

ECOLOGICAL ASSESSMENT OF THE SOUTH AUSTRALIAN  
BEACH-CAST MARINE ALGAE FISHERY

ASSESSMENT REPORT

PREPARED FOR THE DEPARTMENT OF THE ENVIRONMENT  
(DOTE).

FOR THE PURPOSES OF PART 13 AND 13(A) OF THE  
*ENVIRONMENT PROTECTION AND BIODIVERSITY  
CONSERVATION ACT 1999*

23 DECEMBER 2014



# Ecological Assessment of the South Australian Beach-Cast Marine Algae Fishery

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# 1 Forward

The marine, estuarine and freshwater fisheries resources of South Australia are community owned resources. The role of the Government, as custodian of these resources on behalf of the broader community and future generations, is to ensure that they are used in an ecologically sustainable and economically efficient manner, while at the same time maximising returns to the community.

Experience world-wide has demonstrated that where unrestricted use of fisheries resources is allowed, there is little incentive for individuals involved in harvesting to conserve fish stocks. The resulting competition among and between user groups often leads to reduced biological and economic productivity. Left unmanaged, the increase in fishing effort that results from competition is reflected in lower individual catches, over capitalisation and reduced financial returns to the commercial fishing sector. Loss of these resources to the community can result in significant regional economic problems.

In managing fisheries resources, Governments have the primary responsibility of ensuring long-term sustainability. Governments must also ensure that the basis for sharing fisheries resources among all users is clearly understood and accepted as equitable, and that the allocation of fisheries resources and their level of utilisation are consistent with the needs of present and future generations.

To facilitate better decision-making by the Government in managing South Australia's fisheries resources, the Fisheries Council of South Australia (the Council) has been established under the *Fisheries Management Act 2007* (the Act) to provide expertise-based advice to the Minister for Agriculture, Food and Fisheries. The Council is an expertise based committee with members required to have experience in one of the following areas which include; commercial fishing and the processing of aquatic resources, recreational fishing, research and development relevant to the use of aquatic resources, conservation of aquatic resources, socio-economics, business and law. The Council is convened by an independent chairperson. Appointment of members and the terms of reference of the Council are embodied in the Act.

Where there are considered to be threats of serious or irreversible damage to fisheries resources, or the environment upon which they depend, a lack of full scientific certainty or insufficient information will not prevent the Government from making a resource management decision. Where resource management decisions must be made in an environment of uncertainty the Government, in partnership with the Council, will take a precautionary approach to the management of South Australia's fisheries resources.

## 2 Purpose

This report has been prepared by the Fisheries and Aquaculture Division of the Department of Primary Industries and Regions South Australia (PIRSA Fisheries and Aquaculture).

The purpose of this report is to provide the Department of the Environment (DotE) with an updated assessment of the management arrangements in place for the South Australian Beach-Cast Marine Algae Fishery, against the 'Guidelines for the Ecologically Sustainable Management of Fisheries 2nd Edition', set out in the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act).

This report updates the original assessment provided to DotE in 2003 and has been revised consistent with advice received from DotE and through the associated community consultation process on a previous submission in April 2014 (PIRSA 2014a). The revisions take account of a number of key issues including:

- 1) Documenting the changes that have occurred in the fishery since the previous export approval lapsed in 2009.
- 2) Differentiates the commercial macro-algal fishery in South Australia from the removal of seagrass wrack for amenity purposes noting that:
  - a) The sources of marine-algal wrack is ecologically distinct from seagrass wrack - comprising coastal reefs and other environments with a consolidated substratum as opposed to seagrasses which come primarily from areas with sandy substratum.
  - b) The decomposition and ecological use pathways of detrital macro-algal material are different to those of seagrass wrack.
  - c) The harvest process for macro-algal wrack is substantially different – comprising a collection of individual plants using forwarders rather than broad area clearances using bulldozers.
  - d) The geographical region of the macro-algal wrack harvest is spatially distinct from the seagrass harvest. The macro-algal harvest is from beaches in the Otway Bioregion and this area is very distinct (ecologically) from the areas around Kingston (where the seagrass harvests occur), which is located at the southern end of the Coorong Bioregion. The ecology of coastal communities is demonstrably different between these regions (which is consistent with their classification as different Bioregions) and management needs to take explicit cognisance of this.
  - e) The purpose of the macro-algal harvest is for commercial use whereas the purpose of the seagrass harvest is to clean beaches for amenity purposes, noting particularly that the build-up of seagrass wrack on the Kingston beaches is believed to have been artificially created due to the man-made infrastructure.
- 3) Notes that licence conditions for the fishery will be changed to incorporate a spatially explicit approach that is expected to deliver a number of key outcomes in terms of minimising the ecological footprint of the harvesting activity. These include:
  - a) The spatially explicit approach to the harvesting will allow exclusion areas to be identified on the licence and thereby improve operational efficiency for harvesters and compliance assessment by regulatory authorities.
  - b) Areas of high ecological value that are not otherwise being managed though Parks or Conservation Reserves can be identified as exclusion zones.
  - c) The adoption of a spatial strategy also provides an input control that will effectively limit harvest volumes to a maximum of 50% of the available macro-algal biomass (measured across the coastal extent of the fishery).
- 4) New information has been provided in this document that quantifies the scope, scale and management arrangements of the fishery and compares these with best-practice fisheries elsewhere with particular reference to the King Island Bull-Kelp fishery which is considered to be the most similar to the SA macro-algal wrack fishery (Appendix 1).
- 5) Data on the distribution of shore-bird species has been updated and maps of the habitats for the licence area have been provided (Appendix 2). Furthermore, these data have been used in refining the spatial management strategy applied to the macro-algal wrack harvest (licence Y078).

## 3 Introduction

### 3.2 Description of the Fishery

For the purposes of this report, beach-cast seagrass and marine algae accumulations are referred to as 'wracks.' Wracks are comprised of drifting plant matter deposited onto beaches. Technically, wracks may consist of kelp or other detached macro-algae, seagrasses, animal carcasses and other organic matter deposited from the sea onto a beach by waves or winds (Fairweather and Henry 2003; Duong 2008). Harvesting includes the removal, clearance, movement, re-location or disturbance of any part of a wrack. It is emphasised that this report covers only beach-cast material and does not refer to flora attached to a substrate or drifting in the water column, which is not available for harvesting.

Historically, the harvesting of both seagrasses and marine algae in South Australia has been managed under fishery management arrangements even though, for the most part, the removal of seagrass wrack from beaches has been primarily undertaken for amenity purposes and there is no commercial harvest of this material. While this was not so much the case in the earlier part of the 1990's it has been the case for the period since around 2000. On this basis the licencing and management of the removal of seagrass wrack under fishery legislation is essentially an artefact of historical management and fails to account for the amenity clearance process as being much like any other spatially limited beach maintenance activity (such as channel clearance dredging, the management of beach access routes or the maintenance of access to boat ramps). Furthermore, the seagrass wracks removed from beaches is not used for commercial purposes but rather they are dumped and allowed to compost in areas where they do not impact on public amenity.

Key differences between seagrass wrack removal and macro-algal wrack removal include:

1. Amenity clearances are restricted to beaches that have high visitation rates being largely adjacent to the seaside town of Kingston. Recreational use of the beaches is significant and consistent through time meaning that these environments are already highly modified.
2. An assessment of the seagrass wrack removal at Kingston (Duong 2008) concluded that the removal of seagrass wracks at Kingston was acceptable because:
  - a. The cover of wracks at Kingston is probably un-naturally high due to the breakwater at the northern end of the beach acting as a trap;
  - b. Macrofaunal abundance and diversity in the wracks is low;
  - c. The wracks are mostly old, refractory seagrass which does not input nutrients into the beach ecosystem via either decomposition or incorporation into trophic webs;
  - d. Management arrangements require that within harvest areas a proportion of wracks remain on the beach; and
  - e. Wrack harvest occurs infrequently.
3. The spatial extent of Kingston Beach, where seagrass wrack removal occurs, is only 7.2 km in total length. Along this beach extent 100% harvesting occurs only on the northern most 1.6 km which is directly adjacent the town center and Jetty and on the remainder of the beach some wrack is left in place.

On this basis PIRSA believe that the management of wrack removal for the purposes of amenity clearance should be treated as a separate issue and should not be considered as part of the assessment of the marine-algal wrack fishery which operates in a different biogeographical region (Otway Bioregion of Coorong Bioregion) and targets a different resource to the amenity clearances.

In South Australia the commercial harvesting of beach-cast marine algae is a small "cottage" industry. Interest in harvesting has resulted from a rising market demand for algal products both locally and internationally. An authority to collect any marine flora for commercial purposes is required under the Act. The commercial harvesting of marine algal wracks from any beach of the State is therefore under the care, control and management of PIRSA Fisheries and Aquaculture on behalf of the community in accordance with the Act. The Act provides a broad statutory framework to ensure the ecologically sustainable



management of South Australia's aquatic resources. The regulations that govern the management of the South Australian Beach-Cast Marine Algae Fishery are the *Fisheries Management (Miscellaneous Fishery) Regulations 2000* and the *Fisheries Management (General) Regulations 2007*.

The South Australian Beach-Cast Marine Algae commercial fishery has historically been managed under a series of input controls, comprising exclusion zones and restrictions on the allowable methods for harvesting, these are subject to licence conditions. There is only two non-transferrable Miscellaneous Fishery licence which permit the commercial harvest of wrack in South Australia, and these are located in the southeast of the State (Figure 1)<sup>1</sup>. The harvest of wrack for commercial purposes has also been granted to a small number of operators in the past through Ministerial exemptions but currently there are no active exemptions and no further exemption permits will be issued.

In December 2013, PIRSA Fisheries and Aquaculture implemented the *Fisheries Management (Miscellaneous Developmental Fishery) Regulations 2013*. These regulations make provision for the issuing of permits for exploratory and developmental fishing activities for species not currently fished commercially and undertaking fishing activities in new areas. While the harvest of marine-algal wrack in areas not currently allocated to the two Miscellaneous Fishery licence holders may meet the criteria of exploratory and developmental fishing permits, PIRSA Fisheries and Aquaculture has not issued any permits for exploratory and developmental wrack harvest as yet.

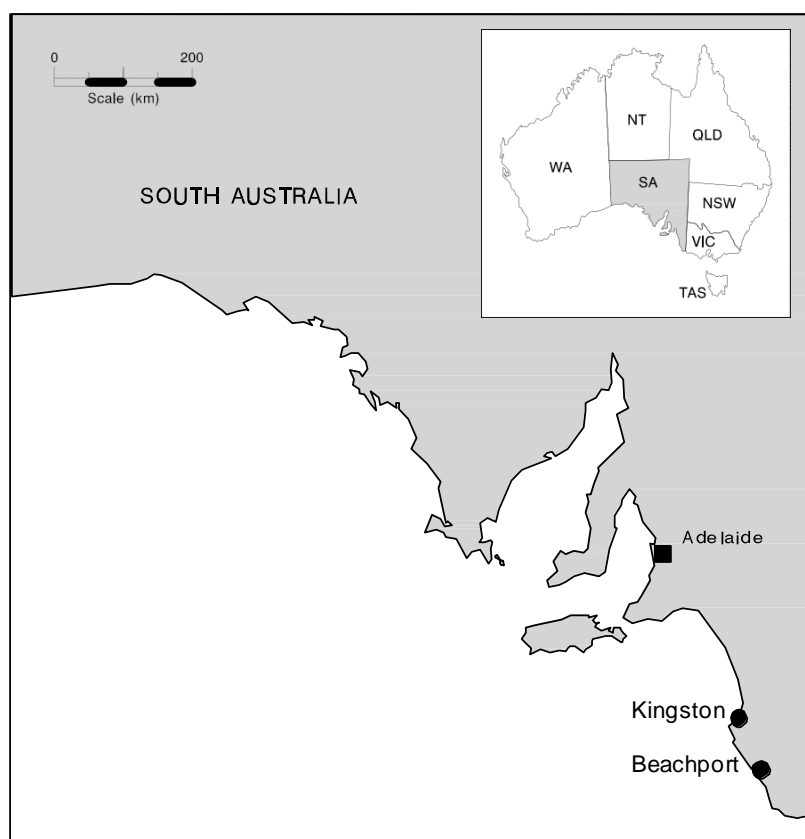


Figure 1: The main harvest areas for the existing commercial licence holders of beach-cast seagrass and marine algae in South Australia (illustrated by black circle).

<sup>1</sup> Noting that the second licence which permits the removal of seagrass wracks for beach amenity purposes as detailed above.

## 3.3 History of the Fishery

### 3.3.1 History

The commercial wrack fishery began to develop in early 1990 when two permits were granted for commercial harvesting of wrack in the southeast of the State. Interest in both algal and seagrass wrack harvesting intensified in 1993, when a number of applications were received by PIRSA Fisheries and Aquaculture for additional permits in the southeast as well as in new areas such as Lady Bay, Port Parham and Port Adelaide (North Haven). These permits were issued (i) for the purposes of market research and development, to identify potential markets for seagrass and algal products and to determine whether or not the industry could be viable and (ii) to allow certain seaside councils to improve local beach access and amenity. In 1996 permits for the commercial harvest of wrack were replaced with Ministerial exemptions, as it was deemed that these permits did not adequately apply for the intended purposes. In late 1996, in response to increased interest in wrack harvest from new and existing exemption holders, PIRSA Fisheries and Aquaculture declared a moratorium on the issue of any new exemptions in the fishery, pending the development of a management plan.

In 2000 a review of management arrangements for the fishery was carried out as part of the process to develop a management plan for harvesting beach-cast seagrass and marine algae. The review concluded the most appropriate management arrangement, for granting access to beach-cast wrack as a commercial operation, was by means of a Miscellaneous Fishery Licence under the *Fisheries Management (Miscellaneous Fishery) Regulations 2000*. In 2003, the Ministerial exemption holders harvesting wracks for commercial purposes were offered a Miscellaneous Fishery Licence in the fishery. This resulted in the issue of three Miscellaneous Fishery Licences for beach-cast wrack harvesting. One of those licences lapsed in 2007 with the death of the licence holder. This licence has not been reinstated as Miscellaneous Fishery Licences are non-transferable. Currently, macro-algal wrack harvesting is seen as small-scale<sup>2</sup> 'developmental fishery with only one licence holder harvesting material between Cape Jaffa (just south of Kingston) and Beachport in the States southeast (Figure 1).

Since 1997, commercial wrack harvesters have provided data on their fishing activities through monthly catch and effort returns. All information collected in catch and effort returns is entered and stored with the South Australian Research and Development Institute (SARDI) Aquatic Sciences division. Fishers are required to provide monthly returns on harvest activity. In these returns fishers may also provide supplementary information on the species harvested, the weight of each species harvested, the location of the harvesting activity, the method used to collect the resource, the method used to process the resource, the use made of the resource and the volume of each product sold. Currently, there are no annual stock assessments by SARDI for the Beach-Cast Seagrass and Marine Algae Fishery. A summary of fisheries data and biological parameters was completed by PIRSA in 2014 (PIRSA 2014b). While such information is confidential under provisions in the Act the data have been published with consent of the licence holders (see below).

Internationally there have been a number of studies which can be used to provide some broad parameters for an assessment of the macro-algal wrack harvest, although there is no such research from South Australia. The dangers of over-exploitation of wracks do not apply to the wracks themselves, but rather to the organisms and communities that are dependent upon it as a source of nutrients, food, shelter, and refuge. There are also no historical records of biomass, composition or turnover rates for wracks on any beach in the State. Moreover, any assessment of wrack abundance is problematic because of the highly patchy and mobile nature of the resource (McClary *et al.* 2005). Thus, estimating the amount of wrack available from any coastal region is problematic because wracks are patchily distributed across sites and between seasons (Kendrick *et al.* 1995; Duong 2008). In the absence of this scientific data and because of concerns regarding the possible impact on coastal fisheries and the environment from the removal of

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<sup>2</sup> Historically harvest tonnages from the SA macro-algal fishery are only around 1/25<sup>th</sup> of the harvest tonnages taken from the King Island southern bull-kelp fishery.

wrack accumulations, PIRSA has adopted a 'precautionary approach' to the harvesting of wrack. Harvest levels have fluctuated over the life of the fishery with variation in wrack availability dependant on storms and market requirements.

Irrespective of an absolute estimate for the sustainable harvest level international best practice for wrack fisheries recommends that harvest rates should not exceed 50% of the total wrack biomass. On this basis the spatial management strategy that has been implemented for this fishery is intended to ensure that this outcome is achieved.

### 3.3.2 Commercial Harvesting

#### Commercial Licencing

Licence conditions specify methods of access and harvesting and any relevant restrictions on harvesting activities considered necessary by PIRSA Fisheries and Aquaculture are developed in consultation with other State agencies such as the Department of Environment, Water and Natural Resources (DEWNR), Department for Manufacturing, Innovation, Trade, Resources and Energy (DMITRE), and the Department of Planning, Transport and Infrastructure (DPTI).

