A9.0 Marine ecology

A9.1 Methodology

A9.1.1 Methodology to describe the existing environment

The description of the existing environment with regard to marine ecology has been informed by a combination of desk-based review of existing information and site-specific survey work. The scope of the survey was agreed with F.I.G. Planning and Building Services through the environmental scoping process, and is summarised in **Section A9.1.1.1**.

A9.1.1.1 Site-specific survey

A programme of marine ecological survey was undertaken during October and November 2020, focussing on the eastern half of Stanley Harbour (**Figure 9.1**). The survey work comprised the following activities:

- Recovery of sediment from the bed of harbour from 26 subtidal stations using a 0.1m^2 Van Veen grab (**Figure 9.1**). Sediment was recovered from each station for macrofaunal, physical (PSA) and chemical analysis (chemical analysis is reported in full in **Section A8**). The sediment samples recovered for macrofaunal analysis were processed through a 500µm mesh sieve and preserved in formaldehyde prior to sending to the laboratory.
- Deployment of a CTD probe at two sampling stations (Stations 3 and 33 shown on **Figure 9.1**) at the start and end of each day in the field (reported in **Section A8**).
- Deployment of a remote operated vehicle (ROV) to survey a 20m transect at each of the 26 subtidal sampling stations. Species counts were made along a swathe of 1m on each side of the transect.

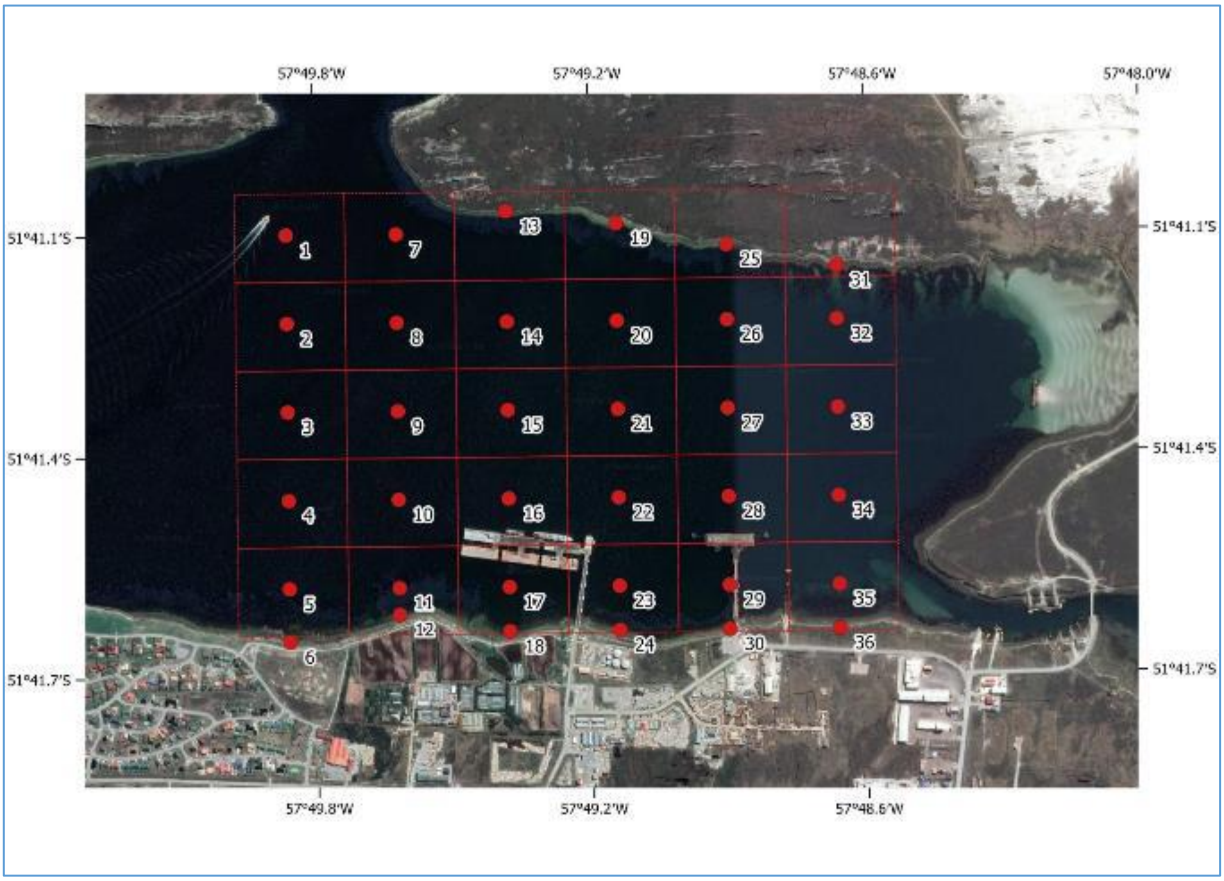

Figure 9.1 Sampling stations for marine and intertidal baseline assessment.

Further detail regarding the above survey work can be found in the marine survey field report (**Ref. 7**).

A9.1.1.2 Marine mammal observation during the marine ground investigation

BAM Nuttall contracted SAERI (Falklands) Ltd to provide Marine Mammal Observation (MMO) as part of its marine ground investigation for the proposed scheme. Observations were conducted from 26 September to 13 November 2020 during times of drilling operations.

Stanley Harbour is frequented by adult and juvenile Commerson's dolphins (*Cephalorhynchus commersonii*) and South American sea lions (*Otaria flavescens)* are regularly seen, with Peale's dolphins (*Lagenorhynchus australis*) being occasional visitors. On rare occasions, leopard seals (*Hydrurga leptonyx*) are seen.

The Falkland Islands are lacking in guidelines regarding mitigation practices for commercial activities such as seabed sediment and rock drilling. As a result, existing MMO guidelines were taken from the UK Government's Joint Nature Conservation Committee (JNCC, 2017) and scaled for the Falkland Islands wildlife and the proposed operation. For example, JNCC guidelines are designed for piling operations (JNCC, 2010) as opposed to drilling. Other JNCC guidelines that were deemed unnecessary for the proposed works included soft-starts and the use of Passive Acoustic Monitoring (PAM).

Observations were carried out on FIPASS with a designated 500m impact zone. Most of the 500m impact zone was monitored when the observer moved continuously between accessible viewpoints to the north and south of FIPASS. The upstairs walkway surrounding the AtLink offices was found to offer the observers better vantage points for drill locations to the north and west of FIPASS. However, due to the size and shape of FIPASS, a 360° view of the water was not possible to observe simultaneously. The results from the observation are detailed in **Section A9.2.2.3**.

A9.1.1.3 Desk-based review of existing information

In addition to the site-specific survey work detailed above, a desk-based review of existing information has been undertaken. Information reviewed as part of the desk-based assessment comprised the findings of previous marine ecological surveys undertaken within the harbour during 2013.

A9.2 Baseline conditions

A9.2.1 Description of benthic ecology and habitats from desk-based review

Studies undertaken in 2013 determined that the surface sediments within Stanley Harbour were dominated by homogeneous soft silts with a relative lack of habitat variability (Royal HaskoningDHV, 2013). This would suggest that benthic and infaunal species diversity within the sediments would be low, with most species present likely to be widespread in similar habitats around the Falkland Islands.

A qualitative survey was undertaken during 2013 (Premier, 2013) to provide baseline benthic information in relation to the construction of the TDF. That survey used different methods of assessment compared to the present study, using SCUBA divers taking photo-quadrats of the seabed and taking smaller core samples for sediment and infaunal analysis. The Premier Oil (2013) survey confirmed that muddy habitats were the most abundant in the survey area for the TDF project, characterised by high (and in some cases, extremely high) abundances of the saffron sea cucumber (*Cladodactyla crocea*). The scythe-edged serolid (*Acanthoserolis schythei*) was also conspicuous to varying extents. Other species present were crabs, such as the ornamented hermit crab (*Pagarus comptus*), the decorator crab (*Eurypodius latreilli*) and purple backed crab (*Peltarion spinulosum*). Molluscs were also present, including the short spired volutid (*Odontocymbiola magellanica*) and the leaden whelk (*Pareuthria plumbea*). Two fish species were recorded - tessellated rock cod (*Patagonotothen tessellata*) and the kelp rock cod (*P. squamiceps*). Of interest, echinoderm species (echinoids, asteroids) were generally absent, except for the beaded brittlestar (*Ophiacantha vivipara*) which was present in high numbers at certain locations. The purple hair bryozoan (*Alyconidium austral*) was also evident at certain sites.

Other distinctive habitats included areas visually dominated by algal detritus (*Macrocystis pyrifera, Lessonia* sp.) and encrusted shell and cobble. These were often associated with the plumose anemone (*Metridium senile*), a recently confirmed additional marine invasive species in the Falkland Islands (Glon *et al.,* 2020). Dense algal habitats were found to be compromised of 100% green algae (primarily various *Ulva* spp.), filamentous green algae (*Bryopsis plumose*), possibly rope algae (*Desmarestia chordalis*) and filamentous red algae.

Consolidated mud/sand habitats were found in shallow water, with higher abundances and higher diversity assemblages of mollusc species, such as the Magellanic copper limpet (*Nacella magellanica*), the small shelled keyhole limpet (*Fissurellidea patagonica*), the leaden whelk, Gever's trophon (*Trophon geversianus*) and a murex species. Two species of sea stars were also found, namely the common sea star (*Anasterias antarctica*) and the rough-edged sea star (*Ganeria falklandica*). Tessellated rockcod (*Patagonotothen tessellata*) were also found as was the crested spiny plunderfish (*Harpagifer palliolatus*). Species accumulation curves of conspicuous epibenthic species neared a plateau at approximately 25 samples, with a predicted total richness of 43 species.

Studies of marine invasive species in Stanley Harbour in 2011 (SMSG, 2011) reported two invasive species present; the Vase tunicate (*Ciona intestinalis*) and the Parchment worm (*Chaetopterus variopedatus*). These species were identified during diver surveys undertaken in 2011; the 2011 surveys focussed on hard structures such as FIPASS and other jetties within Stanley Harbour.

The Vase tunicate is a cold water temperate hermaphroditic solitary ascidian. It is a very competitive species that rapidly covers nearly 100% of the available substratum and excludes almost all of the native species in a short period of time (i.e. it tends to carpet surfaces) (SMSG, 2011). During the 2011 surveys, it was found in particularly dense assemblages on all surfaces of FIPASS, as well as patchily distributed on the seabed (See **Figure 9.2**).

The Parchment worm is less common on man-made structures, but is typically found on rocky substrate around the harbour and the whole of the Falkland Islands. The Parchment worm, as its name suggests is a worm that lives in tough tubes. It is a cryptogenic species and is thought to originally have a North Atlantic distribution. It has been reported in temperate harbours around the world and is quite widely distributed around the Falkland Islands (SMSG, 2011). The locations where the Parchment worm was identified and the abundance of this species recorded in the 2011 survey is shown on **Figure 9.3**.

During the Premier Oil (2013) survey, a plumose anemone was discovered that was later identified as the invasive species *Metridium senile* (Glon *et al.,* 2020). This was the first record of this species within the Falkland Islands. It has since been observed in surveys undertaken elsewhere around the Falkland Islands (including at Jason Island in the far north-west and Bird Islands in the south-west), suggesting it is much wider spread around the Falkland Islands than previously thought (Paul Brewin, SAERI, pers. comm. 2021).

Figure 9.2 Location and abundance of the Vase tunicate (*Ciona intestinalis*) within Stanley Harbour from survey work undertaken in 2011 (SMSG, 2011)

Figure 9.3 **Location and abundance of the Parchment worm (*Chaetopterus variopedatus*) within Stanley Harbour from survey work undertaken in 2011 (SMSG, 2011)**

A9.2.2 Results of site-specific surveys

A9.2.2.1 ROV transect surveys

As noted in **Section A9.1**, a site-specific ROV survey was undertaken within the eastern part of Stanley Harbour. A total of 41 species / putative species were recorded within the survey area (see **Appendix 4**). Immediately evident is the dominance of the saffron sea cucumber (*Cladodactyla crocea*). Densities were higher than those identified during the 2013 survey reported in **Section A9.2.1**. The reason for this is unknown; however, it may be due to summer productivity and coincident reproductive periodicity in this species during the 2021 survey, compared to 2013 surveys which were conducted in winter. Other notable differences between the 2013 and the 2021 survey results were the increase in density and spatial expansion of the plumose anemone (*Metridium senile*) and the Vase tunicate (*Ciona intestinalis*) in 2021. Both of these species are considered to be invasive, and may also be responding to increased abundance and growth in summer, particularly *C. intestinalis*.

Species accumulation curves shown in **Appendix 4** indicate that the accumulation asymptote was not reached, suggesting that further sampling would be needed to understand the full epibenthic species inventory; the Chao2 species richness estimator (based on species incidence) suggests a mean total species richness of approximately 56 species. This is higher than the recorded predicted richness of 43 species in 2013.

To identify primary species (and by extension, habitat) groupings, the species matrix was first transformed using Hellinger transformation (Legendre & Gallagher 2001). Species/putative species groupings were identified based on UPGMA clustering of the Bray-Curtis similarity matrices; groupings at 70% similarity are highlighted in a Principal Component Analysis (PCA) ordination plot (**Figure 9.4**). Initial analysis showed that the abundance of *C. crocea* was having too great an impact on results that could not be resolved through data transformation, and were therefore removed from the final PCA analysis in order to produce more clear interpretations.

In summary, no rare species or habitats were identified in this survey. Species assemblages and habitat types are likely to be found in other similarly shallow, inner bays in the region.

