC principles).

For each of the three target species and their relevant commercial management areas, a long-term Sustainable Harvest Level (SHL) has been derived from available estimates of MSY for Greenlip and Brownlip abalone or calculated as the average commercial catch of Roe's abalone over the reference period (Table 1). Note, the long-term commercial SHLs for Greenlip and Brownlip abalone in Area 3 and Roe's abalone in Area 6 were reduced in 2019 due to the implementation of the Ngari Capes Marine Park and the resultant loss of access (foregone catch) by the commercial fishery (Hesp et al. 2008). Also, there are no long-term SHLs for Area 1 as it is an exploratory fishery located in a remote part of WA, from which there is no regular catch history. The long-term commercial SHLs are applied in the annual process for recommending the TACCs for the fishery each year, in response to the status of the abalone resource relative to the specified reference points (Section 3.4.2).

Table 1. Species-specific and area-specific long-term commercial SHLs used within the harvest control rules for the abalone resource in Western Australia.

Species	Area	Long-term SHL
Roe's abalone	2	18 tonnes (whole weight)
Roe's abalone	5	20 tonnes (whole weight)
Roe's abalone	6	7.5 tonnes (whole weight)
Roe's abalone	8	12 tonnes (whole weight)
Greenlip abalone	2	30 tonnes (meat weight)
Greenlip abalone	3	34 tonnes (meat weight)
Brownlip abalone	2	6 tonnes (meat weight)
Brownlip abalone	3	5.5 tonnes (meat weight)

3.4.1.2 *Other Ecological Assets*

Other ecological assets incorporated in this harvest strategy include bycatch and ETP species, habitats and ecosystem processes that may be affected by fishing activities in the commercial AMF (Table 3). For all ecological components, reference levels have been set to differentiate acceptable fishery impacts from unacceptable fishery impacts according to the risk levels defined in Fletcher (2015). An ecological risk assessment for the AMF was undertaken in 2015 (Webster et al. 2017) to inform these components of the harvest strategy, with these risk scores to be reviewed approximately every five years (Section 3.6.2.2).

3.4.2 *Application of Harvest Control Rules (HCRs)*

For each ecological performance indicator and reference level, an accompanying HCR directs the management needed to meet sustainability objectives (Table 3). These HCRs are designed to maintain the resource above the threshold level and close to a target level, or rebuild it where it has fallen below the threshold (undesirable) or the limit (unacceptable) levels.

3.4.2.1 *Greenlip, Brownlip and Roe's Abalone*

As stipulated by the control rules in this 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 (annual standardised commercial catch rates) relative to the specified (target, threshold and limit) reference levels for that species/area (Figure 3). The HCR described below applies to Greenlip, Brownlip and Roe's abalone in all commercial management areas, other than Area 7 (Perth metropolitan Roe's abalone fishery) of the AMF.

When the performance indicator in a management area falls below the target and/or threshold reference level, the extent to which the annual SHL for the following year will be reduced is reflective of how far the indicator has fallen from the target/threshold reference level (Figure 3). This allows for a precautionary approach to management, with reductions in catches addressed in a timely manner to

minimise the risk of the indicator reaching the limit reference level. If the indicator falls below the limit reference level, a more stringent management response will be implemented, with the annual SHL set to 0-50 % of the long-term SHL (i.e. potentially closing that area to fishing). When there is a positive trend in performance indicator between reference levels (e.g. threshold and target) any potential increase in the annual SHL will be 0-10 % of the previous season's TACC. Above the target reference level, the annual SHL can be set to 90-100 % of the long-term SHL and dependent on the annual weight-of-evidence assessment (e.g. high level of recruitment).
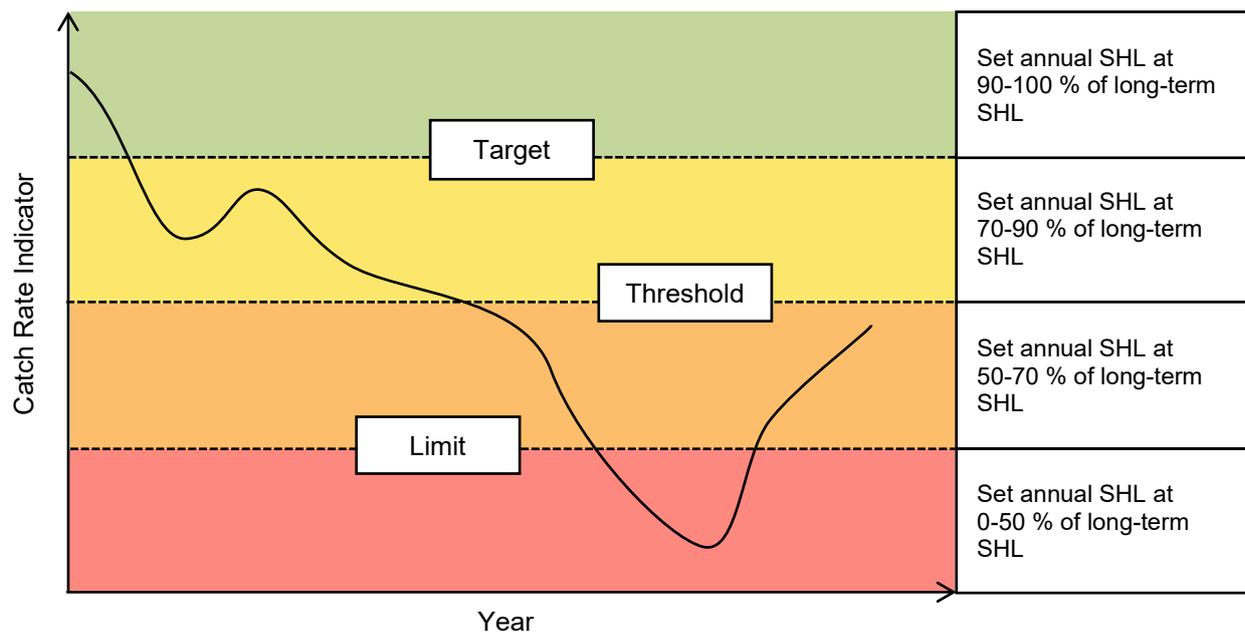
Figure 3. Schematic of how the harvest control rules are applied to managing the abalone resource of Western Australia.

3.4.2.2 *Perth Metropolitan Roe's Abalone Fishery*

For Roe's abalone in the Perth metropolitan fishery, evidence on future harvest sized stock abundance is used as the primary performance indicator and obtained from a stock prediction model (Figure 4). It uses evidence from annual recruitment surveys of Age 1+ animals, combined with the average summer sea surface temperature (SST, 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 Perth metropolitan Roe's abalone fishery because there is a 20-year time series trend of fishery-independent survey data at both fished and unfished sites.
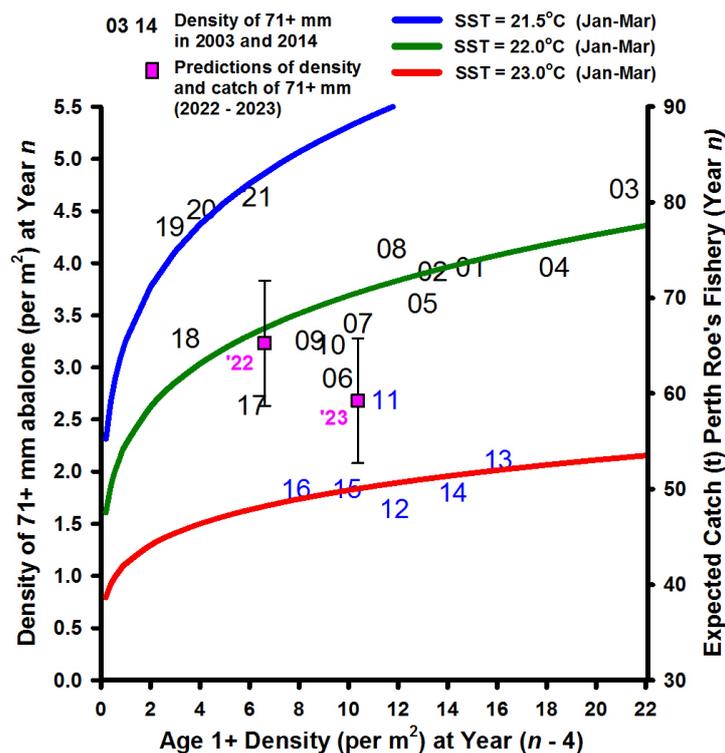
Figure 4: Density (per m²) and expected catch (t) of harvest-sized (≥71 mm) Roe's abalone (year *n*), recruitment density (number per m² of Age 1+ (17 – 32 mm) at year *n* – 4, e.g. 15 = density of Age 1+ in 2011) and the relationship with mean summer SST (January to March) during the 4 year period (years *n* - 3 to *n*).

