

Ecologically sustainable development (ESD) risk assessment of proposed activity to harvest beachcast marine algae

PIRSA Fisheries and Aquaculture

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1 Introduction

An Ecologically Sustainable Development (ESD) risk assessment is an important part of the process of assessing applications for Exploratory or Developmental Permits. The ESD risk assessment process considers an extensive range of issues, risks and opportunities identified by stakeholders and provides a method for prioritising the identified risks based on consequence and likelihood of impacts.

1.1 Exploratory and Developmental Permits

Exploratory Permits may be provided to fishers to develop new commercial fisheries based on species or areas that are not part of an existing fishery. These permits have been available through regulations under the *Fisheries Management Act 2007* since December 2013. Initially, an Exploratory Permit may be provided to allow the gathering of preliminary information to determine the feasibility of commercially harvesting an aquatic resource. If deemed feasible, a Developmental Permit may then be provided to enable a more rigorous assessment of the commercial potential of a fishery, in order to demonstrate that it is ecologically sustainable, economically viable and socially acceptable.

1.2 Proposed Exploratory Activity

The harvesting of beachcast seagrasses and marine algae in South Australia has been managed for two Miscellaneous Fishery licences issued under the *Fisheries Management (Miscellaneous Fishery) Regulations 2000*. These licences allow for commercial harvest within specific areas of the state. PIRSA have received an application for an Exploratory Permit to harvest beachcast marine algae in an area where this activity is currently not licensed. The area of the proposed activity includes beaches from about 8km south east from the Lake George Outlet at Beachport and the South Australian/Victorian border. This area adjoins the area of an existing licence for beachcast marine algae harvest. The proposed activity is for the harvest of beachcast marine algae only and seagrass will not be targeted. PIRSA Fisheries and Aquaculture has not issued any exploratory or developmental permits for this activity to date.

2 Marine Algae Wrack

Beachcast accumulations of decaying seagrass and marine algae (wracks) may consist of kelp or other detached marine 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 addresses beachcast marine algal material and does not refer to flora attached to a substrate or drifting in the water column as the proposed activity is for the harvest of beachcast marine algae only.

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 (Ivey et al 2013).

The commercial harvesting of beachcast marine algae in South Australia is a small, but growing, 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 *Fisheries Management Act 2007* (the Act). The commercial harvesting of wracks from any beach of the state

is 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 commercial harvest of beachcast seagrass and marine algae are the *Fisheries Management (Miscellaneous Fishery) Regulations 2000* and the *Fisheries Management (General) Regulations 2007*.

Existing activities to harvest beachcast marine algae for a commercial purpose are managed using a series of input controls, such as exclusion zones and specific methods of harvesting, subject to licence conditions. There are two non-transferrable Miscellaneous Fishery licences which permit the harvest of wrack in SA, and both are for areas that are located in the south east of the state, each with its own permitted area of operation. Historically, the harvest of wrack for commercial purposes was also granted to a small number of operators through Ministerial exemptions; there are no active exemptions for this activity.

2.1 Biological information

Several studies, most notably in South Australia, Western Australia and South Africa, have highlighted the importance of beachcast seagrass and marine algae accumulations as sources of detritus and of particulate and dissolved nutrients which can contribute to 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 (Griffiths & Stenton-Dozey 1981; Marsden 1991; Duong 2008). Griffiths, Stenton-Dozey & Koop (1983) for example recorded 35 species (of which 22 were insects) amongst kelp wrack, which together amounted to more than 97% of the total intertidal faunal biomass. These organisms can reduce the biomass of dead marine 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 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.

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 novaezealandiae*) - 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 wracks 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 may also have an effect on offshore secondary production although it is not clear to what extent this adds to the inputs from detrital material that is not cast ashore but rather decomposes within the marine environment.

3 Related fisheries

Information available on existing operations that harvest marine algae in South Australia and in Tasmania have been used to inform this ESD risk assessment of the Exploratory Permit application as these operations are similar to those for the proposed additional area for harvest.

3.1 South Australian Miscellaneous Fishery

Existing activities for the collection of seagrass and marine algae in South Australia are permitted under two Miscellaneous Fishery licences. Aside from the two licences permitted to harvest beachcast marine algae, there are no other licences which operate in a similar manner or target similar aquatic resources in South Australia.

Table 1: Information on the current commercial harvest operations for beachcast marine algae in South Australia.

Publicly available information relevant to the fishery	Report from PIRSA Fisheries and Aquaculture to the Department of the Environment (2014) and Department of the Environment Assessment of the South Australian Beach-cast Marine Algae Fishery (2015) both at www.environment.gov.au/marine/fisheries/sa-managed-fisheries .
Area	Around 101.6 km of coastline in the South East of South Australia from Cape Jaffa to Rivoli Bay about 8 km south east of the Lake George Inlet at Beachport.
Fishery status	There is no fishery status assessment for marine algae in South Australia due to the scale of the fishery.
Target species	Beachcast marine algae however Bull Kelp is the main target species
Byproduct species	No byproduct species harvested
Gear	Hand collection, maybe assisted by winches and in some instances a mechanical harvester with a mechanical grab may be used.
Season	Harvest can occur year round in harvestable areas provided in the licence, however seasonal area closures in areas identified as important to shorebirds are in place to allow for migratory birds and hooded plovers to undertake natural activities undisturbed.

Commercial harvest	In 2013, an estimated 100 t wet weight (up to 20 t dry weight) was harvested by a license holder and exported to China as a product sample. In 2014, an estimated 200 t wet weight (up to 40 t dry weight) was harvested and exported to China for product samples to trial processing equipment.
Value of commercial harvest	Not available
Take by other sectors	The amount of marine algae harvested by the recreational and Indigenous sectors is considered negligible.
Commercial licences issued	There are two Miscellaneous licence that allow for harvest of marine algae.
Management arrangements	<ul style="list-style-type: none"> • At least 50 % of the licenced harvest area included in exclusion zones where harvest is prohibited. • Harvest restricted to unattached, beachcast marine algae • Harvest restricted within 4m of foredunes • Seasonal closures in important shorebird areas • No harvest within 100 m of nesting/brooding hooded plover • Operations designed to minimise removal of sand and infauna • Code of conduct for industry.
Export	China
By-catch	The harvest of marine algae in South Australia has no by-catch in terms of what is traditionally considered by-catch in marine based fisheries. Some small infauna including small amounts of finfish, shells, sea cucumber, sea urchin, crabs, octopus and star fish may be unavoidably collected but this risk is mitigated through operations being designed to minimise the removal of sand and infauna.
Interaction with protected species ¹	There is the possibility of interactions with <i>Thinornis rubricollis</i> (hooded plover) and other migratory birds in the current area. Interactions are mitigated through seasonal area closures, restrictions on harvest within 100 m of nesting/brooding hooded plovers, restrictions on harvest within 4 m of foredunes and industry code of conduct.

3.2 King Island Bull Kelp Fishery

King Island is the only other comparable commercial marine algae fishery in Australia. The fishery currently has export approval and a number of management arrangements aimed at reducing ecosystem impacts, including bird interactions. Small-scale licensed operations collect beachcast weed from several locations around Tasmania where large volumes of seaweed and seagrasses are washed ashore. The bulk of this cast weed is bagged and sold in garden shops as garden mulch.

¹ 'Protected species' means all species listed under Part 13 of the EPBC Act, including whales and other cetaceans and threatened, marine and migratory species.