PIRSA Fisheries and Aquaculture has amended the licence conditions for Licence Y078 to ensure that harvesting meets with the requirements to ensure sustainable harvesting in this region. These changes to licence conditions now mean that macro-algal beach wrack<sup>3</sup> will be harvested from all accessible sandy and/or pebble beach areas within the coastal region defined in Figure 2 but specifically excluding:

1. All areas within an Aquatic Reserve proclaimed under the *Fisheries Management Act 2007* (noting that there are currently no such areas in the area covered by the licences);
2. All areas within a Marine Park that have been zoned as Habitat Protection, Sanctuary or Special Use Zones (noting that there are currently no such areas in the area covered by the licences);
3. Any beach adjacent to a designated terrestrial reserve (including any Conservation Reserve or National Park);
4. Additional exclusions Zones that are defined in the licence conditions that comprise 25% of the area otherwise available for harvesting. These have been chosen to include priority areas such that:
  - a. Areas that are otherwise inaccessible through a lack of made roads or tracks;
  - b. All rocky intertidal areas where the substratum comprises a consolidated rock platform.
  - c. An area within 100 m of a creek or other water course that flows onto or across the beach and that is not otherwise excluded by virtue of 1-2 above;
  - d. Areas which have been identified as being of environmental significance (e.g. due to bird habitat).

The attached map (Figure 2) comprises an overview of the area that is available for harvesting (green zones) and those areas that are otherwise excluded from harvesting due to adjacency to a Conservation Reserve or National Park (grey zones) or through the application of additional exclusion zones (red zones).

Within each beach section where harvesting is permitted (green zones), wrack harvests will be conducted between low water mark and up to a point no closer than 4 m from the toe of any dunes or any dune vegetation whichever reaches farthest down the beach profile. Otherwise harvests will include all areas from the low water mark up to the base of any cliff, fence, road or other structure that backs the beach. This prescription is explicitly intended to ensure protection of nests and to minimise other disturbance of shore nesting and / or feeding birds particularly the Hooded Plover.

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<sup>3</sup> Beach wrack is defined as the organic material such as kelp and seagrass that is cast up onto a beach. This definition is very broad and is often taken to include all marine algae as well as any other organic detritus (including dead fish, birds and driftwood). For the purposes of this application the harvest is explicitly focussed on marine macroalgal material and there is no intention to harvest either seagrasses or other organic detritus.

### Commercial Harvesting

Algae are collected using “forwarders” with a specially modified grapple that will allow harvests of larger specimens with minimal sand collection. These machines have been modified from those used in the timber industry and are favoured for their capacity to spread their weight widely and evenly on soft terrain, thereby minimising compression of the underlying sediments. Collected material is loaded onto trucks or trailers for removal. No equipment is left unattended on a beach or overnight and all maintenance activities, including refuelling, are conducted either at the harvesting vehicle storage area or in the designated carpark adjacent to the target beach.

Local councils may also choose to restrict vehicle access to the beach; this includes hours of operation and restricting beach access to existing formalised ramps or tracks. Normal road rules apply on the beach and vehicles must be registered.

Under previous management arrangements there was some ambiguity about how the harvest was to be managed in relation to the use of exclusion zones. The intent of the exclusion zones was to provide a limit of 75% to the amount of material that could be harvested from a beach during a given harvest event. It has been suggested through the public consultation processes that this is open to interpretation such that an area that is left un-harvested on one day could be harvested on another. To address this issue PIRSA Fisheries and Aquaculture are proposing to change the management arrangements such that:

- 1) Permanent exclusion zones have been identified where harvesting is never allowed.
- 2) The extent of these exclusion zones, when combined with the extent of areas from which harvesting is otherwise excluded (e.g. adjacent to designated Parks and Reserves), is now limited to 50% of the total beach extent (across the Licence area).
- 3) In all cases exclusion zones run continuously from the low water mark to the fore-dune or scrub within the area.

The effect of these changes will be to bring the harvest of wracks in South Australia in line with international best-practice by ensuring that there are areas on every beach which will forever remain unharvested and where natural ecological processes and cycles can progress uninterrupted. Secondly, the provisions ensure that even if 100% of the biomass was to be removed from accessible areas the total biomass removal would be kept to no more than 50%, which is considered to be the maximum value for ecologically sustainable wrack fisheries (Orr 2013).

The use of exclusion zones is seen by PIRSA Fisheries and Aquaculture to be a superior strategy to simply limiting the total allowable catch for sustainable management of the wrack fishery. The reasons for this are as follows:

- 1) The value of leaving sections of every beach with undisturbed wracks has been demonstrated in recent work undertaken in the USA by NOAA Sea Grant (Dugan 2014). Dugan (2014) reported that the removal of all beach wrack from “Groomed beaches” (i.e. those swept clean for aesthetic purposes) is likely to result in a number of detrimental changes to beaches including:
  - Dramatically fewer beach hoppers, predatory beetles and other small creatures that hide under and feed on wrack;
  - Fewer native plants that trap windblown sand;
  - Fewer hummocks (low mounds of sand formed by wind);
  - Fewer areas for shorebirds to nest and feed;
  - Conversion of coastal strand habitat to barren sand with loss of dune formation; and
  - Loss of nutrients that would otherwise support coastal and near-shore ecological processes.

In recognition of the importance played by beach wrack in modulating these various biophysical processes in coastal and near-shore ecosystems Dugan (2014) recommended that managers should *“Create no-grooming zones, within which wrack can remain on some sections of the beach year round”*.

- 2) The alternative of limiting catch on the basis of a percentage of total available wrack across the entire beach means that there is potential for every section of a beach to be disturbed, at some level, from harvesting; the use of an exclusion zone strategy prevents this.
- 3) A spatial harvesting strategy will ensure that no single species is totally removed from the wrack across the entire coastal extent due to selective picking of desired species across all wrack piles. Given that it is not yet known whether any particular species plays a more important ecological role in beach-cast macro-algal wracks, the use of the exclusion zones will ensure that there are some areas where all wrack species persist.
- 4) A spatial harvesting strategy will substantially improve compliance programs by providing a greater certainty for harvesters, regulatory agencies and the community about where harvesting activities are allowed and where they are not allowed.

Historically the quantity of wrack harvested from Y078 has been very small by comparison to other wrack fisheries, comprising an annual average harvest of 79 tonnes (over the period 2002 to 2012) and a maximum harvest of 305 tonnes (2008). This demonstrates that the current fishery is operating as a cottage industry in comparison to, for example, the King Island southern bull-kelp harvest which historically averages around 2,500 tonne per annum with a maximum harvest in recent years of 4,000 tonne.

This comparison throws this fishery into a stark contrast; the harvest volumes (and one can argue the concomitant ecological impact associated with harvest activities and wrack removal) is only 3% the size of the King Island harvest (which has operated sustainably since the middle 1970's). On this basis, and after taking account of the changes to the licence conditions (to include a spatially explicit management strategy that acts as an input measure to limit harvest volumes), it is argued that the fishery is able to meet the requirements for export approval.

### Commercial Utilisation

Wrack harvesting has the potential to produce exportable, value-added primary products and thus improve local regional economies. Some of these products may eventually replace existing imported goods. Marine algae are harvested for a variety of uses throughout Australia and overseas while seagrass wrack is commonly stored in paddocks and allowed to decompose for several years before it is suitable for use as a soil improver or as garden mulch (Kirkman & Kendrick 1997). Macroalgae are processed immediately either via composting or by drying on outdoor racks and crushing. The principal use of harvested algae is in the production of hydrocolloids (particularly alginates, agars and carrageenans) although algal derivatives may also be used as a feed source for abalone aquaculture, for the extraction of mineral supplements, as cattle feed, garden fertilisers and pesticides (Colombini & Chelazzi 2003). There is moderate demand for wrack material to supply the domestic market and harvesters have developed products for overseas export.

#### 3.3.3 Amenity Clearance

The decomposition process of wrack often produces hydrogen sulphide gas, which has a highly unpleasant odour and attracts plagues of beach flies (Kirkman & Kendrick 1997). Additionally, excessive accumulation of wrack may create hazards or limit access to specific areas such as boat ramps or marinas. Metropolitan and District Councils are therefore interested in removing wracks from beaches, which are recognised as important local tourism assets, as well as at specific sites where wracks are regarded as a problem. This has the potential of "cleaning up and beautifying" popular tourist beaches and thereby benefiting both local residents and visitors.

Ministerial exemptions have been issued in the past by PIRSA Fisheries and Aquaculture to local councils, including Ceduna District Council, Corporation of the City of Whyalla, and Kingston Regional Council, to clear wrack accumulations. Currently, DEWNR is involved in the management of wrack removal for amenity purposes. In November 2013, PIRSA notified local coastal councils that any enquiries regarding the movement of wrack for an amenity purpose should be directed to DEWNR.



### 3.3.4 Recreational Harvesting

Members of the public often seek to obtain small amounts of beach-cast wrack, for use as 'mulch' or fertiliser on domestic gardens. Decisions relating to recreational (non-commercial) harvest of wrack are the responsibility of the relevant Local Government Authority, where enabled through regulation. In some cases, local by-laws exist which prohibit this without Council permission. In the past these requests have generally been granted, provided the material is harvested by hand, only small quantities are collected, and this is strictly a non-commercial activity. In a few cases, where the Council believes it is detrimental to the shoreline, this activity is either discouraged or actively prohibited. The recreational harvest of wrack from within commercial harvest areas is allowed but must be approved by the local Council due to beach access restrictions. PIRSA Fisheries and Aquaculture has recommended to coastal councils that they should contact DEWNR for recreational wrack harvest management advice. There is currently no estimate of product taken recreationally but this is considered to be a very small amount.

### 3.3.5 Aboriginal Traditional Harvesting

Currently none of the Miscellaneous Fishery Licence holders that are entitled to take wrack are Aboriginal traditional fishers. There are also no known documented historical accounts of Aboriginal traditional use of wrack. The State, Native Title parties and the commercial fishing industry are currently involved in negotiations of Indigenous Land Use Agreements (ILUAs) with a view to resolving native title claims. The future involvement in existing commercial fisheries by Aboriginal traditional fishers or communities may be considered in this process.

### 3.3.6 Illegal Catch

The illegal harvest of beach-cast seagrass and marine algae wrack is considered to be a negligible risk. South Australia has fisheries compliance resources to address any illegal activities. To date there have been no prosecutions for offences in the fishery.

## 3.4 Biological Characteristics

### 3.4.1 Seagrasses

As detailed above the removal of seagrass wrack for amenity purposes is not considered to be part of the macro-algal beach wrack fishery. Further information on seagrasses in Australia and the nature of the wrack have been dealt with elsewhere (PIRSA 2014b).

### 3.4.2 Macro-algae

The marine macro-algal diversity of temperate Australia is one of the richest in the world, with approximately 123 species of Chlorophyta (green algae), 203 species of Phaeophyta (brown algae) and over 800 species of Rhodophyta (red algae) recorded within southern Australian waters (Womersley 1984, 1987, 1994, 1996, 1998); many of these macro-algal species are endemic to the region.

Given this diversity, the accumulation and composition of beach wrack can be highly variable (e.g. DEH 2004, Colombini and Chelazzi 2003, Dugan *et al.* 2011, PIRSA 2014a) and any harvest may be taxonomically diverse such that information on the distribution of any individual or group of species is unlikely to be informative. However, the harvest area includes a section of coast that abuts the western extent of what was traditionally called the Maugean Marine Biogeographical Sub-province (Womersley 1990). More recently, the marine bioregionalisation has been revised in a manner which largely reflects the cumulative distribution patterns of pelagic and demersal fishes, marine plants and invertebrates (IMCRA version 4; Commonwealth of Australia, 2006). Within the context of IMCRA 4.0 the Maugean Sub-province is largely congruent in its South Australian extent with the Otway Bioregion but also extends across the Victorian coastline, the western and eastern Bass Strait and Tasmanian coastal regions through to the Twofold Shelf region into Southern NSW. The area specifically relating to macro-algal wrack harvests in South Australia (licence Y078) is almost entirely within the Otway Bioregion whilst the seagrass harvests from Kingston are located close to the southern extent of the Coorong Bioregion.

Cape Jaffa in the southeast of South Australia represents the westerly limit of the Maugean sub-province (and Otway Bioregion) and as such this is also the westerly limit in the distribution of a number of key

macro-algal taxa including the large kelp (*Macrocystis pyrifera*) and the southern bull kelp<sup>4</sup> (*Durvillaea potatorum*). Within the Maugean sub-province, higher energy rocky intertidal and sublittoral fringes are typically dominated by southern bull kelp (*Durvillaea potatorum*) while subtidal reefs include numerous species of foliaceous red, brown and green macro-algae but tend to be visually dominated by species of the giant kelp (*Macrocystis pyrifera*<sup>5</sup>), the kelp (*Ecklonia radiata*) as well as a large variety of fucalean macro-algal species (IMCRA 1997, Edyvane 1999a, b) including species of *Cystophora* and *Sargassum* as well as the Seirococcacean species (*Phyllospora comosa*, *Seirococcus axilaris* and *Scytothalia dorycarpa*).

Macro-algae grow on shallow rocky substrates and are common on the numerous inshore limestone reefs that dot the coastline of South Australia. Some species, particularly *Durvillaea* and the kelps, grow to very large size and form dense beds from the sub-littoral fringe and into the subtidal. During storms and periods of strong winds, large numbers of these macro-algae are torn off or fragmented by wave action and later washed up on beaches. The supply of cast algae, like seagrass, is highly variable over short time and spatial scales, but is most predominant in winter when very large accumulations may occur. Various seaweed species are found within algal beach wracks; their abundance varies depending on location and the source of the material (Duong 2008). The species that are targeted by the fishery are primarily several large brown algae (including *Durvillaea potatorum* and *Ecklonia radiata*) and some of the red algae such as *Gracilaria*.

### 3.4.3 Nutrient Cycling and Food Webs

Several studies, most notably in South Australia, Western Australia and South Africa, have highlighted the importance of beach-cast seagrass and macro-algal accumulations as sources of detritus and of particulate and dissolved nutrients which form the basis of beach and inshore marine foodwebs (e.g. Griffiths & Stenton-Dozey 1981; Koop & Griffiths 1982; Lenanton *et al.* 1982; Robertson & Hansen 1982; Griffiths *et al.* 1983; Duong 2008). Wracks of dead seagrass and algal material are physically broken down by wave and sand abrasion and are biologically decomposed by the action of bacteria and small invertebrates. Decomposition by bacteria releases nitrogen and phosphorous - nutrients necessary for the growth of offshore seagrass meadows (Bell 1983). In Western Australia, substantially higher concentrations of dissolved nutrients were measured in waters adjacent to beaches covered in decaying wrack material compared with wrack-free beaches, where waters were relatively nutrient- deficient (Bell 1983).

A rich community of detritivores, such as amphipods, isopods (sandflies), coleoptera (beetles) and diptera (flies) rapidly colonises and consumes the decaying vegetation, breaking it down into detritus and particulate carbon (e.g. Griffiths & Stenton-Dozey 1981; Marsden 1991; Duong 2008; Orr 2013). Griffiths, Stenton-Dozey & Koop (1983) for example recorded 35 species amongst kelp wrack of which 22 were insects, which together amounted to more than 97% of the total intertidal faunal biomass. These organisms can reduce the biomass of dead macro-algae to 50% of its initial weight after 2 days and 20% after 14 days, mainly due to consumption by amphipods and dipteran (kelp fly) larvae (Griffiths & Stenton-Dozey 1981; Rieper-Kirchner 1990). Several species of beach flies complete their life cycles within

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<sup>4</sup> Although commonly called bull-kelp, *Durvillaea* is more appropriately called **southern** bull-kelp to differentiate it from species of *Nereocystis* (which is the northern bull-kelp). In fact, *Durvillaea* is not actually a kelp; kelps are brown algae in the order Laminariales while *Durvillaea* was historically placed in its own order (the Durvillaeales) but more recently has been classified into the family Durvillaeaceae within the order Fucales. *Durvillaea* has a direct life cycle, which is one distinguishing feature of the Fucales, but unlike other members of the order it has a diffuse (although apically dominated) meristem.

<sup>5</sup> Previously the western form of giant kelp found in Australia was known as *Macrocystis angustifolia* and it was therefore defined as a different species to *Macrocystis pyrifera* (the form that is broadly distributed around King Island, Victoria and Tasmanian coasts). More recently the genus *Macrocystis* has been revised (Demes *et al.* 2009) and the South Australia form (formerly classified as *Macrocystis angustifolia*) has been merged with *Macrocystis pyrifera*.

seagrass/algal wrack (Blanche 1992 in Kendrick *et al.* 1995; Duong 2008). The herbivorous detritivores are in turn preyed upon by beach-dwelling macrofauna such as beetles, birds and isopods (Duong 2008). Griffiths *et al.* (1983) suggest that at some sites on the southwest coast of South Africa, approximately 95% of the food supply of beach macrofauna comes from the regular, enormous influxes of kelp. Duong (2008) found that algal wrack in South Australia, particularly brown algae including kelps, appeared to be a potential source of nutrition for beach and nearshore consumers such as amphipods and dipterans.

Particulate and dissolved carbon and other organic matter released from wracks by bacteria may either remain *in situ* and enter the sand column as a source of nutrients to interstitial fauna, or be leached back into the sea at high tide to support detrital-based benthic communities. Very high concentrations of dissolved organic matter have been recorded in sand below beach-cast kelp and this in turn supports a high biomass of interstitial meiofauna (Koop & Griffiths 1982; Rieper-Kirchner 1990). Peak numbers of nematodes and oligochaetes, for example, often occur beneath rotting seaweed (Koop & Griffiths 1982).