The predicted availability of harvest size stock (density of abalone ≥71 mm in shell length) in the target year is then converted into a Total Allowable Catch (TAC) for the Perth metropolitan Roe's Abalone fishery. This TAC is divided by the catch-share allocation equations (Table 2), that provide a TACC for the commercial fishery (Area 7) and a TARC for the recreational fishery (Zone 1).

Table 2. Equations to allocate Roe's abalone TAC in the Perth metropolitan Roe's abalone fishery proportionally between sectors, based on the distribution of Roe's abalone spawning biomass and sectoral fishing effort by habitat. In Equation 2, a is the percentage of the commercial fishing effort that occurs in the subtidal habitat (100% in 2020/21) and b is the percentage of the recreational fishing effort that occurs in the subtidal habitat (17% in 2020/21).

Equation 1 – Separate Area 7/Zone 1 SHL by habitat:

Subtidal habitat TAC = SHL × 60%

Platform habitat TAC = SHL × 40%

Equation 2 – Determine TACC and TARC by sector use on each habitat TAC:

$$\text{Area 7 TACC} = \left(\frac{\text{Subtidal habitat TAC}}{(a+b)} \times a \right)$$

$$\text{Zone 1 TARC} = \left(\frac{\text{Subtidal habitat TAC}}{(a+b)} \times b \right) + (\text{Platform habitat TAC})$$

An in-season recreational effort control rule (RECR) management decision process has been established to limit catch to a pre-defined TARC based on annual sustainability assessments. As part of the RECR the Recreational Reference Level (RRL) is set at the TARC minus 6 tonnes (the average hourly catch achieved by recreational abalone fishers in Zone 1). If the RRL is exceeded after the first two or three hours of the Zone 1 fishing season (of the four-five, one hour-long fishing sessions), the season length will be shortened by two or one fishing session(s) respectively. If the RRL is not reached after the completion of the advised WARAF Zone 1 season, the season may be extended by one session. This will only occur if there are no stock sustainability issues, and weather conditions are deemed the main contributing factor. In addition, a review is triggered to determine the reasons for the low recreational catch in Zone 1. An outline of the Zone 1 RECR decision tree is provided in *Appendix 6.2*.

3.4.2.3 *Recovering Depleted Stocks*

A resource that has fallen below the acceptable level and for which suitable management adjustments have been implemented to reduce catch and/or effort (as outlined in the HCRs) is considered to be in a recovery phase (Department of Fisheries 2015). For target stocks that fall below the limit reference level, a recovery strategy will be developed and implemented to ensure that the resource can rebuild at an acceptable rate (i.e. within two generation times). Where the environmental conditions have led, or contributed significantly, to the resource being at an unacceptable level, the strategy needs to consider how this may affect the speed and extent of recovery.

In response to declining stock biomass of Greenlip abalone in Area 3 to below the limit reference level, a recovery strategy has been developed and implemented since 2019 (*Appendix 6.3*).

Table 3. Harvest strategy performance indicators, reference levels and control rules for the WA abalone resource, and associated ecological assets that may be impacted by fishing activities undertaken by commercial and recreational fishing sectors while targeting abalone.

Component	Management objectives	Resource / Asset	Performance Indicators	Reference Levels	Control Rules
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	Annual standardised commercial catch rate in each relevant management area (kg whole weight/hr)	**Targets:** Area 2 – 16.6 Area 5 – 14.4 Area 6 – 15.3 Area 8 – 15.8	1. If the performance indicator is > the Target, set annual SHL at 90-100 % of long-term level. 2. If the performance indicator is ≤ the Target and > the Threshold, set annual SHL at 70-90 % of long-term level.
				Thresholds: Area 2 – 13.3 Area 5 – 11.5 Area 6 – 12.2 Area 8 – 12.7	If the performance indicator is ≤ the Threshold and > the Limit, set annual SHL at 50-70 % of long-term level.
				Limits: Area 2 – 9.9 Area 5 – 8.6 Area 6 – 9.2 Area 8 – 9.5	If the performance indicator is ≤ the Limit, set annual SHL at 0-50 % of long-term level.
			Predicted availability of harvest size stock (density of abalone ≥71 mm in length) in the target year.	Area 7 – Stock Prediction Model	Set annual SHL as a function of stock abundance using the stock prediction model (see Figure 4).

Component	Management objectives	Resource / Asset	Performance Indicators	Reference Levels	Control Rules
Target species	To maintain spawning stock biomass of each target species at a level where the main factor affecting recruitment is the environment	Greenlip abalone Brownlip abalone	Annual standardised commercial catch rate in each relevant management area (Greenlip – kg meat weight/hr and Brownlip – kg meat weight/day)	**Targets:** Greenlip abalone: Area 2 – 21.2 Area 3 – 22.9 Brownlip abalone: Area 2 – 33.7 Area 3 – 14.1	1. If the performance indicator is > the Target, set annual SHL at 90-100 % of long-term level. 2. If the performance indicator is ≤ the Target and > the Threshold, set annual SHL at 70-90 % of long-term level.
				Thresholds: Greenlip abalone: Area 2 – 17.6 Area 3 – 19.1 Brownlip abalone: Area 2 – 28.1 Area 3 – 11.8	If the performance indicator is ≤ the Threshold and > the Limit, set annual SHL at 50-70 % of long-term level.
				Limits: Greenlip abalone: Area 2 – 8.8 Area 3 – 9.6 Brownlip abalone: Area 2 – 14.1 Area 3 – 5.9	If the performance indicator is ≤ the Limit, set annual SHL at 0-50 % of long-term level.

Component	Management objectives	Resource / Asset	Performance Indicators	Reference Levels	Control Rules
Other retained and bycatch (non-ETP) species	To ensure fishing impacts do not result in serious or irreversible harm to any other retained or bycatch species populations	All (non-ETP) bycatch species	Periodic risk assessments incorporating: • current management arrangements, • information on fishing effort and catch (retained and discarded), • species information, • review of alternative measures to minimise unwanted catch, and • other available research.	**Target:** Fishing impacts are expected to generate an acceptable risk level to all other retained and bycatch species, i.e. medium risk or lower.	Continue management aimed at achieving ecological, economic and social objectives.
				Thresholds: A potentially material change to risk levels is identified; or Fishing impacts are considered to generate an undesirable level of risk to any other retained or bycatch species' populations, i.e. high risk.	Review the reasons for this variation within three months and implement an appropriate management response to reduce risk to an acceptable level as soon as practicable.
				Limit: Fishing impacts are considered to generate an unacceptable level of risk to any other retained or bycatch species, i.e. severe risk.	Initiate an immediate management response to reduce the risk to an acceptable level as soon as practicable.
Endangered, threatened and protected (ETP) species	To ensure fishing impacts do not result in serious or irreversible harm to ETP species' populations	All ETP species	Periodic risk assessments incorporating:	**Target:** Fishing impacts are considered to generate an acceptable level of risk to all ETP species' populations, i.e. medium risk or lower.	Continue management aimed at achieving ecological, economic and social objectives.

Component	Management objectives	Resource / Asset	Performance Indicators	Reference Levels	Control Rules
			• current management arrangements, • number of reported ETP species interactions, • species information, • review of alternative measures to minimise unwanted catch, and • other available research.	**Thresholds:** A potentially material change to risk levels is identified; or Fishing impacts are considered to generate an undesirable level of risk to any ETP species' populations, i.e. high risk.	Review the reasons for this variation within three months and implement an appropriate management response to reduce risk to an acceptable level as soon as practicable.
				Limit: Fishing impacts are considered to generate an unacceptable level of risk to any ETP species' populations, i.e. severe risk.	Initiate an immediate management response to reduce the risk to an acceptable level as soon as practicable.
Habitats	To ensure the effects of fishing do not result in serious or irreversible harm to habitat structure and function	Benthic habitats	Periodic risk assessments incorporating: • current management arrangements, • habitat information, • extent of area fished, and • other available research.	**Target:** Fishing impacts are considered to generate an acceptable level of risk to benthic habitats, i.e. medium risk or lower.	Continue management aimed at achieving ecological, economic and social objectives.
				Thresholds: A potentially material change to risk levels is identified; or Fishing impacts are considered to generate an undesirable level of risk to any benthic habitats, i.e. high risk.	Review the reasons for this variation within three months and implement an appropriate management response to reduce risk to an acceptable level as soon as practicable.