Table 2: Information on the collection of beachcast bull kelp (*Durvilleae potatorum*) on King Island and the northern west coast of Tasmania (Department of Sustainability, Environment, Water, Population and Communities, 2011)

Publicly available information relevant to the fishery	<ul style="list-style-type: none"> • <i>Tasmanian Living Marine Resources Management Act 1995</i> • The Department of Environment and Heritage Assessment Report of the Tasmanian Kelp Fishery, 2005. • Department of the Environment, Water, Heritage and the Arts, Assessment Report of the King Island Cast Bull Kelp Fishery 2008. • Submission from Kelp Industries Pty Ltd, 2011
Area	<p>King Island, Tasmania. The fishery is permitted to harvest cast bull kelp, from the following areas:</p> <ol style="list-style-type: none"> 1. the west coast of King Island between Cape Wickham and approximately five kilometres due south of Ettrick Beach; 2. the south coast of King Island from Surprise Bay to the east of Stokes Point; and 3. the south-east coast of King Island from three areas around Red Hut Point, Grassy Harbour and City of Melbourne Bay.
Fishery status	There is no fishery status assessment for kelp, however the current scale of the fishery is small and kelp is considered unlikely to be overharvested.
Target species	Cast bull kelp, <i>Durvilleae potatorum</i> . Cast kelp refers to kelp plants that have been detached from the substrate and carried shoreward by water movement. As the plants cannot reattach, once they are cast onto the shore, they die. In most cases more than 50 per cent of kelp biomass is left at each harvesting site as other species and smaller kelp pieces are not picked up.
Byproduct species	no byproduct species harvested.
Gear	Hand collection, which is sometimes assisted by winches and in some instances a mechanical harvester with a mechanical grab may be used.
Season	Harvest occurs year round but is dependent on prevailing weather conditions. Harvesting and transporting of kelp is prohibited from September to March (inclusive) on sandy beach areas except the north end of British Admiral Beach and any other sandy beach which would not be detrimental to nesting <i>Thinornis rubricollis</i> (hooded plovers).
Commercial harvest	<p>The total dry tonnes of bull kelp that have been harvested from 2007 to 2010 for the King Island Fishery are;</p> <p>2007 – 2223.0 tonnes (t)</p> <p>2008 – 1922.0 t</p> <p>2009 – 1605.5 t</p> <p>2010 – 1900.0 t</p>
Value of commercial harvest	The small number of operators in the fishery currently prevents the public release of this data.
Take by other sectors	The amount of cast bull kelp harvested by the recreational and Indigenous sectors is considered negligible.
Commercial licences issued	Collection is permitted through the use of 100 registered licenses. Four of the licenses are full-time collectors, 40 are part time collectors and the remainder are inactive.
Management arrangements	All kelp collectors must apply for harvesting licenses annually and abide by all restrictions listed on harvesting licenses.

	Harvesting is restricted to areas where it is considered that it will not be detrimental to migratory birds, i.e. harvesting and transporting of kelp and/or equipment is prohibited from September to March (inclusive) on sandy beaches, except the north-end of British Admiral Beach and any other sandy beach for which a representative from the Department of Primary Industries, Parks, Water and Environment had verified in writing that harvesting would not be detrimental to nesting hooded plovers. Code of conduct for industry.
Export	Mainly United Kingdom.
By-catch	No by-catch species harvested.
Interaction with protected species ²	There is the possibility of interactions with <i>Thinornis rubricollis</i> (hooded plover) and other migratory birds in the area. Harvesting is restricted to areas where it is considered that it will not be detrimental to migratory birds, i.e. harvesting and transporting of kelp and/or equipment is prohibited from September to March (inclusive) on sandy beaches, except the north-end of British Admiral Beach and any other sandy beach for which a representative from the Department of Primary Industries, Parks, Water and Environment had verified in writing that harvesting would not be detrimental to nesting hooded plovers.
Ecosystem impacts	The collection of bull kelp by hand and assisted by winches and mechanical grabs are unlikely to have any impacts on the ecosystem.

4 Environment

Marine 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 the kelps, grow to a very large size and form dense subtidal beds. During storms and periods of strong winds, large numbers of these marine algae are torn off or fragmented by wave action and later washed up on beaches. The supply of beachcast algae, like seagrass, is highly variable over short time and spatial scales, but is again 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 targeted by commercial activities are primarily several large brown algae (e.g. *Durvillaea potatorum* and *Ecklonia radiata*) and some of the red algae such as *Gracilaria*.

Cape Jaffa (in the south east of South Australia) represents the westerly limit of the distribution of a number of key taxa including the large kelp (*Macrocystis pyrifera*) and the southern bull kelp³ (*D. potatorum*). Higher energy rocky intertidal and sublittoral fringes are typically dominated by bull kelp (*D. potatorum*) while

² 'Protected species' means all species listed under Part 13 of the EPBC Act, including whales and other cetaceans and threatened, marine and migratory species.

³ 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.

subtidal reefs include numerous species of foliaceous red, brown and green macro-algae. However subtidal reefs tend to be visually dominated by species of the giant kelp (*M. pyrifera*⁴), the kelp *Ecklonia radiata* as well as a large variety of other macro-algal species (Edyvane 1999a, b) including many species of *Cystophora* and *Sargassum* as well as the Seirococcacean species (*Phyllospora comosa*, *Seirococcus axilaris* and *Scytothalia dorycarpa*).

5 Social and Economic Information

The harvest of beachcast marine algae 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. Marine algae are processed immediately either via composting or by drying on outdoor racks and crushing. The principal use for algal derivatives is as a food product for abalone aquaculture feed, although they are also used in the production of alginate and agar, mineral supplements, 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.

6 Methodology - ESD Risk Assessment

PIRSA adopted a process for issue identification, risk assessment, and reporting closely based on the National ESD Framework “How To Guide” (see www.fisheries-esd.com), as well as the Department of Fisheries, Western Australia ESD performance reports pioneered by Dr Rick Fletcher and other WA Fisheries staff.

Identification of issues was informed by the generic ESD component tree approach with each component tree refined specifically for the proposed activity.

Each major component tree reflected the primary components of ESD, and the ESD risk assessment report assesses the performance of the proposed activity for each of the relevant ecological, economic, social and governance issues facing it (Table 3). The process also identified where additional (or reduced) management or research attention is needed, and identified strategies and performance criteria to achieve management objectives to the required standard.

Table 3: Primary ESD Components

Retained Species Non-retained Species General Ecosystem Impacts	Ecological Wellbeing
Community Aboriginal Community	Human Wellbeing
Governance External Factors Affecting Performance of the Fishery	Ability to Achieve

⁴ 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 *M. 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 *M. angustifolia*) has been merged with *M. pyrifera*.

The steps followed to complete the ESD risk assessment report were:

1. A set of “Generic ESD Component Trees” were modified into a set of trees specific to the proposed activity. The final trees are provided in the results section.
2. A risk assessment of the identified issues (or components) was undertaken based on the *consequence* arising from the issue and *likelihood* that this consequence will occur (refer to Table 10 - 17 in the appendix for further information and descriptions of consequence and likelihood levels). The combination of the consequence and likelihood estimated a level of *risk* associated with issues that may undermine or alternatively contribute to ESD objectives (Table 4). The risk assessment was completed based on the input provided through a workshop held with key stakeholders (listed in Table 18) and the collation of the outcomes of this process.

Table 4: Risk matrix

		Consequence Level				
		Negligible	Minor	Moderate	Major	Extreme
Likelihood Levels		0	1	2	3	4
Remote	1	0	1	2	3	4
Unlikely	2	0	2	4	6	8
Possible	3	0	3	6	9	12
Likely	4	0	4	8	12	16

Table 5 - Relationship between risk value, risk category, management response and reporting requirements.

Risk Category	Risk Values	Management Response	Reporting Requirements
Negligible	0-2	None	Brief Justification
Low	3-4	No Specific Management	Full Justification Report
Medium	6-8	Specific Management/ Monitoring Needed	Full Performance Report
High	9-16	Increased Management Activities Needed	Full Performance Report

3. Risks were prioritised according to their severity. For higher level risks - where an increase in management or research attention was considered necessary - a detailed analysis of the issue, associated risks, and preferred risk management strategies was completed. For low risk issues, the reasons for assigning low risk and/or priority were recorded.
4. For higher level risks a full ESD performance report was prepared completed in the context of specific management objectives, include operational objectives, indicators and performance measures.
5. Key government stakeholders were provided with an opportunity to comment on a draft of the report prior to it being released for public consultation.
6. PIRSA will consider comments provided through public submissions during a public consultation period and finalise the report.

