Report supporting Appropriate Assessment of Aquaculture in Castlemaine Harbour SAC (Site code: 000343)

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1 PREFACE

In Ireland, the implementation of Article 6 of the Habitats Directive in relation to aquaculture and fishing projects and plans that occur within designated sites is achieved through sub-Article 6(3) of the Directive. Fisheries not coming under the scope of Article 6.3, i.e. those fisheries not subject to secondary licensing are subject to risk assessment. Identified risks to designated features can then be mitigated and deterioration of such features can be avoided as envisaged by sub-article 6.2.

Fisheries, other than oyster fisheries, and aquaculture activities are licensed by the Department of Agriculture, Food and Marine (DAFM). Oyster fisheries (in fishery order areas) are licensed by the Department of Communications, Climate Action and Environment (DCCAE). The Habitats Directive is transposed in Ireland in the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. 477 of 2011). Appropriate assessments (AA) of aquaculture and risk assessments (RA) of fishing activities are carried out against the Conservation Objectives, and more specifically on the version of the Conservation Objectives that are available at the time of the Assessment, for designated ecological features, within the site, as defined by the National Parks and Wildlife Service (NPWS). NPWS are the competent authority for the management of Natura 2000 sites in Ireland. Obviously, aquaculture and fishing operations existed in coastal areas prior to the designation of such areas under the Directives. Ireland is thereby assessing both existing and proposed aquaculture and fishing activities in such sites. This is an incremental process, as agreed with the EU Commission in 2009, and will eventually cover all fishing and aquaculture activities in all Natura 2000 sites.

The process of identifying existing and proposed activities and submitting these for assessment is, in the case of fisheries projects and plans, outlined in S.I. 290 of 2013. Fisheries projects or plans are taken to mean those fisheries that are subject to annual secondary licencing or authorization. Here, the industry or the Minister may bring forward fishing proposals or plans which become subject to assessment. These Fishery Natura Plans (FNPs) may simply be descriptions of existing activities or may also include modifications to activities that mitigate, prior to the assessment, perceived effects to the ecology of a designated feature in the site. In the case of other fisheries, that are not projects or plans, data on activity are collated and subject to a risk assessment against the Conservation Objectives. Oyster fisheries, managed by DCENR, do not come under the remit of S.I. 290 of 2013 but are defined as projects or plans as they are authorized annually and therefore, should be subject to AA.

In the case of aquaculture, DAFM receives applications to undertake such activity and submits a set of applications, at a defined point in time, for assessment. The FNPs and aquaculture applications are then subject to AA. If the AA or the RA process finds that the possibility of significant effects cannot be discounted or that there is a likelihood of negative consequence for designated features then such activities will need to be mitigated further if they are to continue. The assessments are not explicit on how this mitigation should be achieved but rather indicate whether mitigation is required or not and what results should be achieved.

2 EXECUTIVE SUMMARY

2.1 THE SAC

Castlemaine Harbour SAC (Site code: 000343) is a large site located on the south-east corner of the Dingle Peninsula, Co. Kerry. It consists of the whole inner section of Dingle Bay, i.e. Castlemaine Harbour, the spits of Inch and White Strand/Rosbehy and a little of the coastline to the west. The River Maine, almost to Castlemaine, and much of the River Laune catchment, including the Gaddagh, Gweestion, Glanooragh, Cottoner's River and the River Loe, are also included within the site.

The SAC is designated for the marine habitats Estuaries (1130) and Mudflats and sand flats not covered by seawater at low tide (1140) which support a variety of soft sedimentary communities and community complexes. The site is also designated for a variety of coastal habitats, including saltmarshes, stony banks, sea cliffs and sand dunes, along with alluvial forests further inland. Designated species include plants, lamprey, salmon and otter. Conservation Objectives for marine habitats and constituent communities (within Castlemaine Harbour SAC) were identified by NPWS (2011a) and relate primarily to the requirement to maintain habitat distribution, structure and function, as defined by characterising (dominant) species. For designated species the objective is to maintain various attributes of the populations including population size, habitats quality and the distribution of the species.

2.2 ACTIVITIES IN THE SAC

Within the Castlemaine Harbour SAC aquaculture focuses on the cultivation of the Pacific oyster *Crassastrea gigas*[1] on trestles in intertidal areas, the subtidal cultivation of mussel *Mytilus edulis* on the seabed and intertidal cultivation of Manilla clams (*Ruditapes philipanarium*) using nursery frames followed by planting on the seabed. The intertidal area along the southern shore of Castlemaine Harbour is the main cultivation area for Pacific oyster *Crassostrea gigas* while bottom mussel farming also occurs along the southern shore but predominantly along the northern shore. The Fishery Order for mussel seed covers the main navigational channel from Inch Point to Cromane Island. Clam cultivation is confined to Glenbeigh to the south. The profile of the aquaculture industry in the SAC, used in this assessment, was prepared by BIM and is derived from the list of licence applications received by DAFM and provided to the MI for assessment in January 2018.

2.3 THE APPROPRIATE ASSESSMENT PROCESS

The function of an appropriate assessment is to determine if the ongoing and proposed aquaculture activities are consistent with the Conservation Objectives for the Natura site or if such activities will lead to deterioration in the attributes of the habitats and species over time and in relation to the scale, frequency and intensity of the activities. NPWS (2011a) provide guidance on interpretation of the Conservation Objectives which are, in effect, management targets for habitats and species in the SAC. This guidance is scaled relative to the anticipated sensitivity of habitats and species to disturbance by the proposed activities. Some activities are deemed to be wholly inconsistent with long term maintenance of certain sensitive habitats while other habitats can tolerate a range of

[1] *Crassostrea gigas* has been renamed *Magallana gigas* since 2017; however, the use of *C. gigas* is recognised as an 'accepted, alternative representation' (WoRMS-http://www.marinespecies.org/aphia.php?p=taxdetails&id=140656). This report will continue to refer to *C. gigas*.

activities. For the practical purpose of management of sedimentary habitats, a 15% threshold of overlap between a disturbing activity and a habitat is given in the NPWS guidance (NPWS 2011c). Below this threshold disturbance is deemed to be non-significant. Disturbance is defined as that which leads to a change in the characterizing species of the habitat (which may also indicate change in structure and function). Such disturbance may be temporary or persistent in the sense that change in characterizing species may recover to pre-disturbed state or may persist and accumulate over time.

The appropriate assessment process is divided into a number of stages consisting of a preliminary risk identification, and subsequent assessment (allied with mitigation measures, if necessary) which are covered in this report. The first stage of the process is an initial screening wherein activities are identified which are deemed not to have any impact on the conservation features, because they do not spatially overlap with a given habitat or have a clear pathway for interaction. These activities are excluded from further consideration. The next phase is the Natura Impact Statement (NIS) where interactions (or risk of) are identified. Further to this, an assessment on the significance of the likely interactions between activities and conservation features is conducted. Mitigation measures (if necessary) will be introduced in situations where the risk of significant disturbance is identified. In situations where there is no obvious mitigation to reduce the risk of significant impact, it is advised that caution should be applied in licensing decisions. Overall the Appropriate Assessment is both the process and the assessment undertaken by the competent authority to effectively validate this report and/or NIS. It is important to note that the screening process is considered conservative in that activities which may overlap with habitats but which may have very benign effects are retained for full assessment.

2.4 DATA SUPPORTS

Distribution of habitats and species population data are provided by NPWS[2]. Scientific reports on the potential effects of various activities on habitats and species have been compiled by the MI and provide the evidence base for the findings. The profile of aquaculture activities was provided by BIM. The data supporting the assessment of individual activities vary and provides for varying degrees of confidence in the findings.

2.5 FINDINGS

Aquaculture and Habitats/Species

In the Castlemaine Harbour SAC there are 30 valid oyster production licences with a further 99 new applications (5 of which are for the addition of oysters to currently licensed mussel sites). There is one site licensed for Manilla clams and oysters. In addition there are 15 current licences for mussel cultivation with an additional 5 applications. The likely interaction between aquaculture activity and conservation features (habitats and species) of the site was considered.

An initial screening exercise resulted in a number of habitat features and species being excluded from further consideration. None of the aquaculture activities (existing and/or proposed) overlaps or likely interacts with the following features or species, and therefore the following habitats and species were excluded from further consideration in the assessment:

[2] NPWS Geodatabase Ver: February 2017 - http://www.npws.ie/mapsanddata/habitatspeciesdata/

- Annual vegetation of drift lines [1210]
- Perennial vegetation of stony banks [1220]
- Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]
- *Salicornia* and other annuals colonising mud and sand [1310]
- Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]
- Mediterranean salt meadows (*Juncetalia maritimi*) [1410]
- Embryonic shifting dunes [2110]
- Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120]
- Fixed coastal dunes with herbaceous vegetation (grey dunes) [2130]
- Dunes with *Salix repens* ssp. *argentea* (Salicion arenariae) [2170]
- Humid dune slacks [2190]
- Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae) [91E0] and
- *Petalophyllum ralfsii* (Petalwort) [1395].

Table 2.1 - Community types recorded in Castlemaine Harbour SAC and the Annex I habitats of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide that overlap with overlap with and existing and proposed aquaculture activities

Feature	Community Type	Overlap with intertidal oyster cultivation activities	Overlap with intertidal clam cultivation activities	Overlap with subtidal mussel cultivation
Estuaries (1130)	Intertidal muddy fine sand community complex	✓		✓
	Intertidal sand with *Nephtys cirrosa* community	✓	✓	✓
	Fine to muddy fine sand with Polychaetes community complex	✓	✓	✓
	Zostera dominated community			✓
	Mixed sediment community complex	✓		
Mudflats and sandflats not covered by seawater at low tide (1140)	Intertidal muddy fine sand community complex	✓		✓
	Intertidal sand with *Nephtys cirrosa* community	✓	✓	✓
	Fine to muddy fine sand with Polychaetes community complex	✓	✓	✓
	Zostera dominated community			✓

2.5.1 Habitats

A full assessment was carried out on the likely interactions between existing and proposed culture operations and the Annex 1 habitats of 1130-Estuaries and 1140-Mudflats and sandflats not covered by seawater at low tide. Furthermore, constituent communities of habitat 1130 considered were; Intertidal sand with *Nephtys cirrosa* community, *Zostera* community complex, Fine to muddy sand with polychaetes community, Mixed sediment community and Intertidal muddy fine sand community. For habitat 1140 the constituent communities considered were Intertidal sand with *Nephtys cirrosa* community, *Zostera* community complex, Fine to muddy sand with polychaetes community and Intertidal muddy fine sand community.

Based upon the scale of spatial overlap of current and proposed intertidal oyster aquaculture activities (including access route activity) and the relatively high tolerance levels of the habitats and associated species, the general conclusion is that current and proposed intertidal culture activities are non-disturbing to the Qualifying Interests and their constituent community types. However, an access route for a number of oyster application sites will pose a significant risk to the Conservation Objectives of one marine benthic habitat feature for which the SAC is designated: *Zostera* community complex. *Zostera* habitats are not compatible with vehicular or foot traffic and the access route should be realigned to avoid this sensitive habitat.

Based upon the (small) scale of spatial overlap of current intertidal clam aquaculture activities (including access route activity) and the relatively high tolerance levels of the habitats and associated species, the general conclusion is that current and proposed intertidal oyster and clam culture activities are non-disturbing to the Qualifying Interests and their constituent community types.

Current levels of subtidal (bottom) cultivation of mussels do not pose a significant risk to the Conservation Objectives of marine habitat features, however, the level of proposed mussel cultivation will pose a significant risk to the Conservation Objectives of one marine benthic habitat feature 1130 – Estuaries for which the SAC is designated and specifically a marine community type, i.e., *Zostera* community complex. *Zostera* habitats are not compatible to mussel aquaculture and these areas should be removed from proposed aquaculture licence boundaries.

2.5.2 Species

The likely interactions between the proposed aquaculture activities and the following Annex II Species were assessed; Atlantic Salmon *Salmo salar* (Salmon) [1106], *Petromyzon marinus* (Sea Lamprey) [1095], *Lampetra fluviatilis* (River Lamprey) [1099] and Otter (*Lutra lutra* [1355]). The objectives for these species in the SAC focus upon maintaining the good conservation status of populations. The main aspect of the culture activities that could potentially impact the designated species is the physical presence of trestles that may impede migration of fish and restrict otter access to certain habitats. However, given the locations and level of current and proposed activity it is concluded that activities would be non-disturbing to these Annex II species.

2.5.3 Other considerations

Based upon experience elsewhere, the introduction of '½ grown' or 'wild' oyster or mussel seed stock into aquaculture plots (both within and proximate to the SAC) from outside of Ireland does

pose a clear risk of establishment of non-native species in the SAC. In order to mitigate the risk of introduction of alien species into the SAC as a result of aquaculture activities all movement of stock in and out of the Castlemaine Harbour SAC should adhere to relevant legislation and follow best practice guidelines (e.g. http://invasivespeciesireland.com/cops/aquaculture/).

The result of the proposed increase in oyster cultivation from 1.54% and 2% coverage of Habitats 1130 and 1140 to 31.26% and 34.69 %, respectively, will likely increase the standing stock biomass of this species in the SAC. This increase is considered substantial and the impact of this quantity of oysters on the seston (living and non-living matter in water) levels in the system is likely to be considerable. The indirect impact of reduced plankton levels may have an impact on the constituent communities associated with the habitats in terms of a reduction in secondary production. On the basis of the proposed increase in spatial area of licensing (applications), the risk of seston depletion and impact on carrying capacity of the system, however, cannot be discounted.

The current permitted levels of mussel seed dredging and cockle dredging either individually or in-combination with aquaculture activities exceed the spatial overlap threshold (15%) for significant adverse impacts of on three estuarine (1130) constituent community types (Intertidal sand with *Nephtys cirrosa* community, Fine to muddy fine sand with Polychaetes community complex, Mixed sediment community complex) and one mud and sandflat (1140) constituent type (Intertidal sand with *Nephtys cirrosa* community). Further licensing of mussel aquaculture activities in these community types should be carefully considered.

3 INTRODUCTION

This document assesses the potential ecological interactions of aquaculture activities within the Castlemaine Harbour SAC (Site code: 000343) on the Conservation Objectives of the site. The information upon which this assessment is based is a list of applications and extant licences for aquaculture activities administered by the Department of Agriculture Food and Marine (DAFM) and forwarded to the Marine Institute; as well as aquaculture and fishery profiling information provided on behalf of the operators by Bord Iascaigh Mara. The spatial extent of aquaculture licences is derived from a database managed by the DAFM[3].

4 CONSERVATION OBJECTIVES FOR CASTLEMAINE HARBOUR SAC

The appropriate assessment of aquaculture and fisheries in relation to the Conservation Objectives for Castlemaine Harbour SAC is based on Version 2.0 of the objectives (NPWS 2011a – Version 2 July 2011) and supporting documentation (NPWS 2011b - Version 2 2011, NPWS 2011c - Version 2 April 2011, NPWS 2011d - Version 2 April 2011). The spatial data for conservation features was provided by NPWS[4].

4.1 THE SAC EXTENT

Castlemaine Harbour SAC is a large site located on the south-east corner of the Dingle Peninsula, Co. Kerry. It consists of the whole inner section of Dingle Bay, i.e. Castlemaine Harbour, the spits of Inch and White Strand/Rosbehy and a little of the coastline to the west. The River Maine, almost to Castlemaine, and much of the River Laune catchment, including the Gaddagh, Gweestion, Glanooragh, Cottoner's River and the River Loe, are also included within the site. The full extent of the SAC is shown in Figure 4.1 below.

4.2 QUALIFYING INTERESTS (SAC)

The SAC is designated for the following habitats and species (NPWS 2011a), as listed in Annex I and Annex II of the Habitats Directive:

- Estuaries [1130]
- Mudflats and sandflats not covered by seawater at low tide [1140]
- Annual vegetation of drift lines [1210]
- Perennial vegetation of stony banks [1220]
- Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]
- *Salicornia* and other annuals colonising mud and sand [1310]

[3] DAFM Aquaculture Database version Aquaculture: December 2017
[4] NPWS Geodatabase Ver: February 2017 - http://www.npws.ie/mapsanddata/habitatspeciesdata/

- Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]
- Mediterranean salt meadows (*Juncetalia maritimi*) [1410]
- Embryonic shifting dunes [2110]
- Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120]
- Fixed coastal dunes with herbaceous vegetation (grey dunes) [2130]
- Dunes with *Salix repens* ssp. *argentea* (*Salicion arenariae*) [2170]
- Humid dune slacks [2190]
- Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae) [91E0]
- *Petromyzon marinus* (Sea Lamprey) [1095]
- *Lampetra fluviatilis* (River Lamprey) [1099]
- *Salmo salar* (Salmon) [1106]
- *Lutra lutra* (Otter) [1355]
- *Petalophyllum ralfsii* (Petalwort) [1395]

The spatial extent of the Annex 1 Qualifying Interests Estuaries (1130) and Mudflats and sandflats not covered by seawater at low tide (1140) are illustrated in Figure 4.2 and Figure 4.3, respectively (from NPWS 2011b).

Constituent communities and community complexes recorded within the Annex 1 habitats of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide are listed in NPWS (2011b), presented in Table 4.1 below and illustrated in Figure 4.4.

Table 4.1- The community types recorded in Castlemaine Harbour SAC and the Annex I habitats in which they occur (NPWS 2014b).

Community Type	Annex I Habitats	
	Estuaries (1130)	Mudflats and sandflats not covered by seawater at low tide (1140)
Intertidal muddy fine sand community complex	✓	✓
Intertidal sand with *Nephtys cirrosa* community	✓	✓
Fine to muddy fine sand with Polychaetes community complex	✓	✓
Zostera dominated community	✓	✓
Mixed sediment community complex	✓	

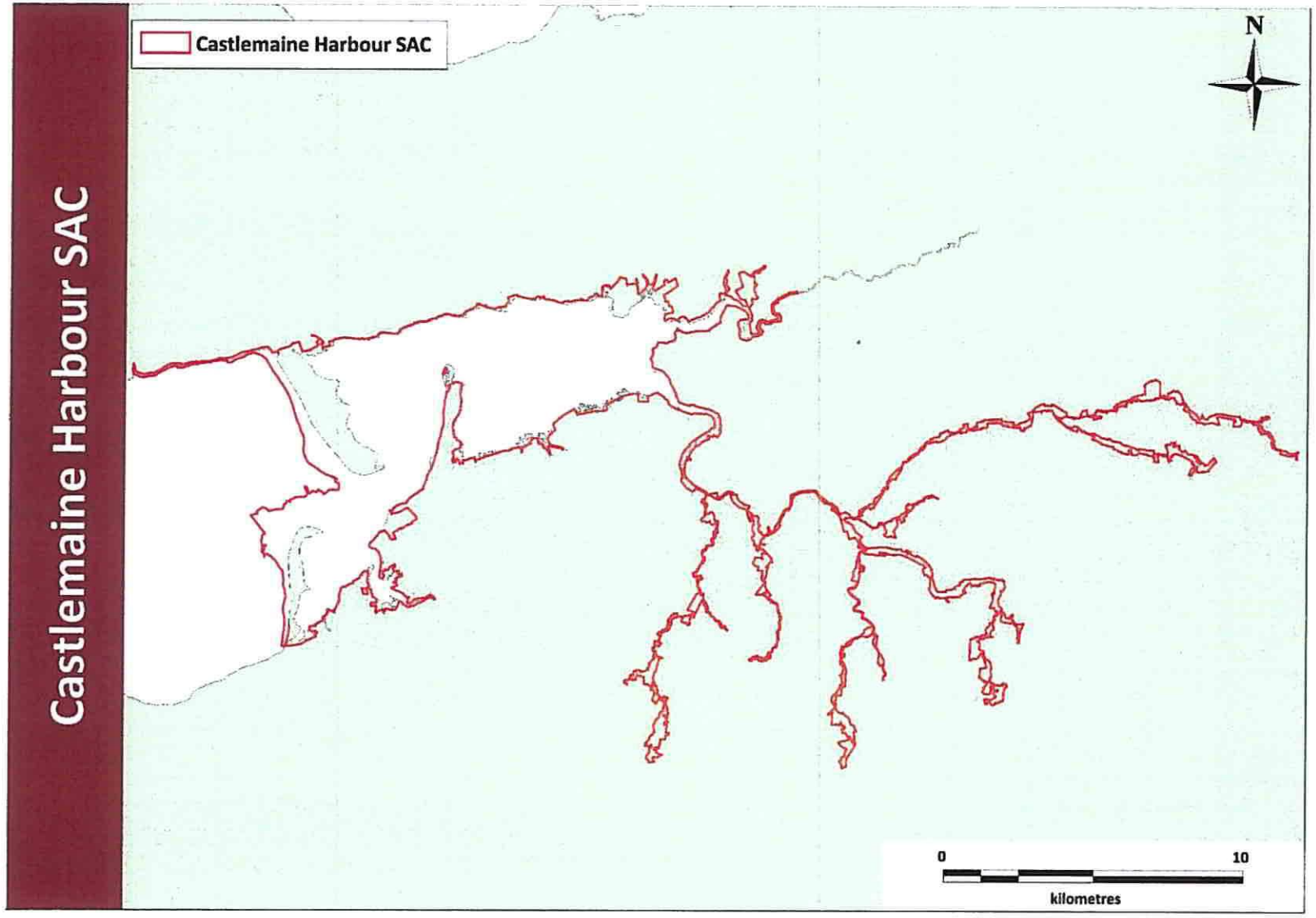

Figure 4.1- The extent of the Castlemaine Harbour SAC (NPWS 2011b).