Component	Management objectives	Resource / Asset	Performance Indicators	Reference Levels	Control Rules
				Limit: Fishing impacts are considered to generate an unacceptable level of risk to any benthic habitats, i.e. severe risk.	Initiate an immediate management response to reduce the risk to an acceptable level as soon as practicable.
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, • annual fishing effort and catch, • number of reported ETP species interactions • species information, • extent of area fished annually, and • other available research.	**Target:** Fishing impacts are expected to generate an acceptable level of risk to ecological processes within the ecosystem, i.e. medium risk or lower.	Continue management aimed at achieving ecological, economic and social objectives.
				Thresholds: A potentially material change to risk levels is identified; or Fishing impacts are considered to generate an undesirable level of risk to ecological processes within the ecosystem, i.e. high risk.	Review the reasons for this variation within three months and implement an appropriate management response to reduce risk to an acceptable level as soon as practicable.
				Limit: Fishing impacts are considered to generate an unacceptable level of risk to ecological processes within the ecosystem, i.e. severe risk.	Initiate an immediate management response to reduce the risk to an acceptable level as soon as practicable.

3.5   Fishery Performance

Defining annual (or periodic) catch or effort tolerance levels for fisheries provides a formal and efficient basis to evaluate the effectiveness of current management arrangements in delivering the levels of catch and/or effort specified by the HCRs and, where relevant, any sectoral allocation decisions (Fletcher et al. 2016). In line with the principles of ESD, this fishery-level review process can also consider the performance against any objectives relating to the economic and social amenity benefits of fishing.

Where possible, and in due consideration of ecological sustainability, fisheries management arrangements can be adjusted or reformed to help meet these economic and/or social objectives.

3.5.1   *Economic and Social Benefits*

Initial economic and social objectives for the AMF and WARAF have been developed in consultation with stakeholders and are provided below. These objectives will be further refined in future versions of this harvest strategy.

Specific PI and reference levels have been developed for some of the economic and social operational objectives to evaluate their benefits (see below). If the performance indicator for an economic and social operational objective is at or above the target level, then the action is to maintain management aimed at achieving economic and social objectives.

If the performance indicator for an economic and social operational objective is below this level, then the action is to consult with the relevant stakeholders to investigate potential causes. If possible, initiate commercial and/or recreational initiatives aimed at moving the performance indicator back to the target level and/or review whether fisheries management arrangements impose constraints, for reasons other than ecological sustainability, that limit the ability to achieve that economic or social objective.

It is important to note that management actions relating to these objectives are to be applied within the constraints of meeting objectives for ecological sustainability and while having regards to the objectives of other sectors.

3.5.1.1 *Commercial Sector Economic and Social Benefits*

The economic and social benefit operational objectives for the AMF are to:
1) provide for the maximum economic efficiency so that sustainable catch for the AMF maximises profits or creates the largest difference between total revenues and the total cost of fishing for commercial fishers; and
2) maintain or provide opportunity to maximise the flow of commercial fishing related economic and social benefit to the broader community.

The performance indicator to evaluate whether commercial fishers in the AMF have been able to maximise their economic efficiency is the proportion of TACC attained annually. The target reference level (Efficiency$_{Target}$) has been set at 75 % of entitlement being utilised each year. Note, the biological target reference level for the

Greenlip and Brownlip abalone stocks correspond to a proxy of maximum economic yield (e.g.1.2B_{MSY}).

No performance indicators or reference levels currently exist to evaluate flow of commercial fishing related economic benefit to the broader community. This objective could be measured using socio-economic surveys in the future.

3.5.1.2 *Recreational Sector Economic and Social Benefits*

The economic and social benefit operational objectives for the WARAF are to:
1) maintain cultural and recreational lifestyle benefits for recreational fishing participants; and
2) maintain or improve recreational fisher experience within a 1-hour recreational fishing session within Zone 1 of the WARAF; and
3) maintain or improve recreational fisher experience within a season of Zone 1 of the WARAF.

The performance indicator to maintain the cultural and recreational lifestyle benefits for recreational fishing participants is the number of abalone recreational fishing licences issued per annum (Participation$_{Target}$). Should there be a decrease of 15 % or greater of the total number of recreational abalone fishing licences over two consecutive seasons the action described above for not meeting the performance indicator would occur.

While not a numerical performance indicator, the in-season weather and sea condition recommendation for every session provided by Surf Life Saving WA based on a risk assessment, has been selected as the performance indictor for maintain or improve recreational fisher experience within a 1-hour recreational fishing session within Zone 1 of the WARAF. This ensures the safety of fishers, volunteers and Department staff involved in the session and provides for an improved experience. The measure of this is if a day is cancelled, a review will occur with key stakeholders to determine why this day was cancelled and any potential changes required.

For the recreational fishing sessions within Zone 1 of the WARAF that occur during the season, the performance indicator is the annual average fishers catch rate per session. To ensure recreational fisher experience within a season of Zone 1 of the WARAF is maintain or improved, the annual average fishers catch rate per session will be above 85 % of the bag limit (Catch$_{Target}$). Performance against this indicator will be assessed at the end of the season.

3.6 Monitoring and Assessment Procedures

3.6.1 *Information and Monitoring*

3.6.1.1 *Commercial Fishing Information*

There is a statutory obligation for fishers in the AMF to provide records of catch and effort information by 10 x 10 nautical 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.

Because 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 among divers and years. 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 WA.

3.6.1.2 *Recreational Fishing Information*

Estimates of recreational catch and effort for Roe's abalone are available from Zone 1 of the WARAF, where field surveys are undertaken each year during the 1-hour fishing sessions. 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 (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 WA to provide bioregional estimates of recreational catches, which include abalone. However, most recreational abalone catch is shore-based, so boat-based estimates only provide partial coverage. The information from these surveys complements the catch and effort data obtained by the annual surveys for Roe's abalone in Zone 1.

3.6.1.3 *Fishery-Independent Information*

Fishery-independent population surveys are undertaken regularly in the different areas of the resource 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 19 indicator sites in the Perth metropolitan Roe's abalone fishery; seventeen 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 (121 sites in Area 2 and 131 sites in Area 3). Survey sites were selected based on 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 (72 sites), while other areas are visited once every 2-3 years.

3.6.2 *Assessment Procedures*

3.6.2.1 *Target Species*

The stock status of Roe's, Greenlip and Brownlip abalone in WA is assessed using a risk-based 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. However, a stock prediction model that allows setting of the annual SHL as a function of stock abundance using fishery-independent data has been developed for the Perth metropolitan Roe's abalone fishery. The development of similar predictive models for other management areas and species of the resource are in the early stages of development.

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 approach to account for the variables that influence the catching efficiency and abundance of abalone (Hart et al. 2009). The annual standardised catch per unit effort (SCPUE) is used as the performance indicator and compared against the species- and area-specific reference levels to determine the annual SHLs in accordance with the HCRs.

Model-based assessments of Greenlip and Brownlip abalone have recently been undertaken to derive management area specific reference levels for the primary performance indicator (i.e. commercial SCPUE). These assessments align with the key assessment levels (tiers) used by DPIRD to determine the status of Western Australian fisheries resources (e.g. Gaughan and Santoro 2021) and range in complexity, data requirements and inherent assumptions. These model-based assessments will be conducted every 2-3 years and provide periodic estimates of spawning biomass (relative to the unfished stock) to be used as a secondary performance indicator (included in the weight-of-evidence assessment), with threshold reference levels at B_{MSY} and limit reference levels at $0.5B_{MSY}$. An example of an integrated model-based assessment for Greenlip abalone in the Augusta sub-area is provided in *Appendix 6.1*.

In the Perth metropolitan Roe's abalone fishery, a stock-recruitment-environment relationship using fishery-independent data has recently been established and is shown in *Appendix 6.1*. It uses evidence from annual spawning biomass surveys, combined with the average summer SST (i.e. January – March) in the year of spawning to predict the recruitment densities (Age 1+) two years later. Evidence on future recruitment densities from this relationship will be used as a secondary performance indicator against spawning biomass reference levels in the weight-of-evidence approach.

3.6.2.2 *Risk Assessments*

The Department uses a risk-based EBFM framework to assess the impacts of fishing on all parts of the marine environment, including the sustainability risks of retained

species, bycatch, ETP species, habitats and the ecosystem. This framework has led the development of the periodic risk assessment process for the abalone resource in WA, which is used to prioritise research, data collection, monitoring needs and management actions to ensure that fishing activities are managed both sustainably and efficiently.

As stated in Section 2.0, the harvest strategy for this resource currently considers impacts on ecological assets other than the target stocks of the commercial abalone fishery. An ecological risk assessment for the AMF was most recently undertaken in December 2015 (Webster et al. 2017). A further ecological risk assessment will be undertaken in late 2021.

Risk assessments will continue to be undertaken or reviewed periodically (at least every 5 years) to reassess any current or new issues that may arise in the fisheries. 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 previously assessed risk levels.

4.0   Management Measures and Implementation

4.1   Management Measures

A number of management measures are in place for the fisheries that target the WA abalone resource (Table 4 and Table 5). These measures can be amended as needed to ensure management objectives are achieved, however, they do not preclude the consideration of other options.