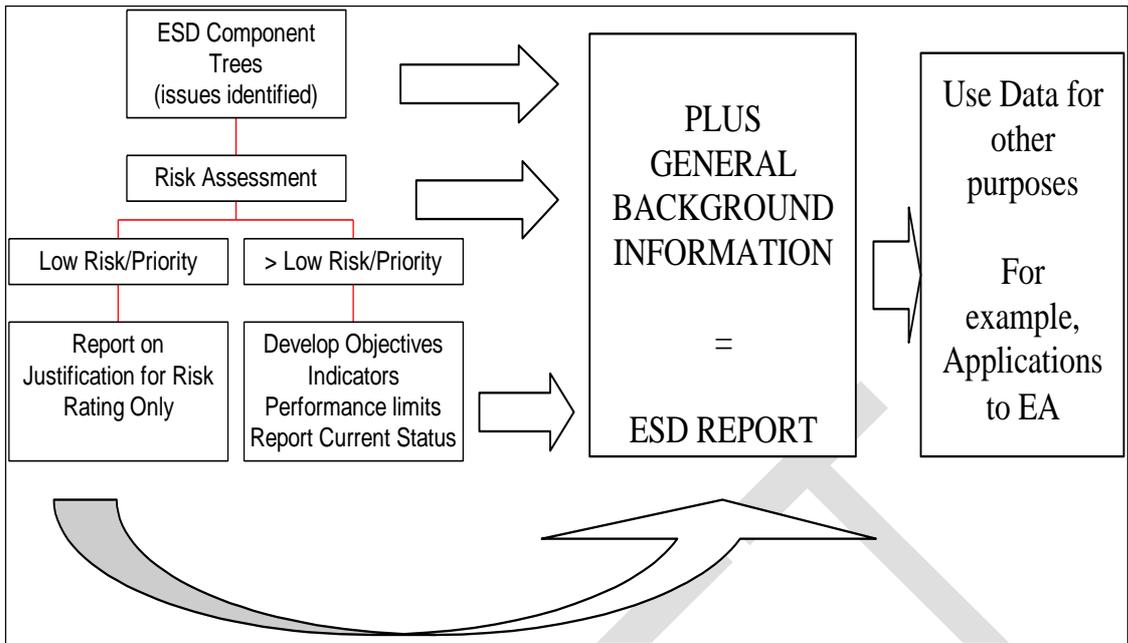
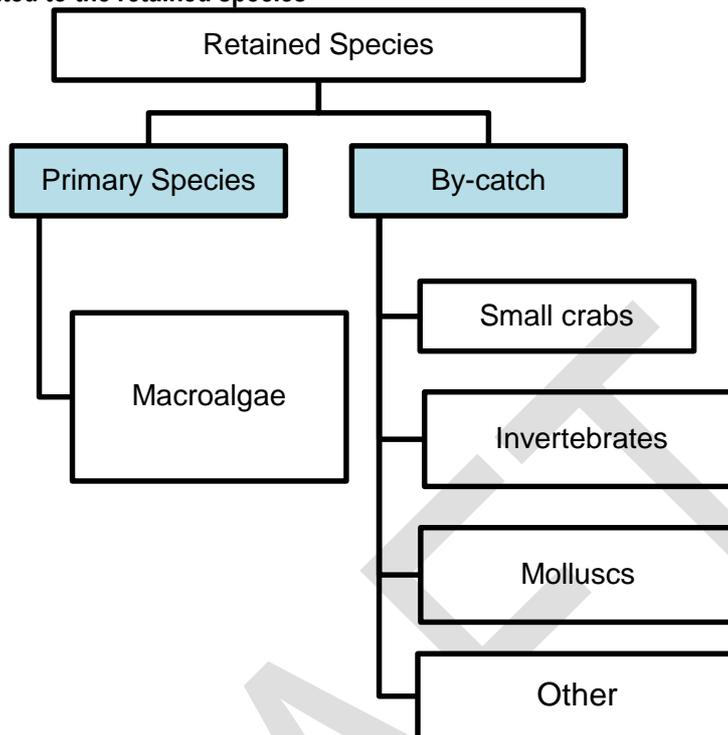


Figure 1: Summary of the ESD reporting framework processes

7 Results

7.1 Issues related to the retained species



This component of the risk assessment was conducted on the basis of the broader impact of the proposed harvest of marine algae on retained species. The risk assessment considered the potential impacts of the existing commercial operations to harvest beachcast marine algae in South Australia to inform the assessment of the proposed activity to harvest beachcast marine algae under the Exploratory Permit application. The levels of productivity within the state waters of both marine algae were also considered. The estimated primary production of marine algae in the area from Cape Jaffa to the Victorian border was estimated to be in the millions of tonnes annually (based on figures from Cheshire et al. 1996), with a small percentage of that production being washed ashore and available for harvest (as shown in the King Island fishery, Cheshire 1991)

7.1.1 Primary Species

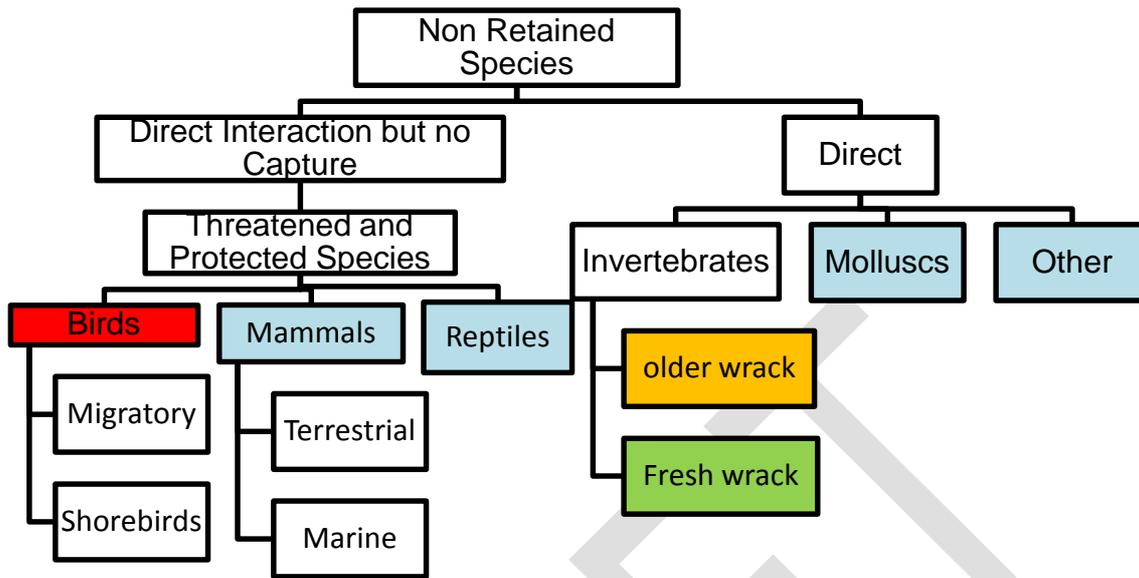
The overall assessment was that the current and proposed harvest operations would not have any significant impact on the broader marine algae production and growth within the marine environment (Consequence level 1) and the likelihood of this occurring was considered possible (Likelihood level 1). **Risk Score (1) = Negligible.**

7.1.2 By-catch

The proposed operations target marine algae however may retain small numbers of some by-catch species however as the operations would be designed to minimise the removal of sand (as are current operations) it was considered that by-catch would be low. The impacts of by-catch on these by-catch species were considered to be minor (Consequence score 1) with the likelihood of this occurring being remote (Likelihood score 1). **Risk Score (1) = Negligible.**

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7.2 Issues related to the non-retained species



7.2.1 Threatened, Endangered and Protected Species (TEPS)

The issue of harvest operations impacting on TEPS through interactions in the area of the proposed activity was considered to be important by the workshop participants.