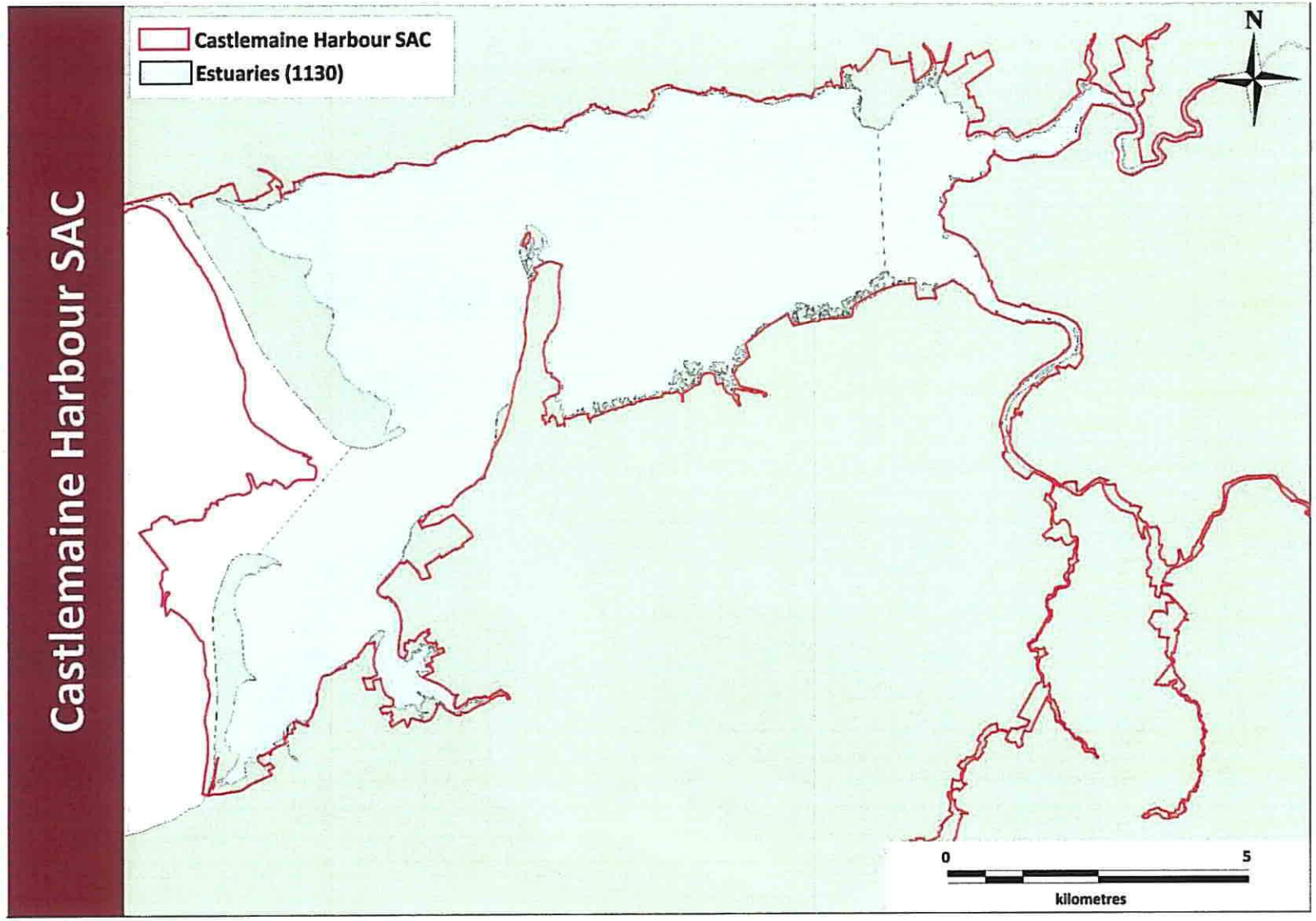

Figure 4.2 - The extent of the marine Annex I Qualifying Interest of (1130) Estuaries within the Castlemaine Harbour SAC (NPWS 2011b).

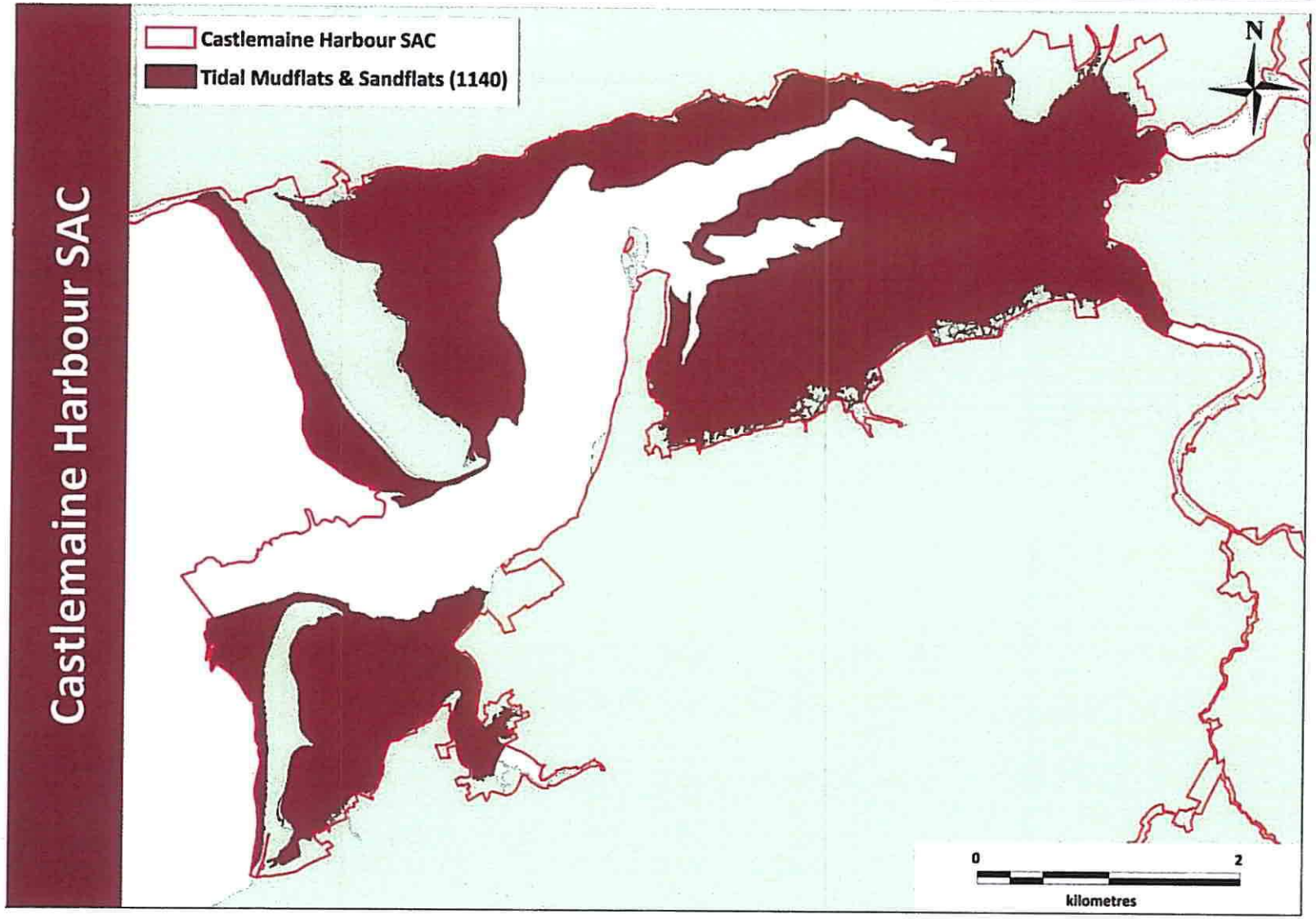

Figure 4.3 - The extent of the marine Annex I Qualifying Interest of (1140) Mudflats and sandflats not covered by seawater at low tide within the Castlemaine Harbour SAC (NPWS 2011b).

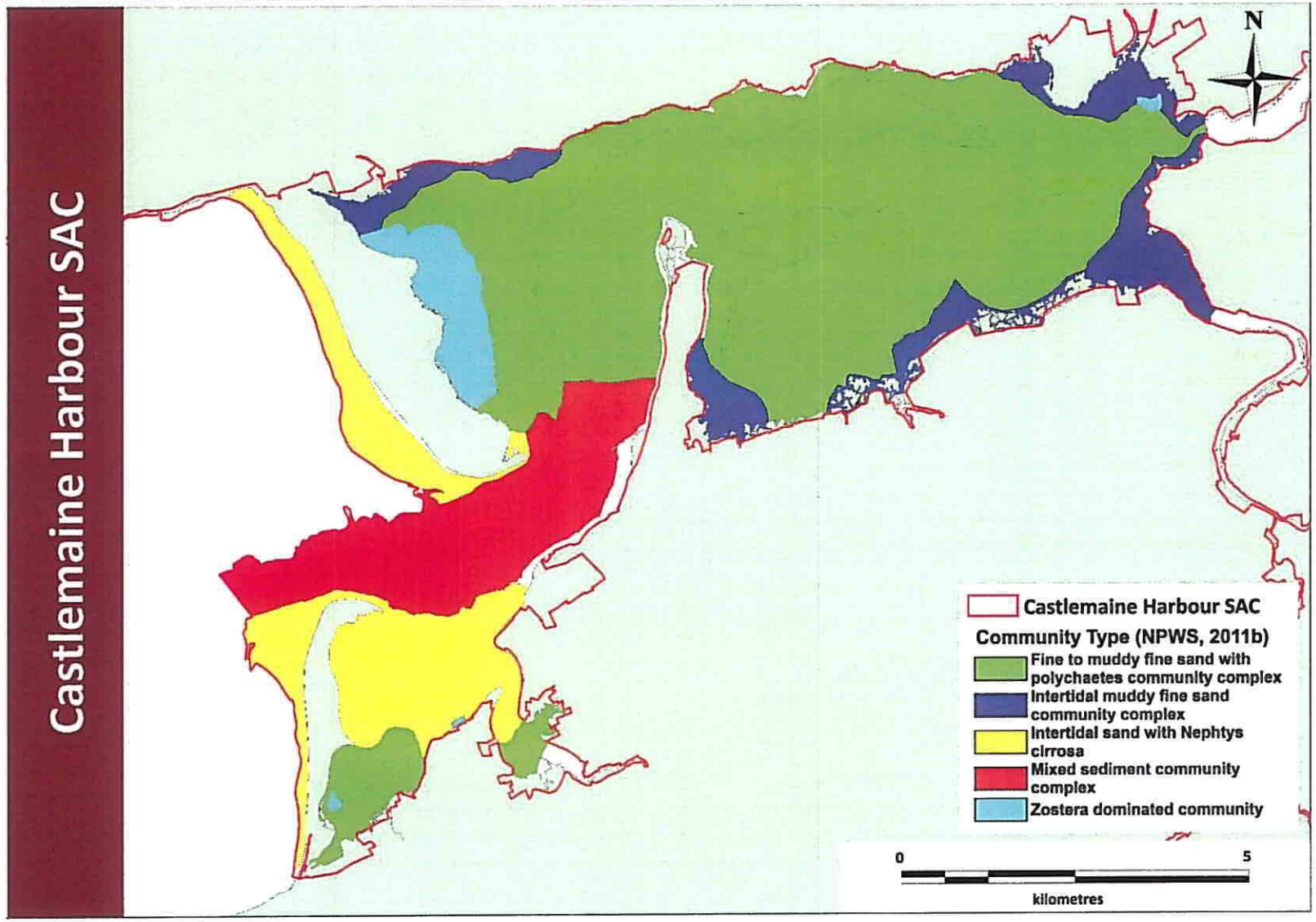

Figure 4.4 - Principal benthic communities recorded within the marine Annex I Qualifying Interests of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide within the Castlemaine Harbour SAC (NPWS 2011b).

4.3 CONSERVATION OBJECTIVES FOR CASTLEMAINE HARBOUR SAC

The Conservation Objectives for the Qualifying Interests for the SAC were prepared by NPWS (NPWS 2011a). The natural condition of the designated features should be preserved with respect to their area, distribution, and extent and community distribution. Habitat availability should be maintained for designated species and human disturbance should not adversely affect such species. The features, objectives and targets of each of the Qualifying Interests within the SAC are listed in Table 4.2 below.

Table 4.2 - Conservation Objectives and targets for marine habitats and species in Castlemaine Harbour SAC (NPWS 2011a, 2011b). Annex I and II features listed in **bold**.

Feature (Community Type)	Objective	Target(s)
Estuaries (1130)	Maintain favourable conservation condition	5695.86ha: Targets are identified that focus on a wide range of attributes with the ultimate goal of maintaining function and diversity of favourable species and managing levels of negative species
(Intertidal muddy fine sand community complex)	Maintain favourable conservation condition	554ha; Likely area derived from an intertidal survey undertaken in 2008.
(Intertidal sand with *Nephtys cirrosa* community)	Maintain favourable conservation condition	486ha; Likely area derived from an intertidal survey undertaken in 2008.
(Fine to muddy fine sand with Polychaetes community complex)	Maintain favourable conservation condition	3555ha; Likely area derived from intertidal and subtidal surveys undertaken in 2008 and 2009 respectively.
(*Zostera* dominated community)	Maintain favourable conservation condition	234ha; Likely area derived from a subtidal survey undertaken in 2009.
(Mixed sediment community complex)	Maintain favourable conservation condition	588ha; Likely area derived from intertidal and subtidal surveys undertaken in 2008 and 2009 respectively.
Mudflats and sandflats not covered by seawater at low tide (1140)	Maintain favourable conservation condition	4286.69ha: Targets are identified that focus on a wide range of attributes with the ultimate goal of maintaining function and diversity of favourable species and managing levels of negative species
(Intertidal muddy fine sand community complex)	Maintain favourable conservation condition	554ha; Likely area derived from an intertidal survey undertaken in 2008.
(Intertidal sand with *Nephtys cirrosa* community)	Maintain favourable conservation condition	861ha; Likely area derived from an intertidal survey undertaken in 2008.
(Fine to muddy fine sand with	Maintain favourable conservation	2637ha; Likely area derived from intertidal and subtidal surveys

Feature (Community Type)	Objective	Target(s)
Polychaetes community complex)	condition	undertaken in 2008 and 2009 respectively.
(*Zostera* dominated community)	Maintain favourable conservation condition	234ha; Likely area derived from a subtidal survey undertaken in 2009.
Annual vegetation of drift lines (1210)	Maintain favourable conservation condition	1.90ha; Targets are identified that focus on a wide range of attributes with the ultimate goal of maintaining function and diversity of favourable species and managing levels of negative species
Perennial vegetation of stony banks (1220)	Maintain favourable conservation condition	Current area unknown. Targets are identified that focus on a wide range of attributes with the ultimate goal of maintaining function and diversity of favourable species and managing levels of negative species
Vegetated sea cliffs of the Atlantic and Baltic coasts (1230)	No information available	
Salicornia and other annuals colonising mud and sand (1310)	Maintain favourable conservation condition	1.24ha; Targets are identified that focus on a wide range of attributes with the ultimate goal of maintaining function and diversity of favourable species and managing levels of negative species
Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) (1330)	Maintain favourable conservation condition	34.0ha; Targets are identified that focus on a wide range of attributes with the ultimate goal of maintaining function and diversity of favourable species and managing levels of negative species
Mediterranean salt meadows (*Juncetalia maritimi*) (1410)	Maintain favourable conservation condition	124.32ha; Targets are identified that focus on a wide range of attributes with the ultimate goal of maintaining function and diversity of favourable species and managing levels of negative species
Embryonic shifting dunes (2110)	Maintain favourable conservation condition	15.20ha; Targets are identified that focus on a wide range of attributes with the ultimate goal of maintaining function and diversity of favourable species and managing levels of negative species
Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) (2120)	Maintain favourable conservation condition	36.22ha; Targets are identified that focus on a wide range of attributes with the ultimate goal of maintaining function and diversity

Feature (Community Type)	Objective	Target(s)
		of favourable species and managing levels of negative species
Fixed coastal dunes with herbaceous vegetation (grey dunes) (2130)	Restore favourable conservation condition	451.31ha; Targets are identified that focus on a wide range of attributes with the ultimate goal of maintaining function and diversity of favourable species and managing levels of negative species
Dunes with *Salix repens* ssp. *argentea* (*Salicion arenariae*) (2170)	Maintain favourable conservation condition	0.34ha area likely greater; Targets are identified that focus on a wide range of attributes with the ultimate goal of maintaining function and diversity of favourable species and managing levels of negative species
Humid dune slacks (2190)	Maintain favourable conservation condition	34.20ha; Targets are identified that focus on a wide range of attributes with the ultimate goal of maintaining function and diversity of favourable species and managing levels of negative species
Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) (91E0)	Restore favourable conservation condition	17.68ha possibly greater; Targets are identified that focus on a wide range of attributes with the ultimate goal of maintaining function and diversity of favourable species and managing levels of negative species
***Petromyzon marinus* (Sea Lamprey) (1095)**	Maintain favourable conservation condition	Targets include: 75% of main stem accessible from estuary, At least three age/size groups present, Mean catchment juvenile density at least 1/m², No decline in extent and distribution of spawning beds and More than 50% of sample sites positive
***Lampetra fluviatilis* (River Lamprey) (1099)**	Maintain favourable conservation condition	Targets include: Greater than 75% of main stem length accessible from estuary, At least three age/size groups of river/brook lamprey present, Mean catchment juvenile density of brook/river lamprey at least 2/m², No decline in extent and distribution of spawning beds and More than 50% of sample sites positive
***Salmo salar* (Salmon) (1106)**	Maintain favourable conservation condition	Targets include: 100% of channel down to second order accessible from estuary. Currently present in 88 - 100% of sites sampled,

Feature (Community Type)	Objective	Target(s)
		Conservation Limit (CL) for each system consistently exceeded, Maintain or exceed 0+ fry mean catchment-wide abundance threshold value. Currently set at 17 salmon fry/5 min sampling, No significant decline in numbers, No decline in number and distribution of spawning redds due to anthropogenic causes and At least Q4 at all sites sampled by EPA. 85% of relevant sites currently at least Q4 on Laune.
***Lutra lutra* (Otter) (1355)**	Restore favourable conservation condition	Targets include: No significant decline in percentage of positive survey sites, No significant decline. Terrestrial habitat area mapped and calculated as 162ha above high water mark (HWM); 193ha along river banks, No significant decline. Marine habitat area mapped and calculated as 812ha, No significant decline river habitat. Length mapped and calculated as 104km, No significant decline in couching, holts, or available fish biomass. No significant increase of barriers to connectivity.
***Petalophyllum ralfsii* (Petalwort) (1395)**	Maintain favourable conservation condition	Targets include: No decline of distribution. Maintain at least current number of populations- 3 at Inch; 1 at Rosbehy. No decline of population. Current known population at Inch estimated ca.72,000 thalli, counted in 2010. Rosbehy currently unknown. No decline of habitat area. At Inch area of suitable habitat at least 0.6011 ha. Rosbehy currently unknown

4.4 SCREENING OF ADJACENT SAC FOR EX-SITU EFFECTS

The nearest SACs to the Castlemaine Harbour SAC, which have marine interests, are the Blasket Islands SAC (Site Code 002172) and the Valentia Harbour/Portmagee Channel SAC (Site Code 002262). Both of these are in excess of 42km from the Castlemaine Harbour SAC and as a result are screened out. Castlemaine Harbour is also an SPA (Site Code: 004029). This SPA was subject to a separate appropriate assessment and therefore can also be screened out.