Moreover, nutrients, detritus, particulate carbon, bacteria and prey organisms in wracks are often transported by wave action into the surf zone where they serve as an important food source for particulate suspension (filter) feeders, crustaceans, molluscs and fish (Kirkman & Kendrick 1997; Duong 2008). For example, work by Lenanton *et al.* (1982) demonstrated that the main prey item of the juveniles of many important commercial fish species such as School Whiting (*Sillago bassensis*), Yellow-eyed Mullet (*Aldrichetta forsteri*) and Australian Herring (*Arripis georgianus*) is the amphipod *Allorchestes compressa* which lives exclusively on detached macrophytes on the beach and in the surf zone.

Detritus from wracks can also be exported offshore to supply food to demersal and abyssal fauna (Suchanek *et al.* 1985 in Thresher *et al.* 1992; Joselyn *et al.* 1983 in Kendrick *et al.* 1995). In addition, work in Tasmania (Thresher *et al.* 1992) strongly suggests that "it might also constitute a widespread and potentially important source of productivity for planktonic ecosystems as well". These authors found evidence that the food chain supporting first-feeding larvae of Tasmanian Blue Grenadier (*Macruronus novaezelandiae*) - the dominant nektonic (midwater) predator of the region - is based on microbial decomposition of seagrass detritus. First, feeding is often maintained to be a critical period for fish larval survival. Moreover, higher rates of larval growth were associated with periods of frequent winter storms, when offshore transport of seagrass detritus from coastal wrack accumulations is at a maximum (Thresher *et al.* 1992). Thus, the export of detrital material from wracks may significantly affect the reproductive success of one of temperate Australia's dominant fish predators (Thresher *et al.* 1992).

The wrack community therefore constitutes a significant food resource consisting of fragments of seaweed and seagrasses, bacteria, meiofauna and beach macrofauna. It may remain *in situ*, providing food for terrestrial detritivores and consumers (including insects and birds) or it may be washed back into the sea during storm or high tide events, where it provides food for benthic coastal communities and important feeding sites for shallow water fish species. Particulate matter from the breakdown of wracks also appears to have a direct effect on offshore secondary production.

#### 3.4.4 Birds

Many shorebirds and seabirds are associated with wrack accumulations (Appendix 2 provides a summary of the distributional information for selected species including Sanderlings, Double banded plovers, Curlew sandpipers, Red-necked stints, Pacific golden plovers, Sharp-tailed sandpipers, Ruddy turnstones, Hooded plovers and Orange bellied parrots). These birds make use of the beach-cast vegetation for a variety of purposes including nesting, shelter during strong winds or storms and camouflage while resting (Campbell & Anderson 2007). A large number of shorebirds also prey upon wrack-inhabiting organisms and constitute an important food resource. This includes the hooded plover (*Thinornis rubricollis*), listed as vulnerable under South Australia's *National Parks and Wildlife Act 1972*, which feeds on wrack-inhabiting crustaceans, insects and polychaetes (Kendrick *et al.* 1995). In Western Australia, decomposing wrack provides an important winter food source for silver gulls, which feed on kelp fly larvae and amphipods and may time their breeding cycle to coincide with the local availability of wrack (Kendrick *et al.* 1995). On King Island, ruddy turnstones and double-banded plovers are amongst the birds that forage in the bull kelp for



small invertebrates. These species have all been recorded feeding in beach-cast vegetation in South Australia.

Wrack accumulations provide protection and camouflage for nest-sites, eggs, chicks and adults alike (McCulloch 1996; Campbell & Anderson 2007).

In South Australia, a total of 40 species of birds have been recorded utilising beach-cast wrack in some way (McCulloch 1996). This includes long-distance migratory birds, waiting out the tide or bad weather in the lee of wrack accumulations, as well as many resident species. Wracks thus constitute a valuable component of bird habitat (McCulloch 1996).

The orange-bellied parrot (*Neophema chrysogaster*) migrates from breeding grounds in Tasmania to coastal areas in Victoria and south east South Australia in each summer period. It usually frequents the dune and coastal scrubs feeding on the vegetation along the coast. This bird is classified as Critically Endangered under the *EPBC Act*, Threatened under the *Victorian Flora and Fauna Guarantee Act 1988*, Endangered under the *Tasmanian Threatened Species Protection Act 1995*, Endangered under the *South Australian National Parks and Wildlife Act 1972*, and Critically Endangered under the *New South Wales Threatened Species Conservation Act 1995*. A Recovery Plan jointly managed by the Commonwealth, Victoria, South Australia, New South Wales and Tasmania has been developed (Orange-bellied Parrot Recovery Team 2006). This species is now listed internationally as critically endangered with a wild population that is believed to number fewer than 50 birds (ref).

### 3.4.5 Coastal Geomorphology

In contrast to macro-algae, which are subject to very rapid deterioration, seagrasses are composed primarily of cellulose fibre with characteristics that inhibit breakdown of the vegetative matter. Beach-cast seagrass accumulations are therefore typically long-lived, taking as many as 3 - 5 years to fully decompose into detrital matter. As a result, seagrass wrack may accumulate to a height of several metres and serve as a physical barrier between the sea and the dune system, reducing wave energy and providing a degree of protection to the foreshore.

Seagrass wracks also enhance the formation and stabilisation of coastal sand dunes and beaches, their fibrous composition acting as a trap to bind drifting sands and reduce sand erosion in winter. They may also contribute to the fertility and stability of substrates behind the foredunes.

## 3.5 Management of the Fishery

### 3.5.1 Current Management Regime

The *Fisheries Management Act 2007* provides the broad statutory framework to ensure the management and ecologically sustainable development of South Australia's aquatic resources.

South Australia has management jurisdiction for beach-cast seagrass and macroalgae from the toe of the fore-dune to the low water mark and for seagrass and macroalgae out to 200 nautical miles, in the waters adjacent to South Australia, under an Offshore Constitutional Agreement between the South Australian and Commonwealth governments.

The regulations that govern the management of the South Australian Beach-Cast Seagrass and Marine Algae Fishery are established in the *Fisheries Management (Miscellaneous Fishery) Regulations 2000* and the *Fisheries Management (General) Regulations 2007*. A set of licence conditions is listed on each Miscellaneous Fishery licence. In relation to the licence, the Minister reserves the right to amend licence conditions and entitlements for the South Australian Beach-Cast Marine Algae Fishery if required to meet sustainability objectives of the *Fisheries Management Act 2007*.

In the future, exploratory and developmental fishing permits for the harvest of beach-cast marine algae in areas not already assigned to either of the existing two Miscellaneous Fishery licence holders may be granted. These permits will additionally be governed through the recently implemented *Fisheries*

*Management (Miscellaneous Developmental Fishery) Regulations 2013*. PIRSA has not issued any permits for exploratory and developmental wrack harvest.

### 3.5.2 Context of the Act

Section 3 of the Act defines terms used within the Act, including aquatic resources. The following definitions are included:

**‘aquatic resource** means fish or aquatic plants’

**‘aquatic resources of the State** means aquatic resources of the waters to which this Act applies but does not include aquatic resources being farmed under an aquaculture licence”

**‘aquatic animal** means an aquatic animal of any species, and includes the reproductive products and body parts of an aquatic animal’

**‘fish** means an aquatic animal other than—

(a) an aquatic bird, an aquatic mammal, a reptile or an amphibian; or

(b) an aquatic animal of a kind declared by the regulations to be excluded from the ambit of this definition’

The taking of all, or any part of, a ‘fish’, is conducted under the provisions of the Act, which is administered by PIRSA. The Act endeavours to ensure the sustainable development of the living aquatic resources of the State. The legislative regime supporting this process is as follows:

In the administration of the Act, the Minister for Agriculture, Food and Fisheries, the Executive Director of Fisheries and the Fisheries Council of South Australia must pursue the following objectives, outlined in Section 7 of the Act:

Section 7 of the Act states:

7 (1) An object of this Act is to protect, manage, use and develop the aquatic resources of the State in a manner that is consistent with ecologically sustainable development and, to that end, the following principles apply:

(a) proper conservation and management measures are to be implemented to protect the aquatic resources of the State from over-exploitation and ensure that those resources are not endangered;

(b) access to the aquatic resources of the State is to be allocated between users of the resources in a manner that achieves optimum utilisation and equitable distribution of those resources to the benefit of the community;

(c) aquatic habitats are to be protected and conserved, and aquatic ecosystems and genetic diversity are to be maintained and enhanced;

(d) recreational fishing and commercial fishing activities are to be fostered for the benefit of the whole community;

(e) the participation of users of the aquatic resources of the State, and of the community more generally, in the management of fisheries is to be encouraged.

(2) The principle set out in subsection (1)(a) has priority over the other principles.

(3) A further object of this Act is that the aquatic resources of the State are to be managed in an efficient and cost effective manner and targets set for the recovery of management costs.

(4) The Minister, the Executive Director, the Council, the ERD Court and other persons or bodies involved in the administration of this Act, and any other person or body required to consider the operation or application of this Act (whether acting under this Act or another Act), must—

(a) act consistently with, and seek to further the objects of, this Act; and

(b) insofar as this Act applies to the Adelaide Dolphin Sanctuary, seek to further the objects and objectives of the *Adelaide Dolphin Sanctuary Act 2005*; and

(c) insofar as this Act applies to the River Murray, seek to further the objects of the *River Murray Act 2003* and the *Objectives for a Healthy River Murray* under that Act; and

(d) insofar as this Act applies to areas within a marine park, seek to further the objects of the *Marine Parks Act 2007*.

(5) For the purposes of subsection (1), **ecologically sustainable development** comprises the use, conservation, development and enhancement of the aquatic resources of the State in a way, and at a rate, that will enable people and communities to provide for their economic, social and physical well-being while—

(a) sustaining the potential of aquatic resources of the State to meet the reasonably foreseeable needs of future generations; and

(b) safeguarding the life-supporting capacity of the aquatic resources of the State; and

(c) avoiding, remedying or mitigating adverse effects of activities on the aquatic resources of the State,

(taking into account the principle that if there are threats of serious or irreversible damage to the aquatic resources of the State, lack of full scientific certainty should not be used as a reason for postponing measures to prevent such damage).

PIRSA achieves these objectives, in part by:

- the development of management arrangements for aquatic resources in consultation with stakeholders; and
- monitoring and promoting community compliance with legislation and regulations.

### 3.5.3 Licence Conditions

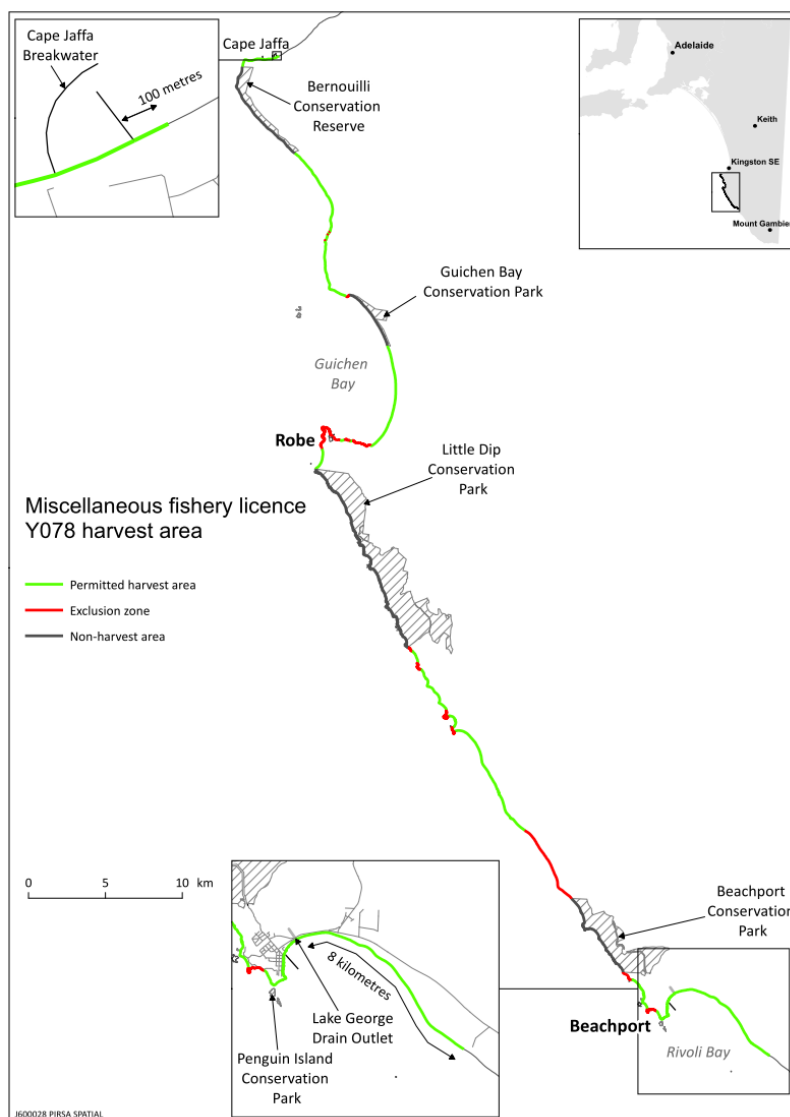
Access to the commercial fishery is provided through a licence for the Miscellaneous Fishery. There are only two non-transferrable Miscellaneous Fishery licences and only one (Licence Y078) which permits the harvest of macro-algal wrack in South Australia for commercial purposes. Both licences are subject to the following conditions:

- The licence holder may nominate a maximum of two (2) agents who may conduct harvesting activity pursuant to this licence, subject to the requirement that a nomination must be made in writing to the Director of Fisheries and receipt of that nomination acknowledged by the Director of Fisheries prior to an agent conducting any harvesting activity.
- The licence holder may only disturb unattached beach-cast seagrass and macro-algae wrack during the harvesting activity.
- The harvesting activity must be designed to avoid the removal of any sand. Sand taken incidental to the harvesting activity is to be returned to the foreshore.

- The licence holder may only harvest beach-cast seagrass and macro-algae wrack pursuant to this licence.
- For the purposes of this licence:
- **"exclusion zone"** means a subsection of an area in which no harvesting activity is conducted, and which runs continuously from the low water mark to the fore-dune or scrub within the area; and **"harvesting activity"** means the act of taking beach-cast seagrass and macro-algae wrack, or an act preparatory to, or involved in, the taking of beach-cast seagrass and macro-algae wrack.

Licence conditions for Y078 (which is used for commercial macro-algal harvest rather than amenity clearance) stipulate specific areas which are available for harvest (note that the licence conditions will be amended consistent with the advice in this document to ensure greater levels of protection to coastal habitats). Licence conditions will be amended to:

1. The licence holder may harvest beach cast macro-algal wrack from the foreshore between the high water mark and the low water mark of coastal beaches in the area between a point on the shore 100 metres east of the northern breakwater at Cape Jaffa Marina and a point eight (8) kilometres in a south easterly direction along the beach from the Lake George outlet, subject to the following conditions:
  - a) Areas of coastline that are adjacent to terrestrial conservation parks and reserves are excluded from harvesting; and
  - b) No harvesting activity may be conducted in an area of an aquatic reserve proclaimed under the *Fisheries Management Act 2007* or an area of a Marine Park zoned as a Habitat Protection Zone, a Sanctuary Zone or a Special Use Area (unless otherwise permitted) under the *Marine Parks Act 2007*; and
  - c) Along all the remaining coastal extent a series of harvest 'exclusion zones' have been identified such that no more than 50% of the total beach extent within the licence area is available for harvest. Absolute geo-referencing for each exclusion zone will be published as an Appendix to the licence. Areas of beach allocated to exclusion zones will be chose such that these zones incorporate:
    - i. Areas that are otherwise inaccessible; and
    - ii. Areas that, under advice from DEWNR, are important bird habitats; and
    - iii. Other areas, as required to make up the totals to 50% of the total beach extent.
2. Within the areas where harvesting is permitted all macro-algal material may be harvested.
3. Within the exclusion zones no harvesting is permitted although harvest vehicles may transit through the areas in order to transport material or equipment to and from areas where harvesting is permitted.
4. Where sand dunes are present no harvesting activity is to take place within four metres of the fore dune.



**Figure 2 –Miscellaneous fishery licence Y078 harvest area.** The solid green lines represents the areas where harvesting is possible noting that these areas are interspersed with exclusion zones that are adjacent to parks and reserves (grey line) and additional areas selected to provide ungroomed areas that complement the existing management arrangements or that are interspersed across beaches that would otherwise be available for harvesting.

In summary, the harvest area for licence Y078 comprises 101.6 km of coastline (Figure 2). Within this coastal extent, areas excluded from harvesting comprise 34 km which are adjacent to conservation parks or reserves (coast delineated in grey on Figure 2) leaving a balance of 67.6 km which is nominally available for harvest. Within this 67.6 km extent a further 17.0 km (coast delineated in red on Figure 2) is removed from harvesting in order to limit harvesting to 50% of the total coastal extent. This 17.0 km has been chosen to complement existing arrangements (e.g. extend protection to shorebird feeding areas to the north of Beachport Conservation Park; Figure 2) and to ensure that there are areas of beach that are “un-groomed” and thereby free of harvests. In total therefore 50.6 km of beach across this licence area is available for harvesting (coast delineated in green on Figure 2) which comprises 49.8% of the total beach extent.