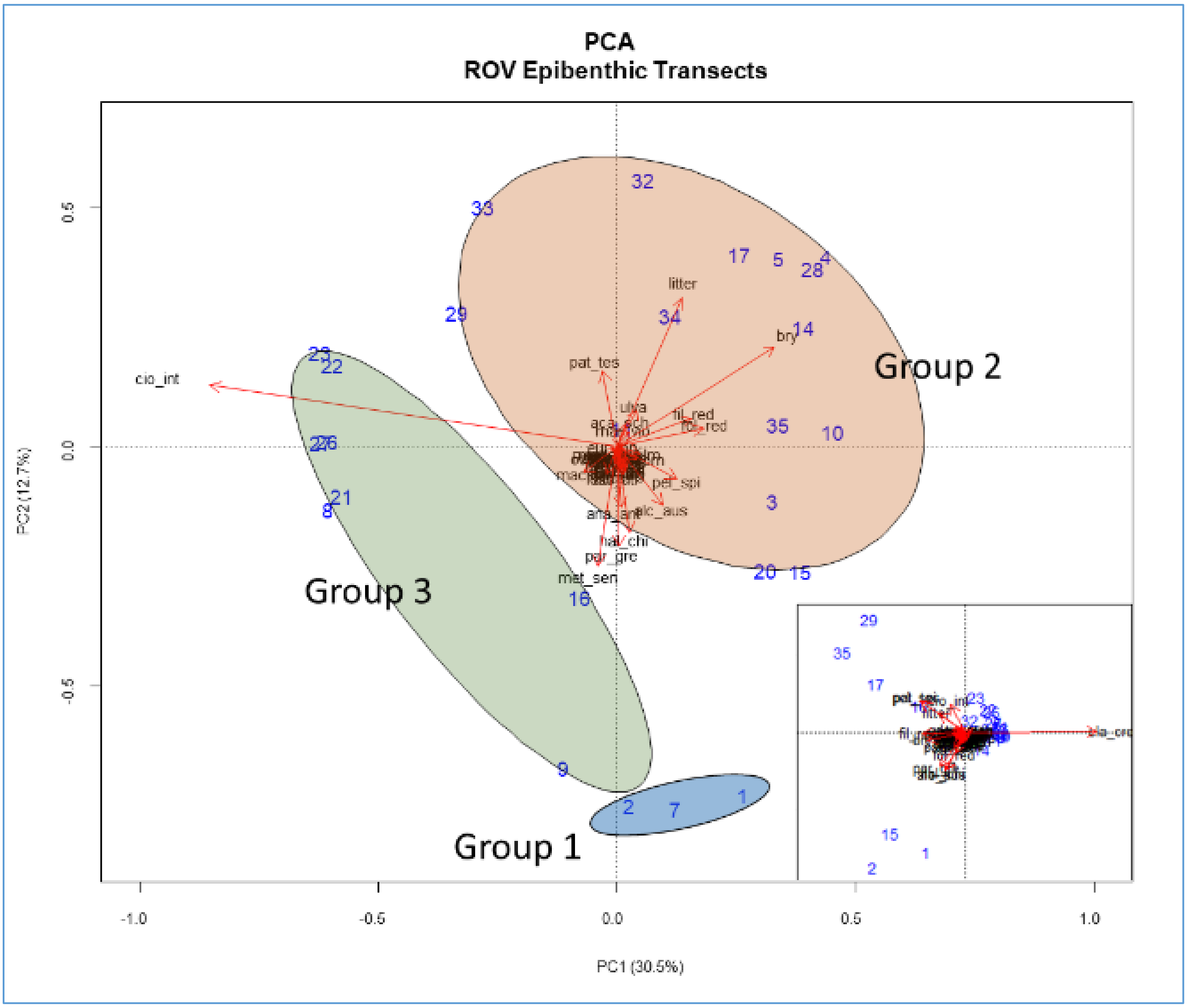

Figure 9.4 **Principal Component Analysis (PCA) of ROV epibenthic transect data. Numbers represent the sampling stations shown on Figure 9.1. Species / putative species codes can be found in Appendix 4). Ellipses are species groupings identified after cluster analysis. The main plot does not include data for *C. crocea*; the ordination plot inset includes these data as an example of heavy skewness caused by high abundance of this species.**

As shown in **Figure 9.4**, three groups were identified. These groupings are mapped onto Stanley Harbour in **Figure 9.5** and are discussed in turn below. **Figure 9.5** also includes an additional variable of *C. crocea* density at each site.

Group 1: This group was found just south of the Narrows, at the entrance of Stanley Harbour (**Figure 9.5**). It is characterised by presence/abundance of a richer invertebrate fauna than the other survey sites. Species present were the Plumose anemone (*M. senile*), Giant tunicate (*Paramogula gregaria*), Popcorn sponge (*Haliclona (Soestella) chilensis*), Common sea star (*Anasterias antarctica*), Purple hair bryozoan (*Alcyonidium austral*) and the Vase tunicate (*C. intestinalis*), as well as a variety of red seaweeds. Seabed habitat was silty mud with evenly distributed clusters of shell (**Plate 9.1** and **9.2**).

Group 2: The majority of stations (15 out of 26) were included in Group 2. This was found mainly at the south-eastern and south-western sampling stations (**Figure 9.5**). Group 2 stations were characterised by high abundance of *Bryopsis* sp. and other red seaweeds, and filamentous and foliose algae such as *Ulva sp*. The Tessellated rock cod (*Patagonotothen tessellata*) was seen hovering above seaweed turf. Seabed habitat was made up of very soft muds and silts, with the anoxic black layer very near the sediment / water interface (**Plate 9.3** and **9.4**).

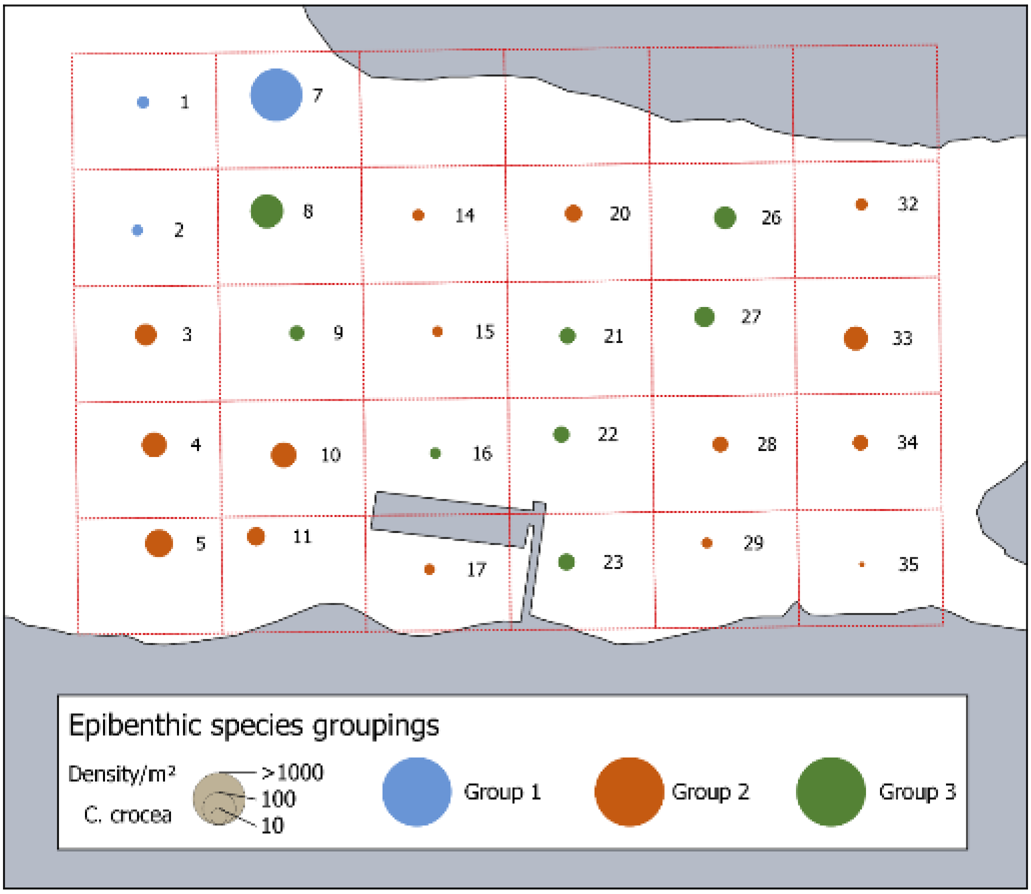

Figure 9.5 **Species groupings of epibenthic species/putative species. The size of circle represents density of *C. crocea***

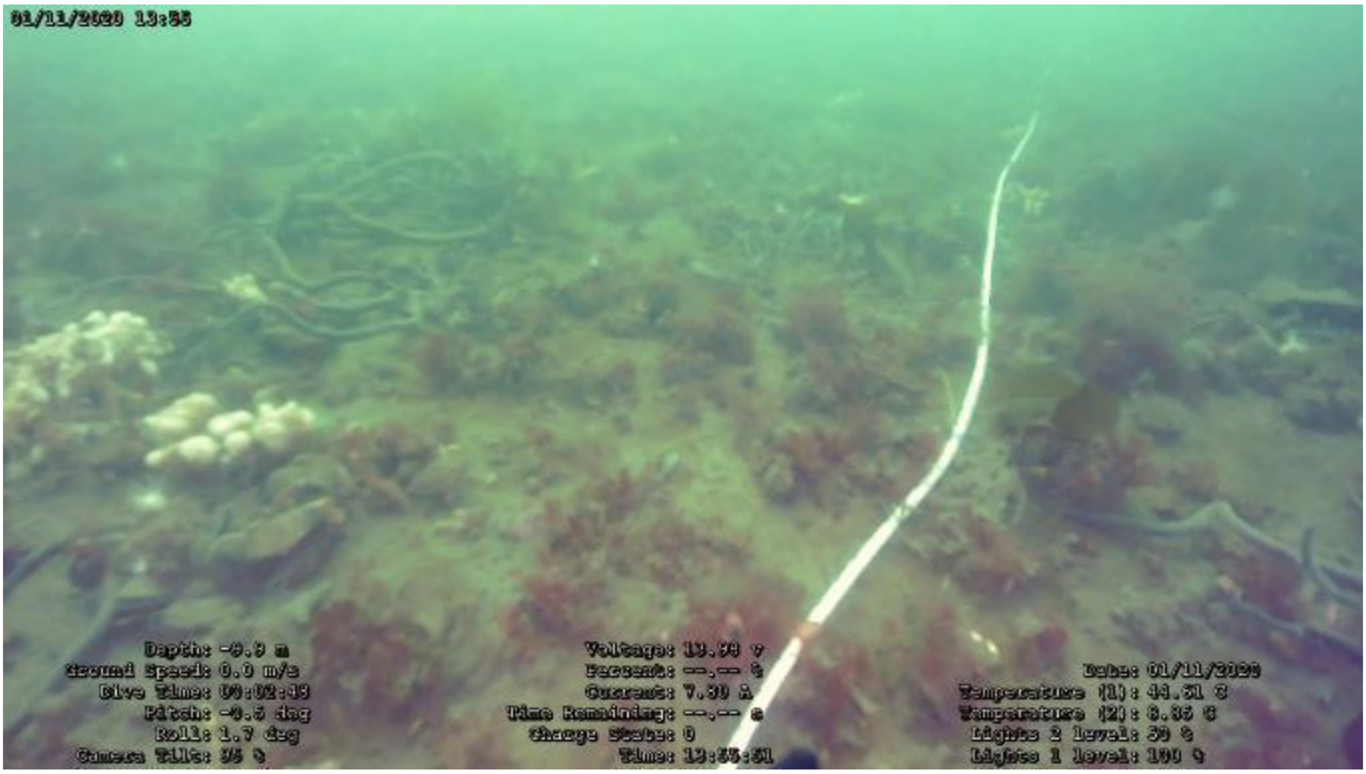

Plate 9.1 **Seabed images of Group 1 species grouping, showing Purple hair bryozoan, popcorn sponge, and various red seaweeds (Station 1)**

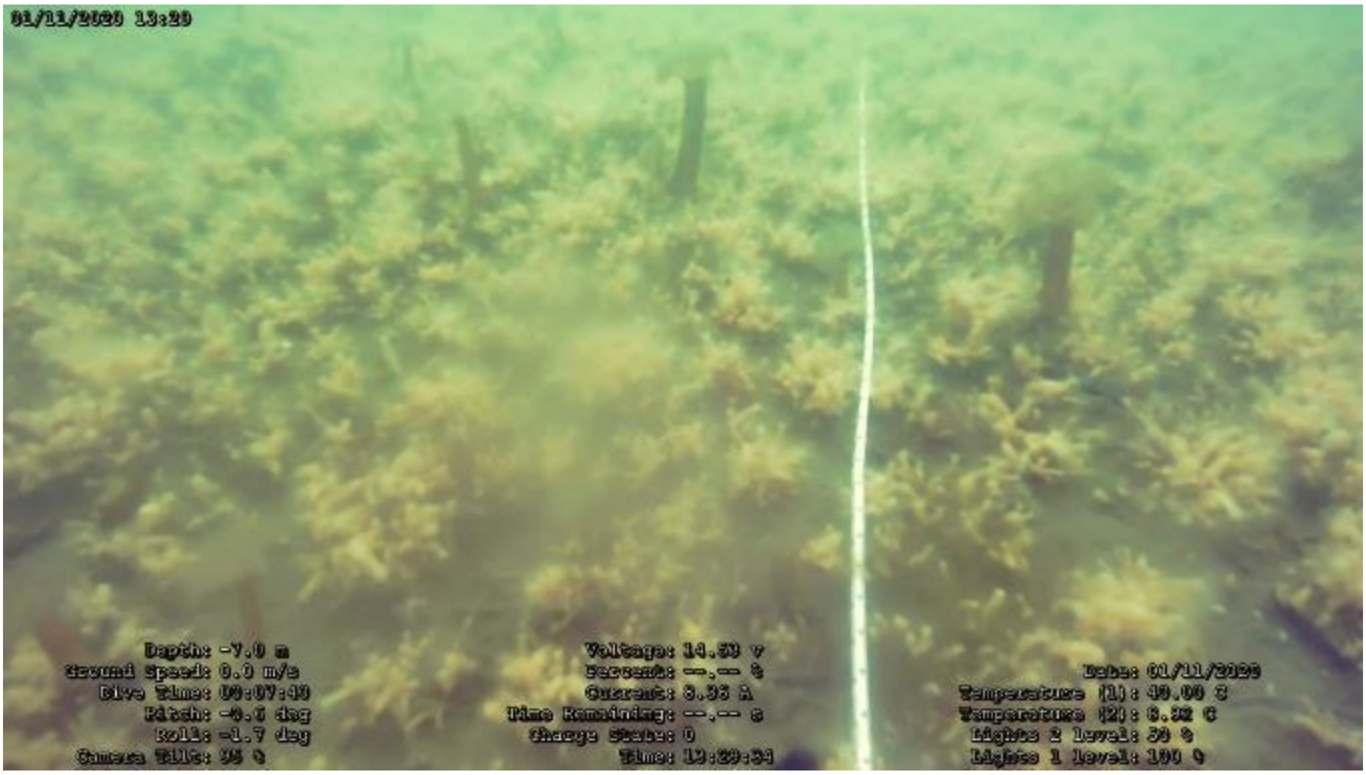

Plate 9.2 Seabed images of Group 1 species grouping, showing very high density of Saffron sea cucumber and Plumose anemones (Station 7)