5 DETAILS OF THE PROPOSED PLANS AND PROJECTS

5.1 DESCRIPTION OF AQUACULTURE ACTIVITIES

Aquaculture activities within the Castlemaine Harbour SAC focus on the intertidal (bags and trestle, basket and trestle and bottom) cultivation of the Pacific oyster *C. gigas,* subtidal (bottom culture) of the Blue mussel, *Mytilus edulis* and intertidal planting of Manilla clams (*Ruditapes philipanarium*). Aquaculture production from Castlemaine Harbour in 2016 totalled 2,178 tonnes (1,728t mussels and 450t Pacific oysters).

This assessment focuses on aquaculture activities which occur within the Qualifying Interests of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide for which the Castlemaine Harbour SAC is designated. Descriptions of spatial extents of existing and proposed intertidal oyster, mussel and clam aquaculture activities (provided below) within the Qualifying Interest were calculated using coordinates of activity areas in a GIS (Figure 5.1). The spatial extent of the cultivation activities (current and proposed) overlapping the Qualifying Interests of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide are presented in Table 5.1 to Table 5.5, while Table 7.1 to Table 7.5 presents spatial overlap on constituent community types of the Qualifying Interests of 1130 and 1140.

5.1.1 Intertidal Oyster Cultivation

5.1.1.1 Current activity

There are currently 30 sites licensed for oyster production in Castlemaine Harbour (See Figure 5.1). Oyster production has a life cycle from seed input to harvest for market of 2½ years. Oysters are sold at a size range from 60-140 grams. The oyster seed is bought in from mainly from oyster nurseries in France. The following seed is being used in Castlemaine Harbour:

- France Nissan (majority of producers use)
- Satmar

Historically other hatcheries in France and the UK have also been suppliers of seed to Castlemaine. Triploid only seed is sourced for Castlemaine Harbour.

5.1.1.1.1 Bag and Trestle Method

Oysters are predominantly grown in trestles and bags in Castlemaine Harbour. The trestles are typically from 20 inches to 26 inches in height is 3m long and carry 5-6 bags.

Seed is generally imported in the Spring and Autumn of each year. Some producers have moved to bringing seed onto their site in Autumn to overwinter the seed and to possibly avoid summer mortality of seed. The intake size ranges from G6-G8. These are packed in oyster bags at a predetermined density and taken to the inter-tidal zone, where the bags are attached to trestles for the growing process to begin. Packing densities of seed is individually determined by each producer. Castlemaine producers start off with densities ranging from 750-2000 seed in 4 ml bags.

Oysters are thinned out and graded as the oysters grow. As the oysters grow, they are taken to the handling / sorting facility or foreshore area for splitting and re-packing, and returned to the trestles. The seed is split following a few months in the 4 ml bag. Splitting generally starts once growth starts. Producers split the oysters either once or twice over the growth cycle. Again the density following splitting varies from producer to producer. Some producers will split down again to ranges of 500-800. Other producers will split down only once to final finishing densities of approx. 120-150 finishing stocking density. If producers split twice they will move from 4 ml bag to 6ml bag and then 9 -10 ml bags for final finishing. Splitting and grading takes place in the producers own sheds, handing facility or on the foreshore.

The trestles are arranged in rows and blocks on site. Again the site layout varies from site to site and producer to producer. Rows are often set out in pairs with sufficient gap between pairs for flat-bottomed vessel to pass, allowing servicing. Other producers will arrange trestles in blocks e.g. block of 40 trestles where there are 4 trestles deep and 8 trestles long. There are gaps left between blocks for access and servicing.

A problem that has been noted by some producers is the shifting of sand banks and strules. Strules are the channels of water that along which the producers place their trestles. The movement of sand has meant that areas that some producers were licenced for historically are now too high due to sand shifting or unworkable.

The majority of oyster sites are accessed by boat for the bringing out of oysters and the taking in of oysters to sites.

Two producers in the Harbour import half grown oysters from another Irish production area (Valentia Harbour). They then finish oysters off to market size and sell for direct human consumption.

In Castlemaine Harbour there is no production of ½ grown oysters (20g – 45g) for selling onto other Irish and French oyster producers.

Producers generally turn each bag on site once a month. Turning takes place when the oysters are growing. This means turning takes place from March up to Oct/Nov depending on growth. Both spring tides of each month will be used by producers to get out to their sites. It is anticipated that 4-5 days around each tide will be used to access the sites.

5.1.1.1.2 Basket and Trestle Method

One producer is currently using the Ortec and SEPA baskets at two sites (T06/313A and T06/313B). Four baskets are attached to each trestle. 70 half-grown oysters are placed in each basket which is then attached to a trestle. The basket moves with the wave motion. Half-grown oysters are generally placed in baskets in February. After approximately 10 months the oysters will be ready for market at Christmas.

5.1.1.1.3 Bottom *Crassostrea gigas* Method

One producer (T06/277B) has a licence to cultivate bottom *C. gigas* oysters (approximately 0.93ha). The producer takes half grown oysters from his bag and trestle sites. The oysters tend to be 1 year

old and approx. 30/40 gr at the time they are placed on the bottom. The placing on the bottom usually takes place around April/May. This allows for the shell to have hardened up over winter in the bag on the trestle. Once spread on the bottom the oysters are harrowed twice a year. This is done on a small boat with an open hand dredge. After approximately 12 months on the bottom the oysters are dredged with a hand dredge. They are then trained by taking them to the bag and trestle site for a number of weeks. Given the nature of this activity, and it's likely impacts, it is combined with the bottom mussel culture in subsequent analysis.

The spatial extent of the current intertidal cultivation activities overlapping the Qualifying Interests of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide are presented in Table 5.1 below, while Table 7.1 presents spatial overlap on constituent communities of the Qualifying Interests of 1130 and 1140.

5.1.1.2 Proposed Activity

New applicants plan to source oyster seed from France hatcheries mainly. Access for sites in East Castlemaine Harbour will be mostly by boat. Access for some sites in Glenbeigh area of Castlemaine Harbour will be across the foreshore. The majority of new licence applications and reviews in Castlemaine Harbour are for oyster licences or oysters trestle culture to be added as a species to a current mussel licence (there are 5 applications for the latter see Figure 5.1). In relation to the review applications, these sites are considered, in any subsequent analysis, as both oyster culture and mussel culture.

The overlap of proposed intertidal cultivation activities with the Qualifying Interests of 1130 and 1140 is presented in Table 5.1 below. Table 7.1 presents spatial overlap on constituent communities of the Qualifying Interests of 1130 and 1140.

5.1.1.3 Site Access

Site access is generally by boat. Boats leave from The Point and Tullig Pier (No. 7 and 2 in Figure 5.1). One producer has access across the foreshore in Douglas Strand (No. 1 in Figure 5.1) and there is also access across the foreshore in Glenbeigh area (No. 11 in Figure 5.1). The newly proposed sites will be accessed from the above and from a number of other access points shown in Figure 5.1. Sites will be accessed on the spring tides of each month dependant on weather.

The spatial extent of the oyster access routes overlapping the Qualifying Interests of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide are presented in Table 5.2 below, while Table 7.2 presents spatial overlap on constituent communities of the Qualifying Interests of 1130 and 1140.

5.1.2 Bottom Mussel Cultivation

5.1.2.1 Current activity

There are currently 15 sites licensed for mussel production in Castlemaine Harbour (see Figure 5.1). Seed mussel is fished from historically identified sub-tidal seed areas and transferred for hardening on an intertidal nursery site in the Fishery Order area (see Figure 5.1) for 6 to 12 months. Seed placed on the nursery area is subsequently transferred to sub-tidal plots in the Order Area for on-

growing until harvest. There are 15 mussel licensed sites east of the Mussel Order in Castlemaine Harbour. These licensed sites are used by individuals as additional on-growing ground to their permitted on-growing ground issued by the co-op. The co-op holds two of the licensed mussel sites. They applied for these sites as the Fishery Order cover did not cover all the on-growing ground that the co-op needed to permit to operators. The Co-op in its division of ground permits some individuals to work its licensed areas. Harvesting of bottom mussels generally takes place from late September until mid-March. Bottom mussel producers can be generalised into two categories large and small vessel operators.

5.1.2.1.1 Large Boats (Dredgers)

Licensed mussel vessels relay the stock onto their subtidal licensed areas generally in the summer (Aug-Sept) from the nursery area in The Order. The larger vessels have 2-4 single dredges each. The types of dredge used are 2m mussel dredges with a flat bar that is designed to skim the surface of the substrate. Relaying onto subtidal licensed areas is achieved by pumping the mussels mixed with seawater from the boat's hold onto the grow-out plots. This pattern of relaying is characterised by the vessels moving across the plots during pumping in an effort to achieve an even distribution of mussel on each plot in order to maximise survival and growth.

One large vessel owner moves mussels from the nursery area in the Fishery Order to a licensed intertidal site in the Harbour. Movement from the nursery is generally completed by August. The mussels are left in the licensed mussel site intertidally until May the following year when they are then moved to Wexford Harbour to fatten up and put on meat.

5.1.2.1.2 Small Boats (Punts)

Small boats generally consist of punts. These operators cannot go out to fish for mussel seed if there is a settlement at the Tower. The Tower historically is the main area of mussel seed settlement. The Tower can only be access by the larger boats. The small boats rely on seed drift onto their Order nursery sites from seed being brought in by the larger vessels onto their nursery sites or natural settlement on their nursery sites. If seed settles on their nursery sites within the Fishery Order Area, they will move this seed when it reaches a size ranging from 25-40 ml onto their licensed aquaculture mussels sites to finish off before harvesting. Half-grown is generally moved in the summer from the nursery. The punts collect the seed using a mixture of beet forks/pikes and hand dredging and then deposit it on their licensed aquaculture sites over the side of the vessels. Again the pattern of relaying is characterised by the vessels moving across the plots in an effort to achieve an even distribution of mussel on each plot. Harvesting from these sites is by hand dredge, piking or handpicking by one operator.

The mussels are spread onto the on-growing sites. They are left here from 6-18 months to put on meat and grow. Harvesting size ranges from 50-75 pieced per kilo. Access to these bottom mussel sites is minimum. Sites tend to be only accessed to take a sample prior to harvest to check pieces per kilo and meat content. Harvesting will be by hand dredge. One producer will hand pick or pike to harvest.

Use of the licensed sites by the small boats will be dependent on the availability of seed. Seed will not be available every year and so sites may not be used every year. One producer has had a problem with shifting channels. His mussel site is no longer in the channel (T6-267D).

The spatial overlap of current mussel cultivation activity with the Qualifying Interests of 1130 and 1140 are presented in Table 5.3 (while Table 7.3 presents spatial overlap on constituent communities of Qualifying Interests of 1130 and 1140). Mussel seed dredging is regarded as a fishery and assessed in Section 9 In-Combination Effects.

5.1.2.2 Proposed activity

There are 5 mussel licence applications submitted. Two applications are by large boats and the other 3 are from small boats.

The spatial overlap of proposed mussel cultivation activity with the Qualifying Interests of 1130 and 1140 are presented in Table 5.3 (while Table 7.3 presents spatial overlap on constituent communities of Qualifying Interests of 1130 and 1140).

5.1.2.3 Bottom Mussel Site Access

Access to bottom mussel sites is by boats. The boats leave from The Point and Tullig Quay (No. 7 and 2 in Figure 5.1). One small boat operator can walk across the foreshore from his house to his mussel site to hand pick mussels for harvest (No. 1 in Figure 5.1). The larger boats all use punts from The Point to get out to where they moor their large boats east of the Point. Punts are used to access sites for sample collection to estimate pieces per kilo and meat yield prior to sale.

The spatial overlap of bottom mussel access routes with the Qualifying Interests of 1130 and 1140 are presented in Table 5.4 (while Table 7.4 presents spatial overlap on constituent communities of Qualifying Interests of 1130 and 1140).

5.1.3 Intertidal Clam Cultivation

5.1.3.1 Current Activity

The operator licensed to produce clams has not been producing clams for a number of years but is planning to commence production again once clam seed becomes available. Historically clam seed was sourced from Irish hatcheries. The life cycle from seed to harvest for clams takes approximately 2 ½ years.

Seed is introduced on site at a size of 2ml. The seed is placed in nursery frames and remains in the frames until they reach a size of 10ml. This stage can take 9 months to a year. Once they reach 10ml the clams are then transplanted into the ground to grow. They are transplanted into lines covered with mesh to keep out predators and to maintain the clams in position. The clam rows are brushed once a week when tides are suitable to keep sand and weed off the clams. Clams are harvested at the following size grades small 70-80 pieces per kilo, medium 60-70 pieces per kilo and large 50-60 pieces per kilo.

The spatial overlap of proposed mussel cultivation activity with the Qualifying Interests of 1130 and 1140 are presented in Table 5.5 (while Table 7.5 presents spatial overlap on constituent communities of Qualifying Interests of 1130 and 1140).

5.1.3.2 Clam Site Access

Access to the clam site is across the foreshore (No. 11 in Figure 5.1). This access route is the same as that used for oysters and is assessed above for oysters (Table 5.2) and is therefore not reassess again here.

Table 5.1 - Spatial extent (ha) of licensed and proposed intertidal oyster aquaculture areas overlapping with the Qualifying Interest of Estuaries [1130] and Mudflats and sandflats not covered by seawater at low tide [1140] in the Castlemaine Harbour SAC (Site Code 000343). Spatial extent of licensed areas presented according to Qualifying Interest and licence status.

Licence Status	Culture Species	Qualifying Interest 1130 (5693.39ha)	Qualifying Interest 1140 (4284.83 ha)
		% Overlap (Overlap ha)	% Overlap (Overlap ha)
Licensed	Oysters Sites	1.54% (87.69ha)	2.00% (85.67ha)
Application	Oysters Sites	30.98% (1764.34ha)	34.33% (1470.93ha)
	Total	32.52% (1852.03ha)	36.33% (1556.6ha)

Table 5.2 - Spatial extent (ha) of intertidal oyster access routes overlapping with the Qualifying Interest of Estuaries [1130] and Mudflats and sandflats not covered by seawater at low tide [1140] in the Castlemaine Harbour SAC (Site Code 000343).

Licence Status	Culture Species	Qualifying Interest 1130 (5693.39 ha)	Qualifying Interest 1140 (4284.83 ha)
		% Overlap (Overlap ha)	% Overlap (Overlap ha)
Oyster Site Access Routes		0.06% (3.36ha)	0.06% (2.51ha)

Table 5.3 - Spatial extent (ha) of licensed and proposed subtidal mussel aquaculture areas overlapping with the Qualifying Interest of Estuaries [1130] and Mudflats and sandflats not covered by seawater at low tide [1140] in the Castlemaine Harbour SAC (Site Code 000343). Spatial extent of licensed areas presented according to Qualifying Interest and licence status.

Licence Status	Culture Species	Qualifying Interest 1130 (5693.39 ha)	Qualifying Interest 1140 (4284.83 ha)
		% Overlap (Overlap ha)	% Overlap (Overlap ha)
Licenced	Mussels*	3.54% (201.66ha)	3.96% (169.87ha)
Application	Mussels	2.96% (168.54ha)	3.81% (163.41ha)
Application	Mussel Longline	1.5% (86.24ha)	0.2% (8.7ha)
	Sub-Total	8.9% (456.44ha)	13.07% (556.11ha)

*including 1 site for bottom oyster culture, approx 1ha.

Table 5.4- Spatial extent (ha) of mussel access routes overlapping with the Qualifying Interest of Estuaries [1130] and Mudflats and sandflats not covered by seawater at low tide [1140] in the Castlemaine Harbour SAC (Site Code 000343).

Licence Status	Culture Species	Qualifying Interest 1130 (5693.39 ha)	Qualifying Interest 1140 (4284.83 ha)
		% Overlap (Overlap ha)	% Overlap (Overlap ha)
Mussel Site Access Routes		0.007% (0.38ha)	0.009% (0.38ha)

Table 5.5- Spatial extent (ha) of licensed intertidal clam aquaculture areas overlapping with the Qualifying Interest of Estuaries [1130] and Mudflats and sandflats not covered by seawater at low tide [1140] in the Castlemaine Harbour SAC (Site Code 000343). Spatial extent of licensed areas presented according to Qualifying Interest and licence status.

Licence Status	Culture Species	Qualifying Interest 1130 (5693.39 ha)	Qualifying Interest 1140 (4284.83 ha)
		% Overlap (Overlap ha)	% Overlap (Overlap ha)
Licenced	Clam Sites	0.28% (16.13ha)	0.38% (16.13ha)

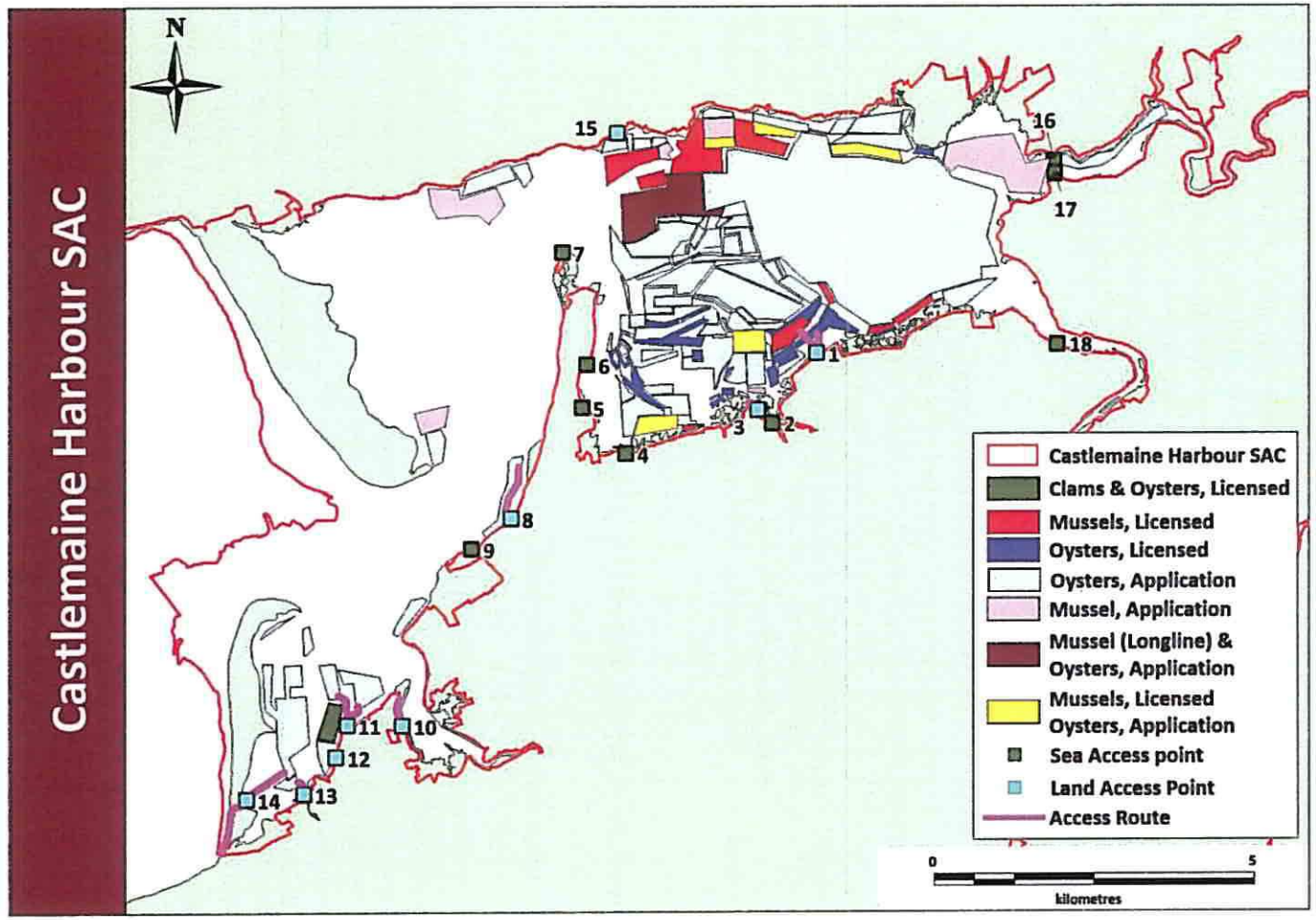

Figure 5.1- Aquaculture sites (licensed and applications) in the Castlemaine Harbour SAC (NPWS 2011b).