It is notable that even if all macroalgal material were to be removed from the “accessible” beach extent and assuming that over time there is a roughly equal distribution of harvestable seaweed across the coastal extent of Y078, then this would still limit the harvest from the licence area to 50% of the nominal biomass. In practice it is highly improbable that all material could ever be removed. Harvesters cannot

service all beach areas over the timeframe during which algae arrives on the beach in a fresh and usable condition and a lot of material degrades before a harvester can schedule a collection. For operational efficiencies harvesting only occurs when large volumes of material are available and this is very much an *ad-hoc* event driven by weather and particularly storm activity. In such circumstances some areas may be harvested intensively but it is virtually impossible to conceive of a situation when all material could be routinely removed from the beach.

It is not possible, at this time, to provide estimates of how much material might actually be harvested; this is an area where ongoing monitoring will provide data. Notwithstanding the historical harvest from this licence area has average 80 tonne per annum with a maximum harvest of 305 tonnes. The current scale of this harvest therefore amounts to a very small “cottage” industry when compared to other operations in Australia or around the world.

### 3.5.4 Management Regime Requirements

When addressing the Guidelines for the Ecologically Sustainable Management of Fisheries 2nd Edition the management regime developed by PIRSA included the following:

Table 1: Requirements of a management regime for assessment against the Guidelines for the Ecologically Sustainable Management of Fisheries 2nd Edition.

The management regime does not have to be a formal statutory fishery management plan as such, and may include non-statutory management arrangements or management policies and programs. The regime should:	
<ul style="list-style-type: none"> <li>Be documented, publicly available and transparent</li> </ul>	The <i>Fisheries Management Act 2007</i> , <i>Fisheries Management (Miscellaneous Fishery) Regulations 2000</i> , <i>Fisheries Management (General) Regulations 2007</i> , <i>Fisheries Management (Miscellaneous Developmental Fishery) Regulations 2013</i> and set of licence conditions for both licence holders are public documents.
<ul style="list-style-type: none"> <li>Be developed through a consultative process providing opportunity to all interested and affected parties, including the general public</li> </ul>	<p>PIRSA achieves the objectives of the <i>Fisheries Management Act 2007</i> in part by the development of management arrangements for aquatic resources in consultation with stakeholders.</p> <p>In particular this document has been substantially revised to take account of advice from DotE and after a review and incorporation of relevant information obtained through the public consultation process conducted in concert with the previous submission (PIRSA 2014a).</p>
<ul style="list-style-type: none"> <li>Ensure that a range of expertise and community interests are involved in individual fishery management committees and during the stock assessment process</li> </ul>	There is no formal fishery management committee or stock assessment process. The harvesting of wracks is subject to specific restrictions relevant to specific locations. Such restrictions have been developed and will continue to be developed in consultation between PIRSA Fisheries and Aquaculture, DEWNR, DPTI, DMITRE and Local Governments.
<ul style="list-style-type: none"> <li>Be strategic, containing objectives and performance criteria by which</li> </ul>	The management objectives of the fishery are contained within the Act, regulations and licence conditions. Performance of these management objectives is monitored through compliance

the effectiveness of the management arrangements are measured	programs and monthly logbook returns. The use of an explicit spatial management strategy will also facilitate operational management by harvesters and allow a greater level of certainty in compliance investigations.
<ul style="list-style-type: none"> <li>Be capable of controlling the level of harvest in the fishery using input and/or output controls</li> </ul>	The fishery uses an explicit spatial management strategy (input control) which restricts the areas available for harvest. The use of 'exclusion zones' where no harvest is to take place will ensure that harvest rates do not exceed 50% of the estimated total biomass of beach-cast macro-algal wrack.
<ul style="list-style-type: none"> <li>Contain the means of enforcing critical aspects of the management arrangements</li> </ul>	PIRSA Fisheries and Aquaculture has a compliance plan in place for the commercial Miscellaneous Fishery. This plan includes conducting random and targeted inspections at landing, and processor facilities, patrolling areas closed to fishing and collating and analysing intelligence received from the Fishwatch reporting service and stakeholders. The use of the explicit spatial management strategy provides the community with a greater capacity to document and report on licence breaches.
<ul style="list-style-type: none"> <li>Provide for the periodic review of the performance of the fishery management arrangements and the management strategies, objectives and criteria.</li> </ul>	<p>Management arrangements can be reviewed at any time. Licence conditions are reviewed and renewed on an annual basis.</p> <p>In the future, exploratory and developmental fishing permits for the harvest of beach-cast seagrass and macroalgae in areas not already assigned to either of the existing two Miscellaneous Fishery licence holders may be granted. These permits will additionally be governed through the recently implemented <i>Fisheries Management (Miscellaneous Developmental Fishery) Regulations 2013</i>. PIRSA Fisheries and Aquaculture has not issued any permits for exploratory and developmental wrack harvest as yet.</p> <p>PIRSA has determined that should any additional licences for wrack harvest be issued this will trigger a re-assessment of the fishery.</p>
<ul style="list-style-type: none"> <li>Be capable of assessing, monitoring and avoiding, remedying or mitigating any adverse impacts on the wider marine ecosystem in which the target species lives and the fishery operates</li> </ul>	Management arrangements can be reviewed at any time. Licence conditions are reviewed and renewed on an annual basis. No formal ongoing monitoring of ecosystem impacts is carried out. The current licence conditions now effectively use an input control (harvestable beach extent) which effectively limits the amount of wrack that can be harvested to a maximum of 50% of the



	available material. This harvest is monitored through compliance programs and monthly logbook returns which report harvest tonnages and the GPS location of the harvest. By limiting harvest areas through licence conditions, impacts on the wider marine ecosystem are in turn mitigated. There have been no reported interactions with Threatened, Endangered and Protected Species (TEPS) in the Miscellaneous Fishery (Tsolos and Boyle 2013).
<ul style="list-style-type: none"> <li>Requires compliance with relevant threat abatement plans, recovery plans, the National Policy on Fisheries Bycatch, and bycatch action strategies developed under the policy</li> </ul>	The South Australian Beach-Cast Marine Algae Fishery is target-specific and has no bycatch in terms of what is traditionally considered bycatch in marine based fisheries. There is the unavoidable removal of commensal organisms during harvest. However, the low harvest rates and exclusion zones ensure that these species are not threatened. There have been no reported interactions with TEPS in the Miscellaneous Fishery (Tsolos and Boyle 2013).

## 4 ESD Assessment of the Management Regime Against Principles 1 and 2

The following sections of this assessment report are presented to address the “Guidelines for the Ecologically Sustainable Management of Fisheries 2nd Edition.”

**Table 2: PRINCIPLE 1 – A fishery must be conducted in a manner that does not lead to over-fishing, or for those stocks that are over-fished, the fishery must be conducted such that there is a high degree of probability the stock(s) will recover.**

Objective 1: The fishery shall be conducted at catch levels that maintain ecologically viable stock levels at an agreed point or range, with acceptable levels of probability.	
<p>Information requirements</p> <p>1.1.1</p> <p>There is a reliable information collection system in place appropriate to the scale of the fishery. The level of data collection should be based upon an appropriate mix of fishery independent and dependent research and monitoring.</p>	<p>Fishery-Dependent Data</p> <p>Section 56 of the <i>Fisheries Management Act 2007</i> requires that the licence holder must lodge with the Minister periodic returns in accordance with the regulations. Section 16 of the <i>Fisheries Management (Miscellaneous Fishery) Regulations 2000</i> requires that the licence holder must fill out a return, in a form determined by the Minister, in respect of each calendar month. The information is collated by SARDI and is treated confidentially. The following information is requested from the licence holder:</p> <ul style="list-style-type: none"> <li>• A list of the target species harvested<sup>6</sup>.</li> <li>• The weight of the target species harvested.</li> <li>• The exact location (GPS coordinates) of the harvesting activity.</li> <li>• The use made of the resource.</li> <li>• The volume of product sold each month.</li> </ul> <p>If the licence holder fails to submit the monthly catch and effort information, they are in breach of</p>

<sup>6</sup> This recognises that wrack can often contain many different species some of which will require a very high level of taxonomic expertise to identify and that it is not practicable, nor useful, to identify all elements of the harvest to species level although the target species are generally well known and easily identifiable.

	<p>section 56 of the Act and section 16 of the regulations, and may face a fine or expiation fee. This information is available to PIRSA Fisheries and Aquaculture on request, for the monitoring of commercial harvest levels. Currently, there are no annual stock assessments or reports produced by SARDI for beach-cast seagrass and marine algae. A summary of fisheries data and biological parameters was completed by SARDI Aquatic Sciences in 2013 (Ivey <i>et al.</i> 2013) and this has subsequently been updated with a targeted assessment by PIRSA Fisheries and Aquaculture (Chalupa, 2014). While harvest data are confidential under provisions in the Act which restrict the publishing of individual data the licence holder has given permission for the publication of these historical harvest data for the purposes of this assessment (see Chalupa, 2014). Licence holders also complete and lodge with SARDI Aquatic Sciences a TEPS log book when any interactions occur. There have been no reported interactions with TEPS in the Miscellaneous Fishery (Tsolos and Boyle 2013).</p> <p>Fishery-Independent Data</p> <p>Any proposed increase in access or the granting of new licences will be subject to environmental assessments to determine the management arrangements that would be required to ensure that the proposed changes would be ecologically sustainable. The assessment must take into consideration the nature, amount, function and turnover rate of the wrack available at the site. Regard must be given to whether the wrack is persistent or highly mobile and the likelihood and rate of replenishment. This information will be used to determine whether the wrack accumulation may be harvested sustainably from an area according to best available evidence. A consultant engaged by the licence applicant may undertake the assessment, but it must be done according to a prescribed methodology so that it can be verified by PIRSA Fisheries and Aquaculture and DEWNR. The methodology must stipulate the parameters to be measured including area covered, time period, methods of estimating amount of wrack, species composition of wrack, likely impact on beach ecology, and identification of bird nesting or critical habitat.</p> <p>Currently, there is no ongoing fishery-independent monitoring, however new licensing arrangements may provide a basis for this to be undertaken.</p>
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<p>Assessment</p> <p>1.1.2</p> <p>There is a robust assessment of the dynamics and status of the species/fishery and periodic review of the process and the data collected. Assessment should include a process to identify any reduction in biological diversity and/or reproductive capacity. Review should take place at regular intervals but at least every three years<sup>7</sup>.</p> <p>1.1.3</p> <p>The distribution and spatial structure of the stock(s) has been established and factored into management responses.</p> <p>1.1.4</p> <p>There are reliable estimates of all removals, including commercial (landings and discards), recreational and indigenous, from the fished stock. These estimates have been factored into stock assessments and target species catch levels.</p> <p>1.1.5</p> <p>There is a sound estimate of the potential productivity of the fished stock/s and the proportion that could be harvested.</p>	<p>A summary of fisheries data and biological parameters was completed by SARDI Aquatic Sciences in 2013 (Ivey <i>et al.</i> 2013) and recently revised and updated (Chalupa, 2014). The more recent report has been written so that it only contains information about wrack harvesting (licences Y078 and Y080) and although the data are confidential under provisions in the Act which restrict the publishing of individual data these licence holders have authorised the publication of these data. The report (PIRSA 2014b) demonstrated that the fishery is managed conservatively by both national and international standards being very small in comparison to the King Island fishery (which is more than 30 times larger in terms of average harvest tonnage). It also noted that while there is little knowledge of the impact of wrack harvesting on coastal fisheries, the sector is currently very small and geographically localised. There is currently no research basis from which to determine ecologically sustainable beach-cast wrack harvest levels but international best-practice suggests that harvest volumes should not exceed 50% of the available biomass (Orr 2013). The explicit spatial management strategy now employed in this fishery limits the harvest area to 50% of the available coastal extent which is intended to ensure that harvest levels cannot exceed this threshold value. There are also no historical records of wrack biomass, composition or turnover rates for any beach in South Australia. Moreover, any assessment of wrack abundance is problematic because of the highly patchy and mobile nature of the resource.</p> <p>Given the potential impact of wrack harvesting on beach and near-shore environments and the lack of quantitative scientific data from which to establish a sustainable harvest level, there are good commercial and conservation motives for adopting a precautionary and spatially explicit approach to harvesting macro-algal wrack.</p> <p>The wrack is unevenly deposited along the foreshore and the time for which the wrack remains stationary on the beach may be highly variable. Transport back into the subtidal zone by wave action, combined with longshore drift results in changes in wrack biomass at time scales of days and weeks. Thus, averaged amounts of beach wrack calculated for a length of coastline are probably over-estimates as wrack is patchily distributed across sites and between seasons</p>
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<sup>7</sup> Review should be undertaken by the relevant management authority in a transparent way.

	<p>(Kendrick <i>et al.</i> 1995; Duong 2008).</p> <p>Accurate commercial catch reporting has been in place for the fishery since 1997 as part of the legislative requirements of the Act. Licence holders are required to provide data on their fishing activities through monthly catch and effort returns. All information collected in catch and effort returns is entered and stored with the SARDI Aquatic Sciences division. Fishers are requested to provide information on the target species, weight of each target species harvested, exact location of the harvesting activity, method used to collect the resource, method used to process the resource, use made of the resource, and volume of each product sold each month. Given the selective nature of the harvesting method, there is little or no discarding in the fishery.</p> <p>Local Councils and DEWNR are involved in the management of recreational harvest of wrack. There is currently no estimate of product taken recreationally but this is considered to be a very small amount. There are also no known documented historical accounts of Aboriginal use of wrack.</p> <p>Currently, there are no annual stock assessments by SARDI for the Beach-Cast Marine Algae Fishery. A summary of fisheries data and biological parameters was completed by SARDI Aquatic Sciences in 2013 (Ivey <i>et al.</i> 2013) and updated by Chalupa (2014). This information is available to PIRSA Fisheries and Aquaculture and is reviewed periodically to ensure compliance with licence conditions. In light of the difficulties in quantifying the amount of wrack available to harvest, it is felt that the most appropriate approach is to apply the precautionary principle and ensure the level of harvest is contained by limiting the numbers of entitlements with controls on the amount of removal being set through an explicit spatial management strategy. On this basis, the management approach to regulating the fishery is through the use of input controls, such as limiting the number of entrants to the fishery, and implementing licence conditions that explicitly identify the areas available for harvest.</p>
Management responses	<p>Currently there are no formal reference points to trigger management actions and no research basis from which to determine ecologically sustainable beach-cast wrack harvest levels. There are also no historical records of wrack biomass, composition or turnover rates for any beach in</p>

<p>1.1.6</p> <p>There are reference points (target and/or limit), that trigger management actions including a biological bottom line and/or a catch or effort upper limit beyond which the stock should not be taken.<sup>8</sup></p>	<p>South Australia. Moreover, any assessment of wrack abundance is problematic because of the highly patchy and mobile nature of the resource. In light of the difficulties in quantifying the amount of wrack available to harvest, it is felt that the most appropriate approach is to apply the precautionary principle as detailed above.</p>
<p>1.1.7</p> <p>There are management strategies in place capable of controlling the level of take.</p>	<p>The spatial management strategy provides an input control over the level of harvest.</p> <p>The harvesting of wracks is subject to specific restrictions relevant to specific locations. Such restrictions have been developed in consultation between PIRSA Fisheries and Aquaculture, DEWNR, DPTI, DMITRE and Local Governments. Provisions include for the preservation of rare or endangered terrestrial flora and fauna, and the prevention of degradation of foreshores, dunes and coastal vegetation communities. In addition, the local district or metropolitan council can impose restrictions on the timing of harvesting to avoid or minimise conflicts with other beach users.</p>
<p>1.1.8</p> <p>Fishing is conducted in a manner that does not threaten stocks of by-product species. (Guidelines 1.1.1 to 1.1.7 should be applied to by-product species to an appropriate level)</p>	<p>Subject to consultation with DEWNR permission may be granted to coastal councils for the removal of permanent accumulations of wrack at locations where councils can provide appropriate justification (public swimming beaches, boat ramps, recreation areas) for the removal of persistent wrack deposits to improve public amenity values whilst maintaining stability of the beach and dune system.</p>
<p>1.1.9</p> <p>The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.</p>	<p>Commercial fishing</p> <p>Commercial harvest is managed under the <i>Fisheries Management Act 2007</i>, <i>Fisheries Management (Miscellaneous Fishery) Regulations 2000</i>, <i>Fisheries Management (General) Regulations 2007</i>, and licence conditions. Commercial harvest of macroalgae is currently restricted to a single licence holder. Future commercial wrack harvest for proposed new areas will be managed through exploratory and developmental fishing permits under the <i>Fisheries Management (Miscellaneous Developmental Fishery) Regulations 2013</i>.</p>

<sup>8</sup> Reference points can allow for seasonal fluctuations in stock recruitment and other areas of uncertainty.