4.2   Implementing Changes to the Management Arrangements

Decision-making processes can be triggered following the identification of new or potential issues as part of an ERA (generally reviewed every 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 AMF:

- 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.

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 AMF is limited to the collection of Roe's, Greenlip and Brownlip abalone.	Abalone Managed Fishery Management Plan FRMR
Size Limits	Minimum shell diameter for Roe's abalone is 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 shell diameter for Greenlip and Brownlip abalone is 145 mm in Area 2, 150 mm in Area 3 and 140 mm in all other areas of the fishery.	Abalone Managed Fishery Management Plan FRMR
Quota System	The Fishery is divided into eight management areas. The AMF is managed via output controls in the form of a TACC, which is divided into ITQ units for Roe's, Greenlip and Brownlip abalone within each management area on AMF Licences. 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. 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. 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. 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.	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. Commercial fishing for Roe's abalone is not permitted on reef tops between Hillarys Boat Harbour and Cape Bouvard.	Abalone Managed Fishery Management Plan (unless exempt)
	Western Australian waters north of Moore River are currently closed to fishing for Roe's abalone indefinitely.	*Prohibition on Taking Abalone (North of Moore River) Order 2011*
	Western Australian waters between Busselton Jetty and Scott River (Augusta sub-area) currently closed to commercial Greenlip fishing and assessed annually based on implemented Recovery Strategy.	*Notice* under *Clause 16(1)* Abalone Managed Fishery Management Plan

Table 5. Management measures and instrument of implementation for the Western Australia Recreational Abalone Fishery.

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 shell diameter for Roe's abalone is 60 mm. Minimum shell diameter for Greenlip and Brownlip abalone is 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 announced Saturdays in summer months (December, January, February and March). 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.	FRMR
	Western Australian waters north of Moore River are currently closed to fishing for Roe's abalone indefinitely.	*Prohibition on Taking Abalone (North of Moore River) Order 2011*

4.2.1 *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 consultation with all affected parties and the approval of the Minister for Fisheries and/or the Department's Director General (DG, or appropriate delegates). 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) The peak bodies of the Western Australian Fishing Industry Council (WAFIC) and Recfishwest are the primary source of advice and representation from the commercial and recreational harvesting sectors, respectively.

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

4.2.1.1 *Commercial Sector Consultation*

Under its funding agreement with the Department, WAFIC is required to undertake statutory consultation functions related to fisheries management and the facilitation of management meetings for licensed fisheries.

Annual Management Meetings (AMMs) between the Department, WAFIC and licence holders in the AMF 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 Abalone Industry Association of Western Australia (AIAWA) and the West Coast Abalone Divers Association (WCADA) on specific commercial abalone science, management and operational issues.

4.2.1.2 *Recreational Sector Consultation*

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

4.2.1.3 *Consultation with Other Groups*

Consultation with customary fishers and non-fisher stakeholders, including Government agencies, conservation sector Non-Government Organisations (NGOs) and other affected/interested parties, is undertaken in accordance with the Departmental Stakeholder Engagement Guideline (Department of Fisheries 2016). 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.

4.2.2 **TACC and TARC Setting Process**

The annual TACC for the AMF is determined by the DG of the Department through a consultative process that occurs towards the end of the fishing season from November to March each year (Figure 5).

Based on results from the preliminary annual assessments of Roe's, Greenlip and Brownlip abalone stocks, preliminary Departmental advice on the recommended annual SHLs based on this harvest strategy (for each species in their relevant

management areas), and an industry consultation form, are sent to abalone licence holders, the AIAWA and WAFIC for consultation.
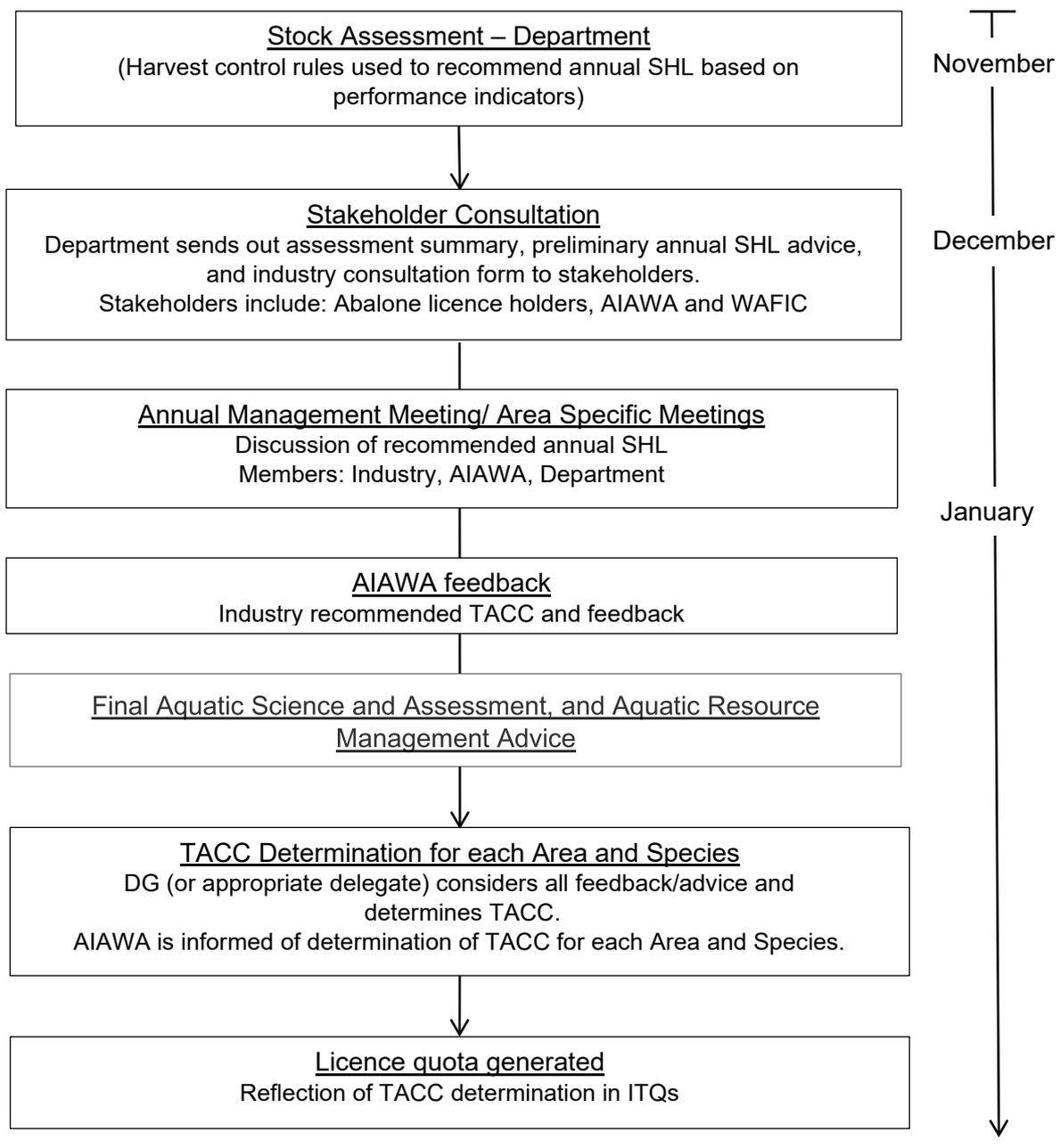
Following the receipt of this preliminary advice, AIAWA may discuss the assessment summary and determine the industry' position on the recommended annual SHLs for the coming season. The Department's annual SHL recommendations are also considered by the AIAWA and abalone industry more broadly at any area-specific meeting and the AMM, along with any co-management arrangement. Following this, AIAWA advises the Department in writing of their position on the annual SHLs and any additional feedback as required.

Final recommendations on the annual SHLs (from the Department's Aquatic Science and Assessment 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 Determination[3], and licence renewals and season arrangements for the following year commence.

In addition to the above, data is not available for the Perth metropolitan Roe's abalone stock assessment to inform TACC and TARC setting in the Fishery (Area 7 of the AMF and Zone 1 of WARAF), until the middle of each year. This means that a similar process, detailed in the flow diagram below, occurs with the recreational and commercial stakeholders at this time. These discussions inform the TARC for the following season and there may be a revision of the TACC mid-season.