6 NATURA IMPACT STATEMENT FOR THE PROPOSED ACTIVITIES

The potential ecological effects of activities on the Conservation Objectives for the site relate to the physical and biological effects of aquaculture cultivation structures and activities and human activities on designated species, intertidal habitats and invertebrate communities, and biotopes within those broad habitat types. The overall effect on the conservation status will depend on the spatial and temporal extent of fishing and aquaculture activities during the lifetime of the proposed plans and projects and the nature of each of these activities in conjunction with the sensitivity of the receiving environment. Bottom cultivation and harvesting of shellfish can, like fishing, alter the surrounding environment, both physically and biologically, not only due to the presence of the culture organisms (e.g. increased deposition, disease, shading, fouling, alien species) but also due to the activities associated with the culture mechanisms (e.g. structures resulting in current alteration, dredging, sediment compaction), the extraction of commercial and natural populations and the physical effects of dredging.

Aquaculture activities within the SAC focus on the intertidal (bags and trestle) cultivation of the Pacific oyster, *C. gigas,* subtidal (bottom culture) of the Blue mussel *Mytilus edulis* and intertidal culture of Manilla clams (*Ruditapes philipanarium*). Details of the potential biological and physical effects of these aquaculture activities on the habitat features, their sources and the mechanism by which the impact may occur are discussed below and summarised in Table 6.1 below. The impact summaries identified in the table are derived from published primary literature and review documents that have specifically focused upon the environmental interactions of mariculture (e.g. Black 2001; McKindsey *et al.,* 2007; NRC 2010; O'Beirn *et al.,* 2012; Cranford *et al.,* 2012; ABPMer 2013a-h).

6.1 BIOLOGICAL EFFECTS OF AQUACULTURE – ALL CULTURE METHODS:

Habitat/Sediment Disturbance - Suspended culture

Mussels and oysters, being suspension feeding bivalve molluscs, feed at the lowest trophic level; feeding largely as herbivores, relying primarily on ingestion of phytoplankton. Therefore, the culture process does not rely on the input of feedstuffs into the aquatic environment. Suspension feeding bivalves filter suspended matter from the water column and the resulting faeces and pseudofaeces (non-ingested material) are then deposited onto the seafloor. This is known as biodeposition and is a component of a greater process called benthic-pelagic coupling. This deposition can accumulate on the seafloor beneath aquaculture installations (suspended and intertidal culture) and can alter the local sedimentary habitat type in terms of organic content and particle size which has, in certain circumstances been shown to alter the infaunal community therein; in the case of bottom mussel culture this deposition results in the formation of "mussel mud" directly beneath the mussels themselves.

Moderate enrichment due to deposition can lead to increased diversity due to increased food availability; however further enrichment can lead to a change in sediment biogeochemistry (e.g. oxygen levels decrease and sulphide levels increase) which can result in a reduction in species richness and abundance resulting in a community dominated by specialist species. In extreme cases of protracted organic enrichment anoxic conditions may occur where no fauna survives and the sediment may become blanketed by a bacterial mat. Changes to the sedimentary habitat due to deposition are indicated by a decrease in oxygen levels, increased sulphide reduction, decrease in REDOX depth and particle size changes.

Several factors can affect the rate of deposition onto the seafloor; these include structure and culture density, site hydrography and site history. Oysters and mussels have a "plastic response" to increased levels of suspended matter in the water column and can modify their filtration rate accordingly and thus increase the production of pseudofaeces which results in an increase in transfer of particles to the seafloor. The degree to which the material disperses away from the footprint of the culture system (e.g. Longlines, BST Longlines, floats, trestles & bags etc.) is governed by the density of mussels/oysters on the system, the depth of water and the water currents in the vicinity. It is likely that some overlap in effect will be realised. The duration and extent to which culture has been conducted on site may lead to cumulative impacts on the seabed, especially in areas where assimilation or dispersion of faeces/pseudofaeces is not rapid. A number of features of the site and culture practices will govern the speed at which faeces/pseudofaeces are assimilated or dispersed by the site. These relate to:

- Hydrography (residence time, tidal range, residual flow) govern how quickly the wastes disperse from the culture location and the density at which they will accumulate on the seafloor i.e. the greater the tidal range and residual flow then the greater the rate of dispersion and therefore the risk of accumulation is reduced.

- Turbidity in the water-the higher the water turbidity the greater the production of pseudo-faeces/faeces by the suspension feeding animal ("plastic response") and therefore greater the risk of accumulation on the seafloor.

- Density of structures-high density of culture structures (e.g. Longlines, floats, trestles & bags etc.) can result in the slowing of water currents/impediment of water flow (baffling effect), slow it down and cause localised deposition of material on the seafloor.

- Density of culture-the greater the density organisms the greater the risk of accumulations of material, suspended culture is considered a dense culture method with high densities of culture organisms over a small area. The density of culture organisms is a function of:

    - depth of the site (shallow sites have shorter droppers and hence fewer culture organisms),

    - husbandry practices – proper maintenance will result in optimum densities on the lines as well as ensuring a reduced risk of drop-off of culture animals to the seafloor as well as ensuring a sufficient distance among the longlines to reduce the risk of cumulative impacts in depositional areas.

Seston filtration - All culture methods

Suspension feeding bivalves such as mussels and oysters have a large filtration capacity and in confined areas, have been shown to alter the phytoplankton and zooplankton community abundance and structure and therefore potentially impact on the production of an area. This method of feeding may reduce water turbidity hence increasing light penetration, which may increase phytoplankton production and therefore food availability. This increase in light penetration can have positive effects on light sensitive species such as maerl, seagrass and macroalgae.

Shading - Suspended culture

The structures associated with suspended culture (e.g. trestles & bags etc.) can prevent light penetration to the seabed and therefore potentially impact on light sensitive species such as maerl, seagrass and macroalgae.

Fouling/Habitat creation - All culture methods

The structures associated with aquaculture, and the culture organisms themselves provide increased habitat for fouling species to colonise and therefore increase diversity; results in increased secondary production and increased nekton production.

Introduction of Non-native species- All culture methods

Movement and introduction of bivalve shellfish can be a vector for the introduction and spread of non-native/alien species. In some instances the introduced species may proliferate rapidly and compete with and in some cases replace the native species. Recruitment of *C. gigas* has been documented in a number of bays in Ireland and appears to have become naturalised (i.e. establishment of a breeding population) in two locations (Kochmann *et al.*, 2012; 2013) and may compete with the native species for space and food.

Another means is the unintentional introduction of non-native species/diseases which are associated with the imported target culture species, and their subsequent spread and establishment. These associated species are referred to as "hitch-hikers" and include animals and plants and/or parasites and diseases that potentially could cause outbreaks within the culture species or spread to other local species.

The introduction and establishment of non-native species can result in loss of native biodiversity due to increased competition for food and habitat and also predation and/or disease.

Disease risk - All culture methods

Due to the nature of the culture methods the risk of transmission of disease from cultured to wild stocks is high, e.g. the introduction of the parasitic protozoan *Bonamia ostreae*, which has caused the mass mortality within Irish native Oyster Beds. This risk can be limited by compiling a bio security plan, screening all introduced stock prior to transferring to on growing site and also good animal husbandry. Disease risk associated with movement of shellfish is governed by Fish health legislation on the movement of shellfish stocks into and out of culture areas and will not be considered further in this assessment.

Monoculture - Bottom culture

The relaying of mussels/clams on the seabed also alters the infaunal community in terms of number of individuals and number of species present. As the habitat is dominated by single species this may lead to the transformation of an infaunal dominated community to an epifaunal dominated community and also cause alteration of sediment type and chemistry due to the production of mussel "mud".

By-catch mortality - Bottom culture

Mortality of organisms captured or disturbed during the harvest and damage to structural fauna or reefs.

Nutrient Exchange - All culture methods

By their suspension feeding nature, removing particulate matter from the water column and releasing nutrients in solid and dissolved forms, bivalves influence benthic-pelagic coupling of organic matter and nutrients. Intensive bivalve culture can cause changes in ammonium and dissolved inorganic nitrogen resulting in increased primary production. The removal of nitrogen from the system is caused by both removal via harvest or denitrification at sediment surface.

6.2 PHYSICAL EFFECTS OF AQUACULTURE

Current alteration - Suspended culture

The structures used in aquaculture (e.g. Longlines, floats, trestles & bags etc.) can alter the hydrodynamics of an area i.e. increase/decrease water flow, this is known as the "Baffling effect". An increase in water flow will result in scouring of the seafloor leading to an increase in coarse sediment while a decrease in current flow will result in an increase in the amount of fine particles being deposited. Both result in a change in the sedimentary habitat structure and therefore can lead to change in the composition of the benthic infaunal community.

Surface disturbance - All culture methods

All aquaculture activities physically alter the receiving habitat, but the level of this disturbance depends on the culture method employed. The culture of bivalves on the seabed (on-bottom) in an uncontained fashion involves the dredging of the seafloor at various stages in the culture process i.e. the collection of seed mussels and relaying of spat, routine maintenance, removal of predators ("mopping"), stock movements and finally harvesting. The frequency of dredging activity depends on site management and how often stock is moved to new ongrowing areas to maximise growth and minimise predation prior to harvest. This dredging activity physically disturbs the seafloor and the organisms therein, and has been demonstrated to cause habitat and community changes.

The intertidal culture of bivalves (e.g. Longlines, Bags & trestles) does not require dredging and therefore is less damaging (physically) to the seafloor than the bottom culture method. However, the intertidal habitat can be affected by ancillary activities on-site i.e. servicing, vehicles on shore; human traffic and boat access lanes, causing an increased risk of sediment compaction resulting in sediment changes and associated community (infaunal and epifaunal) changes. Such activities can result in shallow and/or deep physical disturbance causing burrows to collapse, deeply burrowed organisms to die due to smothering and/or preventing siphon connection to the sediment surface or by directly crushing the animal.

Shading - Suspended culture

The structure associated with suspended culture (e.g. Longlines, floats, trestles & bags etc.) have the potential to prevent light penetration to the seabed and therefore potentially impact on light sensitive species such as maerl, seagrass and macroalgae.

Table 6.1 - Potential indicative environmental pressures of aquaculture activities within the Qualifying Interests of Estuaries [1130] and Mudflats and sandflats not covered by seawater at low tide [1140] of the Castlemaine Harbour SAC.

Activity	Pressure category	Pressure	Potential effects	Equipment / Gear	Duration (days)	Time of year	Factors constraining the activity
Intertidal Oyster Culture	Physical	Current alteration	Structures may alter the current regime and resulting increased deposition of fines or scouring.	Trestles and bags and service equipment	365	All year	At low tide only
		Surface disturbance	Ancillary activities at sites, e.g. servicing, transport increase the risk of sediment compaction resulting in sediment changes and associated community changes.				
		Shading	Prevention of light penetration to seabed potentially impacting light sensitive species				
	Biological	Non-native species introduction	Potential for non-native species (*C. gigas*) to reproduce and proliferate in SAC. Potential for alien species to be included with culture stock (hitch-hikers).				
		Disease risk	In event of epizootic the ability to manage disease in uncontained subtidal oyster populations is compromised.				
		Organic enrichment	Faecal and pseudofaecal deposition on seabed potentially altering community composition				
	Physical	Current alteration	Structures may alter the current regime and resulting increased deposition of fines or scouring.				
Subtidal Shellfish culture	Physical	Surface disturbance	Abrasion at the sediment surface and redistribution of sediment	Dredge	Controlled by Co-Op	Seasonal	Weather for site access. Size of shellfish and market constraints
		Shallow disturbance	Sub-surface disturbance to 25mm				
	Biological	Monoculture	Habitat dominated by single species and				

Activity	Pressure category	Pressure	Potential effects	Equipment / Gear	Duration (days)	Time of year	Factors constraining the activity
	Biological		transformation of infaunal dominated community to epifaunal dominated community.				
		By-catch mortality	Mortality of organisms captured or disturbed during the harvest or process, damage to structural fauna of reefs				
		Non-native species introduction	Potential for alien species to be included with culture stock (hitch-hikers)				
		Disease risk	In event of an epizootic the ability to manage disease in uncontained subtidal shellfish populations would likely be compromised. The risk introduction of disease causing organisms by introducing seed originating from the 'wild' in other jurisdictions				
		Nutrient exchange	Increased primary production. N_2 removal at harvest or denitrification at sediment surface.				
Intertidal Clam bottom culture	Physical	Surface disturbance	Abrasion at the sediment surface and redistribution of sediment	Mechanical harvester	365	All year	At low tide only Size of shellfish and market constraints
		Shallow disturbance	Sub-surface disturbance to 25mm				
	Biological	Monoculture	Habitat dominated by single species and transformation of infaunal dominated community to epifaunal dominated community.				
		By-catch mortality	Mortality of organisms captured or disturbed during the harvest or process, damage to structural fauna of reefs				

Activity	Pressure category	Pressure	Potential effects	Equipment / Gear	Duration (days)	Time of year	Factors constraining the activity
	Biological	Non-native species introduction	Potential for alien species to be included with culture stock (hitch-hikers)				
		Disease risk	In event of an epizootic the ability to manage disease in uncontained subtidal shellfish populations would likely be compromised. The risk introduction of disease causing organisms by introducing seed originating from the 'wild' in other jurisdictions				
		Nutrient exchange	Increased primary production. N_2 removal at harvest or denitrification at sediment surface.				

7 SCREENING OF AQUACULTURE ACTIVITIES

A screening assessment is an initial evaluation of the possible impacts that activities may have on the Qualifying Interests. The screening process is a filter, which may lead to exclusion of certain activities or Qualifying Interests from further assessment, thereby simplifying the process. Screening is a conservative filter that minimises the risk of false negatives.

In this report, screening of the Qualifying Interests against the proposed activities is based primarily on spatial overlap i.e. if the Qualifying Interests overlap spatially with the proposed activities then impacts due to these activities on the Conservation Objectives for the Qualifying Interests is not discounted (not screened out) except where there is absolute and clear rationale for doing so. Conversely, if no spatial overlap and/or no obvious interaction is likely to occur, then the possibility of significant impact is discounted and further assessment of possible effects is not deemed necessary.

Table 5.1 to Table 5.5 highlights the spatial overlap between (existing and proposed) intertidal oyster and subtidal mussel aquaculture activities, and the habitat features of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide, while Table 7.1 to Table 7.5 presents spatial overlap on constituent community types of the habitat features of 1130 and 1140.

7.1 AQUACULTURE ACTIVITY SCREENING

Where the overlap between intertidal oyster/clam or subtidal mussel aquaculture activities, and a feature is zero and there is no likely interaction of risk identified, it is screened out and not considered further. Therefore, the following habitats and species are excluded from further consideration in this assessment:

- Annual vegetation of drift lines [1210]
- Perennial vegetation of stony banks [1220]
- Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]
- *Salicornia* and other annuals colonising mud and sand [1310]
- Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]
- Mediterranean salt meadows (*Juncetalia maritimi*) [1410]
- Embryonic shifting dunes [2110]
- Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120]
- Fixed coastal dunes with herbaceous vegetation (grey dunes) [2130]
- Dunes with *Salix repens* ssp. *argentea* (Salicion arenariae) [2170]
- Humid dune slacks [2190]

- Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae) [91E0]

- *Petalophyllum ralfsii* (Petalwort) [1395]

When overlap was observed it was quantified in a GIS application and presented on the basis of coverage of specific activity representing different pressure types (i.e. intertidal oyster/clam cultivation and subtidal mussel cultivation) and licence status (licensed or application) intersecting with designated conservation features and/or sub-features (community types) (see Table 7.1 to Table 7.5).

Intertidal oyster cultivation

Table 7.1 and Table 7.2 below provides an overview of overlap of oyster aquaculture activities and specific marine community types (identified from Conservation Objectives (i.e. NPWS 2011b) within the broad habitat features of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide. If the aquaculture activity occurs within the SAC but does not overlap with a community type of a Qualifying Feature then the community type is excluded from further assessment.

Of the five community types (see Table 4.1) listed under the habitat feature of Estuaries (1130), one (i.e. *Zostera* community complex) has no spatial overlap with any intertidal oyster aquaculture activities (Table 7.1). On this basis, this community type is excluded from further analysis of oyster aquaculture interactions. Consequently, for Estuaries (1130) the likely interactions of current and proposed oyster cultivation were considered in light of the sensitivity of the constituent communities of Intertidal sand with *Nephtys cirrosa* community, Fine to muddy sand with polychaetes community, Mixed sediment community and Intertidal muddy fine sand community.

For the (1140) Mudflats and sandflats not covered by seawater at low tide, the likely interactions of current and proposed oyster cultivation were considered in light of the sensitivity of three community type (i.e. Intertidal sand with *Nephtys cirrosa* community, Fine to muddy sand with polychaetes community and Intertidal muddy fine sand community) identified for the Qualifying Feature (i.e. no spatial overlap with the *Zostera* community type (see Table 7.1)).

Interaction of access route activity with the Qualifying Feature of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide were assessed with respect to the constituent community type of Sand to muddy fine sand community complex (see Table 7.2).

Subtidal mussel cultivation

An assessment of the likely interactions between current and proposed mussel aquaculture operations and the Qualifying Feature of Estuaries (1130) was based on all five constituent communities (i.e. Intertidal sand with *Nephtys cirrosa* community, Fine to muddy sand with polychaetes community, Mixed sediment community, *Zostera* community complex and Intertidal muddy fine sand community (see Table 7.3)).

With regard (1140) Mudflats and sandflats not covered by seawater at low tide, likely interactions were assessed with respect to the 4 constituent communities of Intertidal sand with *Nephtys cirrosa* community, Fine to muddy sand with polychaetes community, *Zostera* community complex and Intertidal muddy fine sand community (see Table 7.3).

Interaction of access route activity with the Qualifying Feature of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide were assessed with respect to the constituent community type of Sand to muddy fine sand community complex (see Table 7.4).

Intertidal clam cultivation

Of the five community types (see Table 4.1) listed under the habitat feature of Estuaries (1130), three (i.e. *Zostera* community complex, Mixed sediment community complex and Intertidal muddy fine sand community) had no spatial overlap with any intertidal clam aquaculture activities (Table 7.5). On this basis, these community types were excluded from further analysis of clam aquaculture interactions. Consequently, for Estuaries (1130) the likely interactions of current and proposed clam cultivation were considered in light of the sensitivity of the constituent communities of Intertidal sand with *Nephtys cirrosa* community and Fine to muddy sand with polychaetes community.

For the (1140) Mudflats and sandflats not covered by seawater at low tide, the likely interactions of current and proposed clam cultivation were considered in light of the sensitivity of two community type (i.e. Intertidal sand with *Nephtys cirrosa* community and Fine to muddy sand with polychaetes community) identified for the Qualifying Feature (i.e. no spatial overlap with the *Zostera* community type and Intertidal muddy fine sand community (see Table 7.5)).

The clam access route was assessed as part of the oyster access routes and is therefore not repeated again.

Table 7.1 - Habitat utilisation i.e. spatial overlap in percentage and hectares (given in parentheses) of intertidal oyster cultivation activity over community types within the Qualifying Interest 1130 (i.e. Estuaries) and 1140 (i.e. Mudflats and sandflats not covered by seawater at low tide) in the Castlemaine Harbour SAC. Spatial data based on licence database provided by DAFM. Habitat data provided in NPWS 2011b.

Licence Status	Culture Species	Qualifying Interest 1130 (5693.39 ha)					Qualifying Interest 1140 (4284.83 ha)			
		Community Type					Community Type			
		Intertidal sand with *Nephtys cirrosa* community (486.04ha)	Fine to muddy fine sand with Polychaetes community complex (3553.76ha)	*Zostera* dominated community (233.55ha)	Mixed sediment community complex (587.45ha)	Intertidal muddy fine sand community complex (554.1ha)	Intertidal sand with *Nephtys cirrosa* community (861.05ha)	Fine to muddy fine sand with Polychaetes community complex (2636.13ha)	*Zostera* dominated community (233.55ha)	Intertidal muddy fine sand community complex (554.1ha)
		Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)
Licensed	Oyster	-	1.72% (61.15 ha)	-	-	4.79% (26.52 ha)	-	2.24% (59.16ha)	-	4.79% (26.52 ha)
Application	Oyster	21.33% (103.67 ha)	42.73% (1518.61 ha)	-	2.95% (17.34 ha)-	15.3% (84.78 ha)	13.2% (113.67ha)	48.65% (1282.48ha)	-	15.3% (84.78 ha)
	Total	21.33% (103.67 ha)	44.45% (1579.76 ha)	-	2.95% (17.34 ha)	20.09% (111.3 ha)	13.2% (113.67 ha)	50.89% (1341.64ha)	-	20.09% (111.3 ha)

Table 7.2 - Spatial overlap in percentage and hectares (given in parentheses) of intertidal oyster cultivation access routes with community types within the Qualifying Interest 1130 (i.e. Estuaries) and 1140 (i.e. Mudflats and sandflats not covered by seawater at low tide) in the Castlemaine Harbour SAC. Spatial data based on licence database provided by DAFM. Habitat data provided in NPWS 2011b.