It was noted that there have not been any interactions with TEPS recorded by the existing Miscellaneous Fishery licence holders historically. However, it was acknowledged that there may have been some ambiguity in the past about the definition of an interaction with TEPS and reporting requirements, which was considered in the assessment.

The area of proposed operations is considered a key bird habitat included in a number of international agreements for migratory bird species. In addition, a number of endangered species utilise the proposed fishing area during their migrations.

The following species were identified as key species of concern by stakeholders at the ESD risk assessment workshop (Table 6).

Table 6: Species of birds identified at the ESD risk assessment workshop as key species and their classification under the EBPC Act

Species	Scientific name	Listing Status
Hooded Plover	<i>Thinornis rubricollis</i>	Vulnerable
Orange Bellied Parrot	<i>Neophema chrysogaster</i>	Critically Endangered
Double banded Plover	<i>Charadrius bicinctus</i>	Migratory

Curlew Sandpiper	<i>Calidris ferruginea</i>	Migratory ⁵
Pacific Golden Plover	<i>Pluvialis fulva</i>	Migratory
Red Necked Stint	<i>Calidris ruficollis</i>	Migratory
Ruddy Turnstone	<i>Arenaria interpres</i>	Migratory
Sanderling	<i>Calidris alba</i>	Migratory
Sharp Tailed Sandpiper	<i>Calidris acuminata</i>	Migratory

It was considered that the consequence of interaction between the operation and TEP bird species could have a major consequence (Consequence level 3) and the likelihood was considered to be likely (Likelihood level 4). **Risk Score (12) = High.**

The risk was based on the protected status of many of the species in the area (refer to Table 12) and the consideration that in developing arrangements each species should be considered based on their distributions (area and temporally) as well as their behaviour.

Migratory shorebirds arrive from September onwards to their non-breeding grounds in South Australia. Beachcast marine algae and seagrass wrack is important for foraging and roosting for migratory shorebirds, as it contains essential food (amphipods and larvae) and provides camouflage and protection from inclement weather. The majority of migratory shorebirds leave the area in March/April (DotE 2015).

The hooded plover is nesting and or caring for dependent young from September to March (DotE 2015) at which time these birds become site attached.

PIRSA Fisheries and Aquaculture will consider appropriate management arrangements to reduce the potential impact on these listed species in consultation with the Department of the Environment (DotE) and the Department of Environment, Water and Natural Resources (DEWNR).

The impact of habitat disturbance and movement of biological material, and trophic level impacts of this movement, is assessed in the next section related to the general environment impacts of a fishery.

7.2.2 Mammals

Stakeholders considered the potential for interactions with mammals, both marine based and terrestrial, and the fishing operation to be very minimal.

It was considered that the consequence of interaction with the proposed activity would be minor (Consequence level 1) and the likelihood of an interaction was unlikely (Likelihood level 1) **Risk Score (1) = Negligible**

7.2.3 Reptiles

Stakeholders considered the potential for interactions with reptiles and the proposed activity to be very minimal.

⁵ Curlew Sandpiper was listed in the critically endangered category under the EPBC Act on 26/5/15. The status at the time of the workshop was Migratory and the assessment was conducted under this category.

It was considered that the consequence of interaction with the proposed activity would have a minor consequence (Consequence level 1) and the likelihood of an interaction was unlikely (Likelihood level 1)

Risk Score (1) = Negligible

7.2.4 Invertebrates – Older Wrack

It was considered that the older wrack deposited on the beach would have established invertebrate communities associated with it. This was a point of concern for several participants in relation to the impact on shorebirds from the removal of older wrack with associated invertebrates on which these birds forage rather than the risk to the invertebrate species themselves.

It was noted that the harvest operations prefer fresh wrack that would not have decayed to an extent that would encourage colonisation by invertebrates.

Based on the discussions at the workshop about the spatial extent of the proposed activity and the targeted of fresh marine algae, the risk to invertebrates (and therefore flow on impacts on TEPS species) from removal of older marine algae wrack was considered to be **Moderate**.

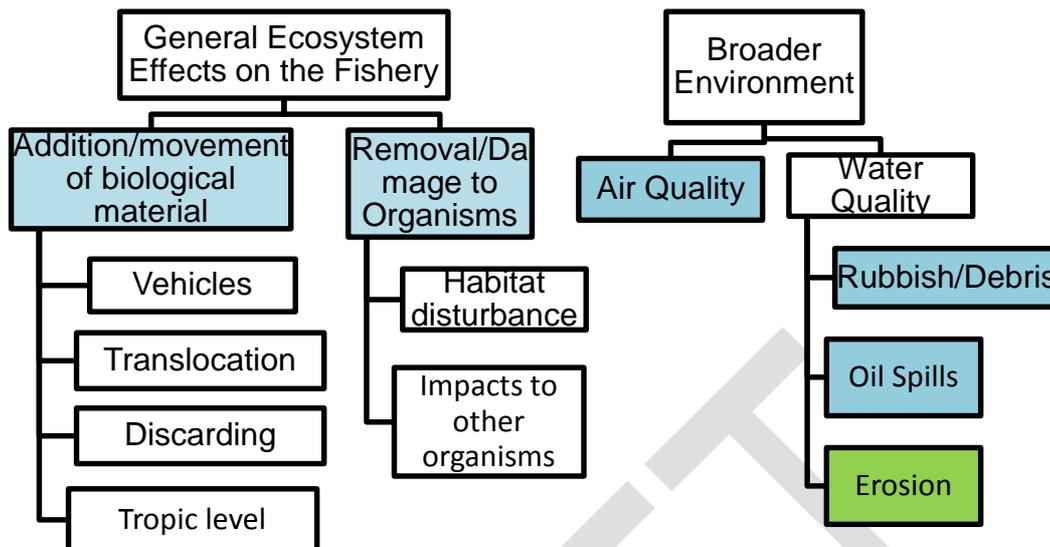
7.2.5 Invertebrates – Fresh Wrack

The risk to invertebrates in fresh wrack was considered to be negligible given that fresh marine algae wrack would have less invertebrates colonising it than older wrack. It was considered that the consequence of interaction with the proposed activity would have a minor consequence (Consequence level 1) and the likelihood of an interaction was possible (Likelihood level 3) **Risk Score (3) = Low**

7.2.6 Molluscs and Other

The remainder of the identified potential 'direct' interactions with mollusc and other species were considered negligible based on the assumption that fresh marine algae wrack would have minimal molluscs or other species attached and this newly deposited wrack would be harvested as the preference. It was considered that the consequence of interaction with the proposed activity would have a minor consequence (Consequence level 1) and the likelihood of an interaction was unlikely (Likelihood level 1) **Risk Score (1) = Negligible**

7.3 Issues related to the general environment impacts of a fishery



A number of impacts on the general ecosystem have been identified previously in the proposed area. It was considered that the beach in the proposed harvest area is impacted by storms and high wave volume and that these natural events are likely to have a significant impacts. In addition, there is some level of recreational vehicle use of the beaches in the same area as well as visitors beach walking in some areas. These anthropogenic interactions would also have an effect on the general ecosystem.