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[3] http://www.slp.wa.gov.au/statutes/subsiduary.nsf/Fisheriesexec?openpage

Stock Assessment – Department (Harvest control rules used to recommend annual SHL based on performance indicators)	November
Stakeholder Consultation Department sends out assessment summary, preliminary annual SHL advice, and industry consultation form to stakeholders. Stakeholders include: Abalone licence holders, AIAWA and WAFIC	December
Annual Management Meeting/ Area Specific Meetings Discussion of recommended annual SHL Members: Industry, AIAWA, Department	
AIAWA feedback Industry recommended TACC and feedback	January
Final Aquatic Science and Assessment, and Aquatic Resource Management Advice	
TACC Determination for each Area and Species DG (or appropriate delegate) considers all feedback/advice and determines TACC. AIAWA is informed of determination of TACC for each Area and Species.	
Licence quota generated Reflection of TACC determination in ITQs	

Figure 5. Annual TACC setting process for the commercial Abalone Managed Fishery.

4.3   Compliance and Enforcement

As the key regulatory agency, DPIRD's compliance role is to achieve sustainability, economic and social objectives by addressing:

- our ability and capacity to influence compliance with the rules; and

- the effectiveness, capacity and credibility of the compliance program.

The Western Australian Fisheries Compliance Strategy (the Strategy; DPIRD 2018) was published in 2018. The purpose of the Strategy is to provide an understanding of the principles underlying the DPIRD's compliance role, as well as how its compliance services are delivered to the WA community. The Strategy aligns with, and complements, DPIRD's Compliance Framework and Risk Assessment Policy,

which informs the risk-based model, compliance planning and the governance structure applied to fisheries compliance services.

The Department's compliance model is based on the Australian Fisheries National Compliance Strategy 2016-2020 (the National Strategy). DPIRD's compliance program is aligned to support the three key compliance strategies recommended by the National Strategy:

- maximising willing compliance;

- effective deterrence; and

- organisational capability and capacity.

Management arrangements for the WA abalone resource are enforced under Operational Compliance Plans (OCPs), with a specific plan developed for the AMF and a more general plan for the WARAF. The OCPs are informed and underpinned by a compliance risk assessment conducted for each fishery, which are reviewed every 1-2 years. The AMF 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 willing 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.

Compliance strategies and activities that are used in the commercial and recreational fisheries targeting the WA abalone resource include:

- land and sea patrols (including vessel, licence and catch inspections);

- port inspections;

- inspections of processing facilities and wholesale/retail outlets;

- quota management;

- aerial surveillance;

- covert operations and observations; and

- intelligence gathering and investigations.

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6.0   Appendix

6.1   Additional Performance Indicators

6.1.1 *Greenlip and Brownlip Abalone*
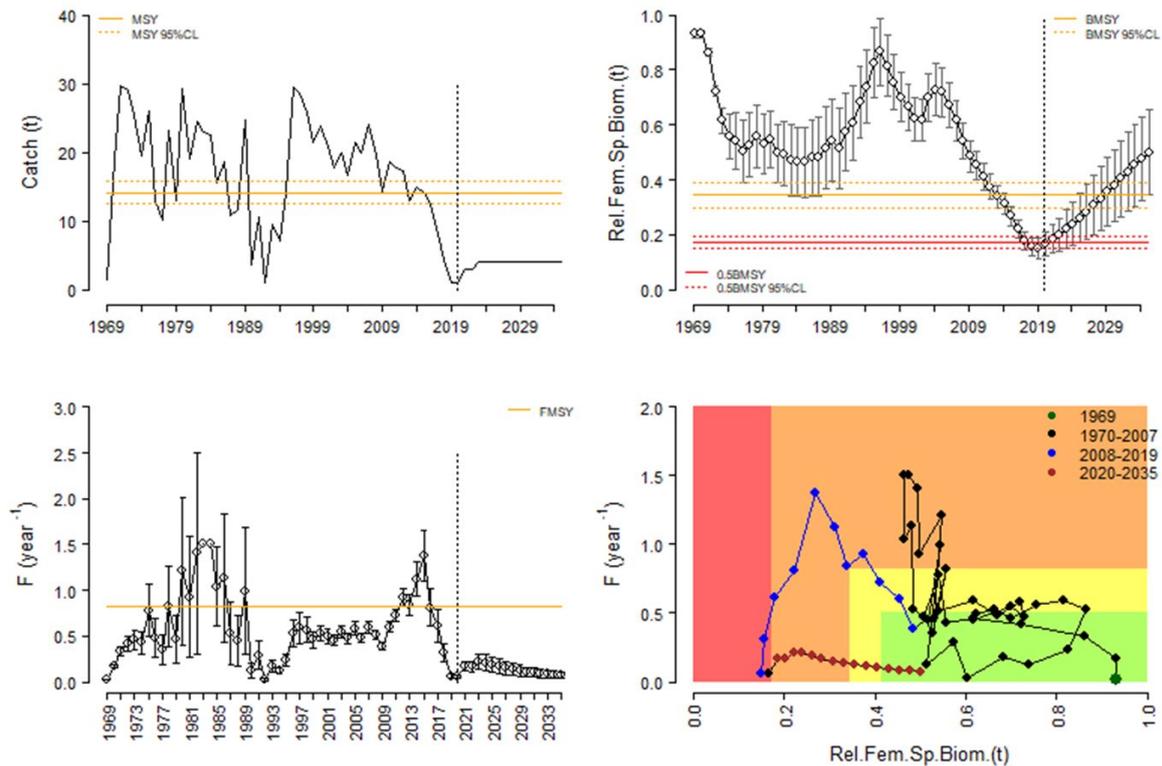
Example – Outputs from a size-based integrated model for Greenlip abalone in the Augusta sub-area, base case scenario (i.e. h = 0.6, M = 0.21 year^{-1}). Top left, Annual catches vs estimated maximum sustainable yield, MSY (± 95 % CLs); top right, estimates of relative female spawning biomass and associated values at B_{MSY} (threshold) and $0.5B_{MSY}$ (limit); bottom left, estimates of fishing mortality, F (year^{-1}) vs F_{MSY}; bottom right, phase plot, showing progression of relative female spawning biomass and fishing mortality. Note, that model projections have been based on total (commercial and recreational) catches of 1 t in 2019 and 2020, 3 t in 2021 and 2022, and 4 t from 2023 to 2035.

### 6.1.2 Roe's Abalone in the Perth Metropolitan Fishery
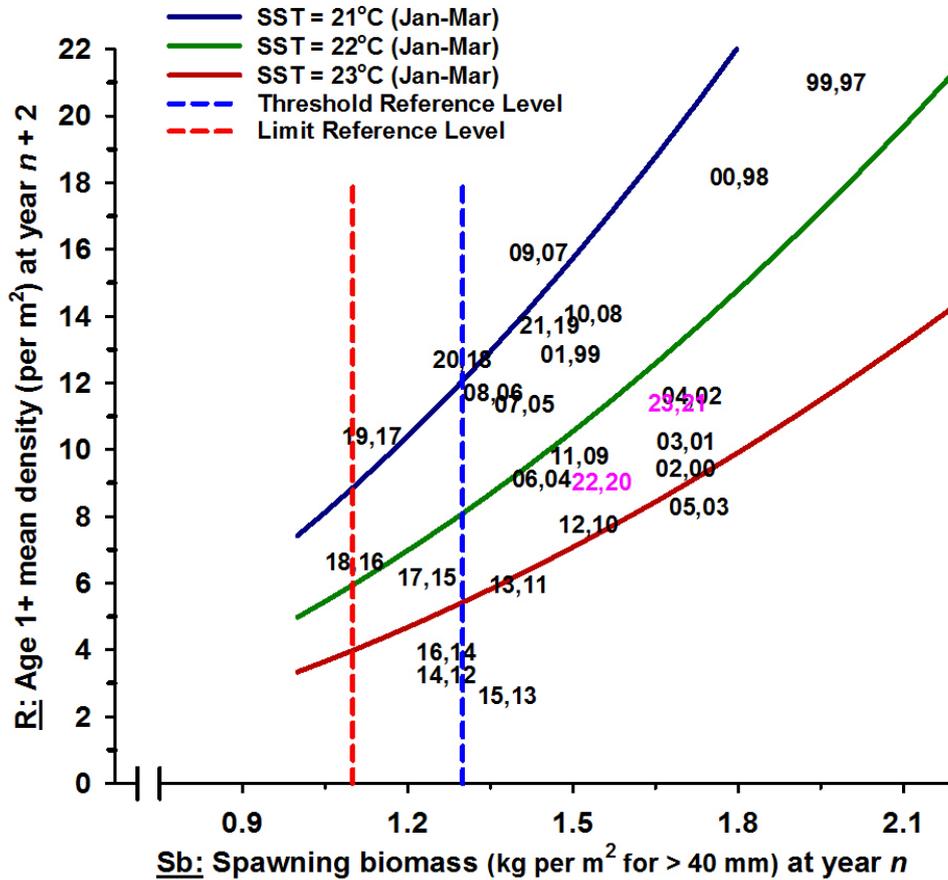
Stock-recruitment-environment relationship for Roe's abalone in the Perth metropolitan fishery. Spawning biomass (kg per m^2 index of ≥40 mm abalone at year n) and recruitment density (number of Age 1+ (17 – 32 mm) per m^2 at year n +2) relationship with summer SST (January to March) at the time of spawning (years n). Pink symbol (e.g. 22,20) represents the predicted Age 1+ recruitment in 2022 arising from the spawning biomass and the summer SST in 2020. Biological reference levels (Limit and Threshold) for spawning biomass are presented as a secondary performance indicator.