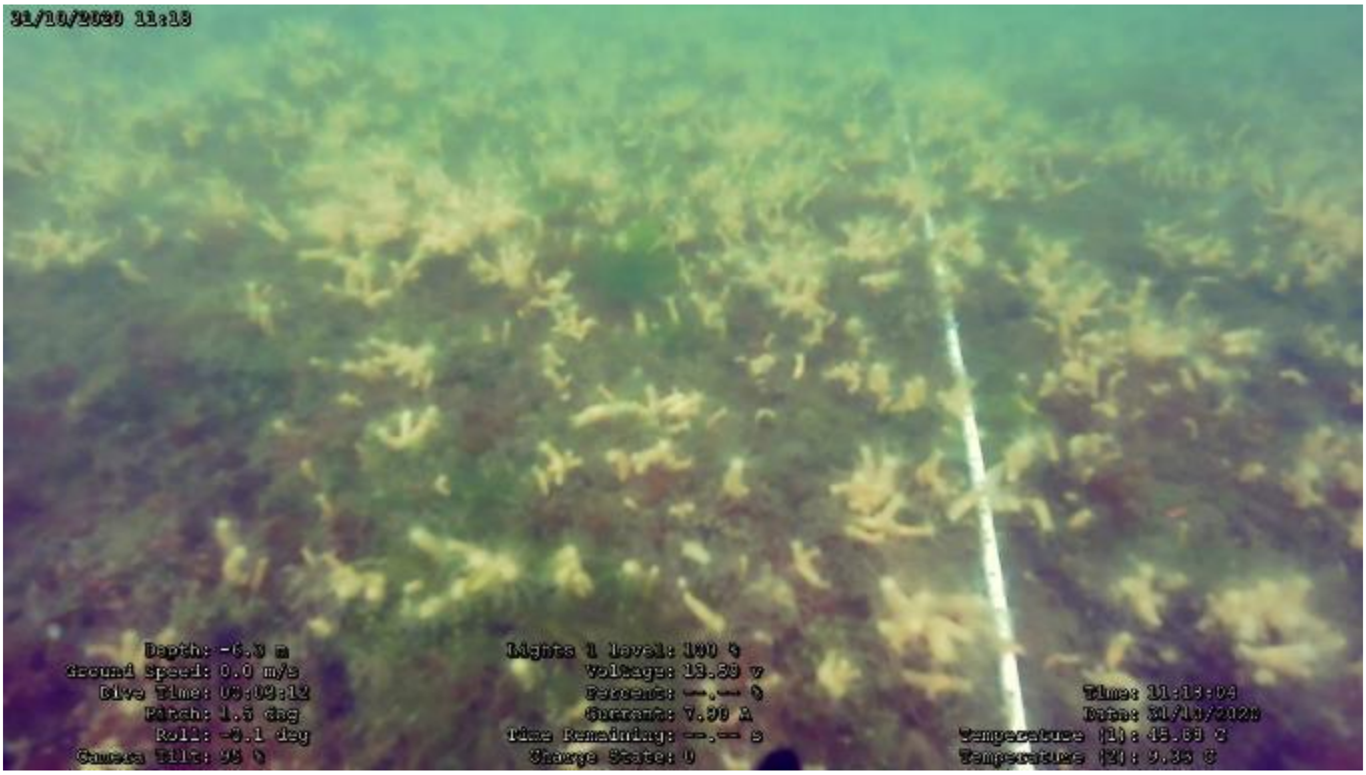

Plate 9.3 Seabed images of Group 2 species grouping, showing abundant Saffron sea cucumbers on a matrix of Bryopsis sp., red, and green algal turf (Station 33)

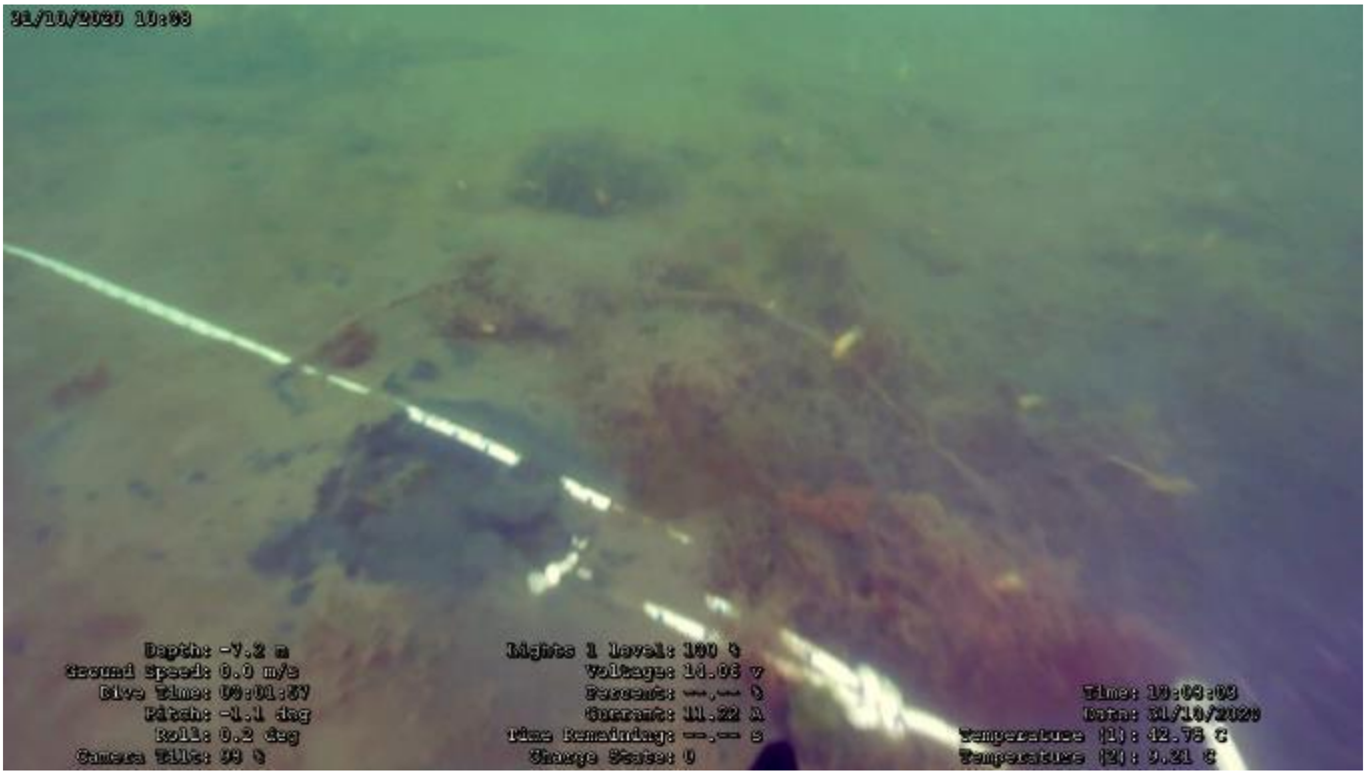

Plate 9.4 Seabed images of Group 2 species grouping, showing a patch of Bryopsis sp, and anoxic black layer exposed by the transect weight (Station 28)

Group 3: These stations were characterised by lower diversity, with a lack of many species found elsewhere, and often relatively featureless seabed of fine silt and fine algal mat. These stations were largely characterised by the presence of the Vase tunicate not seen elsewhere (**Plate 9.5**). These stations were in close proximity to FIPASS, perhaps at least in part, accounting for the Vase tunicate also being located in these areas given that FIPASS is densely colonised by this species (SMSG, 2011).

Interestingly, Station 16 was included in this group, likely due to the very low diversity found in similar stations. This station differed, however, as it showed a highly disturbed seabed with exposed dead shell that is continually exposed by ship activity (**Plate 9.6**). No other stations showed this level of physical disturbance; however, ROV footage revealed some obvious anchor scarring or other mechanical disturbance on the seabed at other stations.

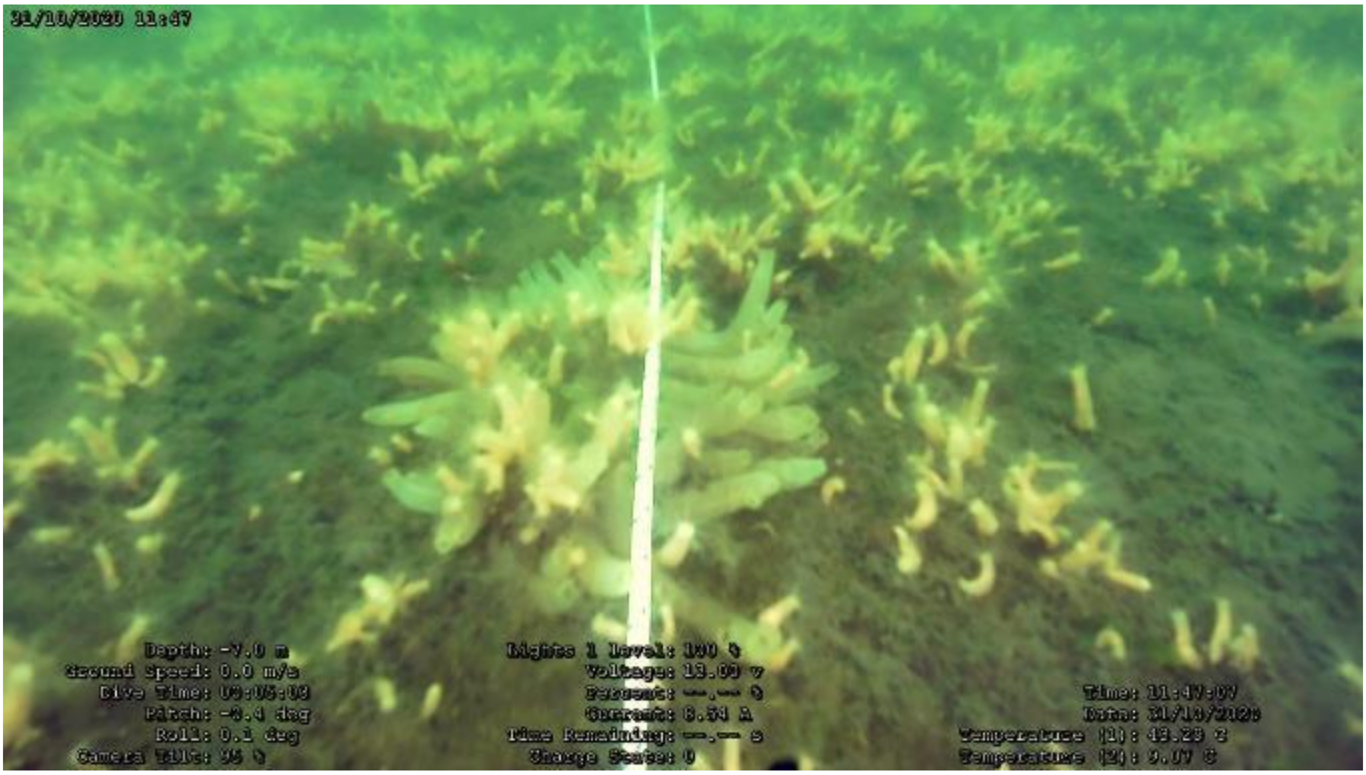

Plate 9.5 Seabed images of Group 3 species grouping showing abundant Saffron sea cucumbers with patches of Vase tunicate (Station 27)

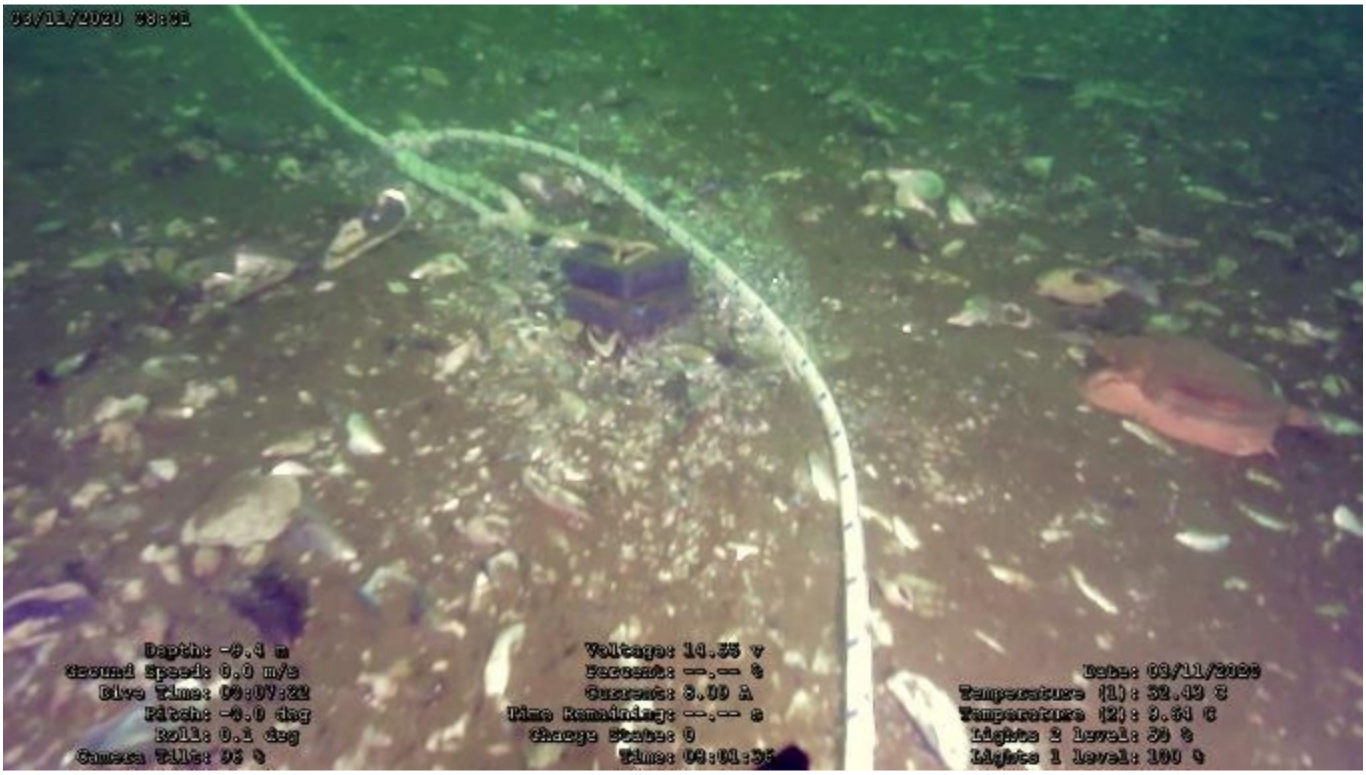

Plate 9.6 Seabed images of Group 3 species grouping, showing disturbed sediment, abundant shells and an individual of Short spired volutid (*Odontocymbiola magellanica*) (Station 16, seaward of FIPASS). The transect weight is shown sitting on the seabed, indicating the relative firmness of the sediment compared to much softer sediments elsewhere.

A9.2.2.2 Benthic infauna

Sediment characteristics

Sediment grain size analysis shows that, generally, the seabed sediments are poorly sorted sands and muds. Sediments were found to be generally anoxic, with the redox layer very close to the surface. A mild to strong sulphur odour was noted when sampling sediments. Sediment textures are shown on **Figure 9.6** (and summarised in **Section A7.2.4** and **A9.2.2.2**).

Habitats predominantly vary in their mud and sand fraction composition when viewing data on a standard Folk diagram (**Figure 9.6**). However, Stations 1, 2, 7 and 16 were distinct in terms of their gravel fraction. Stations 1, 2, and 7 were at the Stanley Harbour side of the Narrows entrance, where video observation indicated significant hard substrates encrusted with flora and fauna. Previous surveys (Premier Oil, 2013) have shown that there is a great deal of dead shell found in this area, which could account for the large gravel size-class fraction. Interestingly, Station 16 is located immediately seaward of FIPASS, an area that is likely highly impacted by vessel propeller wash, exposing conspicuous dead shell at the surface (as shown in ROV video transects (**Plate 9.6**)).

Sediment samples from Stations 20 and 22 were lost during transportation to the laboratory in the UK.