Licence Status	Culture Species	Qualifying Interest 1130 (5693.39 ha)					Qualifying Interest 1140 (4284.83 ha)			
		Community Type					Community Type			
		Intertidal sand with *Nephtys cirrosa* community (486.04ha)	Fine to muddy fine sand with Polychaetes community complex (3553.76ha)	*Zostera* dominated community (233.55ha)	Mixed sediment community complex (587.45ha)	Intertidal muddy fine sand community complex (554.1ha)	Intertidal sand with *Nephtys cirrosa* community (861.05ha)	Fine to muddy fine sand with Polychaetes community complex (2636.13ha)	*Zostera* dominated community (233.55ha)	Intertidal muddy fine sand community complex (554.1ha)
		Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)
Oyster Site Access Routes		0.18% (0.86 ha)	0.025% (0.9ha)	0.09% (0.2 ha)	0.02% (0.11 ha)	0.09% (0.5 ha)	0.1% (0.86 ha)	0.034% (0.9ha)	0.09% (0.2 ha)	0.09% (0.5 ha)

Table 7.3 - Habitat utilisation i.e. spatial overlap in percentage and hectares (given in parentheses) of subtidal (bottom) mussel cultivation activity over marine community types (area with habitat feature in parentheses) within the Qualifying Interest 1130 (i.e. Estuaries) and 1140 (i.e. Mudflats and sandflats not covered by seawater at low tide) in the Castlemaine Harbour SAC. Spatial data based on licence database provided by DAFM. Habitat data provided in NPWS 2011b.

Licence Status	Culture Species	Qualifying Interest 1130 (5693.39 ha)					Qualifying Interest 1140 (4284.83 ha)			
		Community Type					Community Type			
		Intertidal sand with *Nephtys cirrosa* community (486.04ha)	Fine to muddy fine sand with Polychaetes community complex (3553.76ha)	*Zostera* dominated community (233.55ha)	Mixed sediment community complex (587.45ha)	Intertidal muddy fine sand community complex (554.1ha)	Intertidal sand with *Nephtys cirrosa* community (861.05ha)	Fine to muddy fine sand with Polychaetes community complex (2636.13ha)	*Zostera* dominated community (233.55ha)	Intertidal muddy fine sand community complex (554.1ha)
		Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)
Licensed	Mussel*	-	5.47% (194.43ha)	-	-	1.3% (7.23ha)	-	6.17% (162.64ha)	-	1.3% (7.23ha)
Application	Mussel	-	3.43% (122.06ha)	2.83% (6.61ha)	0.002% (0.01ha)	7.19% (39.85ha)	1.16% (9.99ha)	4.44% (116.95ha)	2.83% (6.61ha)	7.19% (39.85ha)
Application	Mussel Longline	-	2.4% (86.24ha)	-	-	-	-	0.3% (8.7ha)	-	-
Total		-	**11.3% (402.73ha)**	**2.83% (6.61ha)**	**0.002% (0.01ha)**	**8.49% (47.08ha)**	**1.16% (9.99ha)**	**10.91% (288.29ha)**	**2.83% (6.61ha)**	**8.49% (47.08ha)**

*including 1 site for bottom oyster culture, approx 1ha.

Table 7.4- Spatial overlap in percentage and hectares (given in parentheses) of subtidal mussel cultivation access routes with community types within the Qualifying Interest 1130 (i.e. Estuaries) and 1140 (i.e. Mudflats and sandflats not covered by seawater at low tide) in the Castlemaine Harbour SAC. Spatial data based on licence database provided by DAFM. Habitat data provided in NPWS 2011c.

Licence Status	Culture Species	Qualifying Interest 1130 (5693.39 ha)					Qualifying Interest 1140 (4284.83 ha)			
		Community Type					Community Type			
		Intertidal sand with *Nephtys cirrosa* community (486.04ha)	Fine to muddy fine sand with Polychaetes community complex (3553.76ha)	*Zostera* dominated community (233.55ha)	Mixed sediment community complex (587.45ha)	Intertidal muddy fine sand community complex (554.1ha)	Intertidal sand with *Nephtys cirrosa* community (861.05ha)	Fine to muddy fine sand with Polychaetes community complex (2636.13ha)	*Zostera* dominated community (233.55ha)	Intertidal muddy fine sand community complex (554.1ha)
		Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)
Mussel Site Access Routes		-	0.0019% (0.067 ha)	-	-	0.056% (0.31 ha)	-	0.003% (0.067ha)	-	0.056% (0.31 ha)

Table 7.5- Habitat utilisation i.e. spatial overlap in percentage and hectares (given in parentheses) of intertidal (bottom) clam cultivation activity over marine community types (area with habitat feature in parentheses) within the Qualifying Interest 1130 (i.e. Estuaries) and 1140 (i.e. Mudflats and sandflats not covered by seawater at low tide) in the Castlemaine Harbour SAC. Spatial data based on licence database provided by DAFM. Habitat data provided in NPWS 2011b.

Licence Status	Culture Species	Qualifying Interest 1130 (5693.39 ha)					Qualifying Interest 1140 (4284.83 ha)			
		Community Type					Community Type			
		Intertidal sand with *Nephtys cirrosa* community (486.04ha)	Fine to muddy fine sand with Polychaetes community complex (3553.76ha)	*Zostera* dominated community (233.55ha)	Mixed sediment community complex (587.45ha)	Intertidal muddy fine sand community complex (554.1ha)	Intertidal sand with *Nephtys cirrosa* community (861.05ha)	Fine to muddy fine sand with Polychaetes community complex (2636.13ha)	*Zostera* dominated community (233.55ha)	Intertidal muddy fine sand community complex (554.1ha)
		Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)	Overlap % (Overlap ha)
Licensed	Clam	2.01% (9.77ha)	0.18% (6.36ha)	-	-	-	1.13% (9.77ha)	0.24% (6.36ha)	-	-

8 ASSESSMENT OF AQUACULTURE ACTIVITIES

8.1 DETERMINING SIGNIFICANCE

The function of an appropriate assessment process is to determine if the ongoing and proposed aquaculture activities are consistent with the Conservation Objectives for the Natura site or if such activities will lead to deterioration in the attributes of the habitats and species over time and in relation to the scale, frequency and intensity of the activities. NPWS (2011b) provide guidance on interpretation of the Conservation Objectives which are, in effect, management targets for habitats and species in the SAC. This guidance is scaled relative to the anticipated sensitivity of habitats and species to disturbance by the proposed activities. Some activities are deemed to be wholly inconsistent with long term maintenance of certain sensitive habitats while other habitats can tolerate a range of activities. For the practical purpose of management of sedimentary habitats a 15% threshold of overlap between disturbing activities and a habitat is given in the NPWS guidance. Below this threshold disturbance is deemed to be non-significant. Disturbance is defined as that which leads to a change in the characterizing species of the habitat (which may also indicate change in structure and function). Such disturbance may be temporary or persistent in the sense that change in characterizing species may recover to pre-disturbed state or may persist and accumulate over time.

The significance of the possible effects of the proposed activities on habitats, as outlined in the Natura Impact Statement (Section 6) and subsequent screening exercise (Section 7), is determined here in the assessment. The significance of effects is determined on the basis of Conservation Objective guidance for constituent habitats and species (Figures 4.4 and NPWS 2011a, 2011b, 2011c).

Within the Castlemaine Harbour SAC the qualifying habitats/species considered subject to potential disturbance and, therefore, carried further in this assessment are:

- 1130 Estuaries
- 1140 Mudflats and sandflats not covered by seawater at low tide
- *Petromyzon marinus* (Sea Lamprey) [1095]
- *Lampetra fluviatilis* (River Lamprey) [1099]
- *Salmo salar* (Salmon) [1106]
- *Lutra lutra* (Otter) [1355]

For broad habitats and community types (Figures 4.2 to 4.4) significance of impact is determined in relation to, first and foremost, spatial overlap (see Section 5; Table 5.1 to 5.6 and Section 7; Tables 7.1 to 7.6). Subsequent disturbance and the persistence of disturbance are considered as follows:

1. The degree to which the activity will disturb the Qualifying Interest. By disturb is meant change in the characterising species, as listed in the Conservation Objective guidance (NPWS 2011b) for constituent communities. The likelihood of change depends on the sensitivity of

the characterising species to the activities in question. Sensitivity results from a combination of intolerance to the activity and/or recoverability from the effects of the activity (see Section 8.2 below).

2. The persistence of the disturbance in relation to the intolerance of the community. If the activities are persistent (high frequency, high intensity) and the receiving community has a high intolerance to the activity (i.e. the characterising species of the communities are sensitive and consequently impacted) then such communities could be said to be persistently disturbed.

3. The area of communities or proportion of populations disturbed. In the case of community disturbance (continuous or ongoing) of more than 15% of the community area it is deemed to be significant. This threshold does not apply to the sensitive habitat *Zostera* where any spatial overlap of activities should generally be avoided.

Effects will be deemed to be significant when cumulatively they lead to long term change (persistent disturbance) in broad habitat/features (or constituent communities) resulting in an impact greater than 15% of the area.

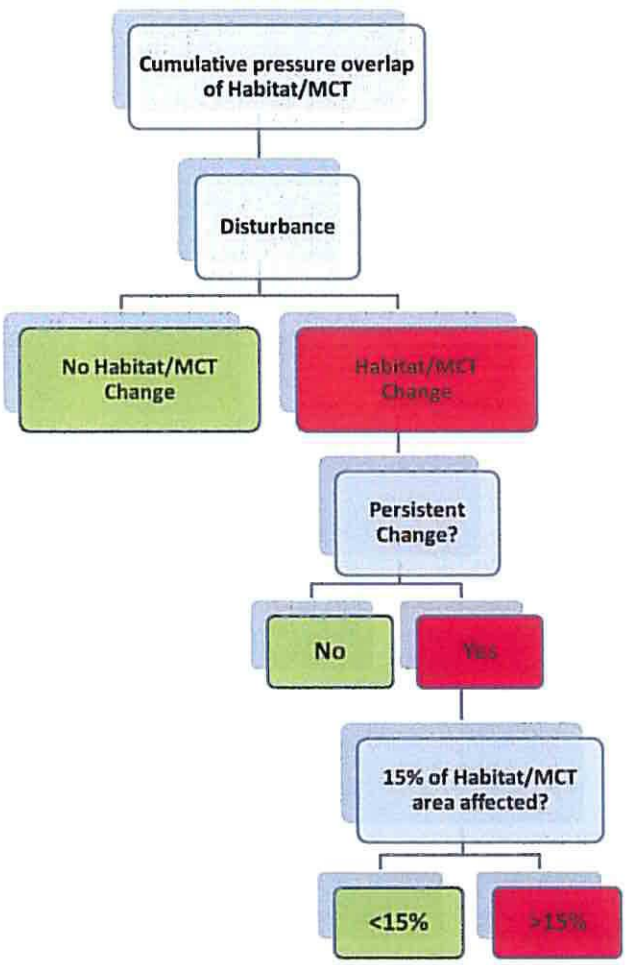

Figure 8.1 - Schematic outlining the determination of significant effects on habitats and marine community types (MCT) (following NPWS 2011b).

In relation to the designated species *Salmo salar* (Salmon) [1106], *Petromyzon marinus* (Sea Lamprey) [1095], *Lampetra fluviatilis* (River Lamprey) [1099] and *Lutra lutra* (Otter) [1355]; the capacity of the species population to maintain themselves in the face of anthropogenic induced disturbance or mortality at the site will need to be taken into account in relation to the Conservation Objectives on a case by case basis.

8.2 SENSITIVITY AND ASSESSMENT RATIONALE

This assessment used a number of sources of information in assessing the sensitivity of the characterising species of each community recorded within the benthic habitats of Castlemaine Harbour SAC. One source of information is a series of reviews commissioned by the Marine Institute which identify habitat and species sensitivity to a range of pressures likely to result from aquaculture and fishery activities (ABPMer 2013a-h). These reviews draw from the broader literature, including the MarLIN Sensitivity Assessment (Marlin.ac.uk) and the AMBI Sensitivity Scale (Borja *et al.*, 2000) and other primary literature. It must be noted that NPWS have acknowledged that given the wide range of community types that can be found in marine environments, the application of conservation targets to these would be difficult (NPWS 2011c). On this basis, NPWS have proposed broad community complexes as management units. These complexes (for the most part) are very broad in their description and do not have clear surrogates which might have been considered in targeted studies and thus reported in the scientific literature. On this basis, the confidence assigned to likely interactions of the community types with anthropogenic activities are by necessity relatively low, with the exception of community types dominated by sensitive taxa, e.g. Mearl and *Zostera*. Other literature cited in the assessment does provide a greater degree of confidence in the conclusions. For example, the output of a recent study has provided greater confidence in terms of assessing likely interactions between intertidal oyster culture and marine habitats (Forde *et al.*, 2015). Sensitivity of a species to a given pressure is the product of the intolerance (the susceptibility of the species to damage, or death, from an external factor) of the species to the particular pressure and the time taken for its subsequent recovery (recoverability is the ability to return to a state close to that which existed before the activity or event caused change). Life history and biological traits are important determinants of sensitivity of species to pressures from aquaculture.

In the case of species, communities and habitats of conservation interest, the separate components of sensitivity (intolerance, recoverability) are relevant in relation to the persistence of the pressure:

- For persistent pressures i.e. activities that occur frequently and throughout the year recovery capacity may be of little relevance except for species/habitats that may have extremely rapid (days/weeks) recovery capacity or whose populations can reproduce and recruit in balance with population damage caused by aquaculture. In all but these cases and if sensitivity is moderate or high then the species/habitats may be negatively affected and will exist in a modified state. Such interactions between aquaculture and species/habitat/community represent persistent disturbance. They become significantly disturbing if more than 15% of the community is thus exposed (NPWS 2011b).

- In the case of episodic pressures i.e. activities that are seasonal or discrete in time both the intolerance and recovery components of sensitivity are relevant. If sensitivity is high but recoverability is also high relative to the frequency of application of the pressure then the species/habitat/community will be in Favourable Conservation Status for at least a proportion of time.

The sensitivities of the community types (or surrogates) found within the Castlemaine Harbour SAC to pressures similar to those caused by aquaculture (e.g. smothering, organic enrichment and physical disturbance) are identified in Table 8.1. The sensitivities of species which are characteristic (as listed in the Conservation Objective supporting document) of benthic communities to pressures similar to those caused by aquaculture (e.g. smothering, organic enrichment and physical disturbance) are identified, where available, in Table 8.2. The following guidelines broadly underpin the analysis and conclusions of the species and habitat sensitivity assessment:

- Sensitivity of certain taxonomic groups such as emergent sessile epifauna to physical pressures is expected to be generally high or moderate because of their form and structure (Roberts *et al.,* 2010). Also high for those with large bodies and with fragile shells/structures, but low for those with smaller body size. Body size (Bergman and van Santbrink 2000) and fragility are regarded as indicative of a high intolerance to physical abrasion caused by fishing gears (i.e. dredges). However, even species with a high intolerance may not be sensitive to the disturbance if their recovery is rapid once the pressure has ceased.

- Sensitivity of certain taxonomic groups to increased sedimentation is expected to be low for species which live within the sediment, deposit and suspension feeders; and high for those sensitive to clogging of respiratory or feeding apparatus by silt or fine material.

- Recoverability of species depends on biological traits (Tillin *et al.,* 2006) such as reproductive capacity, recruitment rates and generation times. Species with high reproductive capacity, short generation times, high mobility or dispersal capacity may maintain their populations even when faced with persistent pressures; but such environments may become dominated by these (r-selected) species. Slow recovery is correlated with slow growth rates, low fecundity, low and/or irregular recruitment, limited dispersal capacity and long generation times. Recoverability, as listed by MarLIN, assumes that the impacting factor has been removed or stopped and the habitat returned to a state capable of supporting the species or community in question. The recovery process is complex and therefore the recovery of one species does not signify that the associated biomass and functioning of the full ecosystem has recovered (Anand and Desrocher, 2004) cited in Hall *et al.,* 2008).

8.3 ASSESSMENT OF THE EFFECTS OF AQUACULTURE PRODUCTION ON THE CONSERVATION OBJECTIVES FOR HABITAT FEATURES IN THE CASTLEMAINE HARBOUR SAC.

Aquaculture pressures on a given habitat are related to vulnerability (spatial overlap or exposure of the habitat to the equipment/culture organism combined with the sensitivity of the habitat) to the pressures induced by culture activities. To this end, the location and orientation of structures associated with the culture organism, the density of culture organisms, the duration of the culture activity are all important considerations when considering risk of disturbance of intertidal oyster cultivation activity to habitats and species. Similarly, important aspects of subtidal mussel cultivation that must be considered include location, organism, the density of mussels culture beds, and the duration of the culture activity and harvesting (i.e. dredging).

NPWS (2011b) provide lists of species characteristic of benthic communities occurring within Annex I features that are defined in the Conservation Objectives.

The constituent communities identified in the broad Annex 1 feature of (1130) Estuaries

- Intertidal sand with *Nephtys cirrosa* community
- Fine to muddy sand with polychaetes community
- Mixed sediment community
- *Zostera* community complex
- Intertidal muddy fine sand community

Constituent communities identified in the broad Annex 1 feature of (1140) Mudflats and sandflats not covered by seawater at low tide) are:

- Intertidal sand with *Nephtys cirrosa* community
- Fine to muddy sand with polychaetes community
- *Zostera* community complex
- Intertidal muddy fine sand community

For **(1130) Estuaries** and **(1140) Mudflats and sandflats not covered by seawater at low tide** there are a number of attributes (with associated targets) relating to the following broad habitat features as well as constituent community types;

1. Habitat Area - it is unlikely that the activities proposed will reduce the overall extent of permanent habitat within the feature (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide. The habitat area is likely to remain stable.

2. Community Distribution - (conserve a range of community types in a natural condition) - this attribute considered interactions with the community types listed above. Table 8.1 below indicates the community types, found within the Qualifying Interests of 1130 and 1140 that are considered further as part of the assessment (i.e. community types which overlap with current and existing aquaculture activities).

Table 8.1 - Community types recorded in Castlemaine Harbour SAC and the Annex I habitats of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide that overlap with overlap with existing and proposed aquaculture activities

Feature	Community Type	Overlap with intertidal oyster cultivation activities*	Overlap with subtidal mussel cultivation*	Overlap with intertidal clam cultivation
Estuaries (1130)	Intertidal sand with *Nephtys cirrosa* community	✓	✓	✓
	Fine to muddy sand with polychaetes community	✓	✓	✓
	Mixed sediment community	✓		
	Zostera community complex	✓	✓	

Feature	Community Type	Overlap with intertidal oyster cultivation activities*	Overlap with subtidal mussel cultivation*	Overlap with intertidal clam cultivation
	Intertidal muddy fine sand community	✓	✓	
Mudflats and sandflats not covered by seawater at low tide (1140)	Intertidal sand with *Nephtys cirrosa* community	✓	✓	✓
	Fine to muddy sand with polychaetes community	✓	✓	✓
	Zostera community complex	✓	✓	
	Intertidal muddy fine sand community	✓	✓	

* Includes access routes

For community types listed under 1140 and 1130 Table 8.2 lists the habitats and Table 8.3 lists the constituent taxa and both provide a commentary of sensitivity to a range of pressures. The risk scores are derived from a range of sources identified above. The pressures are listed as those likely to result from intertidal oyster culture (bags and trestle) and dredging for mussels within the SAC.

The likely interactions between (existing and proposed) intertidal oyster cultivation, subtidal mussel cultivation and intertidal clam aquaculture activities and the broad habitat feature of 1130 and 1140 and their constituent community types are described in Table 8.5 together with broad conclusions and justifications on whether the activities in isolation and/or cumulatively are considered disturbing to the feature in question. It must be noted that the sequence of distinguishing disturbance is as highlighted above, whereby activities with spatial overlap on habitat features are assessed further for their ability to cause persistence disturbance on the habitat. If persistent disturbance is likely then the spatial extent of the overlap is considered further. Other indirect sources of disturbance (e.g., non-native species, seston depletion) are also considered and highlighted below and a conclusion provided as to the level of risk presenting.

Intertidal oyster cultivation

While combined spatial overlap of current and proposed oyster cultivation sites and the constituent marine community types (MCT), identified for the Qualifying Feature habitats of 1130 and 1140, ranges between 2.95% and 50.89% (Table 7.1), published literature (Forde *et al.*, 2015; O'Carroll *et al.*, 2016) however, suggests that the presence of bags on trestles is considered non-disturbing. Consequently, adverse impacts of activities occurring at oyster cultivation sites within the Qualifying Interests of (1130) Estuaries and (1140) of Mudflats and sandflats not covered by seawater at low tide can be discounted (see Table 8.5).