6.2 Western Australian Recreational Roe's Abalone Zone 1: In-Season Management Decision Trees
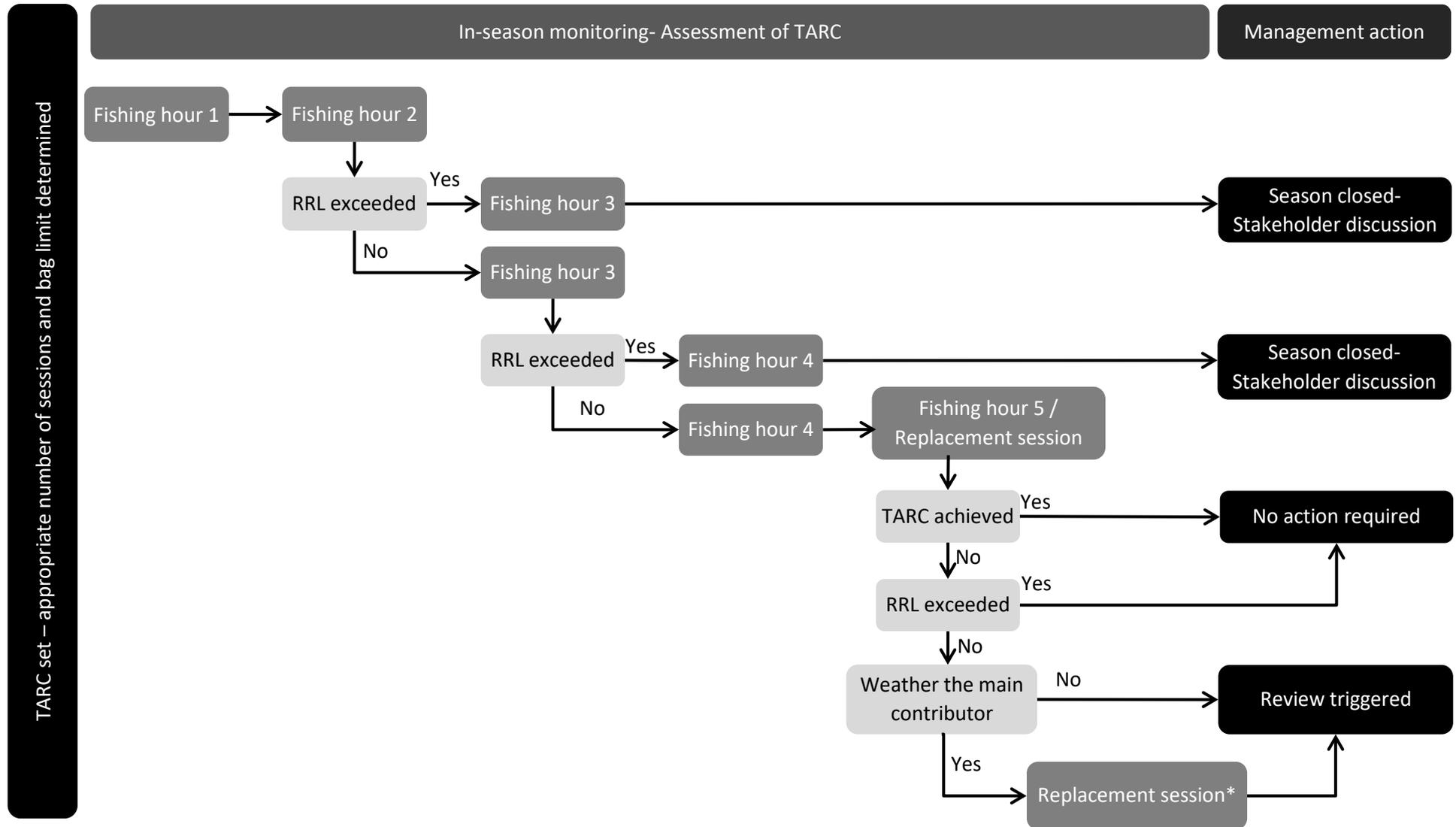
TARC (Total Allowable Recreational Catch) and RRL (Recreational Reference Level).

* Replacement session will only proceed if it is a 5-hour season and if session time has been/can be identified (appropriate risk).
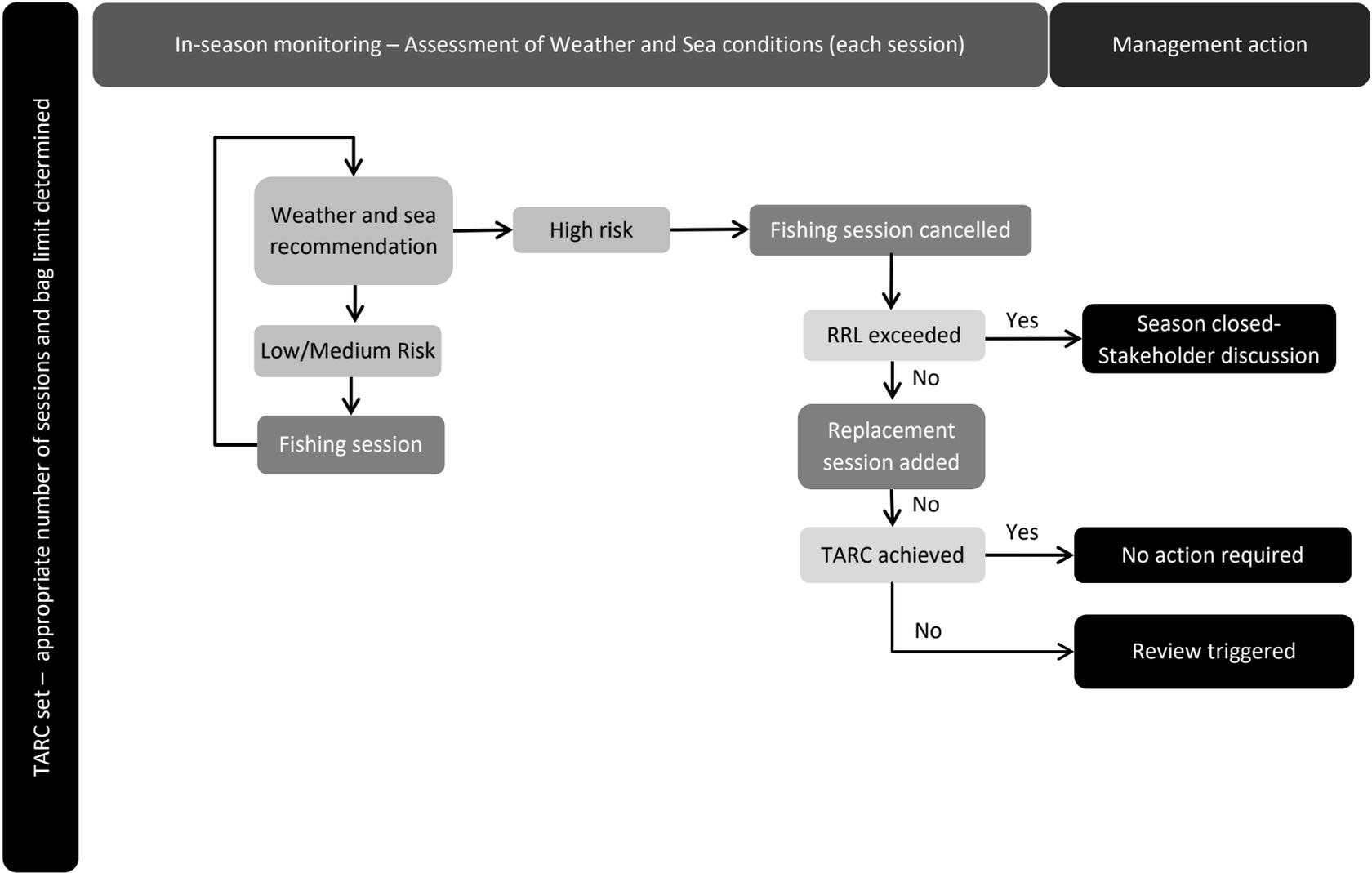
6.3   Recovery Strategy

Western Australian Abalone Resource
Area 3 Greenlip Abalone Recovery Strategy

Introduction

This document is an ancillary document to be read in conjunction with the Fisheries Management Paper No. 283; *Abalone Resource of Western Australia Harvest Strategy 2021-2026* (Harvest Strategy), and future versions of that document.