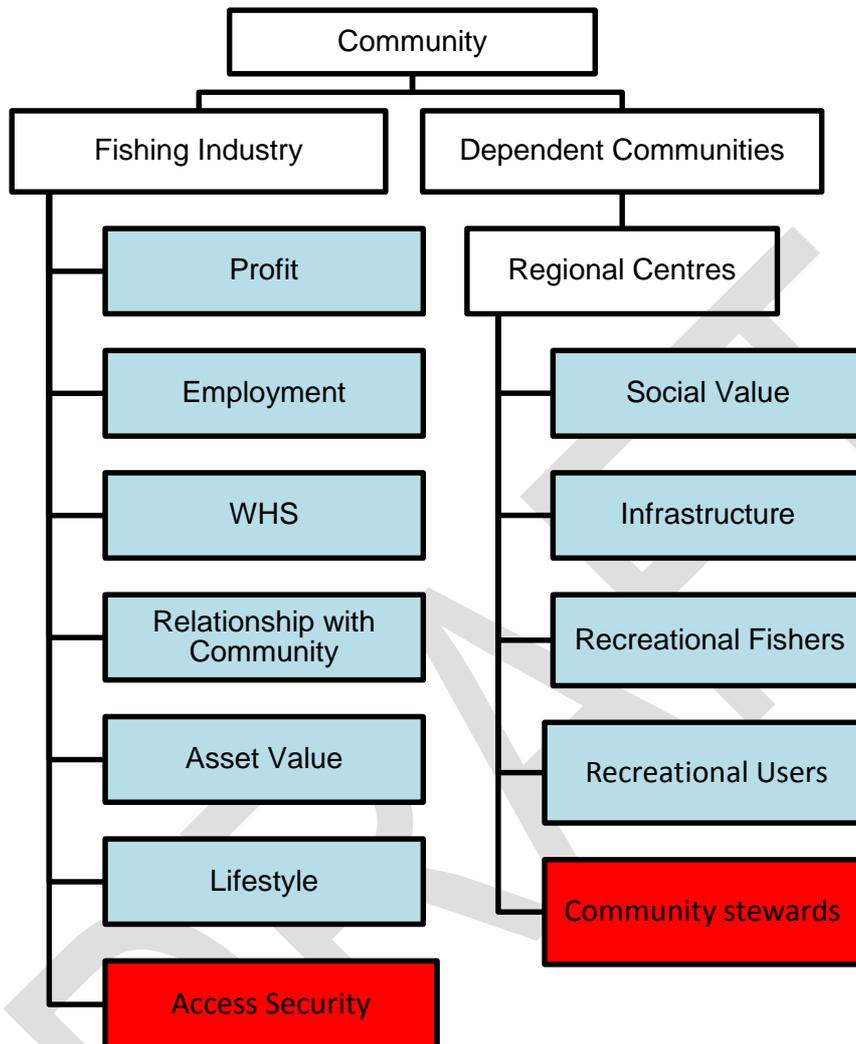
With respect to trophic level interactions with the environment it was noted that fresh wrack is preferred for harvest by operators. Nutrient release from wrack is associated with its decomposition. In addition, it is considered that there are orders of magnitude more marine algae in the water (attached and drifting) that contribute to natural systems. It is therefore considered that trophic level impacts of the proposed beachcast marine algae harvest would be negligible in comparison to the contribution of remaining beachcast and water borne wrack. This includes the potential for impact on other organisms such as rock lobster and abalone in the marine environment adjacent to the proposed area of operation.

Erosion was not assessed in detail at the workshop, however discussions identified concerns related to the potential impact of wrack harvest on erosion of sand dunes, particularly at Southend. It was noted that erosion at Southend had been a concern for some time prior to any algae harvest and was therefore likely to be due to other processes. Seagrass enhances 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. Seagrasses are composed primarily of cellulose fibre with characteristics that inhibit breakdown while marine algae is subject to very rapid deterioration. As the proposed activity would allow for the harvest of marine algae only and not seagrass, and prohibit harvest within four metres of dunes, it was considered that impacts of the proposed activity over the spatial extent of the proposed operation would be **Low**.

Management arrangements for the proposed operation would include a restriction on harvest within four metres of dunes and the restriction to use established roads to access areas, consistent with arrangements for the existing beachcast marine algae operation.

All other general environment components were considered to have a minor consequence (**Consequence level 1**) and likelihood (**likelihood level 1**) due to the nature of the harvesting operation. **Risk Score (1) = Negligible**.

7.4 Contribution of the fishery/industry to community wellbeing

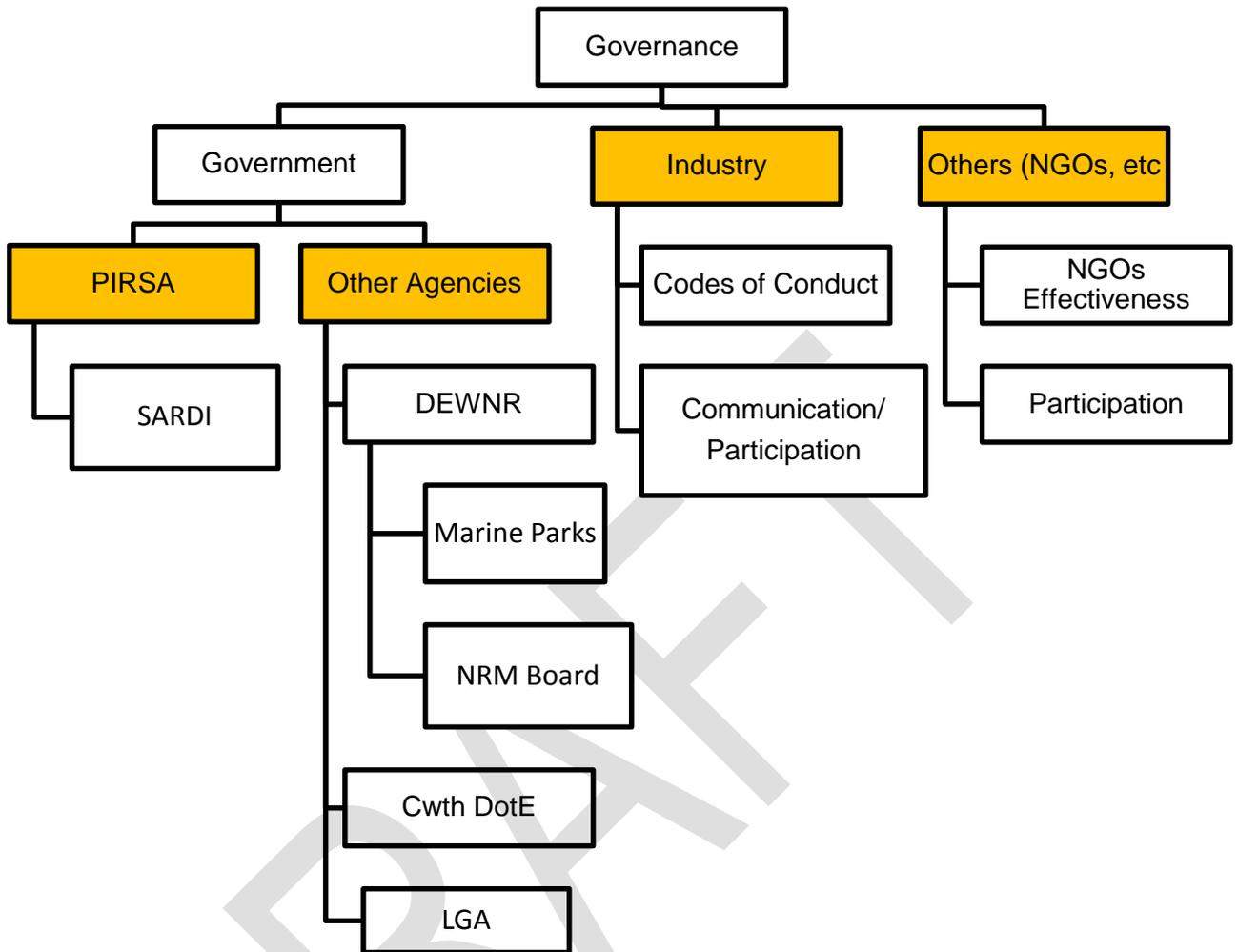


All components except for access security and community stewards were considered to have a minor consequence (Consequence level 1) with a likelihood of remote (Likelihood level 1). **Risk Score (1) = Negligible.**