	<p>Recreational Fishing</p> <p>Members of the public often seek to obtain small amounts of beach-cast seagrass wrack in particular, for use as 'mulch' or fertiliser on domestic gardens. In some cases, local by-laws exist which prohibit this without council permission. These requests have generally been granted, provided the material is harvested by hand and only small quantities are collected. In a few cases, where the council believes it is detrimental to the shoreline, this activity is either discouraged or actively prohibited.</p> <p>Decisions relating to recreational harvests of beach-cast wrack are the responsibility of the relevant Local Government Authority, where enabled through regulation. Such harvest is to remain small-scale and a strictly non-commercial activity. Coastal Councils seeking to authorise recreational collection are encouraged to liaise with DEWNR for management advice.</p> <p>Compliance and Enforcement</p> <p>PIRSA Fishwatch monitors compliance by harvesters of beach-cast seagrass and marine algae. The strategic aim of PIRSA Fishwatch is “to achieve optimal levels of compliance by all fishers”.</p> <p>Optimal compliance is that which holds the level of non-compliance at an acceptable level, which can be maintained at a reasonable cost for compliance services, whilst not compromising the integrity and sustainability of the fisheries resource.</p> <p>Two goals are identified in achieving this strategic aim. These are improved voluntary compliance, whereby fishers are encouraged to voluntarily adopt and support fisheries laws for moral and ethical reasons, and effective deterrence whereby the penalties resulting from illegal activity outweigh benefits gained from that activity.</p> <p>Intelligence is a crucial component of risk management. Intelligence is gathered from field officers, and reports by members of the public, and is reported through the 24-hour Fishwatch hotline (1800 065 522). This offence reporting system has proven effective for other species/fisheries through the number of reports acted upon and a number of resultant</p>
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	<p>convictions.</p> <p>In addition to fisheries compliance obligations, PIRSA Fishwatch communicates with other Government agencies including Police, National Parks, Lands Titles Office, Business Registrar and Commonwealth Government agencies including Customs and Australian Quarantine Inspection Service (AQIS). Communication protocols exist with non-government industries including banking, hire car and real estate agencies.</p> <p>Fisheries officers stationed near state borders or those that participate in interstate operations are cross-authorised with other state fisheries authorities. Fisheries Officers are also cross-authorised under other South Australian Acts of Parliament including:</p> <ul style="list-style-type: none"> <li>• Harbours and Navigation Act</li> <li>• National Parks &amp; Wildlife Act</li> <li>• Historic Shipwrecks Act</li> </ul> <p>Additionally all Police Officers are authorised under the <i>Fisheries Management Act 2007</i>.</p> <p>Management of the fishery by way of input controls significantly reduces the costs and complexities involved with enforcement of regulations and licence conditions. Each licence is to be endorsed with precise information regarding the harvest operation and it is a requirement under the <i>Fisheries Management Act 2007</i> that this licence be carried at all times during harvesting activities in a vehicle being used for the purpose of collecting or transporting wrack. Information contained on the licence will include the specific section of foreshore where harvesting is permitted and the methods of harvesting allowed. The allocated section of foreshore is clearly defined on the licence so there is no ambiguity in interpretation by either harvesters or fisheries compliance officers. Likewise, the material that may be harvested must be clearly identified by name on the licence and any machinery or vehicles used for harvesting must be marked with the licence number in such a way as to be readily observable and identifiable. Compliance officers will carry out random checks of the harvesting operation to ensure that licence conditions are not being breached. Failure of operators to comply with</p>
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	<p>licence conditions may result in prosecution under the <i>Fisheries Management Act 2007</i> and cancellation of the licence. To date there have been no expiations or prosecutions in this fishery.</p> <p>There is no by-product species in this fishery. Licence holders may only harvest beach-cast macro-algal wrack pursuant to their licence. PIRSA Fisheries and Aquaculture monitors a list of the species harvested through the monthly catch and effort log book that each licence holder is required to provide.</p> <p>The continued monitoring and assessment of the fishery coupled with the continued use of management controls, including input controls stipulated on licence conditions, will ensure that this fishery remains sustainable in the long-term.</p> <p>Uncertainties in the biomass available for harvesting (ie the biomass is dependent upon environmental conditions which dislodge the macro-algae) give reason to be particularly cautious at this stage of development of the fishery. Thus, the harvest areas are small and interspersed with exclusion zones. This in itself is a precautionary management response that will ensure that marine algae accumulations are maintained as critical habitat.</p> <p>In the absence of scientific data, and because of concerns regarding the possible impact on coastal fisheries from the regular or over-harvesting of wrack accumulations, PIRSA Fisheries and Aquaculture has always adopted a 'precautionary approach' to the harvesting of beach-cast wracks. As a result, the fishery has been managed conservatively with limited entry, and licence conditions restricting the amount of wrack that can be harvested from an area. However, an increase in requests for permission to harvest wracks at several new locations in South Australia have been received by PIRSA. There has also been pressure from some current harvesters for increased access. In response to the increased interest in wrack harvest, PIRSA Fisheries and Aquaculture have introduced exploratory and developmental fishing permits for the harvest of beach-cast marine algae in areas not already assigned to either of the existing two Miscellaneous Fishery licence holders. These permits will additionally be governed through the recently implemented <i>Fisheries Management (Miscellaneous Developmental Fishery) Regulations 2013</i>. PIRSA has not issued any permits for exploratory and developmental wrack harvest to date.</p>
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Objective 2: Where the fished stock(s) are below a defined reference point, the fishery will be managed to promote recovery to ecologically viable stock levels within nominated timeframes.	
<p>Management responses</p> <p>1.2.1</p> <p>A precautionary recovery strategy is in place specifying management actions, or staged management responses, which are linked to reference points. The recovery strategy should apply until the stock recovers, and should aim for recovery within a specific time period appropriate to the biology of the stock.<sup>9</sup></p> <p>1.2.2</p> <p>If the stock is estimated as being at or below the biological and/or effort bottom line, management responses such as a zero targeted catch, temporary fishery closure or a 'whole of fishery' effort or quota reduction are implemented.</p>	<p>The beach-cast marine algae fishery is a developing fishery with a low number of operators (2). The small harvest amounts that have been taken from long term wrack accumulations ensure that the precautionary principle is applied and that the fishery is not deemed to be over-exploited (1/25 of King Island Kelp Fishery).</p> <p>Management responses such as those outlined are not applicable at this time due to the minimal harvest effort that has been applied to the fishery. If the stock is estimated at being at or below the biological and/or effort bottom line in the future, appropriate management responses would be implemented to address this.</p>

Table 3: PRINCIPLE 2 – Fishing operations should be managed to minimise their impact on the structure, productivity, function and biological diversity of the ecosystem.<sup>4</sup>

Objective 1: The fishery is conducted in a manner that does not threaten bycatch species.	
Information requirements	The South Australian Beach-Cast Marine Algae Fishery is target-specific and has no bycatch in terms of what is traditionally considered bycatch in marine based fisheries. PIRSA Fisheries and

<sup>9</sup> Strategies require that recovery should take place within specified times with certain degrees of probability.

<sup>4</sup> The issues addressed under the principle are those that define components of ecosystem integrity.

<p>2.1.1</p> <p>Reliable information, appropriate to the scale of the fishery, is collected on the composition and abundance of bycatch.</p>	<p>Aquaculture monitors a list of the species harvested through the monthly catch and effort log book that each licence holder is required to provide. Licence holders complete and lodge with SARDI Aquatic Sciences a Threatened, Endangered and Protected Species (TEPS) log book when any interactions occur. There have been no reported interactions with TEPS in the Miscellaneous Fishery (Tsolos and Boyle 2013).</p> <p>There is the unavoidable removal of commensal organisms during harvest. However, the low harvest rates and exclusion zones ensure that these species are not threatened.</p>
<p>Assessments</p> <p>2.1.2</p> <p>There is a risk analysis of the bycatch with respect to its vulnerability to fishing.<sup>5</sup></p>	<p>A risk assessment has not been conducted to determine the vulnerability of bycatch species to the fishery given there is little or no bycatch and the small scale of the current fishery.</p>
<p>Management responses</p> <p>2.1.3</p> <p>Measures are in place to avoid capture and mortality of bycatch species unless it is determined that the level of catch is sustainable (except in relation to endangered, threatened or protected species). Steps must be taken to develop suitable technology if none is available.</p> <p>2.1.4</p> <p>An indicator group of bycatch species is monitored.</p>	<p>PIRSA Fisheries and Aquaculture monitors a list of the species harvested through the monthly catch and effort log book that each licence holder is required to provide. Licence holders complete and lodge with SARDI Aquatic Sciences a TEPS log book when any interactions occur. There have been no reported interactions with TEPS in the Miscellaneous Fishery (Tsolos and Boyle 2013). Licence conditions limit the area and amount of wrack that can be harvested. Given these arrangements and the fact that there is little or no bycatch, PIRSA Fisheries and Aquaculture is confident that measures are in place to avoid the capture and mortality of bycatch species.</p> <p>PIRSA Fisheries and Aquaculture monitors a list of the species harvested through the monthly catch and effort log book that each licence holder is required to provide. Licence holders complete and lodge with SARDI Aquatic Sciences a TEPS log book when any interactions occur. There have been no reported interactions with TEPS in the Miscellaneous Fishery (Tsolos and</p>

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<sup>5</sup> The vulnerability of a bycatch species may be its vulnerability to fishing technology (eg its catchability), or its vulnerability in terms of ecological impact (e.g. loss of predators or prey).

<p>2.1.5</p> <p>There are decision rules that trigger additional management measures when there are significant perturbations in the indicator species numbers.</p> <p>2.1.6</p> <p>The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.</p>	<p>Boyle 2013). Given the nature of the fishery, PIRSA Fisheries and Aquaculture has not considered it necessary to monitor an indicator group of bycatch species.</p> <p>Given the nature of the fishery, PIRSA has not considered it necessary to monitor an indicator group of bycatch species or to develop corresponding decision rules.</p> <p>PIRSA Fisheries and Aquaculture monitors a list of the species harvested through the monthly catch and effort log book that each licence holder is required to provide. Licence holders complete and lodge with SARDI Aquatic Sciences a TEPS log book when any interactions occur. There have been no reported interactions with TEPS in the Miscellaneous Fishery (Tsolos and Boyle 2013). The South Australian Beach-Cast Marine Algae Fishery is a target-specific, selective fishery. Given the licence conditions which limit the area and amount of wrack that can be harvested, there is little or no bycatch. Consequently, PIRSA Fisheries and Aquaculture is confident that the fishery is conducted in a manner which does not threaten bycatch species.</p>
<p>Objective 2: The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities.<sup>6</sup></p>	
<p>Information requirements</p> <p>2.2.1</p> <p>Reliable information is collected on the interaction with endangered, threatened or protected species and threatened ecological communities.</p> <p>Assessments</p> <p>2.2.2</p>	<p>PIRSA Fisheries and Aquaculture monitors a list of the species harvested through the monthly catch and effort log book that each licence holder is required to provide. Licence holders complete and lodge with SARDI Aquatic Sciences a TEPS log book when any interactions occur. There have been no reported interactions with TEPS in the Miscellaneous Fishery (Tsolos and Boyle 2013).</p> <p>Beach-cast wrack does provide a basis for the food chain of a range of migratory species of shorebirds (Appendix 2) as well as providing habitat to vulnerable or endangered species of wildlife, such as the hooded plover and the orange-bellied parrot. Harvesting of wrack may adversely affect bird species that are dependent upon undisturbed seagrass wracks for feeding,</p>

<sup>6</sup> 'Protected' species are those which warrant a higher degree of conservation and for which explicit legislative or other mechanisms exist, e.g. they may be categorised under separate legislation as 'endangered', 'threatened' or 'protected'.

<p>There is an assessment of the impact of the fishery on endangered, threatened or protected species.</p>	<p>resting, nesting and raising chicks. For instance, DEWNR has identified Cape Jaffa and the area of Kingston Beach north of the Blackford Drain and adjacent to an Urban Coastal Zone Reserve as important habitat for Orange-bellied Parrots. Harvesting of wrack also has the potential to incur damage to the foreshore, interfere with beach stability and contribute to coastal erosion.</p>
<p>2.2.3</p>	
<p>There is an assessment of the impact of the fishery on threatened ecological communities.</p>	<p>Any proposed increase in access or the granting of new licences will be subject to environmental impact assessments to determine whether the proposed change to management arrangements would be ecologically sustainable. The assessments must take into consideration the nature, amount, function and turnover rate of the wrack available at the site. Regard must be given to whether the wrack is persistent or highly mobile and the likelihood and rate of replenishment. This information will be used to determine whether the wrack accumulation may be harvested sustainably from an area according to best available evidence. A consultant engaged by the licence applicant may undertake the assessment, but must be done according to a prescribed methodology so that it can be verified by PIRSA Fisheries and Aquaculture and DEWNR. The methodology must stipulate the parameters to be measured including area covered, time period, methods of estimating amount of wrack, species composition of wrack, likely impact on beach ecology, and identification of bird nesting or critical habitat.</p> <p>Licence holders complete and lodge with SARDI Aquatic Sciences a TEPS log book when any interactions occur. There have been no reported interactions with TEPS in the Miscellaneous Fishery (Tsolos and Boyle 2013). Consequently, PIRSA Fisheries and Aquaculture is confident that the fishery is conducted in a manner which has minimal impact on TEPS species, in particular migratory and resident species of birds.</p> <p>There is one threatened ecological community, the Giant Kelp Marine Forests of South East Australia, which may be impacted by the South Australian Beach-Cast Seagrass and Marine Algae Fishery. It is protected under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (the EPBC Act) as a threatened ecological community and is listed as endangered. Giant kelp (<i>Macrocystis pyrifera</i><sup>10</sup>) forests are located in the waters of the south east of South</p>

<sup>10</sup> Note that the taxonomy of the species within the genus *Macrocystis* has been revised (Demes et al 2009) and the South Australia form (formerly classified as *Macrocystis angustifolia*) has been merged with the *Macrocystis pyrifera*.

	<p>Australia and are harvested from wrack in this fishery. However giant kelp plants that have detached from the substrata and washed ashore (wrack) are excluded from the definition of the ecological community and therefore do not trigger the need for referral under national environmental law. Consequently no approval is required for the collection of giant kelp washed up on beaches as they are not part of the ecological community. PIRSA Fisheries and Aquaculture is confident that this threatened ecological community will not be impacted by the harvest of wrack.</p>
<p>Management responses</p> <p>2.2.4</p> <p>There are measures in place to avoid capture and/or mortality of endangered, threatened or protected species.</p> <p>2.2.5</p> <p>There are measures in place to avoid impact on threatened ecological communities.</p> <p>2.2.6</p> <p>The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.</p>	<p>In order to address the issue of migratory birds and to protect nesting or aggregation sites, a number of measures have been implemented. The restriction placed upon harvesters to ensure that no more than 50% of the coastal extent in the licence is available for harvest (thereby limiting the harvest to 50% of the estimated biomass of wrack in an area). This is managed through an explicit spatial management strategy, using a series of exclusion zones along the coastal extent of the licence and thereby ensures that significant habitat remains undisturbed for such species. Furthermore, wrack can only be harvested from specific areas, the removal of any sand must be avoided, where sand dunes are present no harvesting activity is to take place within four metres of the fore dune, and existing ramps or access tracks must be used to access the beach. The timing of harvesting is also dependent on weather events that predominantly occur outside of shorebird nesting season. Additionally, in South Australia a number of important habitats for endangered bird species are protected. The measures taken in this fishery remain consistent with the objectives and needs of the orange-bellied parrot (OBP) Recovery Plan. Detailed mapping of the distribution of shorebirds has been undertaken (Appendix 2) and exclusion zones have been used to prevent harvesting in areas with high levels of utilisation by multiple species (Figure 3 - Figure 11).</p> <p>PIRSA Fisheries and Aquaculture monitors a list of the species harvested through the monthly catch and effort log book that each licence holder is required to provide. Licence holders complete and lodge with SARDI Aquatic Sciences a TEPS log book when any interactions occur. There have been no reported interactions with TEPS in the Miscellaneous Fishery (Tsolos and Boyle 2013). Consequently, PIRSA Fisheries and Aquaculture is confident that measures are in place to avoid the capture and mortality of TEPS, in particular migratory and resident species of birds.</p>

	<p>The Giant Kelp Marine Forests of South East Australia are the only threatened ecological community which may be impacted by the fishery. However licence conditions stipulate that the licence holder may only disturb unattached beach-cast seagrass and macro-algae wrack (including giant kelp) during the harvesting activity. Additionally the licence holder may harvest beach-cast seagrass and macro-algae wrack from the foreshore between the high water mark and the low water mark of coastal beaches in their allocated areas. PISA is confident that these management arrangements mitigate impacts from the fishery on giant kelp threatened ecological communities.</p> <p>PIRSA Fisheries and Aquaculture considers that the risk of the fishery causing mortality of, or injury to TEPS or having impacts on threatened ecological communities is low. This is taking into account the low and sporadic levels of fishing catch and effort, the methods of harvest, and the management arrangements which govern the fishery. Additionally, there have been no reported interactions with TEPS in the Miscellaneous Fishery (Tsolos and Boyle 2013).</p>
Objective 3: The fishery is conducted, in a manner that minimises the impact of fishing operations on the ecosystem generally.	
<p>Information requirements</p> <p>2.3.1</p> <p>Information appropriate for the analysis in 2.3.2 is collated and/or collected covering the fisheries impact on the ecosystem and environment generally.</p>	<p>The contribution of decomposing seagrass and seaweed to productivity in marine ecosystems has been shown to be both measurable and significant. Both in the surf zone and on the beach, wracks are important sites for the nutrient recycling which sustains near-shore primary and secondary production in coastal waters. South Australia's waters are generally nutrient- poor and the decomposition of beach-cast wrack may supply a vital source of particulate and dissolved organic matter to the State's coastal ecosystems. Moreover, the large supply of detritus and prey organisms released during wrack breakdown supports marine food webs, including some that lead to commercially important fish species. This suggests that the removal of wrack material from beaches may have implications for other fisheries that are dependent upon near-shore productivity (Kendrick <i>et al.</i> 1995). This has particular significance for seagrass wrack harvesting in the two gulfs in South Australia where there are few, if any, other nutrient inputs to the system and productivity is low (Smith &amp; Veeh 1989). It may, however, be of less importance in more nutrient-rich coastal marine environments (Kendrick <i>et al.</i> 1995) such as the southeast of South Australia, and perhaps also off the west coast of Eyre Peninsula (refer Figure 1), where seasonal upwelling events return nutrient-rich bottom waters to the surface layers. In the southeast there</p>

is also an additional input of nutrients to the inshore zone via a series of agricultural drains.