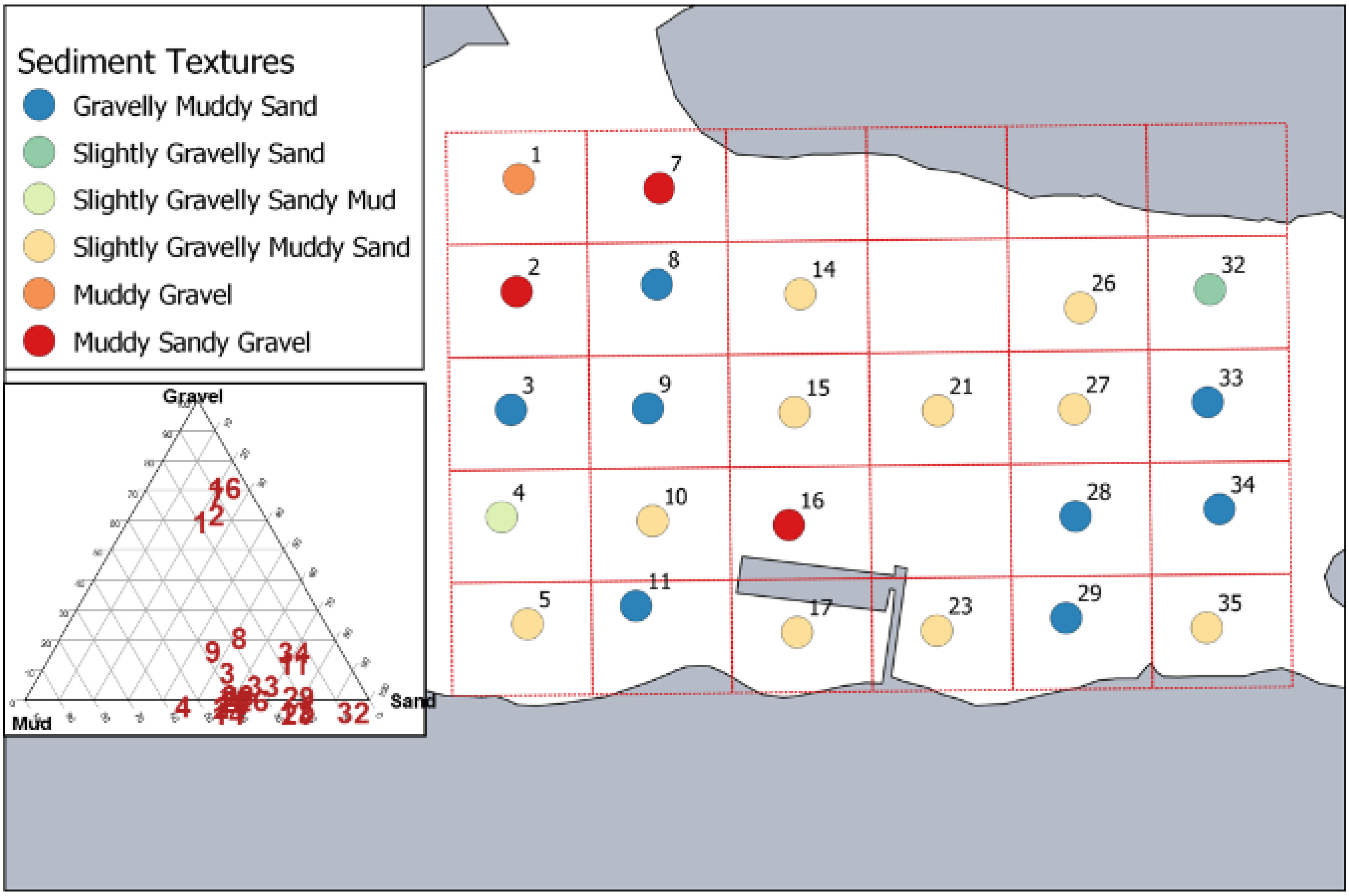

Figure 9.6 Map of diagram of sediment textures, Stanley Harbour. Sediment Folk diagram inset

Full tables of sediment grain size weights, percent composition and sediment statistical distributions can be found in **Appendix 5**.

Sediment infauna

A total of 265 species and putative species, and other biological objects (e.g. eggs, reproductive structures, larvae) were recorded from sediment infaunal analysis (**Appendix 4**) from a total of 6,812 individuals counted and the presence of 42 encrusting species. Infaunal analyses was undertaken on a reduced species list, excluding eggs, reproductive structures and larvae, and combing juvenile forms with adults where this made ecological/statistical sense. The list was further reduced to only those species whose densities were accurately captured by the Van Veen grab sampler (e.g. fish and algae were excluded), and also excluding meiofauna that may have remained in the sample after 500 micron sieving (e.g. nematodes, ostracods). The final list comprised 233 species. Many species were recorded as Present (P); these were encrusting species (e.g. spirorbids, bryozoans) that could not be effectively enumerated. These are analysed separately (**Table 9.1**).

Species presence and abundance was highly patchy. The most specious group were the Polychaetes with 94 species/putative species found. Of these, the most abundant species was *Aphelochaeta magellanica* (3,101 individuals) and another unidentified species of the same Genus (960 individuals). The Family Capitellidae (*Capitella* sp 2 and *Mediomastus* sp. 1) were also particularly abundant, as was the Paronidae (*Paradoneis* sp.1).

The Amphipoda were the next specious group with 27 species observed, with the Phoxocephalidae showing high abundance (*Proharpinia antipoda*, 422 individuals; *Paradexamine nana*, 389 individuals; *Proharpinia stephenseni*, 185 individuals). A total of 36 species/putative species of Gastropods were observed with relatively low abundances.

The Gastropod fauna was dominated by the minute sea snail *Eatoniella* sp (481 individuals), and unidentified Bivalvia (293 individuals). Other dominant species were juvenile Mytildae bivalves (1751 individuals), and a total of 29 Bryozoan (lace coral) species; however, these are not considered infauna *per se*.

Notable in the species list is the occurrence of the Giant barnacle (*Austromegabalanus psittacus*) in two samples near the Narrows entrance (Stations 1 and 2) as well as Sites 7 and 11. All individuals counted were alive. These are highly unlikely to be typical of soft sediment habitats, and are more likely to have broken from adjacent rocky habitats and washed towards the middle of the harbour. Due to the complex hard structures produced by this species, it is also likely to have brought with it many other encrusting species, as well as species that live within the barnacle shell matrix. It can possibly be assumed that the high number of species of bryozoan might be attributed to giant barnacle shell. This should be taken into account when considering overall diversity patterns in Stanley Harbour soft sediment assemblages.

Species diversity

Species accumulation curves (**Appendix 4**) for infaunal sampling did not reach asymptote in Stanley Harbour suggesting that further sampling would be required to understand the full infaunal species inventory. However, the curve is showing signs of levelling off with increasing sampling and is, therefore, suitable for establishing a baseline of infaunal species inventory for the purpose of an EIA. The total number of species found was 233, with a Chao2 richness predicting 299 species.

As shown in **Table 9.1** and **Figure 9.7**, diversity of the infaunal assemblage varies between stations. For mobile species (where abundance was recorded), richness (S) was highest at the entrance of Stanley Harbour at the Narrows, and along eastern-most stations. Species richness was also notably high at Station 11, located near the southern shore. Shannon diversity (H') of mobile infauna also varied between sites in a similar way. Pielou evenness (J') showed less variation between sites, indicating that of the species present at each site, there are few that exhibit disproportionally large abundance. The exception is Station 10, where despite the number of species found being relatively high, the sample was dominated by a single species of Cirratulid polychaete *Aphelochaeta magellanica* (912 individuals).

Table 9.1 Diversity indices for mobile and encrusting species (S only due to being recorded as presence only) at each station, Stanley Harbour

Station	Mobile species			Encrusting species
	Richness (S)	Shannon diversity (H')	Pielou evenness (J')	Richness (S)
1	86	2.78	0.62	21
2	77	2.04	0.47	20
3	21	1.86	0.61	2

Station	Mobile species			Encrusting species
	Richness (S)	Shannon diversity (H')	Pielou evenness (J')	Richness (S)
4	22	1.47	0.47	2
5	17	1.85	0.65	
7	66	3.40	0.81	6
8	17	1.95	0.69	
9	19	1.75	0.59	1
10	17	0.73	0.26	1
11	65	2.83	0.68	6
14	12	1.32	0.53	
15	26	1.38	0.42	2
16	27	1.76	0.53	3
17	25	1.86	0.58	2
20	15	1.22	0.45	
21	23	1.57	0.50	1
22	14	1.41	0.54	1
23	13	1.04	0.40	1
26	17	1.73	0.61	
27	46	3.11	0.81	3
28	23	1.91	0.61	
29	51	2.99	0.76	1
32	66	3.11	0.74	5
33	53	2.55	0.64	7
34	57	2.97	0.73	4
35	40	2.38	0.65	3

Richness of encrusting species was highest at the Narrows entrance stations and moderate at eastern stations (**Figure 9.7**). This is reflective of increased area of hard surfaces for encrusting species to colonise, particularly bryozoans on Giant Barnacles, and also living and dead shell.

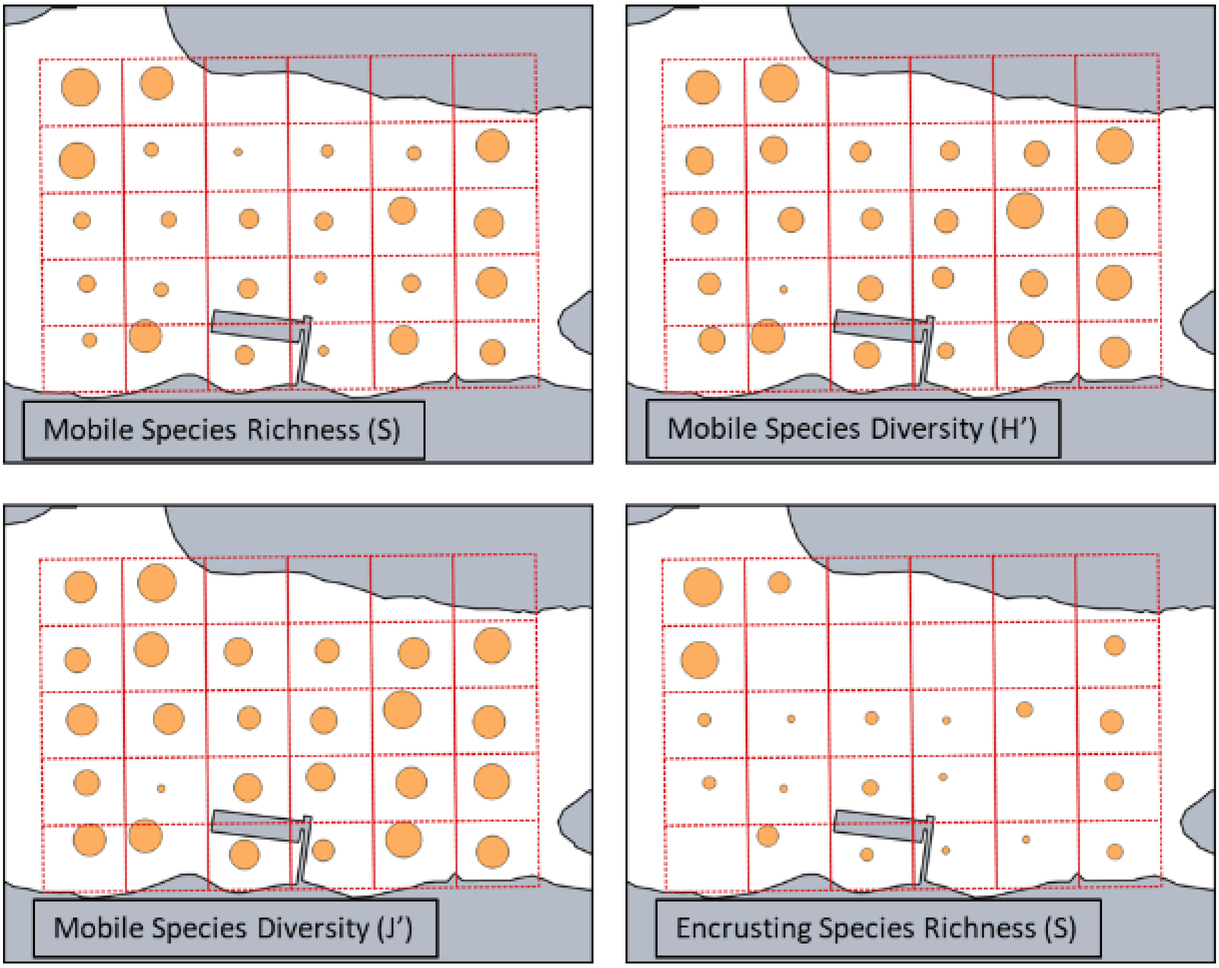

Figure 9.7 Diversity (S, H', J') of mobile infaunal species at each station in Stanley Harbour. For encrusting species, only richness (S) is shown due to being recorded as presence only. Scales of circles are relative within each plot, and not comparable between plots. See Table 9.1 for diversity values.

The infauna species assemblages can be grouped into four groupings after the species matrix was first transformed using Hellinger transformation (Legendre & Gallagher, 2001) which gives appropriate weighting to highly skewed species abundance data. UPGMA (Unweighted Pair-Group Method using Arithmetic averages) clustering of the Bray-Curtis similarity matrices was carried out indicating four groupings at 70% similarity. Constrained ordination (RDA) was carried out on the infaunal mobile species matrix analysis constrained by a matrix of environmental factors consisting of sediment characteristics (% Gravel, % Sand, % Mud), and metals/PAHs. Analysis is summarised as a tri-plot with species groupings overlayed (**Figure 9.8**) and the four groups are discussed in turn below.

Group 1 was characterised by high proportions of gravel, likely due to high amounts of shell (**Figure 9.8**, found at the entrance of Stanley Harbour (**Figure 9.9**). The group is highly influenced by the presence of the Giant barnacle *A. psittacus*. Also present was the Sipunculan worm Golfingiidae and the Cirratulid polychaete *Aphelochaeta* sp. This genus was particularly well represented at all stations, with four species of this genus identified in Stanley Harbour. Stations in Group 1 are relatively low in metals and PAH concentrations.

Group 2 was dominated by the abundance of the polychaetes *Aphelochaeta magellanica*, *Aglaophamus macroura, Mediomastus* sp.1, the Cumacean crustacean *Leucon* sp1, and the amphipod *Proharpinia antipoda* amongst others (**Figure 9.8**). Stations in this group had relatively high concentrations of mercury, selenium, cadmium, nickel, chromium, and arsenic. These stations are located primarily in the east and central areas of Stanley Harbour (**Figure 9.8**).