The access routes used in intertidal areas, by virtue of persistent compaction of the sedimentary habitats, are considered disturbing (De-Grave *et al.*, 1998; Forde *et al.*, 2015; O'Carroll *et al.*, 2016). The access routes for aquaculture sites overlap with all identified constituent community of the Qualifying Interests (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at

low tide (see Table 7.2). The spatial overlap of access routes within these community types ranges between 0.02% and 0.9%. One of these constituent habitats is the *Zostera* dominated community which is located within the 1130 and 1140 Qualifying Interests. The spatial overlap between oyster access routes and the *Zostera* community is 0.09% in both QI habitats. This access route is required for a number of the proposed oyster application sites in the Glenbeigh area. This community type cannot tolerate any overlap. The proximity of structures (used in intertidal oyster culture) may impact flow regimes in and around seagrass bed which may result in a detrimental impact on the overall status of this MCT.

Subtidal (bottom) mussel cultivation

Bottom mussel cultivation, by virtue of dredging activities and modification of community type is considered disturbing. Current mussel cultivation occurs in two constituent marine community types identified for the Qualifying Feature habitat of (1130) Estuaries (see Table 7.3). The spatial overlap of licensed mussel culture activities within these community types ranges between 1.3% and 5.47%. Current mussel cultivation occurs in two community type identified within the Qualifying Features of (1140) Mudflats and sandflats not covered by seawater at low tide (see Table 7.3). The spatial overlap of licensed mussel culture within these community types ranges between 1.3% and 6.17%.

Should all applications for mussel cultivation be granted the spatial overlap of cultivation sites in four constituent communities within the Qualifying Feature (1130) Estuaries will range from 0.002% to 8.9%. In addition, the spatial overlap within the Qualifying Feature (1140) Mudflats and sandflats not covered by seawater at low tide will range from 2.83% to 10.91%. One of these constituent habitats is the *Zostera* dominated community which is located within the 1130 and 1140 Qualifying Interests. The spatial overlap between proposed mussel sites and the *Zostera* community is 2.83% in both QI habitats. This marine community type cannot tolerate any overlap.

Longline Mussel Cultivation

The interaction with this proposed activity was considered in light of the conservation features for which it has direct spatial overlap, i.e., habitat features 1130 and 1140 and one marine community type, Fine to muddy sand with polychaetes community (Table 7.3). Given the proposed culture method will have relatively small biomass associated and will be carried out for a short duration in each year (i.e. capture of seed and subsequent relaying to separate bottom mussel culture site), there is unlikely to be any prolonged impact (i.e. organic enrichment) on the seabed. Consequently, adverse impacts of activities occurring at longline mussel sites within the Qualifying Interests of (1130) Estuaries and (1140) of Mudflats and sandflats not covered by seawater at low tide can be discounted (see Table 8.5).

Intertidal clam cultivation

The culture of clams involves the location of structure on or very close to the seabed and is considered disturbing. Licensed clam cultivation overlaps two constituent community types identified for the Qualifying Feature habitat of (1130) Estuaries (see Table 8.9). The spatial overlap of licensed clam culture activities within these community types ranges between 0.18% and 2.01%. Current clam cultivation overlaps two community type identified within the Qualifying Features of (1140) Mudflats and sandflats not covered by seawater at low tide (see Table 8.9). The spatial overlap of licensed clam culture within these community types ranges between 0.24% and 1.13%.

Introduction of non-native species

As already outlined oyster culture may present a risk in terms of the introduction of non-native species as the Pacific oyster (*Crassotrea gigas*) itself is a non-native species. Recruitment of *C. gigas* has been documented in a number of Bays in Ireland and appears to have become naturalised (i.e. establishment of a breeding population) in two locations (Kochmann *et al.,* 2012; 2013) and may compete with the native species for space and food. In addition to having large number of oysters in culture, Kochmann *et al.,* (2013) identified short residence times and large intertidal areas as factors likely contributing to the successful recruitment of oysters in Irish bays. The residence time in Castlemaine Harbour is estimated as 14 days which is considered below the threshold for successful establishment of *C. gigas*. In addition, the use of triploid seed by operators in the bay will further mitigate the risk. Consequently, the risk of Pacific oysters naturalising in Castlemaine Harbour can be discounted.

While there is minimal risk associated with the introduction of hitchhiker species with hatchery reared oyster seed, the risk posed by the introduction of '½-grown' or 'wild' seed originating from another jurisdiction (e.g. Britain, France) cannot be discounted.

The introduction of seed mussels into all sites considered in this report from outside of the immediate area (i.e., Dingle Bay) poses a risk of introducing non-native species, e.g. the slipper limpet, *Crepidula fornicata*, which cannot be discounted at this stage.

Other Considerations

Existing oyster and mussel cultivation in Castlemaine Harbour is considered modest in terms of standing stock biomass of culture species in the Bay. It is anticipated that such levels will not place demands on the seston (i.e., living and non-living matter in water) in the bay so as to impact on production of shellfish and more importantly on communities and habitats of conservation interest. The proposed increase in oyster cultivation from 1.54% and 2% coverage of Habitats 1130 and 1140 to 31.26% and 34.69%, respectively, will likely increase the standing stock biomass of this culture species in the SAC. This increase is considered substantial and the impact of this quantity of oysters on the seston levels in the system is unknown at this stage. However, it is acknowledged that there will be a reduction plankton levels which may have an impact on the constituent communities associated with the habitats, i.e., a reduction in secondary production. On the basis of the proposed increase in spatial area of licensing (applications), the risk of seston depletion and impact on carrying capacity of the system, therefore, cannot be discounted.

8.3.1 Conclusion Summary

In summary, the cumulative impacts of aquaculture operations are presented in Table 8.5, wherein a commentary is provided on the significance of disturbance. It is concluded (based primarily upon the spatial overlap and sensitivity analysis) current and proposed intertidal oyster and clam aquaculture activities individually and in-combination do not pose a risk of significant disturbance to the conservation habitats in the Castlemaine Harbour SAC (Table 8.5).

It is also concluded that current levels of subtidal (bottom) cultivation of mussels and intertidal clam cultivation do not pose a significant risk to the Conservation Objectives of the majority of marine benthic habitat features for which the SAC is designated. One exception relates to proposed mussel cultivation at site T06/428A which will pose a significant risk to the Conservation Objectives of one

marine benthic habitat feature for which the SAC is designated: *Zostera* community complex. *Zostera* habitats are not compatible to mussel aquaculture.

The overlap of *Zostera* community complex marine community type is not compatible with access routes to aquaculture sites. . In addition to the interactions highlighted in Table 8.5, the risk posed by the introduction of seed stock (e.g., ½ grown oysters and/or mussel seed) from outside of the jurisdiction cannot be discounted.

Furthermore, the impact of the proposed increase in standing stock and biomass of shellfish in the system in relation to seston depletion and subsequent impacts on conservation features cannot be discounted.

Table 8.2 - Matrix showing the characterising habitats sensitivity scores x pressure categories for habitats (or surrogates) in Castlemaine Harbour SAC (ABPMer 2013a-h) (Table 8.4 provides the code for the various categorisation of sensitivity and confidence).

Community Type (Surrogate [EUNIS code])	Surface Disturbance	Shallow Disturbance	Deep Disturbance	Trampling – access by foot	Trampling – access by vehicle	Extraction	Siltation (addition of fine sediments, pseudofaeces, fish food)	Smothering (addition of materials biological or non-biological to the surface)	Changes to sediment composition- increased coarseness	Changes to sediment composition- increased fine sediment proportion	Changes to water flow	Increase in turbidity/suspended sediment	Decrease in turbidity/suspended sediment	Organic enrichment-water column	Organic enrichment of sediments-sedimentation	Increased removal of primary production-phytoplankton	Decrease in oxygen levels- sediment	Decrease in oxygen levels-water column	Introduction of non-native species	Removal of Target Species	Removal of Non-target species	Introduction of antifoulants	Introduction of medicines	Introduction of hydrocarbons	Prevention of light reaching seabed/features
Intertidal sand with *Nephtys cirrosa* community (Polychaete / amphipod dominated sand shores [A2.23])	NS (*)	L (*)	L (*)	NS (*)	L-NS (*)	L-M (*)	L-M (*)	L-M (*)	L-M (*)	M (*)	L-M (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	L-NS (*)	L-NS (*)	NS (***)	NS (*)	NS (*)	NS (*)	NS (*)	L (*)	NS (*)
Fine to muddy sand with polychaetes community (Polychaete/bivalve-dominated muddy sand shores [A2.24])	NS (***)	L (*)	L (***)	NS (*)	L (*)	L-M (*)	L-M (*)	L-M (*)	L-M (*)	NS (*)	L-M (*)	NS	NS (*)	NS (*)	NS (*)	NS (*)	L (*)	L (*)	H (***)	NS (*)	NS (*)	NS (*)	NS (*)	L (*)	NS (*)
Mixed sediment community (Circalittoral mixed sediments [A5.44])	NS (*)	L (*)	L (*)	NE	NE	L-M (*)	L-M (*)	L-M (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	H (*)	NS (*)	NS (*)	NS (*)	NS (*)	L (*)	NS (*)
Zostera community complex (Seagrass beds A2.61)	M-H (***)	M-VH (***)	M-VH (***)	M-H (***)	M-H (***)	M-VH (***)	VH (***)	VH (***)	M (*)	M (***)	M (*)	H (***)	NS (*)	H (***)	H (***)	NS (*)	H-VH (*)	H-VH (*)	H (**)	NS	NS	NEv	NEv	NS (***)	H-VH (**)

Community Type (Surrogate [EUNIS code])	Surface Disturbance	Shallow Disturbance	Deep Disturbance	Trampling – access by foot	Trampling – access by vehicle	Extraction	Siltation (addition of fine sediments, pseudofaeces, fish food)	Smothering (addition of materials biological or non-biological to the surface)	Changes to sediment composition- increased coarseness	Changes to sediment composition- increased fine sediment proportion	Changes to water flow	Increase in turbidity/suspended sediment	Decrease in turbidity/suspended sediment	Organic enrichment-water column	Organic enrichment of sediments-sedimentation	Increased removal of primary production-phytoplankton	Decrease in oxygen levels- sediment	Decrease in oxygen levels-water column	Introduction of non-native species	Removal of Target Species	Removal of Non-target species	Introduction of antifoulants	Introduction of medicines	Introduction of hydrocarbons	Prevention of light reaching seabed/features
Intertidal muddy fine sand community (Polychaete/bivalve-dominated muddy sand shores [A2.24])	NS (***)	L (*)	L (***)	NS (*)	L (*)	L-M (*)	L-M (*)	L-M (*)	L-M (*)	NS (*)	L-M (*)	NS	NS (*)	NS (*)	NS (*)	NS (*)	L (*)	L (*)	H (***)	NS (*)	NS (*)	NS (*)	NS (*)	L (*)	NS (*)

Table 8.3 - Matrix showing the characterising species sensitivity scores x pressure categories for species in Castlemaine Harbour SAC (ABPMer 2013a-h) (Table 8.4 provides the code for the various categorisation of sensitivity and confidence.)

Community Type (Surrogate [EUNIS code])	Species (characterizing species identified from NPWS 2011b)	Surface Disturbance	Shallow Disturbance	Deep Disturbance	Trampling – access by foot	Trampling – access by vehicle	Extraction	Siltation (addition of fine sediments, pseudofaeces, fish food)	Smothering (addition of materials biological or non-biological to the surface)	Changes to sediment composition-increased coarseness	Changes to sediment composition-increased fine sediment proportion	Changes to water flow	Increase in turbidity/suspended sediment	Decrease in turbidity/suspended sediment	Organic enrichment-water column	Organic enrichment of sediments-sedimentation	Increased removal of primary production-phytoplankton	Decrease in oxygen levels- sediment	Decrease in oxygen levels-water column	Introduction of non-native species	Removal of Target Species	Removal of Non-target species	Introduction of antifoulants	Introduction of medicines	Introduction of hydrocarbons	Prevention of light reaching seabed/features
Intertidal sand with *Nephtys cirrosa* community (Polychaete / amphipod dominated sand shores [A2.23])	*Nephtys cirrosa*	NS (*)	L (***)	L (***)	NS (*)	L (*)	L (*)	NS (***)	NS (*)	L (*)	NS (*)	L (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	M (*)	M (*)	NS (*)	NS (*)	NEv	NEv	NS (*)
	Bathypoeia pilosa	NS (*)	L (***)	L (***)	NS (*)	L (*)	L-M (*)	(***)	L-M (*)	L-M (*)	L-M (*)	NS (*)	NS (*)	NS (*)	L-M (*)	L-M (*)	NS (*)	L-M (***)	L–M (***)	L-M (*)	NS (*)	NS (*)	NS (*)	NEv	NEv	NS (*)
	Scolelepis squamata	NS (*)	NS (***)	NS (*)	NS (*)	NS (*)	L-M (*)	L-M (***)	L-M (***)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (***)	NS (*)	L (*)	L (*)	M (*)	NS (*)	NS (*)	NS (*)	NEv	NS (***)	NS (*)
Fine to muddy sand with polychaetes community (Polychaete/bivalve-dominated muddy sand shores [A2.24])	Angulus tenuis	NS (*)	L (*)	(***)	NS (*)	L (*)	M (*)	NS (*)	H (*)	M-H (*)	NS (*)	L-M (*)	L (*)	NS (*)	NS (*)	NEv	L-NS (*)	NEv	NEv	M (*)	NS (*)	NS (*)	NS (*)	NEv	NEv	NS (*)
	Eteone longa	NS (*)	L (*)	L (*)	NS (*)	L (*)	M (*)	NS (*)	L-M (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (**)	NEv	NS (*)	NS (*)
	Scoloplos armiger	NS (*)	L (*)	L-M (*)	NS (*)	L (*)	H (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (***)	NS (***)	NS (*)	M (***)	M (***)	M (*)	M (**)	NS (*)	NS (*)	NEv	NEv	NS (*)
	Pygospio elegans	L (*)	L (**)	M (***)	L (*)	L (*)	L-M (*)	L (***)	L-M (***)	L-M (*)	NS (**)	L-M (*)	NS (*)	NS (*)	NS (*)	NS (***)	NS (*)	L (**)	L (**)	M (*)	NS (*)	NS (*)	NS (*)	NEv	NEv	NS (*)
	Spio mainensis	L (*)	L (***)	L (***)	L (*)	L (*)	L-M (*)	NS (*)	M (*)	L-M (*)	L-M (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (***)	NS (*)	NEv	NEv	VH (*)	NS (*)	NS (*)	NS (*)	NEv	NS (***)	NS (*)
	Capitella capitata	L (*)	L (**)	L (**)	L (***)	L (*)	L (*)	L (*)	NS (*)	NS (*)	NS (***)	NS (*)	NS (*)	NS (*)	NS (***)	NS (***)	NS (*)	L (***)	L (***)	NS (*)	NS (*)	NS (*)	NS (**)	L (***)	NS (***)	NS (*)

Community Type (Surrogate [EUNIS code])	Species (characterizing species identified from NPWS 2011b)	Surface Disturbance	Shallow Disturbance	Deep Disturbance	Trampling – access by foot	Trampling – access by vehicle	Extraction	Siltation (addition of fine sediments, pseudofaeces, fish food)	Smothering (addition of materials biological or non-biological to the surface)	Changes to sediment composition-increased coarseness	Changes to sediment composition-increased fine sediment proportion	Changes to water flow	Increase in turbidity/suspended sediment	Decrease in turbidity/suspended sediment	Organic enrichment-water column	Organic enrichment of sediments-sedimentation	Increased removal of primary production-phytoplankton	Decrease in oxygen levels- sediment	Decrease in oxygen levels-water column	Introduction of non-native species	Removal of Target Species	Removal of Non-target species	Introduction of antifoulants	Introduction of medicines	Introduction of hydrocarbons	Prevention of light reaching seabed/features
	Macoma balthica	L (*)	L (*)	M (**)	L (**)	M (*)	M-H (**)	NS (**)	M-H (*)	M (*)	NS (*)	NS (*)	NS (**)	NS (*)	NS (**)	NS (**)	NS (*)	NS (**)	NS (**)	M (**)	NS (*)	NS (*)	NS (*)	NEv	M (**)	NS (**)
Mixed sediment community (Circalittoral mixed sediments [A5.42])	*Angulus tenuis*	NS (*)	L (*)	L (***)	NS (*)	L (*)	M (*)	NS (*)	H(*)	M-H (*)	NS (*)	L-M (*)	L (*)	NS (*)	NS (*)	NEv	L-NS (*)	NEv	NEv	M (*)	NS (*)	NS (*)	NS (*)	NEv	NEv	NS (*)
	Nephtys cirrosa	NS (*)	L (** *)	L (***)	NS (*)	L (*)	L (*)	NS (***)	NS (*)	L (*)	NS (*)	L (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (*)	M (*)	M (*)	NS (*)	NS (*)	NEv	NEv	NS (*)
Zostera community complex (Seagrass beds A2.61)	*Zostera*	M-H (** *)	M-VH (** *)	M-VH (***)	M-H (***)	M-H (***)	M-VH (***)	VH (***)	VH (***)	M (*)	M (***)	M (*)	H (***)	NS (*)	H (***)	H (***)	NS (*)	H-VH (*)	H-VH (*)	H (**)	NS	NS	NEv	NEv	NS (***)	H-VH (**)
Intertidal muddy fine sand community (Polychaete/bivalve-dominated muddy sand shores [A2.24])	*Macoma balthica*	L (*)	L (*)	M (**)	L (**)	M (*)	M-H (**)	NS (**)	M-H (*)	M (*)	NS (*)	NS (*)	NS (**)	NS (*)	NS (**)	NS (**)	NS (*)	NS (**)	NS (**)	M (**)	NS (*)	NS (*)	NS (*)	NEv	M (**)	NS (**)
	Pygospio elegans	L (*)	L (**)	M (**)	L (*)	L (*)	L-M (*)	L (***)	L-M (***)	L-M (*)	NS (**)	L-M (*)	NS (*)	NS (*)	NS (*)	NS (***)	NS (*)	L (**)	L (**)	M (*)	NS (*)	NS (*)	NS (*)	NEv	NEv	NS (*)
	Corophium volutator	L (** *)	L (** *)	L (***)	L (*)	L (*)	L (*)	L (***)	L (***)	M (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (***)	NS (***)	NS (*)	L (***)	L (***)	NEv	NS (*)	NS (*)	NA	NEv	L (***)	NS (*)
	Hediste diversicolor	NS (*)	L-M (**)	L-H (**)	NS (*)	L (*)	L-H (*)	NS (***)	L-M (*)	M-H (*)	NS (*)	NS (*)	NS (*)	NS (*)	NS (**)	NS (**)	NS (*)	NS (**)	NS (**)	L-M (*)	L-M (*)	NS (*)	NS (*)	M-H (**)	M-H (**)	NS (*)

Table 8.4 - Codes of sensitivity and confidence applying to species and pressure interactions presented in Tables 8.1 and 8.2.

Pressure interaction codes for Table 8.1 and 8.2	
NA	Not Assessed
NEv	No Evidence
NE	Not Exposed
NS	Not Sensitive
L	Low
M	Medium
H	High
VH	Very High
*	Low confidence
**	Medium confidence
***	High Confidence

Table 8.5 - Spatial interactions between current and proposed aquaculture activities and constituent communities of the habitat features of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide with a broad conclusion on the interactions. Licenced Status: L- licenced A-Application.