The removal of beach-cast material may disrupt terrestrial and marine food webs, interfere with nutrient recycling to the near-shore zone and deprive subsurface beach organisms of dissolved organic materials (Anderson *et al.* 1989). This net loss of organic matter from the shoreline could impact upon sandy beach ecosystems, but the level of impact in relation to the level of wrack harvest are unknown.

Any proposed increase in access or the granting of new licences will be subject to environmental impact assessments to indicate that this proposed change to management arrangements would be ecologically sustainable. The assessment must take into consideration the nature, amount, function and turnover rate of the wrack available at the site. Regard must be given to whether the wracks are persistent or highly mobile and the likelihood and rate of replenishment. This information will be used to determine whether the wrack accumulation may be harvested sustainably from an area according to best available evidence. A consultant engaged by the licence applicant may undertake the assessment, but must be done according to a prescribed methodology so that it can be verified by PIRSA Fisheries and Aquaculture and DEWNR. The methodology must stipulate the parameters to be measured including area covered, time period, methods of estimating amount of wrack, species composition of wrack, likely impact on beach ecology, and identification of bird nesting or critical habitat.

PIRSA Fisheries and Aquaculture monitors a list of the species harvested through the monthly catch and effort log book that each licence holder is required to provide. Licence holders complete and lodge with SARDI Aquatic Sciences a TEPS log book when any interactions occur. There have been no reported interactions with TEPS in the Miscellaneous Fishery (Tsolos and Boyle 2013).



<p>Assessment</p> <p>2.3.2</p> <p>Information is collected and a risk analysis, appropriate to the scale of the fishery and its potential impacts, is conducted into the susceptibility of each of the following ecosystem components to the fishery.</p> <p>(a) Impacts on ecological communities</p> <ul style="list-style-type: none"> <li>• Benthic communities</li> <li>• Ecologically related, associated or dependent species</li> <li>• Water column communities</li> </ul> <p>(b) Impacts on food chains</p> <ul style="list-style-type: none"> <li>• Structure</li> <li>• Productivity/flows</li> </ul> <p>(c) Impacts on the physical environment</p> <ul style="list-style-type: none"> <li>• Physical habitat</li> <li>• Water quality</li> </ul>	<p>Impacts on ecological communities</p> <p>Beach-cast seagrass and algal wracks serve several important ecological functions in environments extending from the supralittoral<sup>7</sup> to the abyssal<sup>8</sup> and encompassing both benthic<sup>9</sup> and pelagic<sup>10</sup> systems. Sandy beaches are characterised by an absence of attached macrophytes and hence an almost complete lack of in situ primary production (Griffiths <i>et al.</i> 1983). The import of detached macrophytes from offshore beds provides organic material that delivers nutrients to the interstitial food chain as well as acting as the primary food source for intertidal fauna (Marsden 1991). The macrofauna in particular relies entirely on material imported from the sea to meet its nutritional requirements. Wracks, therefore, provides a rich food supply that are not only persistent, but also concentrated high up on the beach.</p> <p>There are a number of potential environmental impacts associated with beach cleaning that include: direct impacts to the beach and nearshore environments; disruption of the natural cycle of beach nourishment from nearshore sand dynamics; and impacts to significant sites and features. Off-beach environmental impacts relate mainly to the disposal of beach litter such as plastics, glass and fishing wastes, as well as wrack, at municipal landfills or other locations (Fairweather and Henry 2003).</p> <p>However, the limited areas from which wracks in South Australia are harvested and the 'exclusion zones' will serve to maintain nearshore environments and maintain beach nourishment and ecological processes.</p>
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<sup>7</sup> Above the high water mark

<sup>8</sup> Pertaining to the ocean depths

<sup>9</sup> Of or on the sea bed

<sup>10</sup> Of or in the water column

#### Impacts on food chains

The removal of beach-cast material may disrupt terrestrial and marine food webs, through the removal of important food species from different levels of the food chain. However, the use of dispersion zones allows for the maintenance of important habitat and therefore links in terrestrial and marine food webs.

#### Impacts on the physical environment

Fairweather and Henry (2003) highlight a number of potential impacts from removing wracks which include: pollution and emission impacts from the combustion and noise from machinery; disturbance of fauna from the presence of human workers; removal of natural ecological components including wrack itself (i.e. as a form of organic matter, nutrient source, habitat and refuge) or sediments; and the loss of dune vegetation and seed reserves, if cleaning extends up into foredunes. Sound emissions may scare off nesting or feeding birds and hydrocarbon- based pollution such as exhaust fumes and oil leaks may also occur.

The harvest conditions imposed on beach-cast seagrass and marine algae harvesters ensure that there is minimal impact on the physical habitat. Harvesters must take away no sand from their harvest areas, use exclusion zones where wracks are to be maintained for ecological reasons and are only able to access the beach from existing ramps or access tracks. Local councils will restrict hours of access and administer any seasonal access restrictions as necessary to prevent problems through sound emissions and to ensure that all vehicles and machinery are registered and in good condition to ensure minimal damage to the beach ecosystem. In addition, harvesters are restricted to only removing wracks that are farther than four metres from the toe of the foredune.

The harvest of beach-cast wracks is a land-based activity and thus has little or no impact upon water quality. The only potential for water quality impact is through the use of machinery in the harvest areas. It is believed that there will be minimal impact from the use of this machinery as it is for only short time periods and the harvesters are not to harvest from below the low water mark, thus giving them no reason to enter the water.

<p>Management responses</p> <p>2.3.3</p> <p>Management actions are in place to ensure significant damage to ecosystems does not arise from the impacts described in 2.3.1.</p> <p>2.3.4</p> <p>There are decision rules that trigger further management responses when monitoring detects impacts on selected ecosystem indicators beyond a predetermined level, or where action is indicated by application of the precautionary approach.</p> <p>2.3.5</p> <p>The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.</p>	<p>A number of management actions are in place to minimise significant damage to related ecosystems. These include the strict regulation of harvest areas including no harvest within four metres of the foredune, no harvest below the low water mark, no sand to be removed, the use of exclusion zones, and only allowing harvesters to harvest wrack from small areas. PIRSA Fisheries and Aquaculture monitors a list of the species harvested through the monthly catch and effort log book that each licence holder is required to provide. Licence holders complete and lodge with SARDI Aquatic Sciences a TEPS log book when any interactions occur. There have been no reported interactions with TEPS in the Miscellaneous Fishery (Tsolos and Boyle 2013).</p> <p>Currently there is no ongoing monitoring of impacts on selected ecosystem indicators beyond a predetermined level. There is also no research basis from which to determine ecologically sustainable beach-cast wrack harvest levels. The dynamic nature of wrack accumulations means that the turnover naturally may be as high, if not higher than the precautionary amounts allowed to be harvested under strict input controls. Thus, PIRSA Fisheries and Aquaculture believe that the precautionary approach in minimising harvest licences, harvest areas and the input controls linked with this provide sufficient ability to prevent any detrimental ecosystem impacts.</p> <p>An environmental impact study was conducted by a private consultant prior to approval being granted for the existing Beachport harvest area. Any proposed increase in access or the granting of new licences will be subject to further environmental impact assessments to indicate that this proposed change to management arrangements would be ecologically sustainable.</p> <p>South Australia's <i>Fisheries Management Act 2007</i> is centred on ensuring that the State's aquatic resources are managed in accordance with established ESD principles. As defined in the Act, ESD comprises the use, conservation, development and enhancement of the aquatic resources of the State in a way, and at a rate, that will enable people and communities to provide for their economic, social and physical well-being while also:</p> <ul style="list-style-type: none"> <li>• Sustaining the potential of aquatic resources of the State to meet the reasonably foreseeable needs of future generations</li> <li>• Safeguarding the life-supporting capacity of the aquatic resources of the State</li> <li>• Avoiding, remedying or mitigating adverse effects of activities on the aquatic resources</li> </ul>
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of the State

Management considerations must also take the precautionary principle into account: "...if there are threats of serious or irreversible damage to the aquatic resources of the State, lack of full scientific certainty should not be used as a reason for postponing measures to prevent such damage".

The highly precautionary nature of the input controls and access granted to this fishery ensures that the development of the fishery will prevent serious ecological impacts.

## 5 Acronyms

<b>AQIS</b>	Australian Quarantine Inspection Service
<b>DEWNR</b>	Department of Environment, Water and Natural Resources
<b>DMITRE</b>	Department for Manufacturing, Innovation, Trade, Resources and Energy
<b>DotE</b>	Department of the Environment
<b>DPTI</b>	Department of Planning, Transport and Infrastructure
<b>EPBC Act</b>	Environment Protection and Biodiversity Conservation Act 1999
<b>ERD</b>	Environment Resources and Development
<b>ESD</b>	Ecologically Sustainable Development
<b>ILUA</b>	Indigenous Land Use Agreement
<b>PIRSA</b>	Department of Primary Industries and Regions, South Australia
<b>SARDI</b>	South Australian Research and Development Institute
<b>TEPS</b>	Threatened, endangered and protected species

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## 7 Appendix 1 – Executive Summary taken from “Macro-algal Wrack Fishery Assessment” (PIRSA 2014b).

This report summarises information relevant to the South Australian Miscellaneous Fishery, specifically to those licence holders permitted to harvest beach-cast seagrass and macro-algal wrack.

The Miscellaneous Fishery is licensed under the *Fisheries Management Act 2007* and consists of two licence holders permitted to harvest beach-cast wrack. The licences are subject to specific licence conditions which required the licence holders to record and provide monthly catch and effort information to the Minister. The information is collated and reported on by the South Australian Research and Development Institute of South Australia (SARDI) Aquatic Sciences. The information contained in relation to harvest volumes has been authorised by the two licence holders to be made publicly available and transparent for this assessment.

Beach-cast accumulations (wracks) of decaying seagrass and marine algae are considered essential components of coastal ecosystems. They serve several important roles in the ecology of local coastal environments. Wracks contribute to the food web dynamics of beach and near-shore marine communities, including valuable fisheries, by supporting microbial processes and invertebrate fauna that are preyed upon by higher-level consumers and supplying nutrients that can be utilised by plant and animal communities (Kirkman and Kendrick, 1997). Many bird species, some of high conservation status, also utilise these habitats. Wracks also provide protection to coastal dunes and other important coastal environments.

The seagrass wrack fishery is limited in spatial scale being restricted to a 7.2 km extent of beach around the town of Kingston where the harvest of seagrass wrack is undertaken primarily to address a beach amenity issue. The build-up of wrack in this region is a result of the development of groynes along the coast which causes trapping of excessive quantities of seagrass wrack. An assessment of the seagrass wrack removal at Kingston (Duong 2008) concluded that there was no environmental impediment to the removal of this wrack.

The macro-algal wrack fishery occurs across a more extensive length of coastline comprising some 102 km from Cape Jaffa in the north to Kingston in the south. Historically the macro-algal wrack fishery, although covering a larger coastal extent than the seagrass fishery, has been a very small operation in comparison to similar fisheries elsewhere (being on average about 1/25<sup>th</sup> the size of the King Island based southern bull kelp fishery). This smaller size means that there is a concomitantly smaller number of operators with much less time being spent on beaches undertaking harvesting operations.

While there have been no reported interactions with Threatened, Endangered or Protected Species it is acknowledged that the macro-algal wrack fishery occurs along a coastline where there is potential for interactions with a number of shore-bird species. These interactions can be managed through licence conditions to ensure that operators do not impact on nesting birds and those interactions with feeding / foraging birds are controlled. It is noted that two species, the Hooded Plover and the Orange-bellied Parrot are both listed species and there is a particular need to ensure that management of the harvest operations (including transport to and from beaches) is undertaken to ensure that there are no adverse interactions with these species.

It is recommended that licence conditions for the fishery should be revised in the light of recent work including the advice from DotE and key stakeholders. Such a revision should include the adoption of a spatial management strategy that would ensure that areas of coast with high conservation significance are protected through the use of explicit harvest exclusion zones. The area to be protected through harvest exclusion zones should comprise 50% of the coastal extent of the Licence Y078.

## 8 Appendix 2 – Shorebird mapping data used as a basis for definition of exclusion zones.

Mapping has been undertaken for a number of key shorebird species that, based on advice from DotE, are of most concern from an Environment Protection and Biodiversity Conservation (EPBC) assessment perspective (Table 4). The following maps (Figure 3 - Figure 11) provide data from the SA Department of Environment, Water and Natural Resources (DEWNR). It is notable that both Sharp-tailed Sandpipers and Ruddy Turnstones have very wide distributions occupying almost all habitats along this coastline. The other species have distributions that typically include most of the back of beach bush habitats particularly in the southern extent of the licence areas around Beachport Conservation Park (associated with Lake George and the surrounds).

**Table 4 - Shorebird species of conservation significance and for which distributional data is available (data provided by SA DEWNR).**

Common name	Latin name	Conservation status (IUCN Red List Category)	Figure reference
<b>Sanderling</b>	<i>Calidris alba</i>	Least concern	Figure 3
<b>Double banded plover</b>	<i>Charadrius bicinctus</i>	Least concern	Figure 4
<b>Curlew sandpiper</b>	<i>Calidris ferruginea</i>	Least concern	Figure 5
<b>Red-necked stint</b>	<i>Pluvialis ruficollis</i> <i>Calidris ruficollis</i>	Least concern	Figure 6
<b>Pacific golden plover</b>	<i>Pluvialis fulva</i>	Least concern	Figure 7
<b>Sharp-tailed sandpiper</b>	<i>Calidris acuminata</i>	Least concern	Figure 8
<b>Ruddy turnstone</b>	<i>Arenaria interpres</i>	Least concern	Figure 9
<b>Hooded plover</b>	<i>Thinornis rubricollis</i>	Vulnerable	Figure 10
<b>Orange bellied parrot</b>	<i>Neophema chrysogaster</i>	Critically endangered	Figure 11

Many of these species feed and forage quite broadly across both the intertidal sandflats and into the dunes and in many cases make use of the coastal salt lakes, scrub and pastures in the area behind the main beach. Importantly, one species (the Hooded Plover) makes almost exclusive use of the beach itself where it feeds and nests.

“Hooded Plovers feed from the water’s edge to the base of the foredune and sometimes even in the dunes. They eat a wide variety of insects, and flotsam and jetsam. Seaweed provides an important component of their habitat and foraging ecology, with rotting seaweed providing food for invertebrates which Plovers then prey upon.” (parknotes, undated)

The other species of very high conservation significance is the Orange-bellied Parrot. This is one of Australia’s most threatened species with less than 50 parrots thought to exist in the wild today. The bird migrates between the Australian mainland and Tasmania spending summer breeding in Tasmania and winter in coastal Victoria and South Australia (Birdlife Australia, undated). Unlike the Hooded Plover this

species makes use of coastal eucalypts and saltmarshes both areas where no wrack harvesting would occur. Notwithstanding, there is a clear need for harvesters to understand the conservation status of the bird and how to ensure that their activities do not bring them into contact with birds or their habitat. The greatest risk is during travel across tracks and access routes that pass through coastal shrub and bushland and particularly while operating close to coastal saltmarshes. Key strategies are to ensure that operational management is conducted with due regard to these species and in particular that vehicles travel at slower speeds thereby minimising risks of encounters.