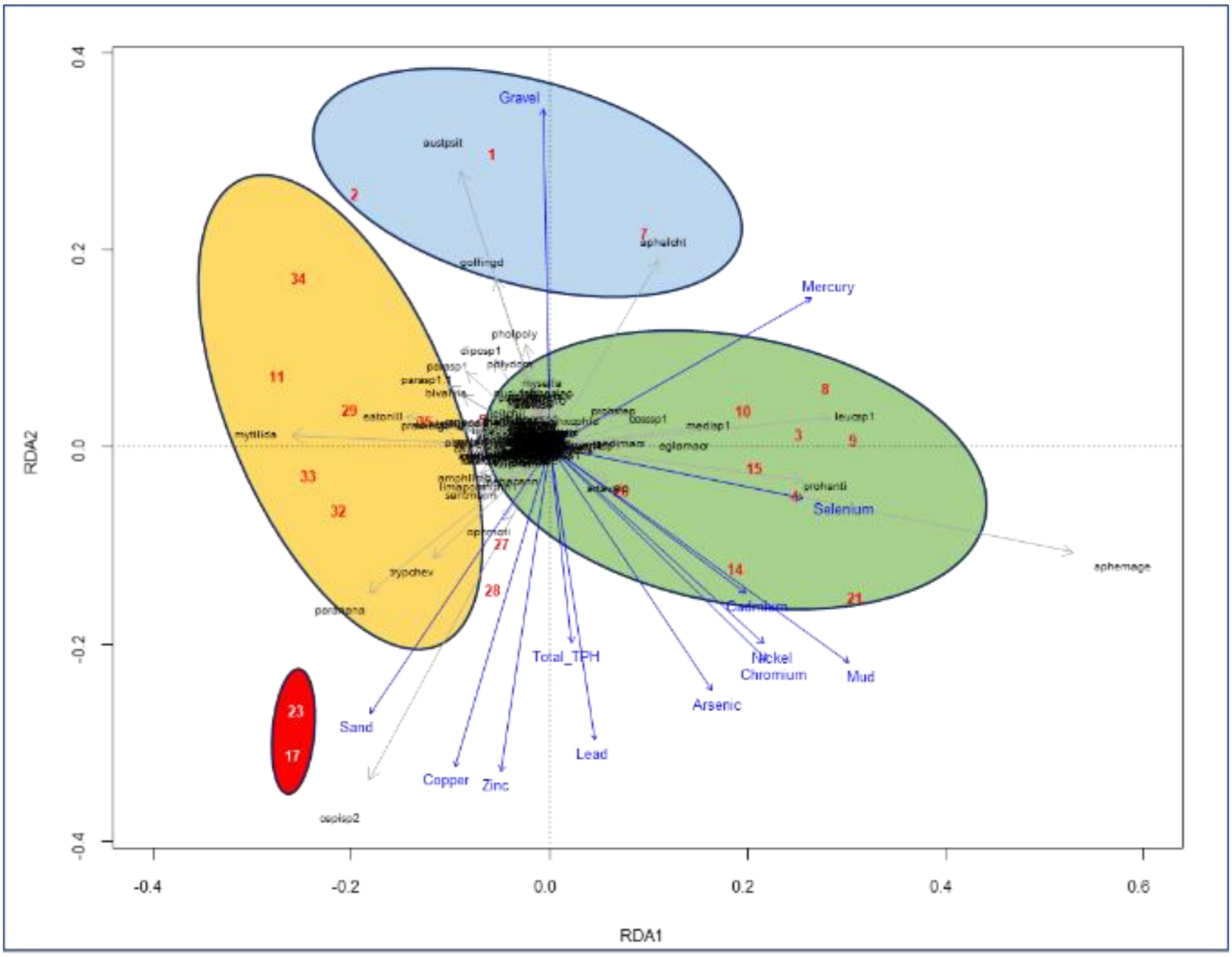

Figure 9.8 Constrained ordination tri-plot, illustrating the relationship between sites (numbers) based on species and sediment characteristics. Overlayed are species groups based on UPGMA clustering and Bray-Curtis similarity (70%). Grouping groupings can be compared to Figure 9.9. Species codes are found in Appendix 4

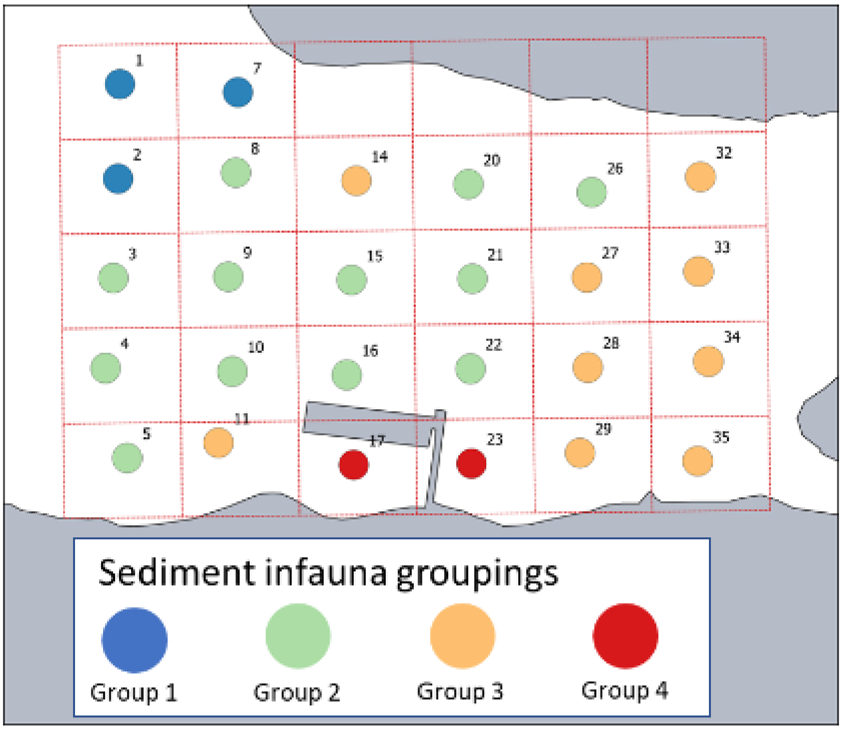

Figure 9.9 Location of infaunal species groupings, Stanley Harbour. Figure groupings can be compared to Figure 9.7

Group 3 stations were dominated by amphipod *Paradexamine nana*, *Tryphosites chevreuxi*, the unidentified mussel in the family Mytilidae, namely because they were juveniles, particularly at Station 11, and the gastropod *Eatoniella* sp. (**Figure 9.8**). These stations contained relatively lower concentrations of metals and PAHs compared to Group 2, with Station 27 and 28 showing signs of elevated metal and PAH concentrations compared to others in Group 3 as indicated by their position in the lower half of the ordination plot (**Figure 9.7**).

Group 4 was represented by Stations 17 and 23. These stations are situated between FIPASS and the coast to the south (i.e. immediately inland of FIPASS) (**Figure 9.9**). These stations are characterised primarily by high abundance of the polychaete *Capitella* sp.2. Sediments at these stations are somewhat sandier that other sites, with higher concentrations of copper and zinc in the sediments.

Marine invasive species

As reported in **Section A9.2.1**, surveys were undertaken in 2011 and 2013 to investigate marine invasive species (SMSG, 2011) along the coastal areas of Stanley Harbour. The 2011 survey confirmed the presence of the invasive species *Chaetopterus variopedatus* (Parchment worm) and *Ciona intestinalis* (Vase tunicate) encrusting marine structures. More recently (in 2013), the Plumose anemone *Metridium senile* was identified as an invasive (Glon *et al.,* 2020), as it is in other parts of the world associated with ports and harbours.

The site-specific ROV survey undertaken in 2021 within Stanley Harbour has confirmed the presence of two of the three invasive species previously identified within the 2011 and 2013 surveys (namely Vase tunicate and Plumose anemone). The Vase tunicate was identified at 14 of the 26 subtidal ROV stations within Stanley Harbour in 2021, whilst the Plumose anemone was found at four of the 26 ROV stations in 2021. The absence of the Parchment worm in 2021 could be explained by the fact that the ROV surveys were generally undertaken within soft sediment habitats which are not usually used by this species (it is generally found encrusted on hard structures or reefs).

In addition to the above species, the 2021 survey also identified the likely presence of the Corphid amphipod *Monocorophium acherusicum,* which has been reported as an invasive species from the North Atlantic (Schwindt *et al.,* 2020). It is small, tube-forming on hard substrates as well as in sediment. This was identified in nine of the subtidal grabs recovered in 2021; a total of 68 individuals were found, with a peak of 26 at sampling station 32 (refer to **Figure 9.1**). Its impact on the Stanley Harbour marine ecology is not known at this time.

The distribution and abundance of the invasive species identified during the 2021 surveys is shown on **Figure 9.10, 9.11** and **9.12.** All abundance data shown in **Figure 9.10** to **9.12** has been standardised to numbers per m^2.

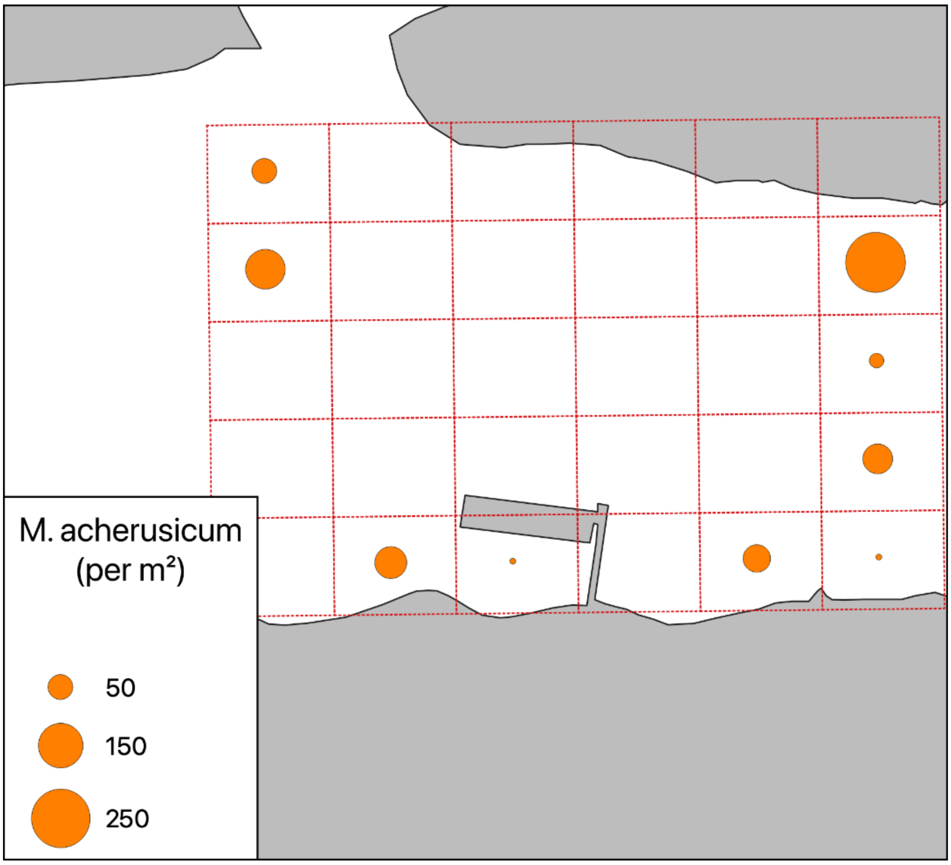

Figure 9.10 **Location and abundance of the Corphid amphipod *Monocorophium acherusicum* within the 2021 grab survey**

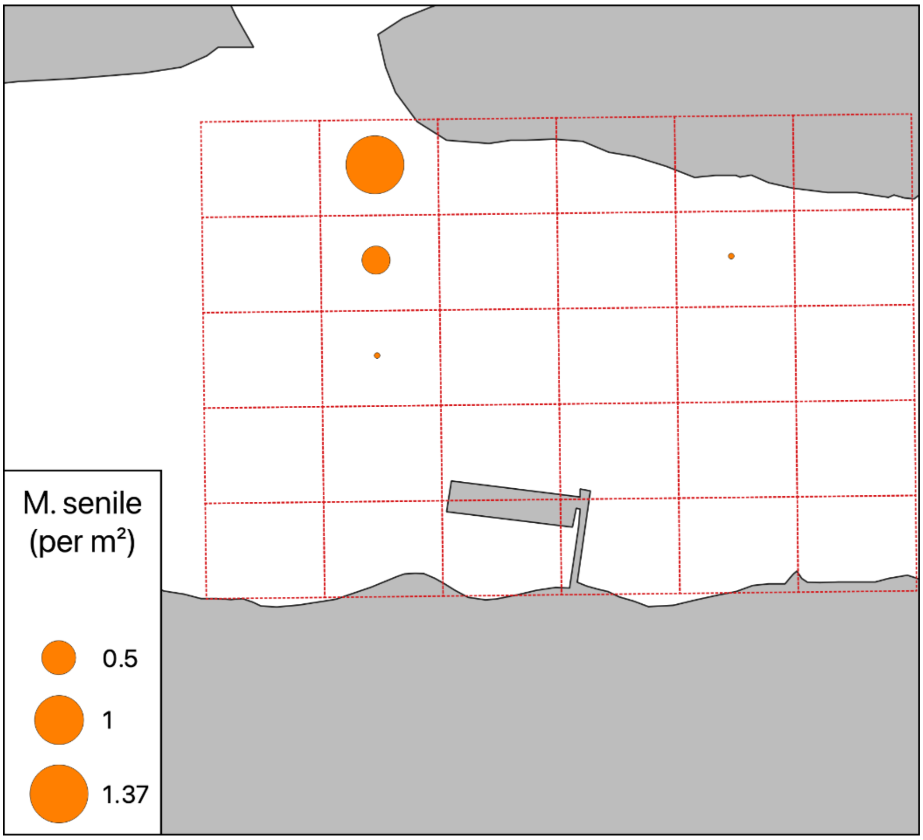

Figure 9.11 **Location and abundance of the Plumose anemone *Metridium senile* within the 2021 ROV survey**

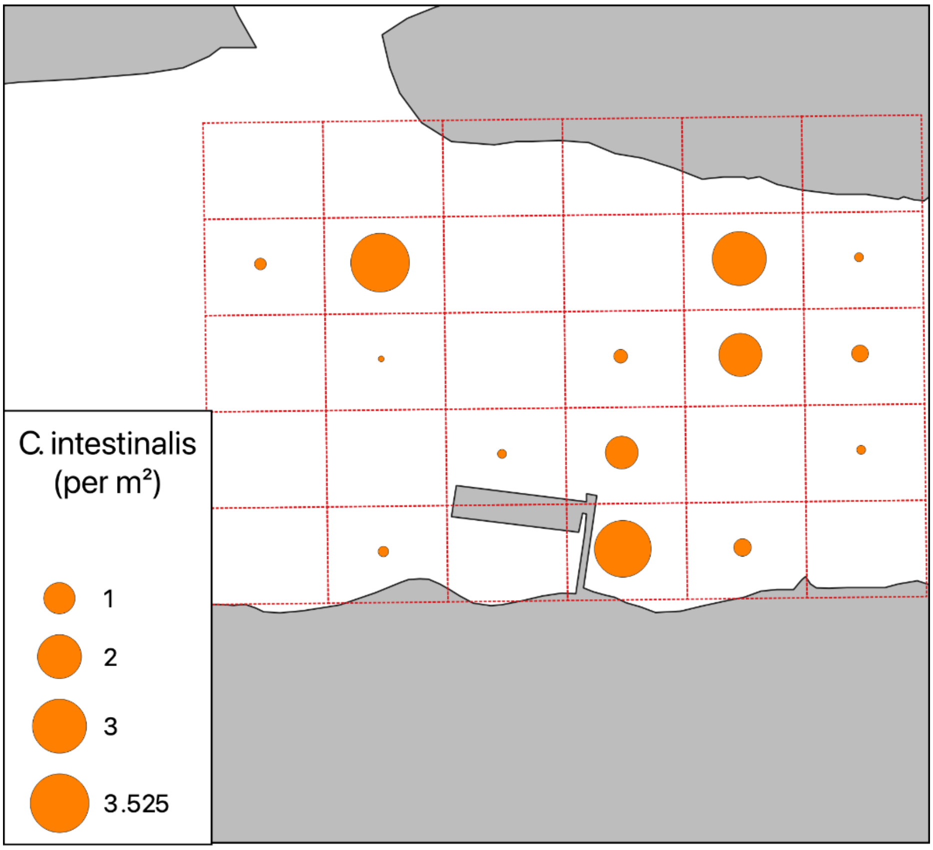

Figure 9.12 Location and abundance of the **Vase tunicate *Ciona intestinalis* within the 2021 ROV survey**

It should be noted that the underside of FIPASS has not been subject to ecological survey during the 2021 project specific survey. However, the proposals to dismantle FIPASS on the beach means that there is an insignificant risk of spreading invasive species to other areas of the marine environment.