Culture Species (Status)	Qualifying Interest 1130 (5693.39 ha)					Qualifying Interest 1140 (4284.83 ha)			
	Intertidal sand with *Nephtys cirrosa* community (486.04ha)	Fine to muddy fine sand with Polychaetes community complex (3553.76ha)	*Zostera* dominated community (233.55ha)	Mixed sediment community complex (587.45ha)	Intertidal muddy fine sand community complex (554.1ha)	Intertidal sand with *Nephtys cirrosa* community (861.05ha)	Fine to muddy fine sand with Polychaetes community complex (2636.13ha)	*Zostera* dominated community (233.55ha)	Intertidal muddy fine sand community complex (554.1ha)
Oyster Sites (L)	N/A	**Disturbing: No Justification:** Published literature (Forde *et al.*, 2015) suggests that activities occurring at trestle culture sites are not disturbing.	N/A	N/A	**Disturbing: No Justification:** Published literature (Forde *et al.*, 2015) suggests that activities occurring at trestle culture sites are not disturbing.	N/A	**Disturbing: No Justification:** Published literature (Forde *et al.*, 2015) suggests that activities occurring at trestle culture sites are not disturbing.	N/A	**Disturbing: No Justification:** Published literature (Forde *et al.*, 2015) suggests that activities occurring at trestle culture sites are not disturbing.
Oyster Sites (A)	**Disturbing: No Justification:** Published literature (Forde *et al.*, 2015) suggests that activities occurring at trestle culture sites are not disturbing.	**Disturbing: No Justification:** Published literature (Forde *et al.*, 2015) suggests that activities occurring at trestle culture sites are not disturbing.	N/A	**Disturbing: No Justification:** Published literature (Forde *et al.*, 2015) suggests that activities occurring at trestle culture sites are not disturbing.	**Disturbing: No Justification:** Published literature (Forde *et al.*, 2015) suggests that activities occurring at trestle culture sites are not disturbing.	**Disturbing: No Justification:** Published literature (Forde *et al.*, 2015) suggests that activities occurring at trestle culture sites are not disturbing.	**Disturbing: No Justification:** Published literature (Forde *et al.*, 2015) suggests that activities occurring at trestle culture sites are not disturbing.	N/A	**Disturbing: No Justification:** Published literature (Forde *et al.*, 2015) suggests that activities occurring at trestle culture sites are not disturbing.
Oyster Access Route	**Disturbing: Yes Justification:** Compaction by vehicles can lead to change in community composition. The spatial overlap with the community type is 0.18%.	**Disturbing: Yes Justification:** Compaction by vehicles can lead to change in community composition The spatial overlap with the community type is 0.027%.	**Disturbing: Yes Justification:** Compaction by vehicles can lead to change in community composition. This community type is not tolerant of any overlap. The spatial overlap with the community type is 0.09%.	**Disturbing: Yes Justification:** Compaction by vehicles can lead to change in community composition The spatial overlap with the community type is 0.02%.	**Disturbing: Yes Justification:** Compaction by vehicles can lead to change in community composition The spatial overlap with the community type is 0.09%.	**Disturbing: Yes Justification:** Compaction by vehicles can lead to change in community composition The spatial overlap with the community type is 0.1%.	**Disturbing: Yes Justification:** Compaction by vehicles can lead to change in community composition The spatial overlap with the community type is 0.037%.	**Disturbing: Yes Justification:** Compaction by vehicles can lead to change in community composition The spatial overlap with the community type is 0.09%. This habitat is not tolerant of any overlap.	**Disturbing: Yes Justification:** Compaction by vehicles can lead to change in community composition The spatial overlap with the community type is 0.15%.
Mussel (L)	N/A	**Disturbing: Yes Justification:** Dredging can lead to changes in community composition. The spatial overlap with the community type is 5.47%.	N/A	N/A	**Disturbing: Yes Justification:** Dredging can lead to changes in community composition. The spatial overlap with the community type is 1.3%.	N/A	**Disturbing: Yes Justification:** Dredging can lead to changes in community composition. The spatial overlap with the community type is 6.17%.	N/A	**Disturbing: Yes Justification:** Dredging can lead to changes in community composition. The spatial overlap with the community type is 1.3%.
Mussel (A)	**Disturbing: Yes Justification:** Dredging can lead to changes in community composition. The spatial overlap with the community type is 0.57%.	**Disturbing: Yes Justification:** Dredging can lead to changes in community composition. The spatial overlap with the community type is 0.94%.	**Disturbing: Yes Justification:** This community type is not tolerant of any overlap. The spatial overlap with the community type is 2.83%.	N/A	**Disturbing: Yes Justification:** Dredging can lead to changes in community composition. The spatial overlap with the community type is 7.19%.	**Disturbing: Yes Justification:** Dredging can lead to changes in community composition. The spatial overlap with the community type is 1.16%.	**Disturbing: Yes Justification:** Dredging can lead to changes in community composition. The spatial overlap with the community type is 4.44%.	**Disturbing: Yes Justification:** Dredging can lead to changes in community composition. The spatial overlap with the community type is 2.83%. This habitat is not tolerant of any overlap	**Disturbing: Yes Justification:** Dredging can lead to changes in community composition. The spatial overlap with the community type is 7.19%.
Clam (L)	**Disturbing: Yes Justification:** Structures can lead to changes in community composition. The spatial overlap with the community type is 2.01%.	**Disturbing: Yes Justification:** Structures can lead to changes in community composition. The spatial overlap with the community type is 0.18%.	N/A	N/A	N/A	**Disturbing: Yes Justification:** Structures can lead to changes in community composition. The spatial overlap with the community type is 1.13%.	**Disturbing: Yes Justification:** Structures can lead to changes in community composition. The spatial overlap with the community type is 0.24%.	N/A	N/A
Cumulative Impact of Licenced and Proposed Aquaculture Activity	**Disturbing: No Justification:** The overall spatial overlap with the community type is 2.76%. This value is below the spatial overlap threshold (15%) for significant adverse impacts of on this community type.	**Disturbing: No Justification:** The overall spatial overlap with the community type is 6.62%. This value is below the spatial overlap threshold (15%) for significant adverse impacts of on this community type.	**Disturbing: Yes Justification:** The spatial overlap with the community type is 2.92%. This community type is not tolerant of any overlap.	**Disturbing: No Justification** The overall spatial overlap with the community type is 0.02%. This value is below the spatial overlap threshold (15%) for significant adverse impacts of on this community type.	**Disturbing: No Justification** The overall spatial overlap with the community type is 8.58%. This value is below the spatial overlap threshold (15%) for significant adverse impacts of on this community type.	**Disturbing: No Justification:** The overall spatial overlap with the community type is 2.39%. This value is below the spatial overlap threshold (15%) for significant adverse impacts of on this community type.	**Disturbing: No Justification:** The overall spatial overlap with the community type is 10.89%. This value is below the spatial overlap threshold (15%) for significant adverse impacts of on this community type.	**Disturbing: Yes Justification:** The spatial overlap with the community type is 2.83%. This habitat is not tolerant of any overlap.	**Disturbing: No Justification** The overall spatial overlap with the community type is 8.64 %. This value is below the spatial overlap threshold (15%) for significant adverse impacts of on this community type.

8.4 ASSESSMENT OF THE EFFECTS OF AQUACULTURE PRODUCTION ON THE CONSERVATION OBJECTIVES FOR OTTER *LUTRA LUTRA* IN THE CASTLEMAINE HARBOUR SAC.

The Castlemaine Harbour SAC is designated for the otter (*Lutra lutra*); Conservation Objectives for the species within the SAC sites have been defined by NPWS and primarily relate to population size and distribution (NPWS 2011a).

As the aquaculture production activities within the SAC spatially overlap with otter (*Lutra lutra*) territory, these activities may have negative effects on the abundance and distribution of populations of the species. The risk of negative interactions between aquaculture operations and aquatic mammal species is a function of:

1. The location and type of structures used in the culture operations- is there a risk of entanglement or physical harm to the animals from the structures?

2. The schedule of operations on the site – is the frequency such that they can cause disturbance to the animals?

Shellfish Culture: Shellfish culture operations are likely to be carried out in daylight hours. The interaction with the otter is likely to be minimal given that otter foraging is primarily crepuscular. It is unlikely that these culture types pose a risk to otter populations in the Castlemaine Harbour SAC.

Impacts from intertidal oyster/clam and subtidal mussel cultivation can be discounted on the basis that the proposed activities will not lead to any modification of the following attributes for otter:

- Extent of habitat (terrestrial, marine and/or freshwater habitat).

- The activity involves net input rather than extraction of fish biomass so that no negative impact on the essential food base (fish biomass) is expected

- The number of couching sites and holts or, therefore, the distribution, will not be directly affected by aquaculture and fisheries activities.

- Shellfish production activities are unlikely to pose any risk to otter populations through entrapment or direct physical injury.

- The oyster culture structures are raised from the seabed (0.5m -1m) and are oriented in rows, thus allowing free movement through and within the site.

- Disturbance associated with vessel and foot traffic at oyster cultivation sites could potentially affect the distribution of otters at the site. However, the level of disturbance is likely to be very low given the likely encounter rates will be low dictated primarily by tidal state and in daylight hours.

The current levels of licensed shellfish culture and applications are considered **non-disturbing** to otter conservation features in the Castlemaine Harbour SAC.

8.5 ASSESSMENT OF THE EFFECTS OF AQUACULTURE PRODUCTION ON THE CONSERVATION OBJECTIVES FOR ATLANTIC SALMON *SALMO SALAR* IN THE CASTLEMAINE HARBOUR SAC

The Castlemaine Harbour SAC is designated for the Atlantic Salmon (*Salmo salar*) (NPWS, 2011a).

Significant declines in sea survival and reduced returns to the coast and rivers of Atlantic salmon in recent decades have been recorded in Ireland (Salmon Management Task Force Report (Anon., 1996); O'Maoileidigh *et al.*, 2004; Jackson *et al.*, 2011). The reasons for the reduced sea survival remain unclear and speculation has covered such issues as global warming effects (Friedland *et al.*, 2000; Friedland *et al.*, 2005), changes in locations or availability of prey species, loss of post-smolts as by-catch in pelagic fisheries, increased fishing pressure, habitat changes and sea lice infestation (Finstad *et al.*, 2007; SSCWSS 2013). However, despite many years of study, processes contributing to the high mortality of juvenile Atlantic salmon between ocean entry and the first winter at sea remain poorly understood (Jones, 2009).

It is acknowledged in this assessment that the Favourable Conservation Status of the Salmon has been achieved for the Castlemaine Harbour SAC. Despite the range of pressures discussed above, it is concluded that existing and proposed aquaculture activities in the SAC are unlikely to pose any significant risk to the following salmon attributes;

- Distribution (in freshwater)
- Fry abundance (freshwater)
- Population size of spawners (fish will not be impeded or captured by the proposed activity)
- Smolt abundance (out migrating smolts will not be impeded or captured by the proposed activity)
- Water quality (freshwater)

Current and proposed aquaculture activities are likely to be non-disturbing to the Conservation Objective for Atlantic Salmon within the Castlemaine Harbour SAC.

8.6 ASSESSMENT OF THE EFFECTS OF AQUACULTURE PRODUCTION ON THE CONSERVATION OBJECTIVES FOR SEA LAMPREY *PETROMYZON MARINUS* AND RIVER LAMPREY *LAMPETRA FLUVIATILIS* IN THE CASTLEMAINE HARBOUR SAC

The Castlemaine Harbour SAC is designated for the Sea Lamprey *Petromyzon marinus* [1095] and the River Lamprey *Lampetra fluviatilis* [1099]. For these species the objective is to maintain various attributes of the populations including population size, habitats quality and the distribution of the species. Specific population attributes include:

- Extent of river accessible
- Access to spawning
- Availability of juvenile habitat
- Spawning beds
- Juvenile density
- Population structure of juveniles

The main aspect of the intertidal and mussel culture activities that could potentially impact the designated species of Sea Lamprey and River Lamprey is the physical presence of trestles that may impede migration of fish and the accidental capture/injury of fish when harvesting/relaying mussels. Despite these potential interactions it is concluded that, given levels of existing and proposed, intertidal oyster and subtidal mussel cultivation activities in the SAC do not pose significant risk to the above listed population attributes for designated Lamprey species.

Current and proposed aquaculture activities are likely to be non-disturbing to the Conservation Objectives for Sea Lamprey and River Lamprey within the Castlemaine Harbour SAC.

9 IN-COMBINATION EFFECTS OF AQUACULTURE, FISHERIES AND OTHER ACTIVITIES

9.1 FISHERIES

9.1.1 Habitats

Putative fishery activities occurring in the marine benthic habitats of the SAC are limited to cockle dredging and seasonal seed mussel fisheries. Table 9.1 presents the spatial extent of fisheries activities combined with (disturbing) aquaculture activities overlapping the habitat feature (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide in Castlemaine Harbour SAC (data provided by DAFM), while Table 9.2 present overlap with respect to the constituent marine community types within habitat 1130 and 1140. The SAC also supports a low level of periwinkle harvesting from one location on the eastern shore of Cromane Island.

9.1.1.1 Dredging

Cockle hydraulic dredging

- Fisheries data indicate suitable cockle habitat located Glenbeigh in the southwestern corner of the SAC covering approximately 614ha (see Figure 9.1). This cockle habitat co-occurs with constituent marine community types within the marine Annex I Qualifying Interest of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide. It also overlaps extensively with proposed oyster trestle aquaculture and licensed clam aquaculture.

- Cockle Fishery overlaps with 10.79% habitat 1130 (see Table 9.1) and with the constituent marine community types as follows; 0.69% Fine to muddy fine sand with polychaetes community complex and 42.88% Intertidal sand with *Nephtys cirrosa* community (see Table 9.2).

- Cockle Fishery overlaps with 14.34% of habitat 1140 (see Table 9.1) and with the constituent marine community types as follows; 0.93% Fine to muddy fine sand with polychaetes community complex and 24.21% Intertidal sand with *Nephtys cirrosa* community (see Table 9.2).

- Cockle fishing is considered putative only as annual returns are considered very low.

Mussel seed Fishery

- Seed mussel is fished from a range of sub-tidal seed areas (identified as 'Seed Mussel Fishery Areas' in Figure 9.1). Seed mussel beds in this area are ephemeral and unstable. The mussel bed and underlying sediment is prone to turn over and wash out by winter storms and by starfish predation. This is a general, although not universal, characteristic of seed mussel beds throughout Europe (Dare *et al.* 2004). In Castlemaine, seed mussel beds occur in different locations each year on sand, mud, shingle and stones and show

no distinct substrate preference. Removal of seed mussel by dredging therefore occurs against a background of dynamic natural change that occurs on an annual basis in this habitat. It is considered that likely effects on the resident biological communities that might arise through smothering or changes in suspended sediment loading will not be significant against the natural dynamics of the site. Recoverability of all biotopes associated with seed mussel, following physical disturbance, is high (www.marlin.ac.uk). The substratum required for settlement of mussel and re-establishment of the mussel bed is unlikely to be significantly altered above background levels in these dynamic high energy habitats. The types of dredge used for dredging mussel seed beds are lighter than other bivalve dredges and do not have a blade or teeth. At the time of fishing, the mussel beds are elevated from the surrounding substratum and the dredge does not penetrate the seafloor and disturbance of the sediments below the bed is not therefore significant, again compared to natural background variability. This is supported by evidence of repeated annual settlement of mussels in the area although commercial seed fishing has been in operation since 1977.

- Potential seed areas overlap with 5.35% habitat 1130 (see Table 9.1) and with the constituent marine community types as follows; 4.56% Fine to muddy fine sand with polychaetes community complex, 20.51% of Mixed sediment community and 3.79% Intertidal muddy fine sand community (see Table 9.2).
- Potential seed areas overlap with 3.04% of habitat 1140 (see Table 9.1) and with the constituent m*arine* community types as follows; 4.24% Fine to muddy fine sand with polychaetes community complex and 2.14% Intertidal sand with *Nephtys cirrosa* community (see Table 9.2).
- The annual exploitation of the seed mussel constitutes disturbance as a principal characterising species is reduced.

Fishery Order - Relaying and dredging of mussels

- The Fishery Order (FO) encompasses a large area between Inch and Cromane spits (Figure 9.1) and is designated for the culture of mussels. While the overall area is large and covers considerable portions of the habitat features 1130 and 1140 (Table 9.2) and Marine Community types (Table 9.2), it should be noted that the activities within the order area a restricted to clearly defined areas (Figure 9.1) as covered in the Fishery Natura Plan (FNP) which was implemented and assessed during 2016. The purpose of clearly defining the areas for activities served two purposes, to reflect the actual areas used historically for the culture of mussels and to avoid any overlap with sensitive habitats e.g., *Zostera* beds.
- Relaying onto intertidal and subtidal areas within the FO is achieved by pumping the mussels mixed with seawater from the boat's hold onto the grow-out plots. This pattern of relaying is characterised by the vessels moving across the plots during pumping in an effort to achieve a fixed density of mussel on each plot in order to maximise survival and growth and remain within limits defined in the FNP
- Seed mussel is relayed for hardening on an intertidal nursery site in the Fishery Order area (see Figure 9.1) for 6 to 12 months.
- The small boats rely on seed drift onto their Order nursery sites from seed being brought in by the larger vessels onto their nursery sites or natural settlement on their nursery sites. If seed settles on their nursery sites within the Fishery Order Area, they will move this seed when it reaches a size ranging from 25-40 ml onto their licensed aquaculture mussels sites to finish off before harvesting. Half-grown is generally moved in the summer from the nursery. The punts collect the seed using a mixture of beet forks/pikes and hand dredging and then deposit it on their licensed aquaculture sites

over the side of the vessels. Again the pattern of relaying is characterised by the vessels moving across the plots in an effort to achieve an even distribution of mussel on each plot. Harvesting from these sites is by hand dredge, piking or handpicking by one operator.

- The active areas within the, Fishery Order overlaps with 4.2% habitat 1130 (see Table 9.1) and with the constituent marine community types as follows; 6.7% Fine to muddy fine sand with polychaetes community complex and 0.1% Intertidal muddy fine sand community, (see Table 9.2).
- The Fishery Order overlaps with 3.9% of habitat 1140 (see Table 9.1) and with the constituent marine community types as follows; 0.1% Intertidal muddy fine sand community, 6.3% (see Table 9.2).
- The activity of relaying seed mussels onto intertidal habitats constitutes a disturbance by virtue of the fact that the activity will likely lead to a shift in community composition.
- There is no risk of direct impact i.e. active relaying of seed close to or through the sea grass bed will not occur.
- While it is noted that relaying does not occur within the *Zostera* habitat east of Inch Island, this seagrass bed could be indirectly affected by mussel relay to the east if seed mussel or mussel mud drifts onto the seagrass and become established. This would reduce the area of seagrass habitat.
- The relaying of seed in the inter-tidal area leads to some changes in the species composition of macrobenthos. The removal of mussel cover by dredging will, presumably, lead to a reversal of those changes and a return to a species composition representative of the community type. The dredge essentially removes the mussel structure and the fauna associated with it. The underlying sediment may remain undisturbed as the 'mussel mud', which accumulates in the bed, detaches the bed from the underlying substrate (Saurel *et al.* 2003). The typical fauna of this underlying substrate is then re-established at a rate depending on the sediment type and exposure. Dredging releases fine sediment, from the mussel mud, into the water column and the dispersal plume depends on local tidal conditions during dredging. In areas where mussels are bottom cultivated disturbance and dispersal of the mussel mud is important in facilitating the recovery of the typical fauna of the underlying sediment and to avoid raising the bed higher into the inter-tidal zone.
- There is no risk of direct impact i.e. active dredging close to or through the sea grass bed will not occur. However, the seagrass bed could be affected by the dispersal of fine sediments onto the seagrass bed resulting from dredging activity.

Sensitivities to dredging

Soft sediment communities, particularly suspension feeders and crustaceans, are sensitive to fishing pressure from dredging but this depends on intensity of the fishing pressure. Recovery time is prolonged (measured in years) compared to coarser substrates due to the fact that such habitats are mediated by a combination of biological, chemical and physical processes compared to coarse substrates which are dominated by physical processes (ABPMer 2013e).