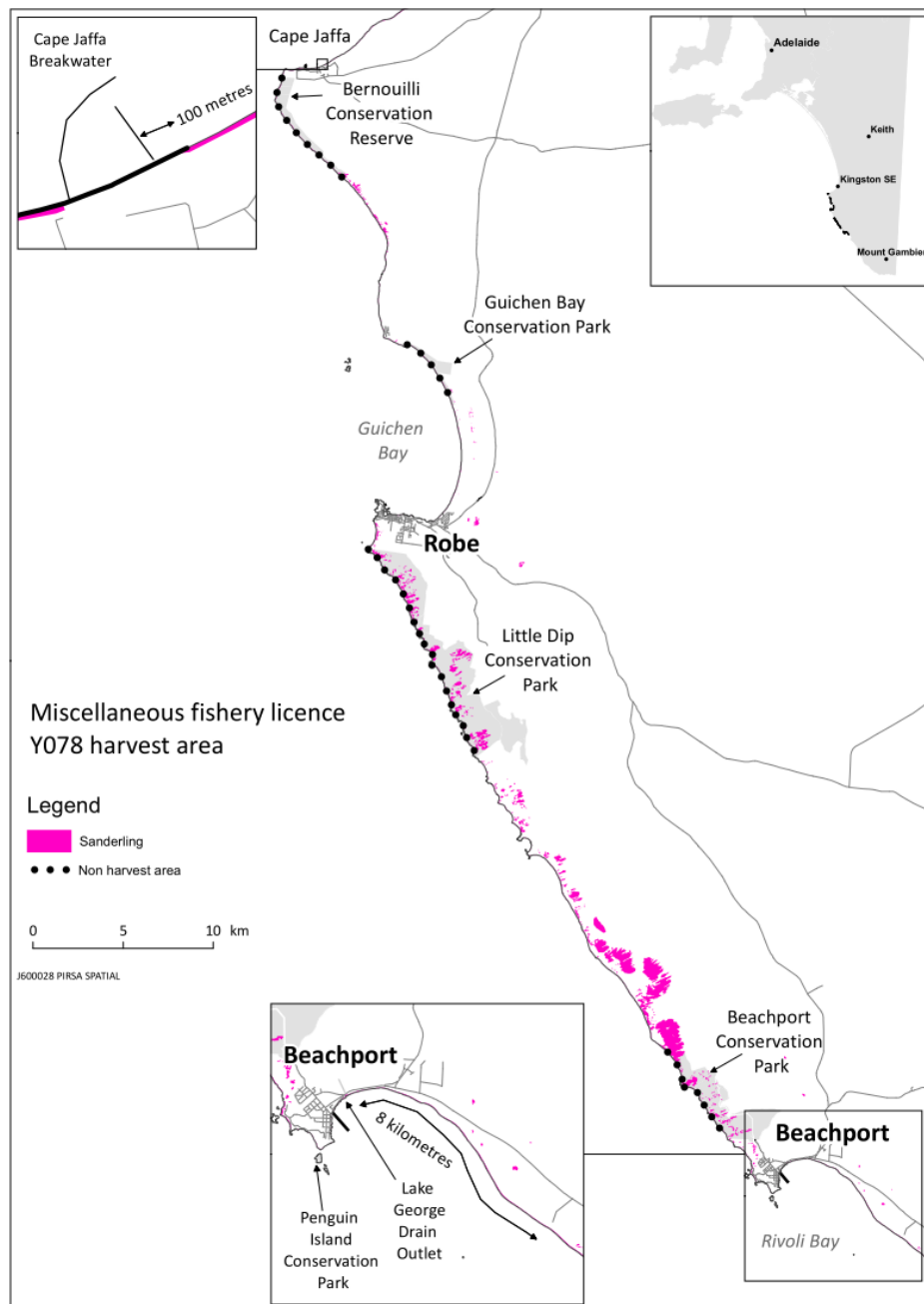


Figure 3 - Known distribution of the Sanderling (*Calidris alba*) along the coastal extent of Licence Y078. Sanderlings feed on invertebrate prey buried in the sand in the upper intertidal zone.

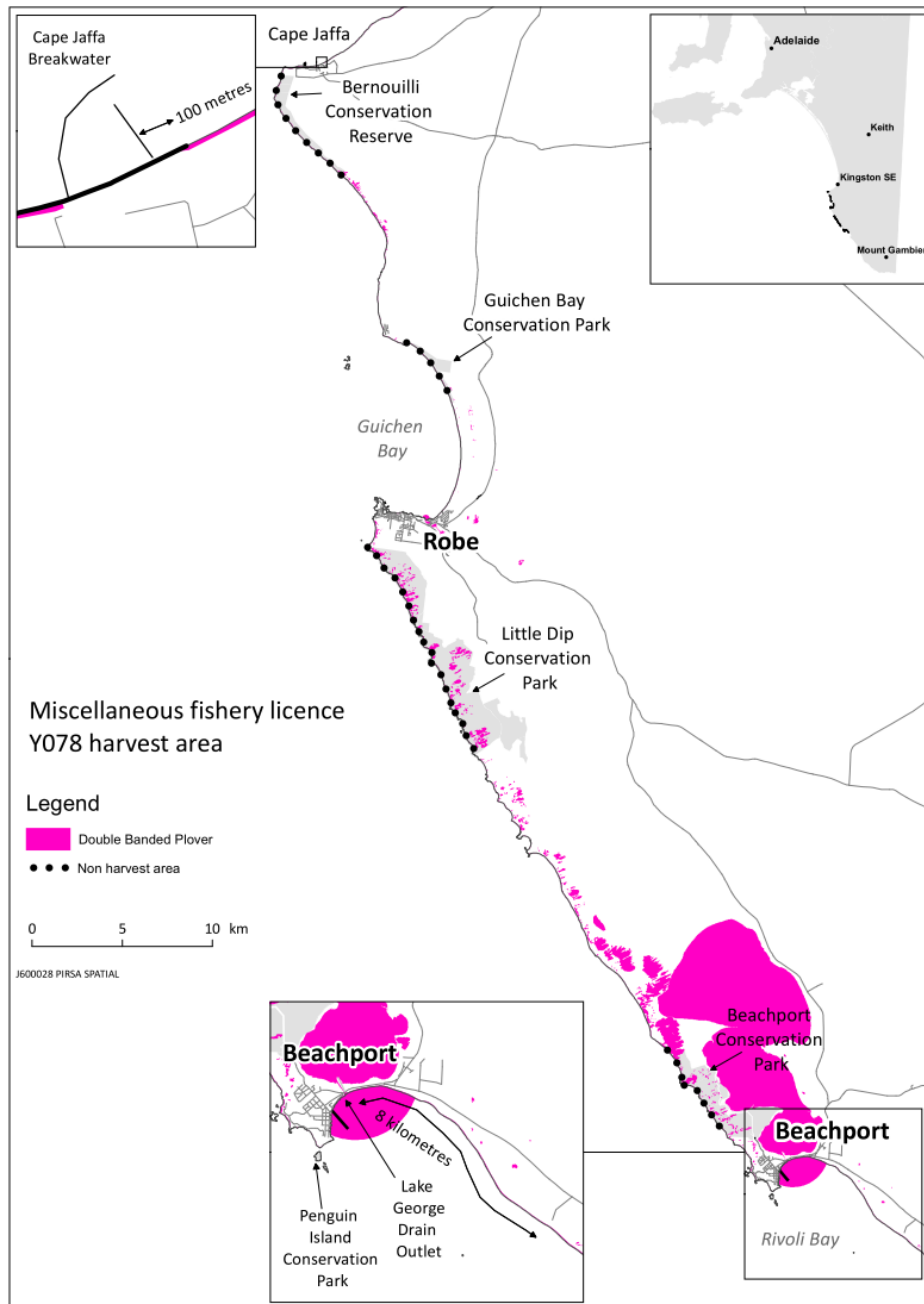
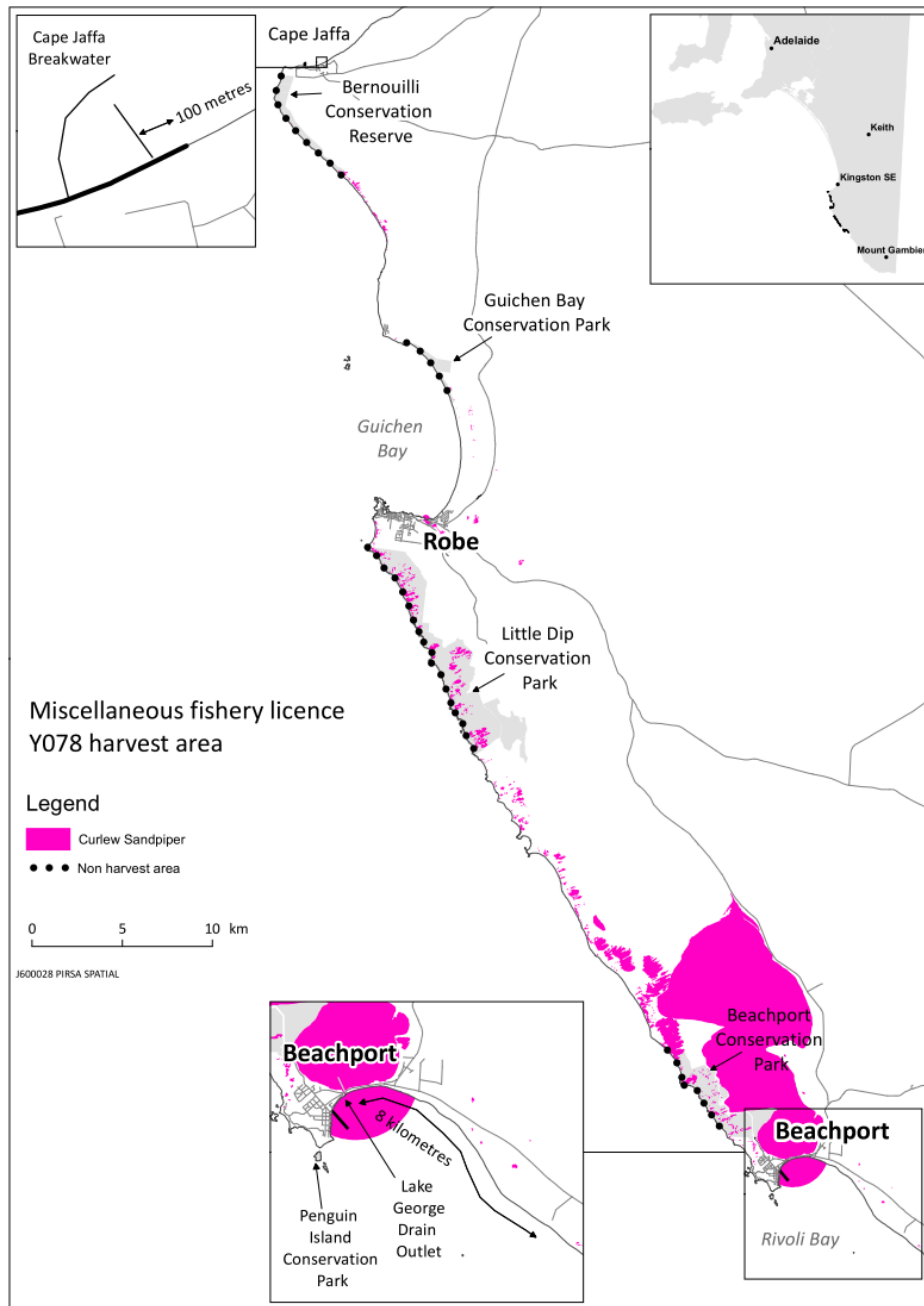
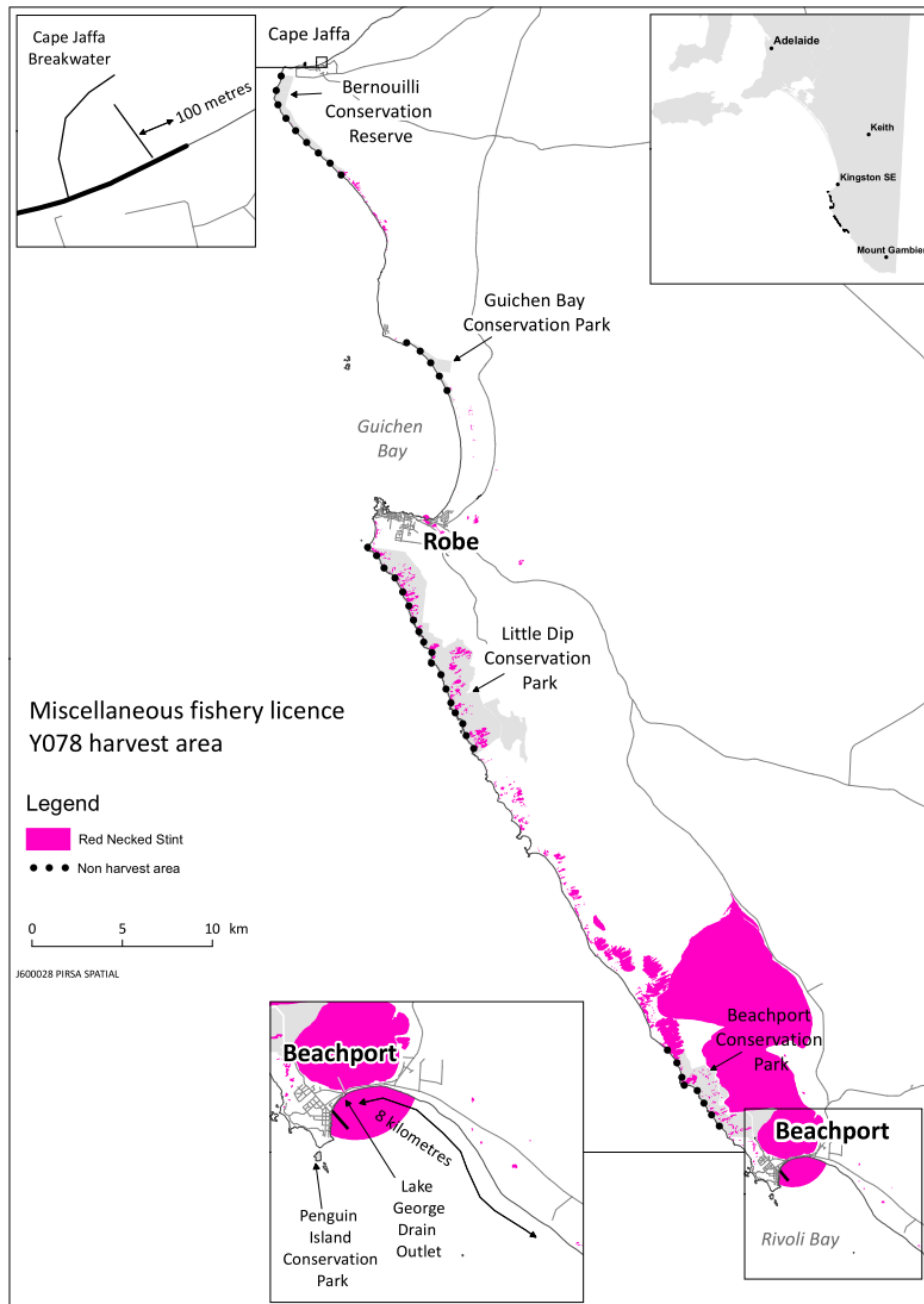


Figure 4 - Known distribution of the Double Banded Plover (*Charadrius bicinctus*) along the coastal extent of Licence Y078. Double-banded Plovers are diurnal and nocturnal. The species forages on vegetated shingle beds, closely cropped pasture, tilled ground and mudflats. In harbours, the species forages on pasture and sandflats at high tide. Feeding method varies with time, tide and weather.



**Figure 5 - Known distribution of the Curlew Sandpiper (*Calidris ferruginea*) along the coastal extent of Licence Y078. Curlew Sandpipers forage in soft mud on marshes and the coast, mainly picking up food by sight, with a preference for insects and other small invertebrates.**



**Figure 6 - Known distribution of the Red Necked Stint (*Calidris ruficollis*) along the coastal extent of Licence Y078. They forage in wet grassland and soft mud, mainly picking up food by sight. In their non-breeding habitat they feed on intertidal mudflats and along the muddy margins of freshwater lakes. They mainly eat insects and other small invertebrates.**