A9.2.2.3 Fish and fisheries

Few fish were captured or observed using the site-specific survey undertaken in 2021. However, it is understood that the following fish species are known to occur within Stanley Harbour and the surrounding areas:

- Tessellated rock cod (*Patagonotothen tessellata*).
- Blue-spotted rock cod (*P. cornucola*).
- Kelp rock cod (*P. squamiceps*).
- Humped rock cod (*P. sima*).
- Orange fin rock cod (*P. brevicauda*).
- Crested spiny plunderfish (*Harpagifer palliolatus*) (possible endemic species, taxonomy is currently under revision (P Brickle, *pers comm*)).
- Mullet (*Eleginops maclovinus*).

Fish species themselves are not afforded any legal protection within the waters of the Falkland Islands. However, the Fisheries (Conservation and Management) Ordinance 2005 establishes a combination of closed areas and a three mile no-take zone around the entire coastline of the Falkland Islands. As such, commercial fishing is not allowed within the inshore waters of the Falkland Islands and it is generally considered that commercial species are not found in Stanley Harbour in significant numbers, although there is potential for them to be present in low numbers.

A9.2.3Marine mammals

Marine mammals of the Falklands can be divided into two main categories, namely pinnipeds (elephant seals, sea lions, fur seals, leopard seals), and cetaceans (whales, dolphins and porpoises). Cetaceans can be further divided into baleen whales (mysticeti) such as the humpback whale, sei whale and Southern right whale, which feed by extruding plankton from seawater which is filtered through baleen plates; and toothed whales and dolphins (odontoceti) such as killer whales, sperm whales, dolphins and porpoises which all have teeth for prey capture.

Stanley Harbour is a frequented by adult and juvenile Commerson's dolphins (*Cephalorhynchus commersonii*), and South American sea lions (*Otaria flavescens*) are regularly seen, with occasional sightings of Peale's dolphins (*Lagenorhynchus australis*). On rare occasions, leopard seals (*Hydrurga leptonyx*) are also sighted.

A9.2.3.1 Pinnipeds

Amongst seals and sealions, at least six species have been recorded in the Falkland Islands in recent years, three of which are known to breed on the islands; South American fur seal (*Arctocephalus australis*), Southern sea lion (*Otaria flavescens*); and Southern elephant seal (*Mirounga leonina*). Occasionally, leopard seals can be seen in Stanley Harbour and Port William, and are often seen hauling out on nearby Surf Bay. Elephant seals are rarely seen in the Stanley area, and the ross seal (*Ommatophoca rossii*), is only rarely seen in the Falklands.

South American fur seals pup in December, which is followed by their moult period, which can last up until May the following year. Elephant seals have two known breeding locations in the Falklands (**Figure 9.13**), however, they also utilise haul-out areas across the islands, particularly during their haul-out periods. Southern sea lions have 70 breeding colonies across the Falklands, and South American fur seals have a total of nine known breeding colonies (Auge *et al*., 2015).

In relation to the Stanley Harbour / Port William region, only the Southern sea lion is found in significant numbers and can be seen throughout the area at any time of year (Baylis *et al*., 2015). The Southern sea lion regularly hauls out on Stanley's wharfs and pontoons, including FIPASS; individuals haul-out in the centre areas between barges on the supporting structures, to the rear of FIPASS on the pontoon, fendering and Ro-Ro. The number of sea lions using the pontoons vary, from single individuals to three-four at a time. There is a Southern sea lion breeding colony south of Stanley, at Seal Point, approximately 18.5km around the coastline, or 5.5km across land. There is also a relatively small colony of South American fur seal to the north of Berkley Sound, approximately 20km from the proposed scheme (**Figure 9.13**; Baylis *et al*., 2015)).

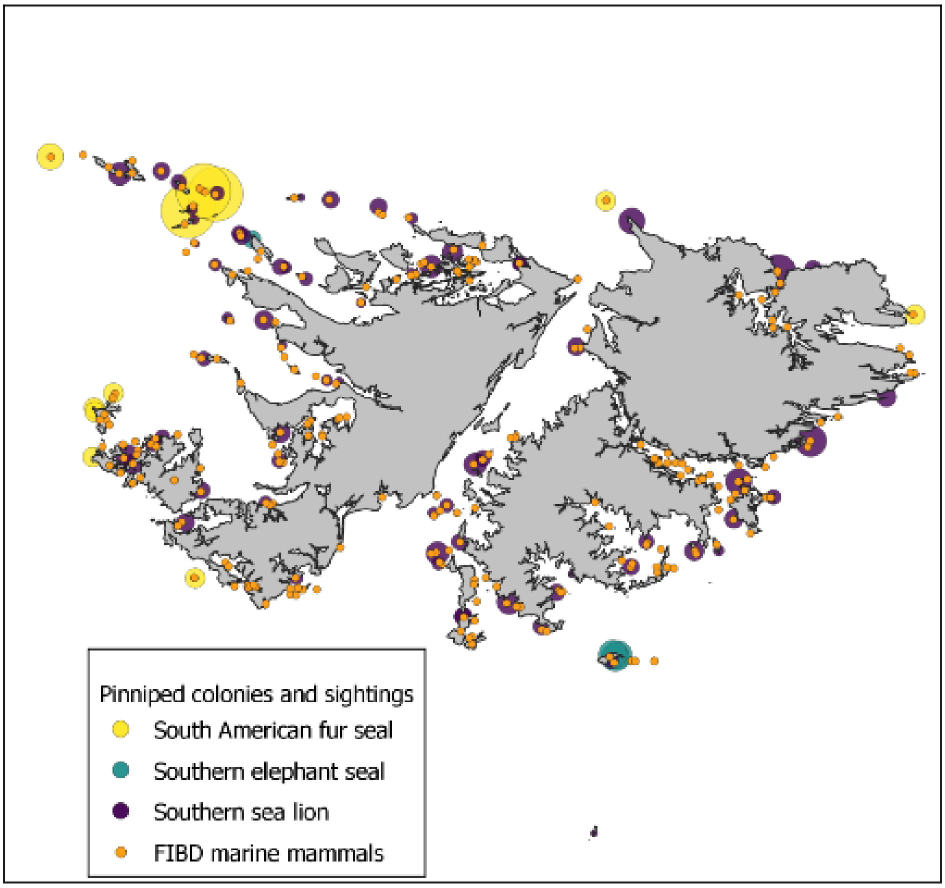

Figure 9.13 **Sea lion, fur seal and elephant seal colonies in the Falklands. Symbol size is proportional to colony size (numbers of individuals observed). Also shown are FIBD records for fur seals, sea lions and elephant seals combined, where the point indicates observed presence (Baylis per com, FIBDV8_20140601)**

The fifth census of Southern sea lion abundance and distributions was undertaken in January and February 2014 (Baylis *et al*., 2015). All known breeding colonies were surveyed during the survey period, and the number of pups at each site recorded (**Figure 9.14**; Baylis *et al*., 2015). In total, 4,443 pups were recorded during the 2014 census, at 70 different breeding colonies around the Falkland's; this was a 60% increase in the number of pups compared to the 2003 census, equating to an annual increase of 8.5%. At Seal Point, a total of 93 pups were recorded in 2014. Over the Falklands, the estimated total population of Southern sea lions is 7,500, based on the number of pups observed in 1995 and 2003 (Crespo *et al*., 2012).

A tagging study of Southern sea lions in the Falklands has shown that individuals will make foraging trips from their haul-out sites up to 268km (84km on average), with a foraging trip duration of a maximum of six days (or an average of four) (Baylis *at al*., 2015).

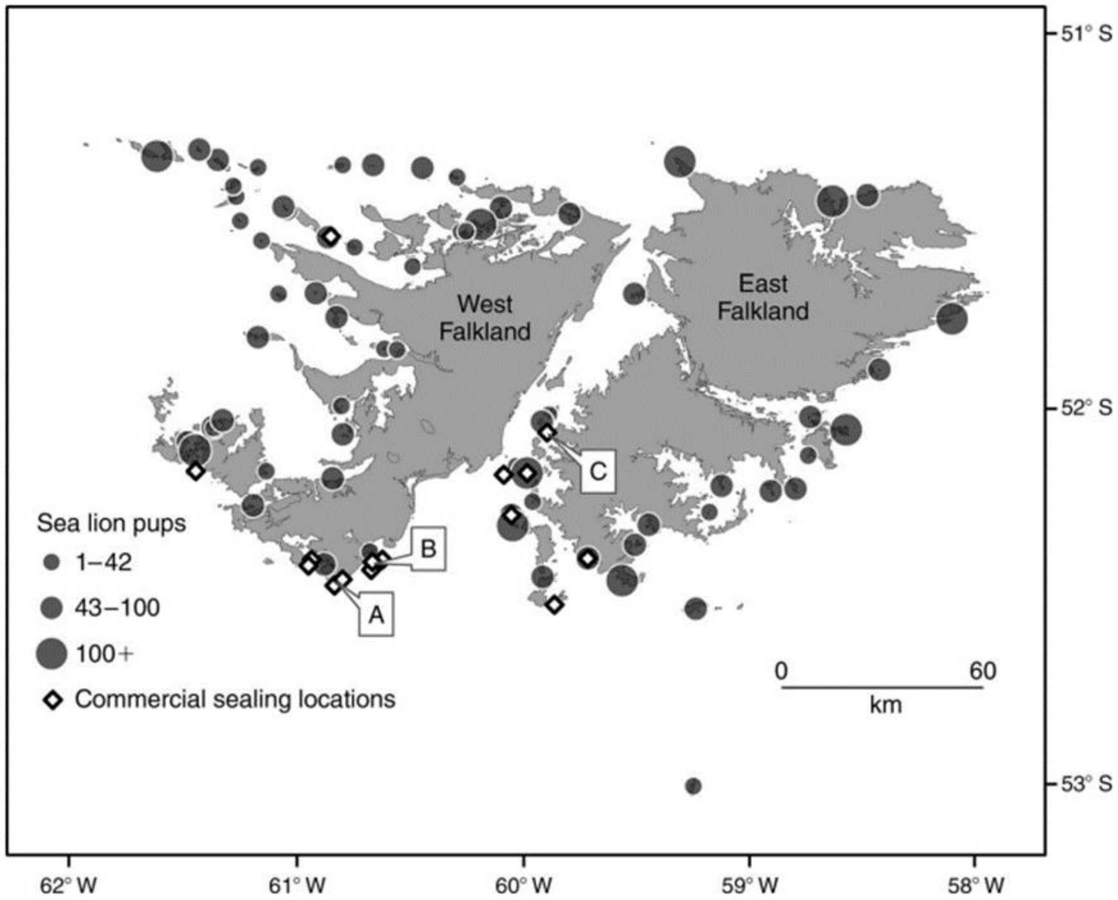

Figure 9.14 **The location and size of Southern sea lion breeding colonies surveyed in 2014 (Baylis *et al*., 2015)**

A series of at-sea surveys were carried out by the Joint Nature and Conservation Committee (JNCC) from February 1998 and January 2001 around the Falkland Islands, to report on the distribution of marine mammals (and seabirds) (White *et al*., 2002). In total, 20,907km^2 of survey effort was achieved over the three year period, and the survey effort is shown in **Figure 9.15**.

A total of 937 South American fur seals were recorded during the three year JNCC surveys for marine mammals and seabirds (White *et al*., 2002). While fur seals were recorded in all seasons, peaks in abundance were observed in the summer months (June and July), with a second peak in November. For the area covering Stanley, a density of between 0.001 and 0.019 per km^2 was reported for the periods from June to January (no density estimate was available for the Stanley area from February to May due to a lack of sightings) (**Figure 9.16;** White *et al*., 2002).

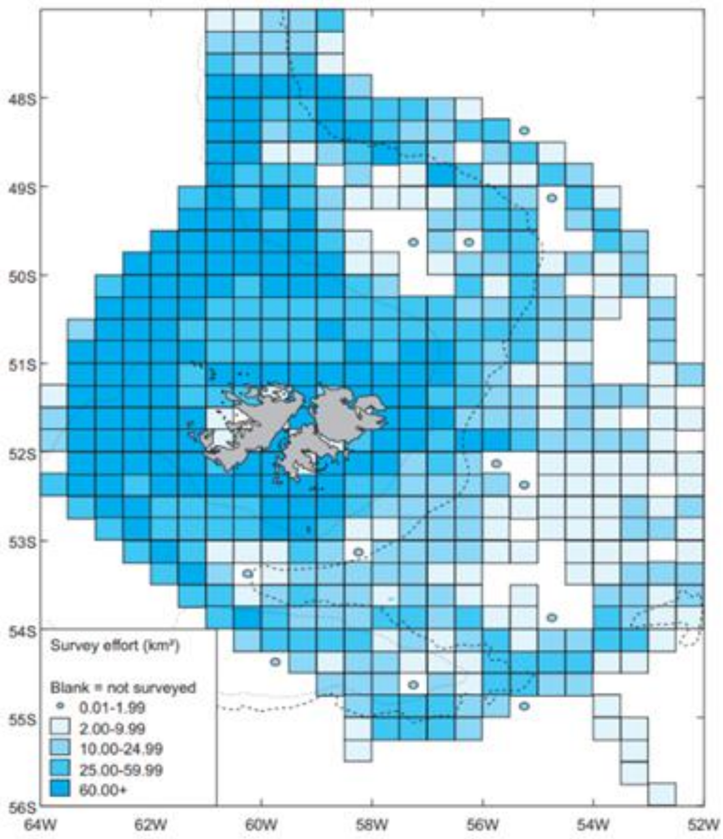

Figure 9.15 **Total survey effort for the three year JNCC marine mammal surveys of the Falkland Islands (White *et al.,* 2002)**