This Recovery Strategy has been developed in line with the Western Australian (WA) Harvest Strategy Policy (DPIRD 2015) and establishes performance levels that represent an appropriate rate of recovery for Greenlip abalone in Area 3 of the AMF in WA (*Figure 1*). This rate of recovery is consistent with the vulnerability and productivity of Greenlip abalone and the dynamics of the commercial and recreational fisheries that target the WA Abalone Resource.

Figure 1. Boundaries and management areas of the commercial Abalone Managed Fishery in WA. The fishery for Greenlip and Brownlip abalone operates in Areas 1 to 4 and the Roe's abalone fishery operates in Areas 1, 2, 5, 6, 7 and 8.

Under the Target Species component of the Harvest Strategy, when the Performance Indicator (PI), being the annual standardised commercial catch per unit effort (SCPUE), for a particular species (i.e. Greenlip abalone, Brownlip abalone or Roe's abalone) within a specific Management Area breaches the limit reference level (limit), the Harvest Control Rule (HCR) specify that action is required to reduce the annual Total Allowable Commercial Catch (TACC) to between 0-50% of the long-term Sustainable Harvest Level (SHL). This action is undertaken to rebuild the spawning biomass and consequently increase the PI to above the threshold reference level. This is consistent with the key ecological objective - to maintain spawning biomass of Greenlip abalone at a level where the main factor affecting recruitment is the environment (i.e. above B_{MSY}).

The maximum time permitted to recover a stock under the Marine Stewardship Council (MSC) standards is two times the generation time. Based on this approach, and a generation time for Greenlip abalone in WA of 8 years (i.e. $1/M+L_{50}$ maturity, where M is assumed to be 0.2 and L_{50} maturity is 3 years) the maximum time to recovery is 16 years (Hart et al. 2017). Therefore, the aim of this recovery strategy is to rebuild the stock to above the level of B_{MSY} (i.e. the threshold level) by 2035.

While this document has been developed as a Recovery Strategy for Greenlip abalone in Area 3, this Strategy establishes a process for when the PI of any abalone species breaches a limit and needs to enter a recovery phase.

Recreational catch levels of Greenlip abalone in this area are relatively small and not considered a risk to stocks. The combined recreational catch across the Southern Zone (Busselton Jetty to the South Australian Border) of Greenlip and Brownlip abalone is estimated to total 8 t (Strain et al. 2021b). For this reason, it has been excluded, at this stage, from actions under this Recovery Strategy. It may be included in the Recovery Strategy in the future, if the PI for Greenlip abalone continues to decline or the outputs of the stock assessment demonstrate that recovery will not be achieved within agreed timeframes.

Abalone Resource Stock Assessment

The stock assessment for the Abalone Managed Fishery (AMF) is published (available on the Fisheries website under MSC publications), and informs the stock status for the Department's Annual Report and the Status Reports of the Fisheries and Aquatic Resources of Western Australia, the MSC annual audit and the biennial Status of Australian Fish Stocks Report. This assessment is undertaken through a weight-of-evidence approach and evaluates the PI for each species within the individual management areas of the AMF against the specified reference levels.

For Greenlip abalone in Area 3, a model-based assessment will also be updated periodically to monitor the stock relative to MSY-based reference levels, and to evaluate whether the stock is rebuilding at the required rate. This has been

incorporated into the Harvest Strategy and the weight-of-evidence assessment for this stock.

# The Strategy for the Recovery of Greenlip abalone - Area 3

As the PI for Greenlip abalone in Area 3 has breached the limit, the Harvest Strategy requires that appropriate management action be taken to reduce the annual TACC to 0-50% of the long-term SHL, to return the PI to above the threshold within two generations (i.e. 16 years). The Recovery Strategy is to be initiated in the year immediately following a breach of the limit and defines when the timeframe for recovery begins.

Three steps have been identified as part of the process to recover Greenlip abalone in Area 3 in accordance with the requirements of the Recovery Strategy (Figure 2 and 3), the time frames for these steps are consistent with the maximum time permitted to recover by the MSC. There steps are:

Step 1: Initiate Recovery (Milestone: PI above limit within 4 years of the limit breached).

Step 2: Recover by rebuilding the PI to the threshold reference level (Milestone: at or above the threshold within 16 years of the limit breached).

Step 3: Building to the Target (Milestone: PI above the target).
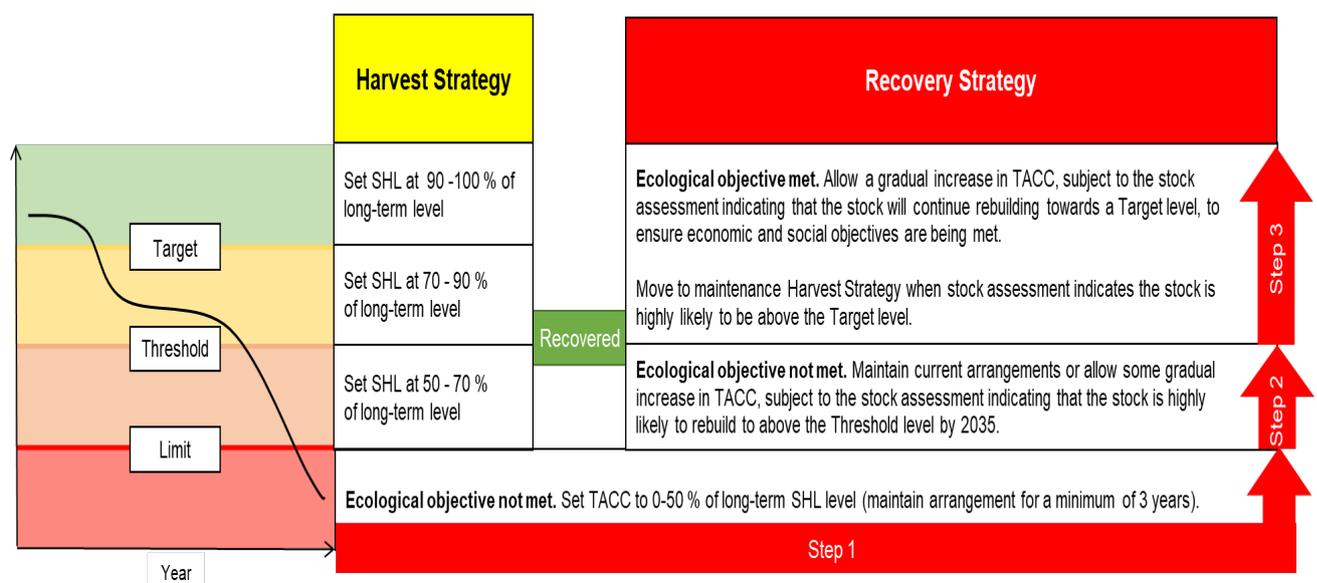
Figure 2. Illustration of the current WA Abalone Resource Harvest Control Rule within the Harvest Strategy and the Recovery Strategy as outlined in this document.
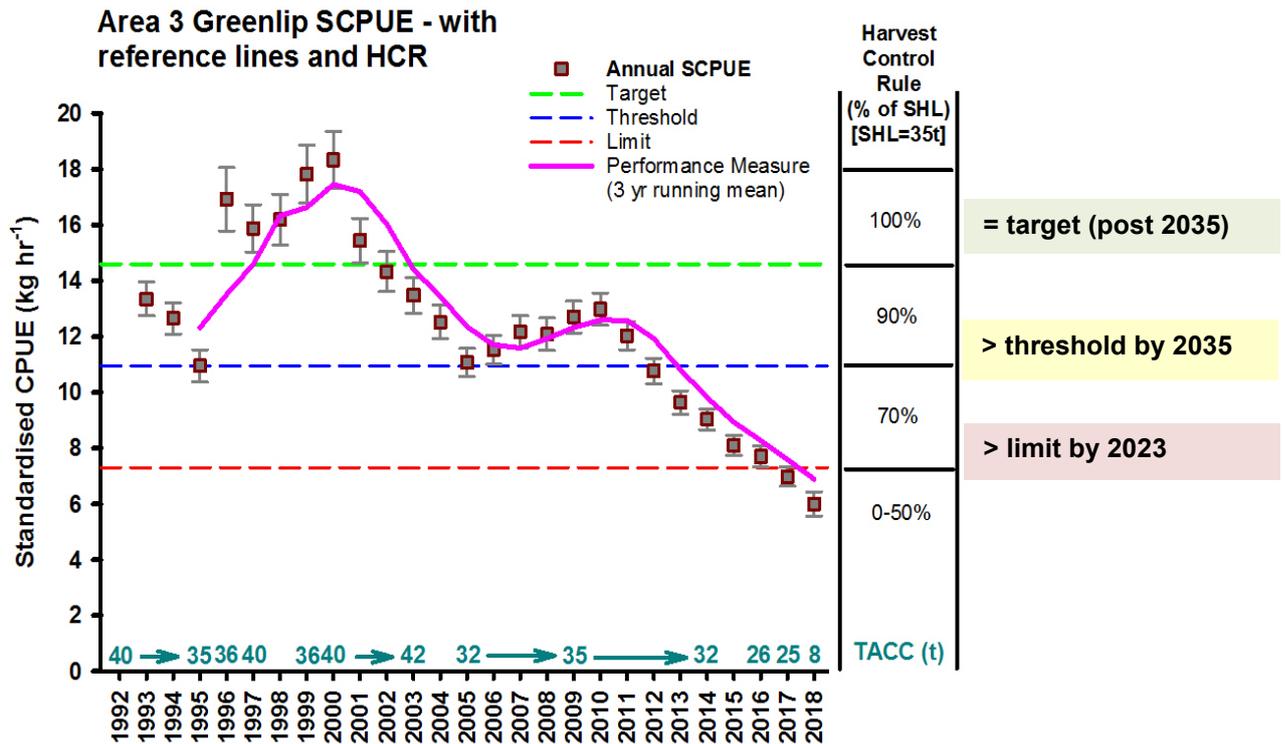
Figure 3. Illustration of the required milestone timeframes under this Recovery Strategy against the Area 3 Greenlip abalone target, threshold and limit reference levels, as well as the annual SCPUE (kg.hr⁻¹) and PI (3 year running mean) in 2018. Note, this illustration was produced under the previous version of this Harvest Strategy when the PI was the 3-year running mean of annual SCPUE, the current version of the Harvest Strategy now uses the annual SCPUE as the PI (see Section 3.4.1.1).