It was noted that access security was an important issue for the proponent as this may have a severe impact on the economic viability of the operation. **Risk = High.**

In addition, the involvement of the community steward groups was considered an issue that needed to be managed through ongoing consultation with PIRSA and stakeholders with an interest in the areas being utilised by the licence holder. The licence holder was open to working with local groups if there were issues of concerns in specific areas to ensure that conflicts or concerns are mitigated during their operations. **Risk = High.**

7.5 Issues related to the governance of the fishery/industry



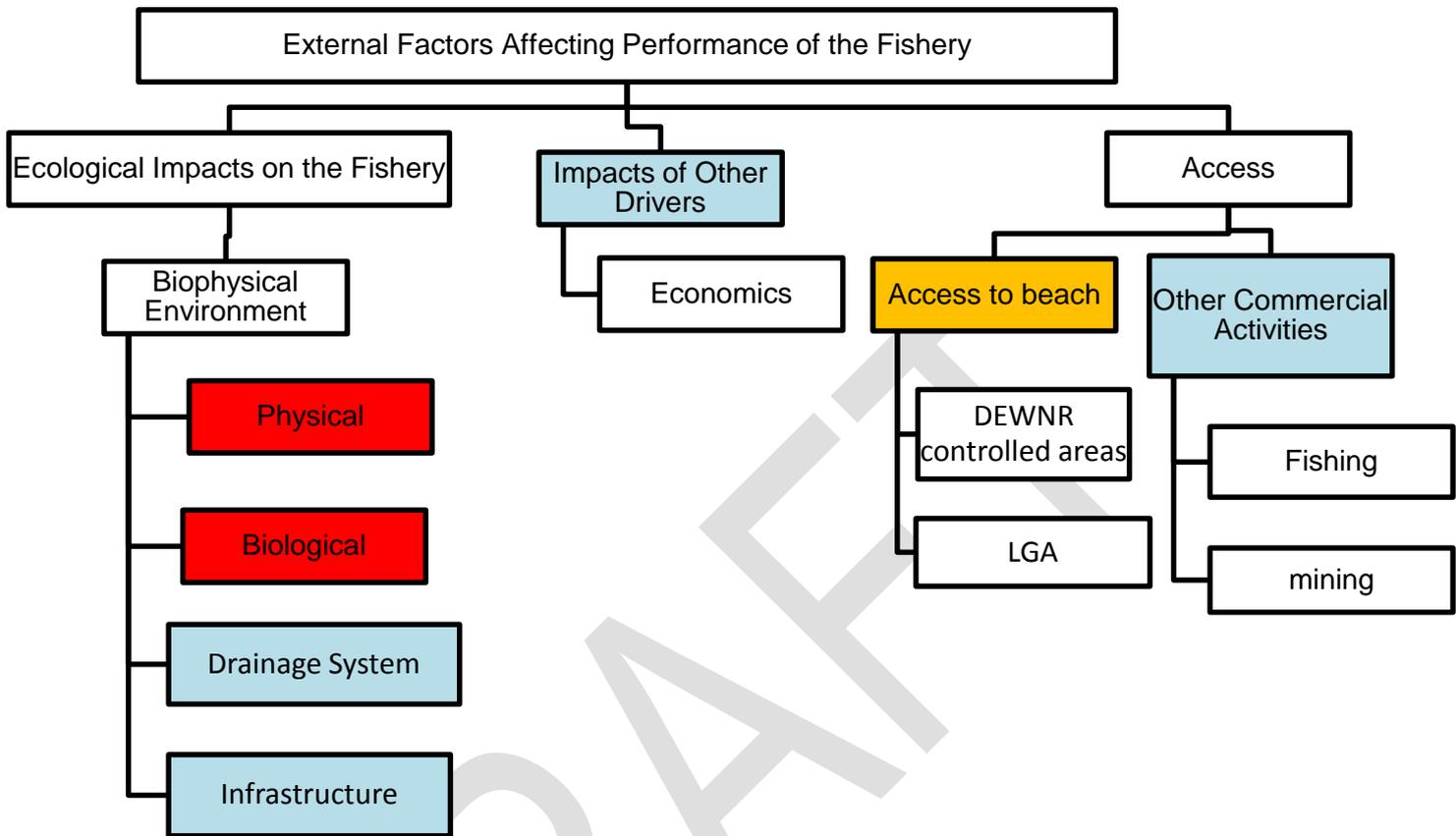
The stakeholder workshop identified PIRSA as a governance risk to the operation, specifically given that the fishery is very small and that management arrangements that reduce operating efficiency may impact the ability of the licence holder to be viable. It was considered that the consequence of such impacts to the proposed operation was moderate (Consequence level 2) with a likelihood of possible (Likelihood level 3). **Risk Score (6) = Medium.**

Other agencies which could have impacts on the licence holders included the Department of the Environment (DotE), Local Government Association (LGA) and the Department of Environment, Water and Natural Resources (DEWNR). The stakeholder workshop identified that these bodies could have direct management implications which could impact the economic viability of the proposed operation. Consequence was considered major (Consequence level 3) with a likelihood of remote (Likelihood level 3) due to the limited size of the proposed activity was assessed. **Risk Score (9) = Medium.**

Stakeholders at the workshop considered that clear governance related to industry codes of conduct and effective communication/participation were important. **Risk = Medium.**

Industry members at the workshop considered that clear governance related to NGO effectiveness and participation was important to maintain access to the fishery. **Risk = Medium.**

7.6 External Impacts Affecting Performance of the proposed activity:



Given that the marine algae wrack, and in particular Bull Kelp were at the most eastern biological extent of their range, the impact of biological and physical changes i.e. climate change, could have a significant impact on the availability of wrack. With the uncertainty of the impacts of climate change on this species within South Australia a major consequence (Consequence level 3) with a likelihood of possible (Likelihood level 3) was assessed for the biological and physical environment components. **Risk Score (9) = High.**

Economics was identified as an external driver, but considered to be of negligible risk given that similar operations have operated in other areas for many years. **Risk = Negligible.**

Access to beach to harvest wrack may be impacted through changes to access through adjacent DEWNR managed areas (terrestrial conservation parks, etc) or changes to access to beaches under local council management arrangements. **Risk = Medium.**

Impact of the activity of other activities on the harvest activity was considered **negligible.**

7.7 Summary of ESD Reporting Framework

In summary, the ESD reporting framework for all components of the fishery identified five components of potentially high risk through the stakeholder workshop process. The majority of these were related to general community issues and future changes in the biophysical environment and its impact in the production of

marine algae wrack. Interactions with TEP species, specifically migratory birds was also identified as a high risk (Table 7).

Medium risk were identified in relation to invertebrates in older wrack and the broader food web impacts associated with the removal of this food source, particularly on TEP species such as migratory birds. Medium risks were also identified related to governance arrangements impacting on the fishery and external factors that may affect fishery performance (Table 7).

The remainder of components were identified as having low or negligible risk associated with the proposed activity in the area of operation. A table summarising the outcomes of all of the components assessed is provided in Table 8.

Table 7: Summary of ESD risk rating outcomes

Component Trees	High	Medium	Low	Negligible	Total
Retained Species	0	0	0	2	2
Non-retained species	1	1	1	4	7
General Ecosystem	0	0	1	5	6
General Community	2	0	0	10	12
Governance	0	4	0	0	4
External Factors affecting Fishery Performance	2	1	0	4	7
Total	5	6	2	25	38

7.8 Performance report for high and medium risk components

Full ESD performance reports are provided for each of the identified high and medium risk components (Table 9). As the activity assessed is a proposed activity, the performance report is in the context of potential management objectives including proposed operational objectives and options for management strategies.