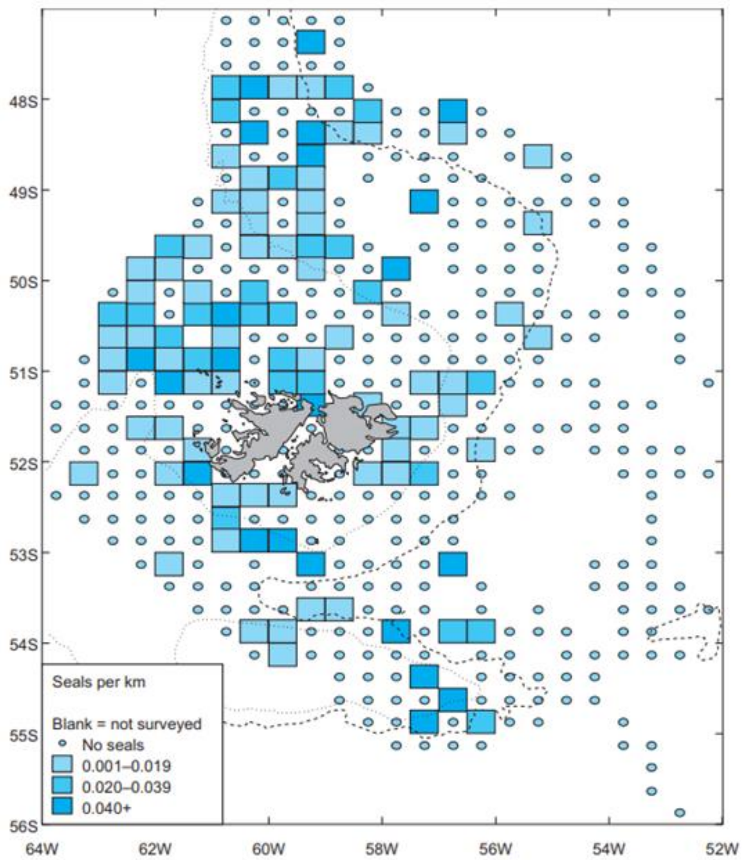

Figure 9.16 **Example densities of the South American fur seal, from June to October, where the species was present in the highest numbers, as estiamted from the three year JNCC marine mammal surveys (White *et al*., 2002)**

A9.2.3.2 Cetaceans

The highly productive waters of the inshore Falklands shelf areas support large resident populations of Commerson's dolphins (*Cephalorhynchus commersonii*) and Peale's dolphins (*Lagenorhynchus australis*), as well as at least four species of baleen whales, that among other locations, visit inshore areas of Berkley Sound and Port William seasonally for feeding or resting, namely sei whales (*Balaenoptera borealis*), fin whales (*Balaenoptera physalus*), Southern right whales (*Eubalaena australis*) and Antarctic minke whales (*Balaenoptera bonaerensis*). Killer whales (*Orcinus orca*) can also occasionally be seen off Cape Pembroke and Berkeley Sound. In total there have been 25 cetacean species observed in the Falklands; notably humpback whales (*Megaptera novaeangliae*) have recently been seen off the coast of Cape Pembroke and in Falkland Sound.

While evidence suggests that there would be a low risk of sei whale presence within Stanley Harbour (as outlined below), they are included in the following baseline review, and subsequent impact assessments, due to their presence in the nearby Berkley Sound. Due to the lack of site-specific survey data, it is not possible to be certain that no sei whale would be present within potential impact ranges, as the survey data presented in the following sections did not include coverage of the Stanley Harbour area. Sei whale are sensitive to the potential impacts from the proposed scheme, and therefore, under a precautionary approach, have been included, however, given the shallow water depth and the narrow entrance into the harbour area they are unlikely to be present in the close vicinity of the proposed scheme footprint. In addition, the entrance into the harbour is a shipping lane which may also influence the marine mammals in the harbour.

Commerson's and Peale's dolphins

The SAERI Dolphins of the Kelp project conducted Falkland-wide aerial transect surveys within 10km of the shore, with the aim of estimating abundances and distributions of both Commerson's and Peale's dolphins around the Falklands (Costa and Cazzola, 2018). The aerial surveys were undertaken over nine days, from March to May 2017, with the majority of effort undertaken in sea conditions of Beaufort 4 or less (83% of effort). Small boat-based focal studies were also undertaken, using both Photo-ID and acoustic monitoring surveys to investigate seasonal site fidelity of inshore cetaceans for population dynamics of Commerson's and Peale's dolphins between 2015-2018. The projects aimed to establish baseline data on the abundance, distribution, natural history and genetic diversity of the Falklands inshore cetacean populations to provide a scientific basis for conservation and ecosystem-based marine management initiatives (Costa and Cazzola, 2018). **Figure 9.17** shows the aerial transect survey lines undertaken as part of the Dolphins of the Kelp project, with Stanley Harbour being at the northern end of Stratum 8 (Costa and Cazzola, 2018).

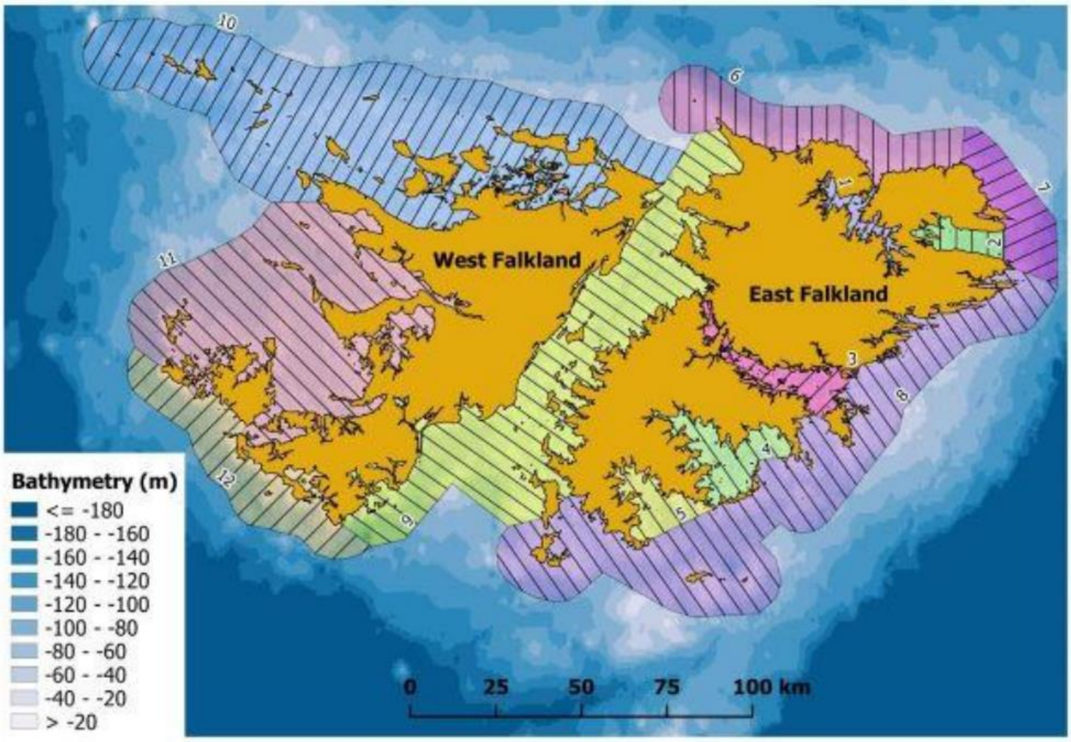

Figure 9.17 **Study area and aerial transect lines for the Dolphins of the Kelp Project (Costa and Cazzola, 2018)**

A total of 454 sightings were made during these aerial surveys, with a total seven species recorded. The most commonly recorded species was the Commerson's dolphin (238 sightings), with relatively fewer Peale's dolphin (total of 60 sightings). Both species were recorded near to Stanley Harbour. The abundance estimates derived for Commerson's and Peale's dolphins, from the aerial surveys are 5,789 (coefficient of Variation (CV) = 0.18), and 1,896 (CV = 0.33), respectively (Costa and Cazzola, 2018).

The small-scale focal boat survey, one of which was focused on Port Stanley, Port William and Berkley Sound, was undertaken in both summer and winter seasons (November and December 2016 and 2017, January 2017, June and July 2017 and 2018, February to March 2018) (Costa and Cazzola, 2018). In total, during all boat surveys, 560 sightings were made, the majority of which were again of Commerson's dolphins (348 sightings), with fewer Peale's dolphins (162 sightings). Commerson's dolphins are present all along the coastline, but where 'hotspots' exist, the number of animals present was higher in summer than winter. Peale's dolphins showed a restricted distribution (Port William seems to be a 'hotspot' for this species), and although recorded in summer and winter, more animals were sighted in the winter. Where the two species overlap, Commerson's dolphins occupied the inner part of the bay and Peale's the outer. Within Stanley Harbour, only Commerson's dolphins were recorded, and in Port William, only Peale's dolphin were sighted. **Figure 9.18** gives an example of Commerson's and Peal's distributions in Nov/Dec 2016 (Costa and Cazzola, 2018).

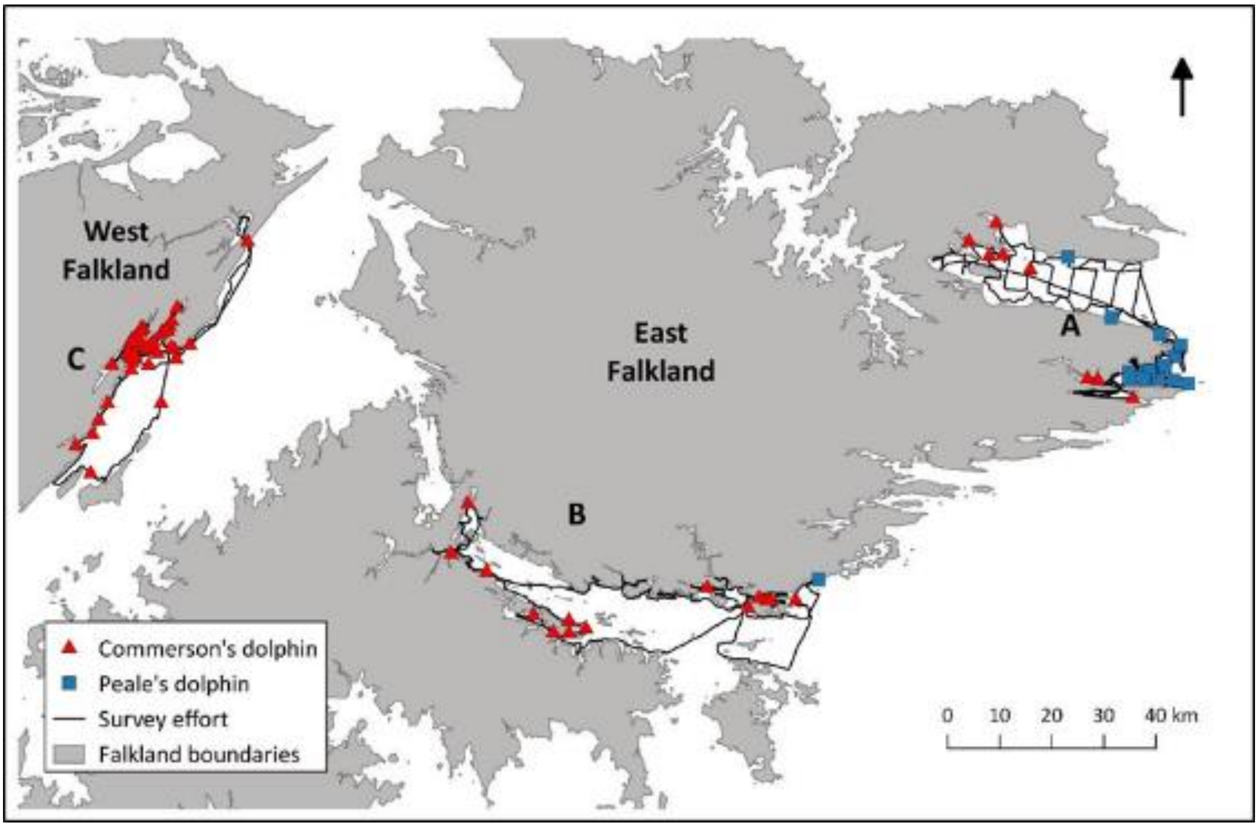

Figure 9.18 Survey effort and dolphin sightings between 21 November and 22 December 2016, in the three focal areas; A, Port William and Berkeley Sound; B, Choiseul Sound and Bertha's Beach; C. Port Howard and many Branch Harbour (source: Costa and Cazzola, 2018)

The Photo-ID studies suggest that there is connectivity between Commerson's dolphins in survey area A and B (shown on **Figure 9.18**), but not between survey areas A or B and Area C. For Peale's dolphins, no individuals were recorded in more than one survey area (Costa and Cazzola, 2018).

The results of the genetic analyses undertaken for Peale's dolphins found that there is a significant difference between the east and west Falklands populations, suggesting limited connectivity between the populations. Limited sharing of genetics was also identified between the east and west Falklands populations of Commerson's, but there was no evidence of population differentiation. Genetic separation was however evident for both Commerson's and Peale's dolphins from the contingent continental populations, with enough significance to suggest they should be considered as a separate stock, and should be managed as such (Costa and Cazzola, 2018).

Surveys specifically designed for sei whale distributions around the Falkland Islands were undertaken in 2018, which focused on the west coast of the Falklands (Weir, 2018). During these surveys, additional visual survey effort was completed for all transit time, which included survey effort for the entire coastline of the Falklands, with a total of 157.2 hours of survey effort (covering 1,959.6km of effort). Within this non-transect survey effort, a total of 1,998 marine mammals were recorded, with a total of 423 Peale's dolphins, 383 Commerson's dolphins, 559 sei whales and 607 unidentified baleen whales. This data, along with the transect line data collected within the west Falklands, was used to determine density and abundances of marine mammal species wherever survey effort was sufficient. Within this analysis, it was assumed that all unidentified baleen whales were sei whales, as the most common species in the Falklands. As survey effort was not equal throughout the survey and transit areas, relative abundance and densities were calculated.

For Port William, the estimated relative density of Peale's dolphins was estimated to be between 0.01 and 0.5 individuals per km^2, to more than $2.0km^2$ (**Figure 9.19**; Weir, 2018). For Commerson's dolphins, the estimated density within Port William was estimated to be less than 0.001 individuals per km^2 (**Figure 9.20**; Weir, 2018). It should be noted however, that survey effort was lower within the inner areas of Port William and Stanley Harbour.