Step 1: Initiate Recovery

Aim: To initiate the recovery of Greenlip abalone in Area 3, the Recovery Strategy requires that appropriate management action be undertaken as soon as practicable to enable the PI to return to above the limit within 4 years of a breach.

Actions under Step 1

To provide urgent and effective reductions in fishing pressure and increase protection of Greenlip abalone in Area 3 during 2018 (above the limit) and 2019 (now below the limit), the following actions have been taken in accordance with the Harvest Strategy:

2018/19 (between the limit and the threshold)
- reduction in the TACC from 24.5 t to 8 t (22.8% of the long-term SHL); and
- increased the minimum legal size limit to 150 mm.

2019/20

- reduction in the TACC from 8 t to 4 t (11.4% of the long-term SHL); and
- closure of the Augusta sub-area (shown in Figure 4 below) to commercial fishing for Greenlip abalone.

These actions meet the Harvest Control Rule that is required to set the annual TACC at 0-50% of the long-term SHL and this Recovery Strategy.
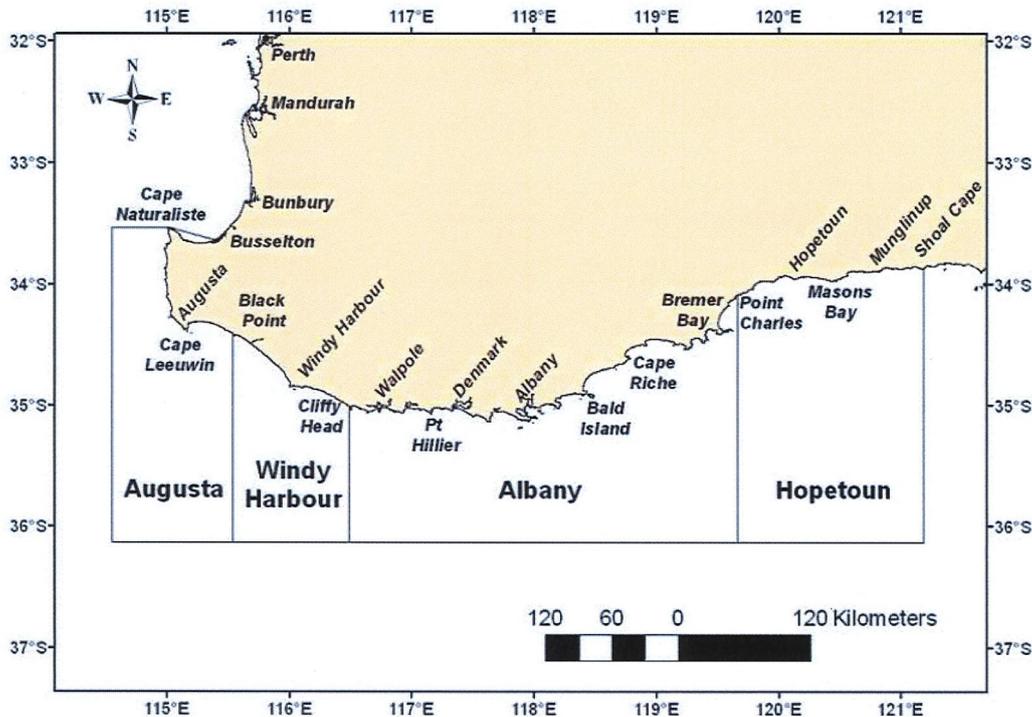
Figure 4. Sub-areas within Area 3 of the WA Abalone Managed Fishery.

To achieve the Step 1 aim and continue the recovery of Greenlip abalone in Area 3 to above the limit, the following management actions will be taken:

1. The Department will maintain the reduced TACC already imposed (4 t) for a minimum of 3 years or until the stock assessment demonstrates a high probability that the PI has increased above the limit.

2. The Department will maintain the commercial closure of the Augusta sub-area until the weight–of-evidence assessment shows improvement in stock indicators.

When is further action required under Step 1

If the outcomes of the stock assessment indicate the PI for Greenlip abalone in Area 3 has declined in this time, the Department will implement management action to reduce catch by a further 50-100%. Appropriate management action will be discussed in the annual capacity setting process.

Step 2: Recover by Rebuilding

Aim: To rebuild the PI to the threshold (Milestone: at or above the threshold within 16 years of the limit breached i.e. by 2035).

Actions under Step 2

To achieve Step 2 and maintain the PI above the limit, the Department will implement the following management action:

1. the annual TACC will not automatically increase to 50% of the long-term SHL when the PI increases above the limit;
2. any TACC increase will be subject to outputs of the stock assessment demonstrating that recovery to above the threshold level will be achieved within agreed timeframes;
3. while below the threshold, the annual TACC will not exceed 70% of the long-term SHL.

When is further action required under Step 2

If the outcomes of the stock assessment indicate the PI for Greenlip abalone in Area 3 has declined in this time, the Department will implement further management action to reduce catch by 30-50%. Appropriate management action will be discussed in the annual capacity setting process.

Step 3: Building to Target

Aim: To rebuild the PI to the target to ensure economic and social objectives can be met.

Actions under Step 3

To achieve Step 3 and maintain the PI above the threshold and rebuild to the target, the Department will implement the following management action:

1. the annual TACC will not automatically increase to 70% of the long-term SHL when the PI increases above the threshold;
2. any TACC increase will be subject to outputs of the stock assessment indicating that the stock will continue rebuilding towards the target level;
3. while below the target, the annual TACC will not exceed 90% of the long-term SHL.

When is further action required under Step 3

If the outcomes of the stock assessment indicate the PI for Greenlip abalone in Area 3 has declined in this time, the Department will implement further management action to reduce catch by 10-30%. Appropriate management action will be discussed in the annual capacity setting process.

Appendix. Monitoring and assessment schedule for Area 3 Greenlip abalone - 2019 to 2035

Table 1. Proposed timing for monitoring, assessment, key strategy reviews and the objective and milestones during the recovery.

Year	Commercial catch + effort	Recreational catch + effort	Fishery independent data	Weight-of-evidence	Model-based assessment	Performance Indicator against predicted recovery requirement	Harvest Strategy Review	Recovery milestone
2019	●		●	●		●		
2020	●		●	●	●	●	●	
2021	●	●	●	●	●	●	●	
2022	●		●	●		●		
2023	●		●	●		●		PI above the limit
2024	●		●	●		●		
2025	●		●	●		●	●	
2026	●	●	●	●	●	●	●	
2027	●		●	●		●		
2028	●		●	●		●		
2029	●		●	●		●		
2030	●		●	●		●	●	
2031	●	●	●	●	●	●	●	
2032	●		●	●		●		
2033	●		●	●		●		
2034	●		●	●		●		
2035	●		●	●	●	●	●	PI at or above the threshold

Column groups: Monitoring (Commercial catch + effort, Recreational catch + effort, Fishery independent data); Assessment (Weight-of-evidence, Model-based assessment); Aims achieved? (Performance Indicator against predicted recovery requirement, Harvest Strategy Review, Recovery milestone).