Table 8: Summary report of all components of ESD risk assessment

Component	Risk/Issue	Risk rating	Objective Developed	Proposed Strategies Developed	Indicator Developed	Indicator Robustness	Actions
Retained Species							
Primary Species – Macroalgae		Negligible	Yes	Yes	Yes	High	*
Retained Species– By-catch		Negligible	Yes	Yes	Yes	High	*
Non Retained Species							
Direct interaction but no capture – TEPS - Birds		High	Yes	Yes	Yes	High	*
Direct interaction but no capture – TEPS – Mammals		Negligible	Yes	Yes	Yes	High	*
Direct interaction but no capture – TEPS – Reptiles		Negligible	Yes	Yes	Yes	High	*
Direct - Invertebrates - Older Wrack)		Medium	Yes	Yes	Yes	Low	**
Direct - Invertebrates - Fresh Wrack)		Low	Yes	Yes	No	N/A	***
Direct – Mollucs		Negligible	No	Yes	No	N/A	***
Direct – Other		Negligible	No	Yes	No	N/A	***

General Environment						
General Ecosystem Effects on the Fishery - Addition/movement of biological material	Negligible	Yes	Yes	No	N/A	**
General Ecosystem Effects on the Fishery - Removal/Damage to Organisms	Negligible	Yes	Yes	No	N/A	**
Broader Environment - Air Quality	Negligible	No	No	No	N/A	***
Broader Environment- Water Quality - Rubbish/debris	Negligible	No	No	No	N/A	***
Broader Environment - Water Quality- Oil Spills	Negligible	No	No	No	N/A	***
Broader Environment – Water Quality - Erosion	Low	No	No	No	N/A	**
General Community						
Fishing Industry – Profit	Negligible	No	No	No	N/A	***
Fishing Industry – Employment	Negligible	No	No	No	N/A	***
Fishing Industry – WHS	Negligible	No	No	No	N/A	***
Fishing Industry – Relationship with Community	Negligible	No	No	No	N/A	***
Fishing Industry – Asset Value	Negligible	No	No	No	N/A	***
Fishing Industry – Lifestyle	Negligible	No	No	No	N/A	***

Fishing Industry - Access Security	High	Yes	Yes	Yes	High	**
Dependent Communities - Regional Centres – Social Value	Negligible	No	No	No	N/A	***
Dependent Communities- Regional Centres – Infrastructure	Negligible	No	No	No	N/A	***
Dependent Communities- Regional Centres – Recreational Fishers	Negligible	No	No	No	N/A	***
Dependent Communities - Regional Centres – Recreational User	Negligible	No	No	No	N/A	***
Dependent Communities- Community Stewards	High	Yes	Yes	Yes	Low	**
Governance						
Governance - PIRSA	Medium	Yes	Yes	Yes	Medium	**
Governance - Other Government agencies	Medium	Yes	Yes	Yes	Medium	**
Governance - Industry	Medium	Yes	Yes	Yes	Medium	**
Governance - Others (NGOs)	Medium	Yes	Yes	No	N/A	**
External impacts on the fishery						
Ecological impacts on the fishery - Physical	High	Yes	Yes	Yes	Low	**
Ecological impacts on the fishery - Biological	High	Yes	Yes	Yes	Low	**
Ecological impacts on the fishery - Drainage System	Negligible	No	No	No	N/A	***

Ecological impacts on the fishery - Infrastructure	Negligible	No	No	No	N/A	***
Impacts of Other Drivers	Negligible	No	No	No	N/A	***
Access - Access to Beach	Medium	Yes	Yes	Yes	Low	**
Access - Other Commercial Activities	Negligible	No	No	No	N/A	***

Notes: * management arrangements to be included in proposed management arrangements, ** to be monitored, *** no current actions identified

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Table 9: Full performance report for High and Medium risks

Component	Risk/Issue	Description	Risk rating	Proposed Objective	Proposed Strategies	Performance Indicator	Indicator Robustness	External Drivers
Non Retained Species	Direct interaction but no capture – TEPS - Birds	Risk of fishery impacts on TEPS species.	High	Interactions with TEP species are sustainable	<p>Appropriate area closure to minimise interactions with TEP species, nesting birds, birds with dependent young and migratory bird</p> <p>Prohibiting harvest operations within 100 m either side of an area where <i>Thinornis rubricollis</i> (hooded plovers) are nesting or caring for dependent young from September to March (inclusive)</p> <p>Harvest prohibited within 4 m of foredunes</p>	<p>Number of interactions reported in wildlife interaction logbooks</p> <p>Total area of beach on which harvesting occurs is not greater than 50% of total coastal extent of the licence</p>	High	Negative impacts of interactions between birds and other users of beaches in the harvest area including anthropogenic activities (vehicles, dogs and people on beaches), coastal development etc.
	Invertebrates - Older Wrack	Risk of fishery impacts on invertebrates utilising the older wrack on the beach and broader food web.	Medium	Impact of proposed activity on invertebrates in older wrack is sustainable	<p>Total area of wrack harvested annually is < 50% of total area of wrack</p> <p>Harvest of beachcast unattached algae only</p>	Total area of beach on which harvesting occurs is not greater than 50% of total coastal extent of the licence.	Low	Climate change may also impact on invertebrates utilising older wrack

Community Wellbeing	Fishing Industry - Access Security	Access security for permit holder	High	Provide flexible opportunities to ensure fishers can access the resource within the constraints of ecological sustainability	Management arrangements allow for efficient fishing operations within constraints of ecological sustainability	DotE Export approval for the fishery Fishing endorsements to access the resource is maintained if management arrangements allow for activity within the constraints of ecologically sustainability.	High	
	Dependent Communities- Community Stewards	Community Steward participation where appropriate	High	Community confidence in fisheries agencies to manage fisheries enabled	Proposed management arrangements provided for public comment and communicated to other agencies.	Management arrangements for the proposed activity is publically available on PIRSA Website	Low	Misunderstanding about the industry may result in loss of community confidence in the industry
Governance	PIRSA	Risk to the fishery through lack of sufficient resources to manage fishery efficiently	Medium	Licence/permit holder participation in management of the fishery through	Proposed management arrangements are developed in consultation with proponent	A primary contact person at PIRSA maintained A primary contact person for permit holders is maintained Regular contact between	Medium	
	Other Government agencies	Risk to the fishery from other Government agencies	Medium	Management arrangements for the proposed activity are communicated to other agencies	Proposed management arrangements provided for public comment and communicated to other agencies.	management arrangements for the proposed activity is publically available on PIRSA Website	Medium	Policies and procedures of other departments may conflict with the objectives of the fishery
	Industry	Risk of the Industry governance	Medium	Industry code of practice developed	Code of practice to be developed by industry	Harvest operations apply code of practice where appropriate	Medium	

				Harvest operations are consistent with industry code of practice where possible				
	Others (NGOs)	Risk to the fishery from governance arrangements of other organisations (NGOs)	Medium	Management arrangements for the proposed activity are communicated to other agencies	Proposed management arrangements provided for public comment		N/A	Misunderstanding about the industry may result in loss of community confidence in the industry
External factors affecting the performance of the fishery	Ecological impacts on the fishery - Physical	Risk to the fishery from changing biophysical environment and the possible impacts on the fishery of climate change. Change in the distribution of this species.	High	Changes due to climate change are considered when setting management arrangements for fishery	Changes due to climate change are considered when setting management arrangements for fishery	Climate change is considered in future ESD Risk Assessments	Low	Climatic driven changes to the physical or biological environment
	Ecological impacts on the fishery - Biological		High				Low	
	Access to Beach	Risk of changes to regulations of Government or local council impacting on access to harvest area	Medium	Management arrangements for the proposed activity are communicated to other agencies	Proposed management arrangements provided for public comment and communicated to other agencies.	management arrangements for the proposed activity is publically available on PIRSA Website	Low	Policies and procedures of other Government agencies or local councils may conflict with the objectives of the fishery

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9 Appendix

Table 10 - Consequence categories for the major target/vulnerable species. The default objective is - maintain the biomass above the target reference point".