9.1.2 In-combination effects - Conclusion

When considering in-combination effects, it is important to note that licensed aquaculture activities will take priority over other activities (including fisheries) that might have been subsequently approved as well as those activities still at the application stage. Therefore, when the in-

combination effects of existing fisheries activities and aquaculture activities are considered the following is presented (information derived from Tables 9.1 and 9.2):

- As oyster trestles and mussel seed collection using longlines are considered non-disturbing to marine habitats, on the basis of spatial overlap they will have no in-combination effect with other activities.
- Oyster access routes (0.06%) and licensed bottom mussel culture (3.54%) accounts for 3.6% overlap with the 1130 Estuary habitat (Table 9.1). When combined with other potentially disturbing activities, i.e., active mussel seed dredging and subsequent relaying and dredging in the Fishery Order area (9.55%), the overlap increases to 13.15% and up to 15.84% when new mussel applications are included. This level of overlap is **considered potentially disturbing**.
- Oyster access routes (0.025%), licensed bottom mussel culture (5.47%), accounts for approximately 5.5% overlap with the 1130 Estuary marine community type, Fine to muddy fine sand with Polychaetes community complex. When combined with other potentially disturbing activities i.e., active mussel seed dredging and subsequent relaying and dredging in the Fishery Order area (11.26%) the overlap increases to 16.76% and up to 17.7% when new mussel applications are included. This level of overlap is **considered potentially disturbing**.
- Licensed clam culture accounts for 2.01% overlap with the 1130 Estuary constituent community type; Intertidal sand with *Nephtys cirrosa* (42.88%). This overlap increases to 44.42%[5] if Cockle dredging is included. New mussel aquaculture applications will see this overlap increase to 47.21%. Seed mussel dredging from the potential seed areas increases the overlap to 51%. This level of overlap is **considered potentially disturbing**.
- Mussel seed dredging accounts for >15% overlap with the 1130 Estuary constituent community type; Mixed sediment community (20.5%). This level of overlap is **considered disturbing**. This increases to 20.53% when new oyster access routes are included. This level of overlap is **considered potentially disturbing**.
- Licensed mussel aquaculture (1.3%) and existing oyster access routes (0.09%) overlap with 1.39% of the 1130 Estuary constituent community type; Intertidal muddy fine sand community complex. Mussel seed relaying and dredging in the Fishery Order area is neglible (0.1%) increasing to 1.49% overlap. When new mussel applications are included the overlap increases to 8.49%. This level of overlap is **considered not disturbing**.
- Licensed clam culture overlaps with the 1140 Habitat constituent marine community type Intertidal sand with *Nephtys cirrosa* by 1.13%. This overlap increases to 25.08%[6] when Cockle dredging is considered. . When existing seed mussel dredging is included the overlap increases to 26.57%. New mussel aquaculture applications will see this overlap increase to 27.73%. Seed mussel dredging from the potential seed areas increases the overlap to 29.87% and up to 30.39% when the mussel relaying and dredging in the Fishery Order area is included. This level of overlap is **considered potentially disturbing**.
- Licensed clam (0.24%), mussel culture (6.77%) and oyster access routes (0.034%) accounts for 7.044% overlap with the 1140 Habitat constituent community type Fine to muddy fine sand with polychaetes community complex. This overlap increases to 18.50% when cockle dredging and seed mussel dredging is included. New mussel aquaculture applications will see this overlap increase to 22.36%. This level of overlap is **considered potentially disturbing**.

[5] Addition 1.5% not 2.01% as shown in Table 7.5 as the full 2.01% includes an area already covered by the dredge site.

[6] Addition 0.87% not 1.13% as shown in Table 7.5 as the full 1.13% includes an area already covered by the dredge site.

There are a number of points of clarification to note when interpreting the in-combination extent of spatial overlap on habitats and marine community types. First, the in-combination effects are calculated on the basis of spatial extent only and, at this stage of analysis, does not consider the frequency of the likely disturbing activity (particularly as it relates to the fishery activities). To this end is can be clarified that:

- The cockle fishery (as identified above) potentially covers an extensive area, but on the basis of the fishery assessment conducted in 2016[7] the level of activity at this site is identified as being very low (single operator hand harvesting) and of minimal impact on habitats and community type.
- Similarly, the extent of the mussel seed fisheries are identified as being extensive but, in reality, the activities only occur in a small area in any one year on the basis of targeted surveys carried out annually by BIM.

Finally, the existing licensed aquaculture activities are considered active. Any other activities (fishery or new aquaculture applications) assessed, since these licences were issued (circa 2011), will have had to consider these licensed activities as in-combination effects. The Fishery Assessment conducted in 2016[8] did consider in-combination effect between licensed aquaculture and proposed fishery activities and found no risks presenting on the basis of low intensity of fishery activities over smaller spatial scales than the putative scales identified in this report. In short, assessment of in-combination effects is considered in the order in which activities are licensed.

[7]http://www.fishingnet.ie/sea-fisheriesinnaturaareas/concludedassessments/castlemaineharbour-sacspa/#d.en.72077

Table 9.1- Spatial overlap in percentage of disturbing activities combining aquaculture and fisheries that overlapping with the Qualifying Interest of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide in Castlemaine Harbour SAC. Spatial overlap of habitat presented according to equipment used. Habitat data provided in NPWS 2011b.

Disturbance Source/Equipment Type	Species	Qualifying Interest 1130 (5693.39ha)	Qualifying Interest 1140 (4284.83 ha)
		Overlap	Overlap
Fishery Order Area		30.63% (1743.74ha)	23.27% (997.22ha)
Disturbing Activities			
Habitat Change (relay) & Dredge	Mussel Relay and Dredge Areas (FO as per FNP)	4.2% (238.4ha)	3.9% (167ha)
Dredge	Mussel Seed (Potential Seed Areas)	5.35% (304.68ha)	3.04% (130.33ha)
Dredge	Cockle[8]	10.79% (614.28ha)	14.34% (614.28ha)
Dredge	Mussels-licenced	3.54% (201.66ha)	3.96% (169.87ha)
Dredge	Mussels-application	2.69% (152.95ha)	3.45% (147.84ha)
Habitat Change	Clam Sites	0.28% (16.13ha)	0.38% (16.13ha)
Compaction	Oyster Site Access Routes	0.06% (3.36ha)	0.06% (2.51ha)
Total (%)		**26.91%**	**29.22%**

[8] Cockle fishery is putative only and is included here as a precaution.

Table 9.2 - Spatial overlap in percentage of potentially disturbing activies (fisheries and aquaculture) over marine community types (area in Ha) within the broad habitat qualifying of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide in Castlemaine Harbour SAC. Spatial overlap presented according to equipment used. Habitat data provided in NPWS 2011b.

Disturbance Source/ Equipment Type	Species/ licence type	Qualifying Interest 1130 (5693.39 ha)					Qualifying Interest 1140 (4284.83 ha)			
		Marine Community Type					Marine Community Type			
		Intertidal sand with *Nephtys cirrosa* community (486.04ha)	Fine to muddy fine sand with Polychaetes community complex (3553.76ha)	*Zostera* dominated community (233.55ha)	Mixed sediment community complex (587.45ha)	Intertidal muddy fine sand community complex (554.1ha)	Intertidal sand with *Nephtys cirrosa* community (861.05ha)	Fine to muddy fine sand with Polychaetes community complex (2636.13ha)	*Zostera* dominated community (233.55ha)	Intertidal muddy fine sand community complex (554.1ha)
Fishery Order (F.O.) Area		0.92% (4.45ha)	34.41% (1222.77ha)	92.62% (216.38ha)	21.86% (128.42ha)	25.83% (143.12ha)	0.52% (4.45ha)	24.02% (633.28ha)	92.62% (216.38ha)	25.83% (143.12ha)
Disturbing Activities										
Relay & Dredge	FO as per FNP	-	6.7% (238.0ha)	-	-	≈0.1% (0.44ha)	-	6.3% (166.7ha)	-	≈0.1% (0.44ha)
Dredge	Mussel Seed Fishery	3.79% (18.42ha)	4.56% (162.15ha)	-	20.51% (120.46ha)	-	2.14% (18.43ha)	4.24% (111.9a)	-	-
Hydraulic dredge	Cockle[9]	42.88% (208.2ha)	0.69% (24.58ha)	-	-	-	24.21% (208.43ha)	0.93% (24.58ha)	-	-
Dredge	Mussels-licenced	-	5.47% (194.43ha)	-	-	1.3% (7.23ha)	-	6.17% (162.64ha)	-	1.3% (7.23ha)
Dredge	Mussels-application	0.57% (2.79ha)	0.94% (33.43ha)	2.83% (6.61ha)	-	7.19: (9.85ha)	1.16% (10ha)	3.85% (101.38ha)	2.83% (6.61ha)	7.19% (9.85ha)
Habitat Change	Clam Sites	2.01% (9.77ha)	0.18% (6.36ha)	-	-	-	1.13% (9.77ha)	0.24% (6.36ha)	-	-
Compaction	Oyster Site Access Routes	0.18% (0.86 ha)	0.025% (0.9ha)	0.09% (0.2 ha)	0.02% (0.11 ha)	0.09% (0.5 ha)	0.1% (0.86 ha)	0.034% (0.9ha)	0.09% (0.2 ha)	0.09% (0.5 ha)
Total of active areas		48.74%[10] (240.04ha)	18.57% (659.85ha)	2.92% (6.81ha)	20.53% (120.57ha)	8.68% (18.02ha)	28.74% (247.49ha)	19.75%[10] (574.46ha)	2.92% (6.81ha)	7.39% (18.02ha)

[9] Cockle fishery is putative only and is included here as a precaution.
[10] Overlapping areas accounted for in total, hence the smaller than expect value

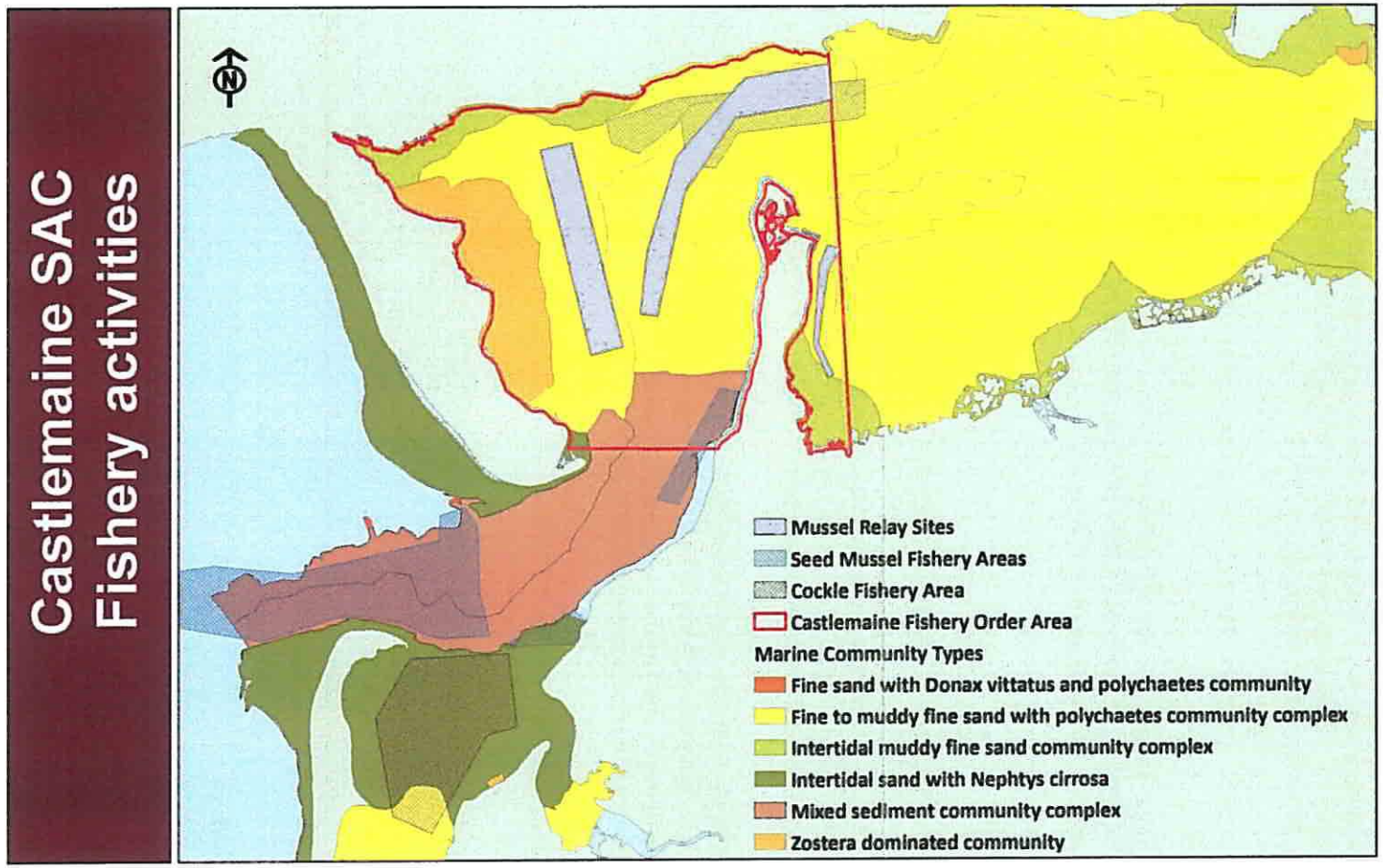

Figure 9.1 –Location of fishery activities, i.e. Fishery order – mussel culture areas, cockle fishery area and seed mussel fishery areas relative to principal benthic community types recorded within the marine Annex I Qualifying Interest of (1130) Estuaries and (1140) Mudflats and sandflats not covered by seawater at low tide of the Castlemaine Harbour SAC (NPWS 2011b).

9.1.3 Species

9.1.3.1 Otter

Otters are a designated feature of the Castlemaine Harbour SAC and otters forage throughout the area and may interact with fishing gear. All fisheries extract fish biomass which may reduce habitat quality for the designated species *Lutra lutra* otter [1355].

9.1.3.2 Fish

Designated diadromous species for the Castlemaine Harbour SAC include *Salmo salar* (Salmon) [1106], *Petromyzon marinus* (Sea Lamprey) [1095] and *Lampetra fluviatilis* (River Lamprey). Net and trawl fisheries can impact on fish migration and as bycatch.

9.1.4 Conclusion

With respect to the designated species *Lutra lutra* it was concluded that significant negative interactions were unlikely to occur as generally the only risk posed by marine fisheries arises from the use of pots and trammel nets to catch lobsters and bait, respectively in shallow water reef habitat. There are no pot and net fisheries within the Castlemaine Harbour SAC. Consequently, **in-combination effects of fisheries with aquaculture activities on the species can be discounted.**

With respect to the designated fish species *Salmo salar*, *Petromyzon marinus* and *Lampetra fluviatilis* it was concluded that significant negative interactions were unlikely to occur as there is no net or trawl fisheries in Castlemaine Harbour SAC. Consequently, **in-combination effects of fisheries with aquaculture activities on the species can be discounted.**

9.2 POLLUTION PRESSURES

There are a small number of activities which are terrestrial in origin that might result in impacts on the conservation features of the Castlemaine Harbour SAC. Primary among these are point source discharges from domestic sewage outfalls distributed along the harbour and municipal urban waste water treatment plants. The pressure derived from these point sources may impact upon levels of dissolved nutrients, suspended solids and some elemental components e.g. aluminium in the case of water treatment facilities.

9.2.1 Conclusion

Pressures resulting from aquaculture activities are primarily localised compaction of sediment along access routes. It was, therefore, concluded that given the pressure resulting from point discharge location such as the urban waste-water treatment and/or combined sewer outfalls would likely impact on physico-chemical parameters in the water column, any **in-combination effects with aquaculture activities are considered to be minimal or negligible.**

10 SAC AQUACULTURE CONCLUDING STATEMENT

10.1 ASSESSMENT REPORT CONCLUDING STATEMENT

Current and proposed aquaculture activities occurring in the Castlemaine Harbour SAC focuses on the cultivation of oysters (using bags and trestles) in the intertidal zone, clams in the intertidal zone (using rays and nets) and bottom cultivation of mussels in the subtidal zone. Based upon this and the information provided in the aquaculture profiling report (Section 5), the likely interaction between these culture methodologies and conservation features (habitats and species) of the SAC were considered.

10.1.1 Habitats

An initial screening exercise resulted in the following habitat features and species being excluded from further consideration by virtue of the fact that no spatial overlap of the culture activities was expected to occur; Annual vegetation of drift lines [1210], Perennial vegetation of stony banks [1220], Vegetated sea cliffs of the Atlantic and Baltic coasts [1230], *Salicornia* and other annuals colonising mud and sand [1310], Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330], Mediterranean salt meadows (*Juncetalia maritimi*) [1410], Embryonic shifting dunes [2110], Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120], Fixed coastal dunes with herbaceous vegetation (grey dunes) [2130], Dunes with *Salix repens* ssp. *argentea* (Salicion arenariae) [2170], Humid dune slacks [2190], Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae) [91E0] and *Petalophyllum ralfsii* (Petalwort) [1395].

A full assessment was carried out on the likely interactions between existing and proposed culture operations and the feature Annex 1 habitats of 1130 Estuaries and 1140 Mudflats and sandflats not covered by seawater at low tide. The likely effects of the aquaculture activities (species, structures, access routes) were considered in light of the sensitivity of constituent habitats and species of the Annex 1 habitats 1130 and 1140. Annex I 1130 constituent communities considered include; Intertidal sand with *Nephtys cirrosa* community, *Zostera* community complex, Fine to muddy sand with polychaetes community, Mixed sediment community and Intertidal muddy fine sand community. Annex I 1140 constituent communities considered include Intertidal sand with *Nephtys cirrosa* community, *Zostera* community complex, Fine to muddy sand with polychaetes community and Intertidal muddy fine sand community.

The capture of mussel seed using rope collectors is considered non-disturbing on the basis of the fixed (and short) duration of the deployment of the collectors (i.e. summer months). Based upon the scale of spatial overlap of current and proposed intertidal oyster aquaculture activities (including access route activity) and the relatively high tolerance levels of the habitats and associated species, the general conclusion is that current and proposed intertidal culture activities are non-disturbing to the Qualifying Interests and their constituent community types.

The review of five existing licences to vary licences from mussel culture to include oyster culture does not present a risk to habitat conservation features.

However, an access route for a number of oyster application site will pose a significant risk to the Conservation Objectives of one marine benthic habitat feature for which the SAC is designated:

Zostera community complex. *Zostera* habitats are not compatible with vehicular or foot traffic and the access route should be realigned to avoid this sensitive habitat.

Current levels of subtidal (bottom) cultivation of mussels do not pose a significant risk to the Conservation Objectives of marine habitat features on the basis that intertidal cover of mussels are limited to 12% cover in both aquaculture sites and intertidal fishery order areas and considering the caveats identified in Section 9.1.2, i.e., that existing licensed aquaculture activities have previously and continue to be at a level that is considered non-disturbing. On the basis of spatial overlap alone, proposed mussel culture sites (i.e. applications) do potentially risk disturbing conservation features as the 15% threshold is exceeded when considered in-combination with other (fishery) activities. Furthermore, the potential overlap of a proposed mussel cultivation site (T6-428A) will also pose a significant risk to the Conservation Objectives of one marine benthic community type for which the SAC is designated: *Zostera* community complex. *Zostera* habitats are not compatible to mussel aquaculture.

10.1.2 Species

The likely interactions between the proposed aquaculture activities and the following Annex II Species were assessed; Atlantic Salmon *Salmo salar* (Salmon) [1106], *Petromyzon marinus* (Sea Lamprey) [1095], *Lampetra fluviatilis* (River Lamprey) [1099] and Otter (*Lutra lutra* [1355]). The objectives for these species in the SAC focus upon maintaining the good conservation status of populations. The main aspect of the culture activities that could potentially impact the designated species is the physical presence of trestles that may impede migration of fish and restrict otter access to certain habitats. However, given the locations and level of current and proposed activity it is concluded that activities would be non-disturbing to these Annex II species.

10.1.3 Other considerations

Based upon experience elsewhere, the introduction of '½ grown' or 'wild' oyster or mussel seed stock into aquaculture plots (both within and proximate to the SAC) from outside of Ireland does pose a clear risk of establishment of non-native species in the SAC. In order to mitigate the risk of introduction of alien species into the SAC as a result of aquaculture activities all movement of stock in and out of the Castlemaine Harbour SAC should adhere to relevant legislation and follow best practice guidelines (e.g. http://invasivespeciesireland.com/cops/aquaculture/).

The result of the proposed increase in oyster cultivation from 1.54% and 2% coverage of Habitats 1130 and 1140 to 31.26% and 34.69 %, respectively, will likely increase the standing stock biomass of this species in the SAC. This increase is considered substantial and the impact of this quantity of oysters on the seston (living and non-living matter in water) levels in the system is likely to be considerable. The indirect impact of reduced phytoplankton levels may have an impact on the constituent communities associated with the habitats in terms of a reduction in secondary production. On the basis of the proposed increase in spatial area of licensing (applications), the risk of seston depletion and impact on carrying capacity of the system, however, cannot be discounted. The additional biomass likely to result from the use of rope seed collection of mussels are unlikely to greatly impact on the carrying capacity of the system as the additional biomass will be generated from within the SAC.

The current permitted levels of mussel seed dredging and cockle dredging either individually or in-combination with aquaculture activities exceed the spatial overlap threshold (15%) for significant

adverse impacts of on three estuarine (1130) constituent community types (Intertidal sand with *Nephtys cirrosa* community, Fine to muddy fine sand with Polychaetes community complex, Mixed sediment community complex) and one mud and sandflat (1140) constituent type (Intertidal sand with *Nephtys cirrosa* community). Notwithstanding that a cockle fishery is unlikely to occur throughout the designated area, further licensing of mussel aquaculture activities in these community types should be carefully considered.

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