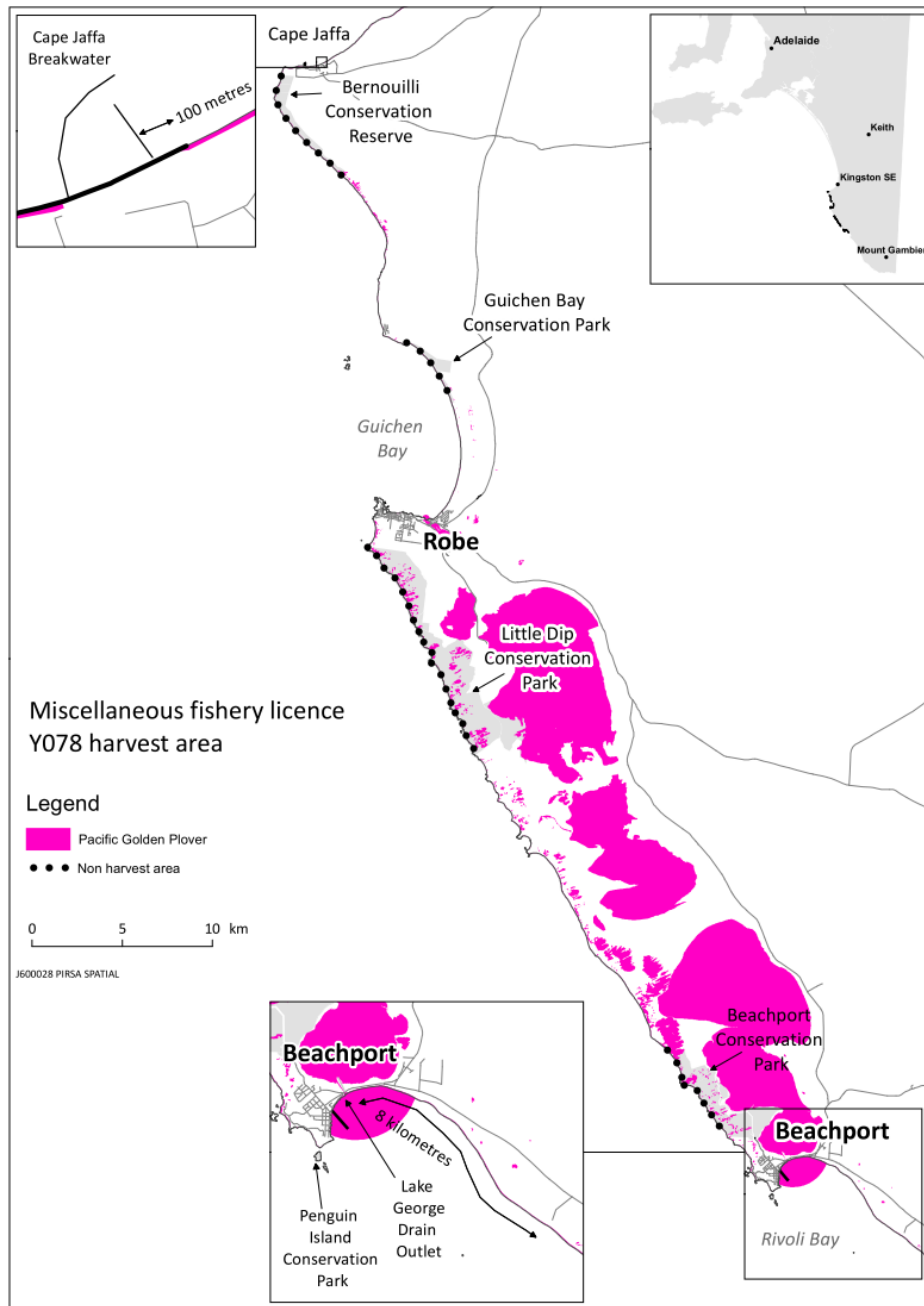
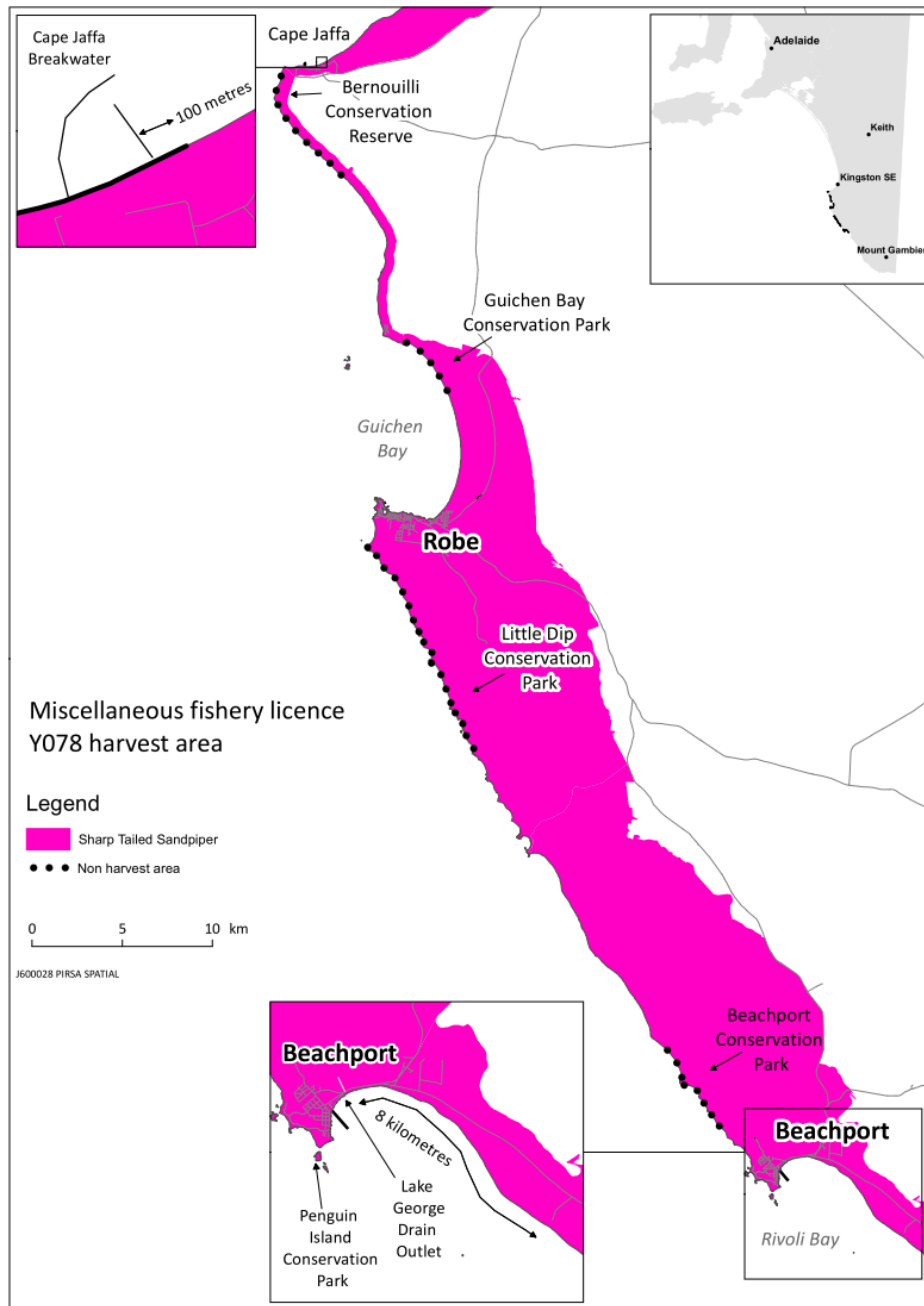


Figure 7 - Known distribution of the Pacific Golden Plover (*Pluvialis fulva*) along the coastal extent of Licence Y078. Double-banded Plovers are diurnal and nocturnal. This bird forages for food on tundra, fields, beaches and tidal flats, usually by sight. It eats insects and crustaceans and some berries.



**Figure 8 - Known distribution of the Sharp Tailed Sandpiper (*Calidris acuminata*) along the coastal extent of Licence Y078. These birds forage on grasslands and mudflats picking up food by sight, sometimes by probing. They mainly eat insects and other invertebrates.**

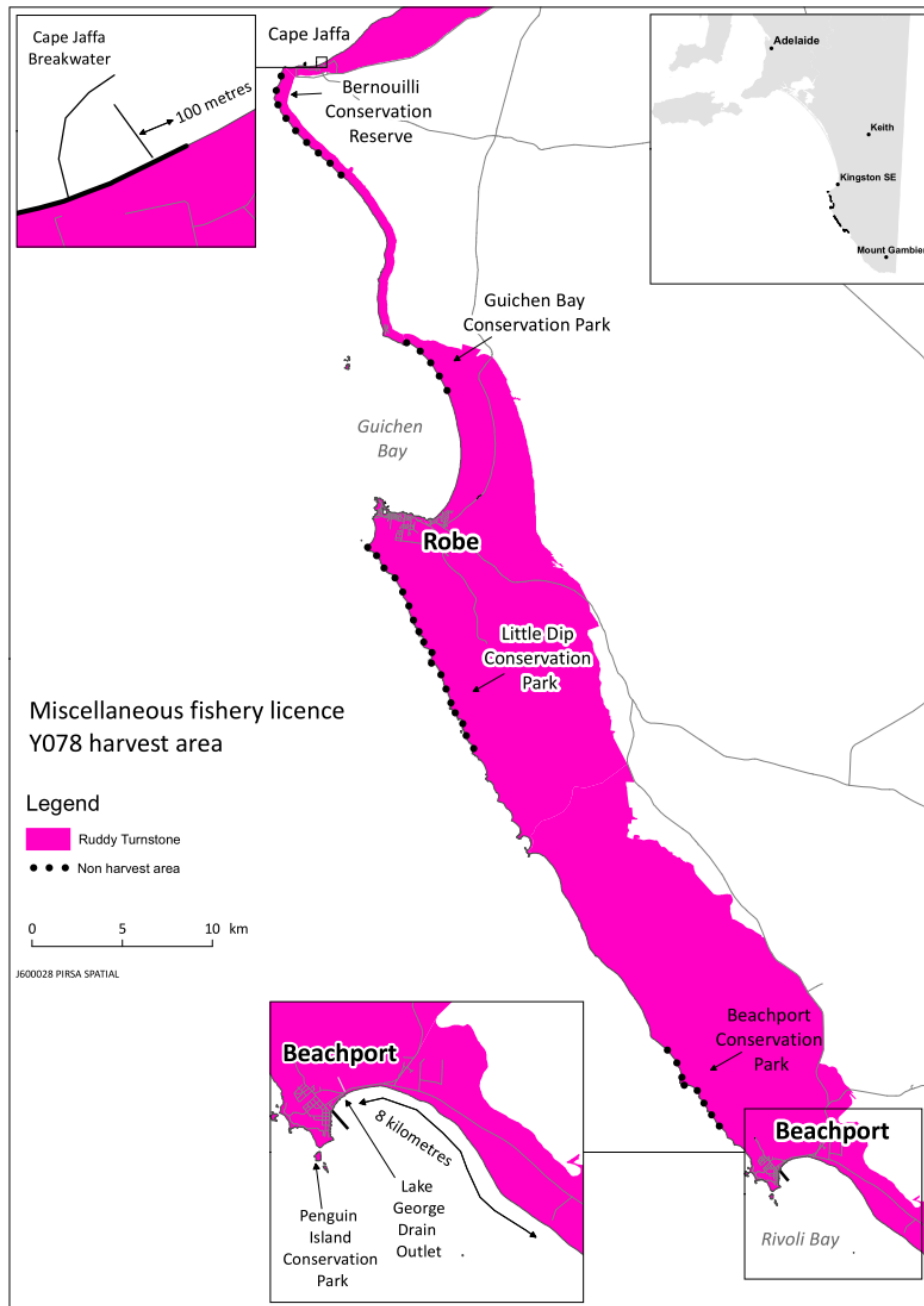


Figure 9 - Known distribution of the Ruddy Turnstone (*Arenaria interpres*) along the coastal extent of Licence Y078. Double-banded Plovers are diurnal and nocturnal. Ruddy turnstones typically feed on insects in the summer, though their diet is extended to other invertebrates such as crustaceans, molluscs, and worms in other seasons.

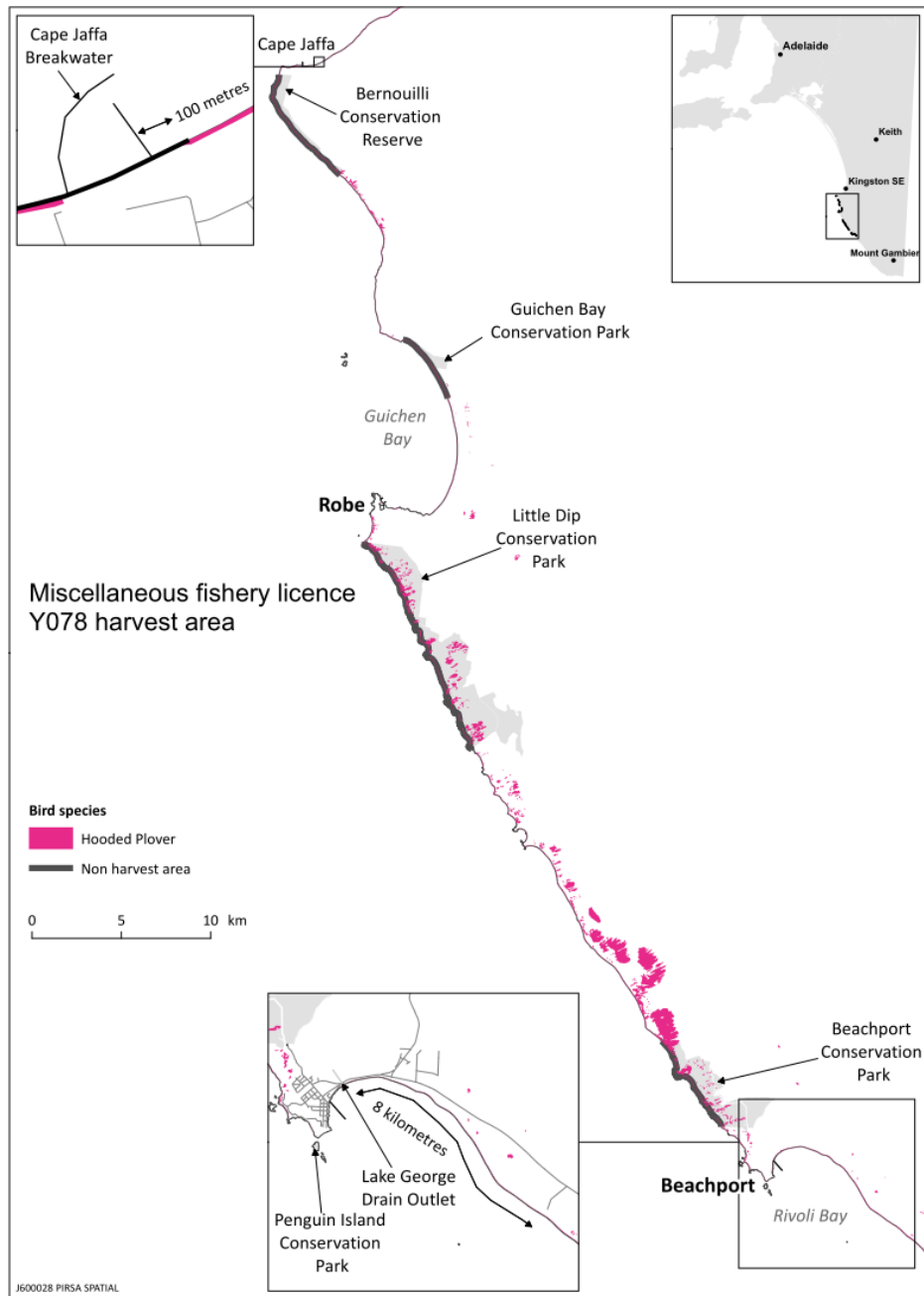


Figure 10 - Known distribution of the Hooded Plover (*Thinornis rubricollis*) along the coastal extent of Licence Y078. Hooded Plovers inhabit sandy ocean beaches where they feed on invertebrates from the sand near the water's edge. They lay their eggs in shallow scrapes in the sand on the upper beach.

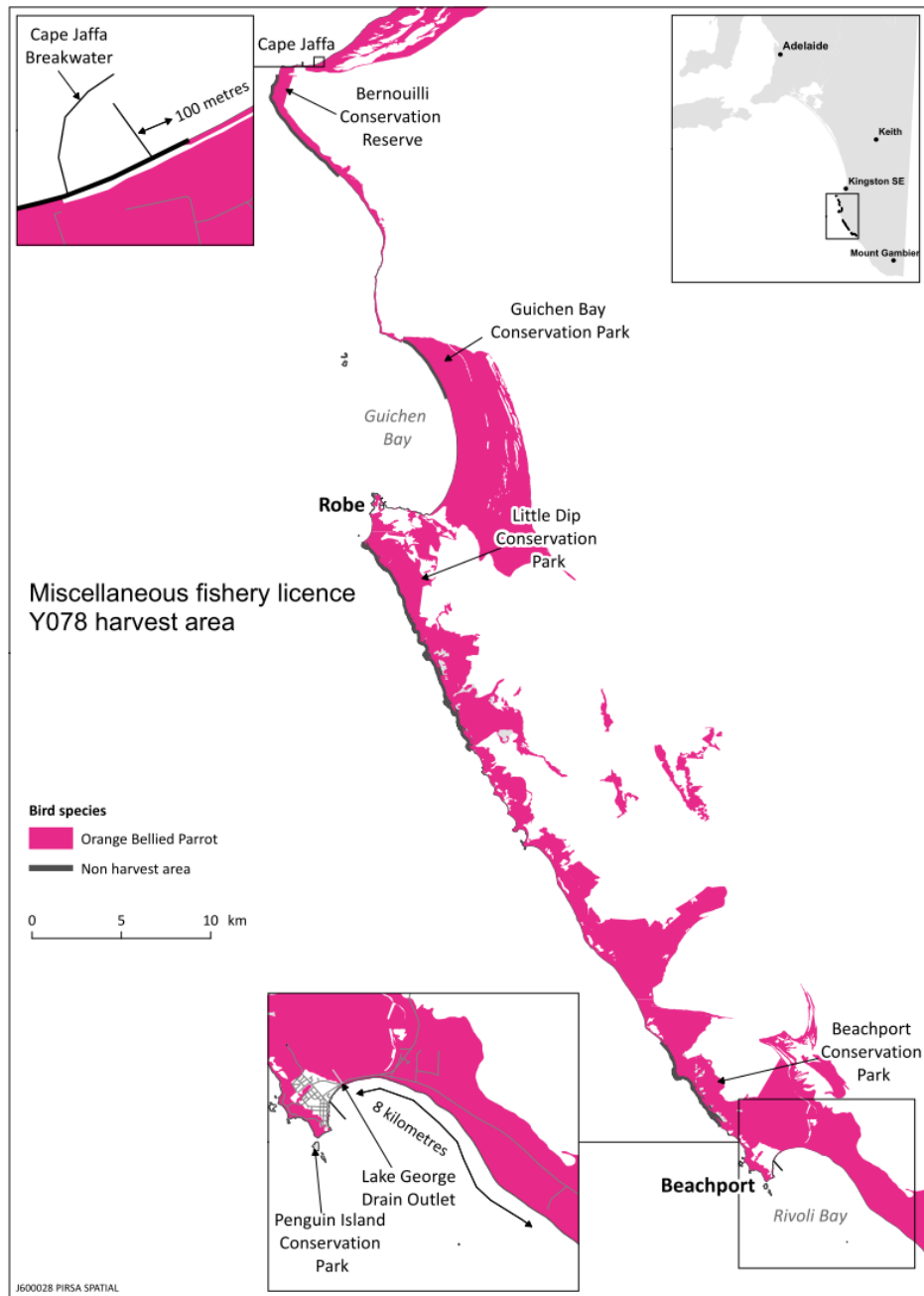


Figure 11 - Known distribution of the Orange Bellied Parrot (*Neophema chrysogaster*) along the coastal extent of Licence Y078. Orange-bellied Parrots winter in areas of coastal Victoria and South Australia. They feed in the saltmarsh and coastal scrub environments behind the actual beach.