Level	Ecological (Target/Vulnerable Species)
Negligible (0)	No measureable decline Exploited Stock Abundance Range 100% to 90% unfished levels
Minor (1)	Either not detectable against background variability for this population; or if detectable, minimal impact on population size and none on dynamics. Exploited Stock Abundance Range < 90% to 70% unfished levels
Moderate (2)	Fishery operating at, or close to, the exploitation rate that will deliver MSY. Exploited Stock Abundance Range < 70% to > Bmsy
Major (3)	Stock has been reduced to levels below MSY and may also be getting into the range where recruitment overfishing may occur. Exploited Stock Abundance Range < Bmsy to > Brec
Extreme (4)	Stock size or significant species range contraction > 50% have occurred and recruitment levels reduced affecting future recruitment and their capacity to increase from a depleted state (i.e. recruitment overfishing) Exploited Stock Abundance Range < Brec

Table 11 - Consequence categories for the by-product species/minor by-catch species. The default objective is - to maintain appropriate levels of biomass of by-catch species to minimize any significant impact on their dynamics and the broader ecosystem.

Level	Ecological (by-product/general by-catch)
Negligible (0)	Very few individuals are captured in relation to likely population size (<1%)
Minor (1)	Take in this fishery is small (< 10%), compared to total take by all fisheries and these species are covered explicitly elsewhere. Take and area of capture by this fishery is small, compared to known area of distribution (< 20%).
Moderate (2)	Relative area of, or susceptibility to capture is suspected to be less than 50% and species do not have vulnerable life history traits.
Major (3)	No information is available on the relative area or susceptibility to capture or on the vulnerability of life history traits of this type of species AND The relative levels of capture/susceptibility suspected/known to be greater than 50% and species should be examined explicitly
Extreme (4)	N/A Once a consequence reaches this point it should be examined using target species table.

Table 12 - Consequence categories for the by-catch of protected species. The default objective is to maintain levels of catch of these species at acceptable levels.

Level	Protected species by-catch
Negligible (0)	Some level of interaction may occur but either no mortalities generated or extremely few are recorded at the time scale of years.
Minor (1)	Very few individuals of the protected species are directly impacted in most years, no general level of public concern
Moderate (2)	The fishery catches or impacts these species at the maximum level that is accepted
Major (3)	The catch or impact by the fishery on the protected species is above that accepted by broader community but there are few/no additional stock implications
Extreme (4)	The catch or impact is well above the acceptable level and this is may be having significant additional impacts on the already threatened status.

Table 13 - Consequence categories for the impacts on habitats. The default objective is - to maintain the spatial extent of habitat impacts from the fishing activity to a comparatively small percentage of the habitat/ community.

Level	Ecological (ECOSYSTEM)
Negligible (0)	No measurable change in community structure would be possible against background variations
Minor (1)	Some relatively minor shifts in relative abundance may be occurring but it may be hard to identify any measurable changes at whole of trophic levels outside of natural variation.
Moderate (2)	Clear measurable changes to the ecosystem components without there being a major change in function. (i.e. no loss of components or real biodiversity), these changes are acceptable. None of the main captured species play a 'true' keystone role
Major (3)	Ecosystem function altered significantly and some function or components are locally missing/declining/increasing &/or allowed new species to appear. The level of change is not acceptable to enable one or more high level objective to be achieved. Recovery measured in many years to decadal.
Extreme (4)	An extreme change to ecosystem structure and function. Very different dynamics now occur with different species/groups now the major targets of capture and/or dominating the ecosystem. Could lead to a total collapse of ecosystem processes. Long-term recovery period may be greater than decades

Table 14 - Consequence categories for economic outcomes. The default objective is – the maintenance or enhancement of economic activity.

Level	Ecological (HABITAT)
Negligible (0)	No measurable impact on the habitat would be possible.
Minor (1)	Barely measurable impacts on habitat(s) which are very localised compared to total habitat area. (Suggestion – these impacts could be < 5%; < 3%; <2%) of the original area of habitat)

Moderate (2)	<p>There are likely to be more widespread impacts on the habitat but the levels are still considerable acceptable given the % of area affected, the types of impact occurring and the recovery capacity of the habitat</p> <p>(Suggestion – for impact on non-fragile habitats this may be up to 50% [similar to population dynamics theory] - but for more fragile habitats, to stay in this category the percentage area affected may need to be smaller, e.g. 20% and for critical habitats less than 5%)</p>
Major (3)	<p>The level of impact on habitats may be larger than is sensible to ensure that the habitat will not be able to recover adequately, or it will cause strong downstream effects from loss of function.</p> <p>(Suggestion - Where the activity makes a significant impact in the area affected and the area > 25 - 50% [based on recovery rates] of habitat is being removed; whilst for critical habitats this would be < 10%)</p>
Extreme (4)	<p>Too much of the habitat is being affected, which may endanger its long-term survival and result in severe changes to ecosystem function and the entire habitat is in danger of being affected in a major way/removed.</p> <p>(Suggestion this may equate to 70 - 90% of the habitat being affected or removed by the activity; for more fragile habitats this would be > 30% and for critical habitats 10-20%)</p>

Table 15 - Consequence categories for social disruptions. The default objective is – maintenance or enhancement of appropriate social structures and outcomes.

Level	Social Implications
Negligible (0)	Not measurable or no direct involvement
Minor (1)	Direct impacts may be measurable but minimal concerns
Moderate (2)	Some direct impacts on social structures but not to the point where local communities are threatened or social dislocations will occur
Major (3)	Severe impacts on social structures, at least at a local level.
Extreme (4)	Changes will cause a complete alteration to some social structures that are present within a region of a country

Table 16 - Suggested consequence levels for economic outcomes. The default objective is - maintenance or enhancement of economic activity.

Level	Economic
Negligible (0)	None or not detectable
Minor (1)	Possible detectable, but no real impact on the economic pathways for the industry or the community.
Moderate (2)	Some level of reduction for a major fishery or a large reduction in a small fishery that the community is not dependent upon.

Major (3)	Fishery/industry has declined significantly in economic generation and this will have clear flow on effects to other parts of the community. May result in some level of political intervention.
Extreme (4)	Total collapse of any economic activity coming from what was an industry that the community derived a significant level of their income or employment (resource dependency), including possible debts. High levels of political intervention likely.

Table 17 - Likelihood Definitions – these are usually defined for the likelihood of a particular consequence level actually occurring within the assessment period.

Level	Descriptor
Likely (4)	A particular consequence level is expected to occur (Probability of 40 - 100%)
Possible (3)	Evidence to suggest this consequence level is possible and may occur in some circumstances (Probability of 10 - 35%)
Unlikely (2)	The consequence is not expected to occur but it has been known to occur elsewhere (Probability of 2 -10%)
Remote (1)	The consequence has never been heard of in these circumstances, but it is not impossible (Probability < 2%)

Table 18: Attendees at ESD Risk Assessment Workshop 21 January 2015, Millicent.

Name	Organisation
Peter Harriott	Wattle Range Council
Richard Sage	District Council of Grant
Leo Lin	Licence holder
Walt Wu	Licence holder
Maureen Christie	Friends of Shorebirds SE
Ross Anderson	DEWNR
Jeffrey Campbell	Friends of Shorebirds SE
Lauren Oxlade	Wattle Range Council
Bob Bates	Kingston District Council
Anthony Cheshire	Science to Manage Uncertainty
Cath Bell	Robe Coastcare
Iain Steward	VWSG
Barry Tarr	PIRSA
Keith Rowling	PIRSA
Alex Chalupa	PIRSA