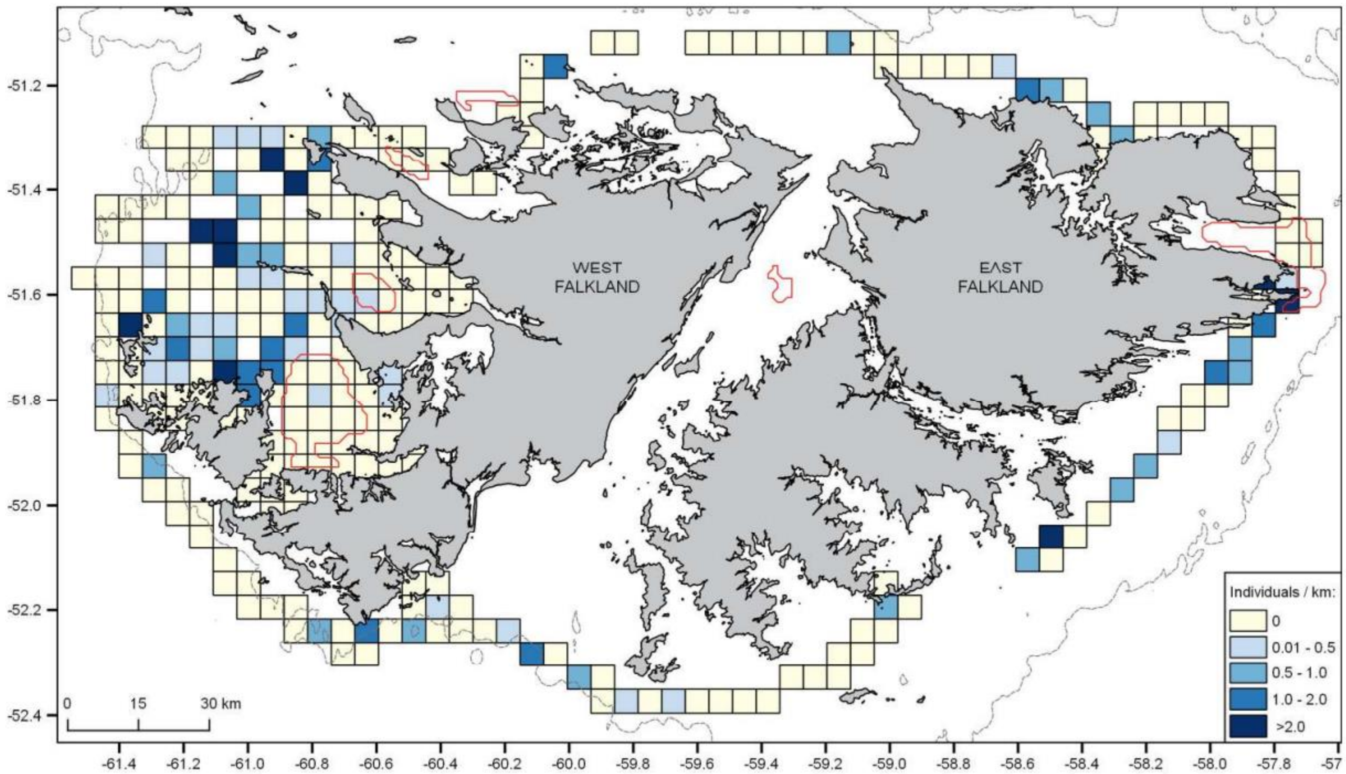

Figure 9.19 **The estimated relative densities of Peal's dolphins in the Falklands (Weir, 2018).**

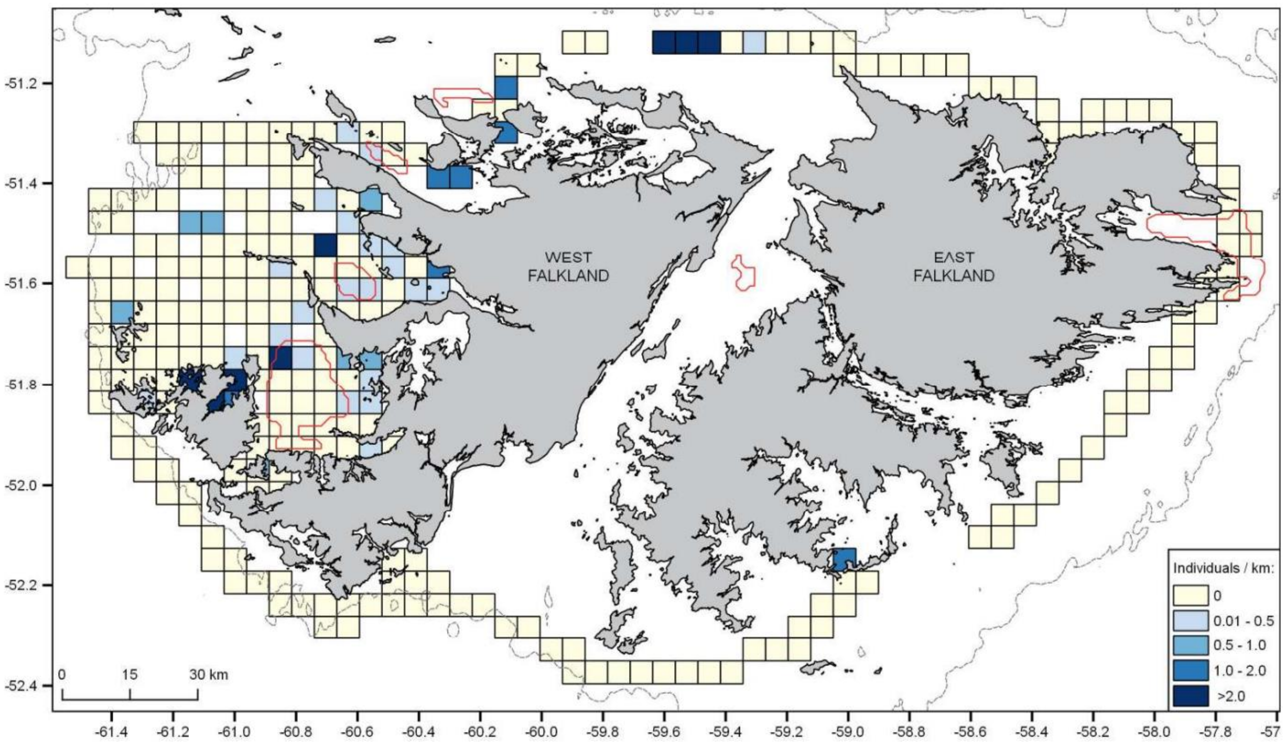

Figure 9.20 **The estimated relative densities of Commerson's dolphins in the Falklands Weir, 2018).**

Within the three year JNCC marine mammal surveys (of 1998 to 2001), a total of 2,617 Peale's dolphins were recorded during the three years of surveys for marine mammals and seabirds (White *et al*., 2002), with the majority being reported in areas with waters of less than 200m in depth. For the area covering Stanley, a density of between 0.03 and 0.079 per km^2 was reported for Peale's dolphins (**Figure 9.21**; White *et al*., 2002).

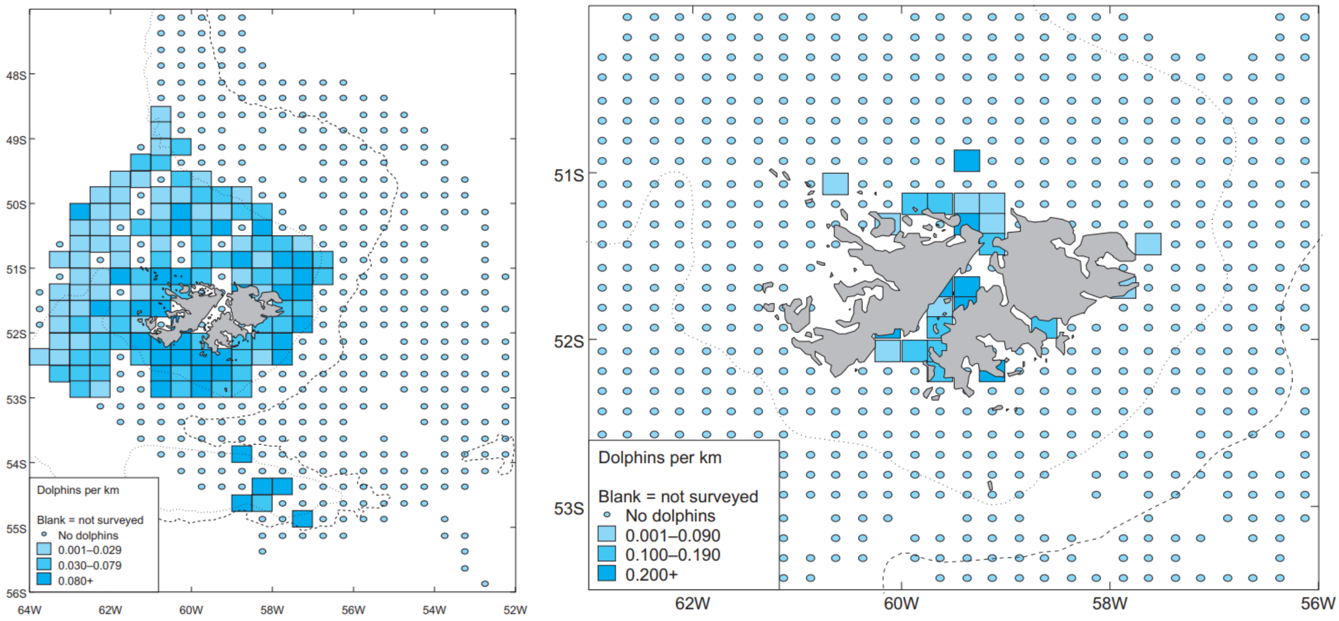

Figure 9.21 Densities of Peale's dolphin (left) and Commerson's dolphin (right) as estiamted from the three year JNCC marine mammal surveys (White *et al*., 2002)

During the JNCC survey, a total of 336 Commerson's dolphins were recorded (White *et al*., 2002), with the majority being reported in coastal areas, and partially enclosed waters. For the area covering Stanley, a density of between 0.001 and 0.09 per km^2 was reported (**Figure 9.21** White *et al*., 2002).

The reproductive peak of Commerson's dolphins was found to be February and March, with some new-borns being observed up until July, and for Peal's dolphins the peak was observed to be January (Costa and Cazzola, 2018). Newly born and juveniles have been observed in Port William (Peal's and Commerson's) and Stanley Harbour (Commerson's only).

Sei and Southern right whales

The most commonly occurring whales that utilise inshore waters near Stanley are sei whales and Southern right whales (Weir, 2017). More recently, humpback whales (*Megaptera novaeangliae*) have also been observed at Port William and Berkley Sound (C. Weir, pers comm).

Berkeley Sound, Falkland Sound and the west coast of West Falkland are used by sei whales for feeding, and individuals are likely to use the Falklands in summer months as part of their wider distribution range. Southern right whales are present during late autumn/winter, with numbers seemingly increasing in the last few years. They tend to occupy inshore waters, sometimes very close to land in East Falkland. In winter 2018 few individuals (15-25) were observed near the Volunteer Point area and in Choiseul Sound. In both years, mating behaviour was observed, although calves were not recorded. Anecdotal observations have reported Southern right whales in as far as Gypsy Cove in Port William, with one account of a Southern right whale in the area around FIPASS (Frans and Augé, 2016).

While the Dolphins of the Kelp project was focused on Commerson's and Peale's dolphins, other marine mammal species, including sei whales and Southern right whales were also surveyed and reported on (Costa and Cazzola, 2018). During the aerial surveys, of the 454 total sightings, sei whale was the most often sighted whale species (total of 74 sightings), with just one Southern right whale recorded. The estimated abundance of sei whales was reported as 148 (CV = 0.31), while the numbers of Southern right whales were too low to determine an estimated abundance level (Costa and Cazzola, 2018).

Falklands Conservation is conducting ongoing research into Southern right whale and sei whale population structure through a Darwin Plus funded project currently underway. During early 2017, Falklands Conservation initiated a project entitled, '*Developing a site-based conservation approach for sei whales (Balaenoptera borealis) at Berkeley Sound, Falkland Islands*'. The project aimed to improve knowledge of sei whales in the Falkland Islands, increase awareness and provide information on the potential for interaction between whales and human activities, and results are presented in Weir (2017).

A series of surveys were undertaken as part of this project, including shore-based, aerial and boat-based. All surveys were focused on Berkley Sound and Port William (the aerial transect survey tracts are shown on **Figure 9.22**; Weir, 2017). A total of 14 shore-based surveys were completed (from Pembroke Lighthouse), from January to June 2017. A total of six aerial surveys were undertaken, from February to May. Boat-based surveys were undertaken from February to May 2017, with 26 surveys undertaken in total, over a total survey effort of 2,841.6km and 99.6 active search hours. All sightings data were corrected for availability bias (to account for the time where marine mammals are underwater and therefore not possible to detect from aerial survey methods). The boat-based surveys were aimed to collect information on abundance and distributions, as well as to determine the potential for Photo-ID studies to be undertaken, and data on diet (through faecal sampling), genetic studies and cue rates was also collected (Weir, 2017).

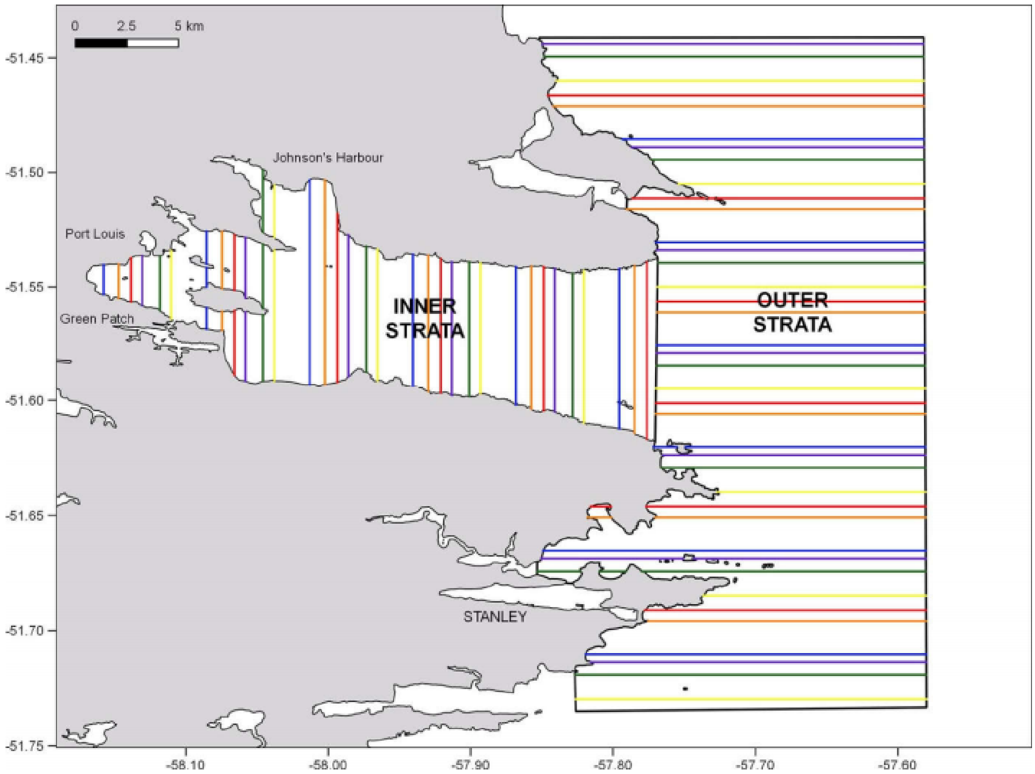

Figure 9.22 Aerial survey transect lines for Berkley Sound (Weir, 2017).

During the shore-based surveys, a total of 240 individuals were sighted while on-effort, and 148 while off-effort. Of those, 74 individuals were sei whales (a further 40 individuals were reported as unidentified large baleen sei-type whale), and 39 were identified as Southern right whales. Three juvenile sei whales were reported in total through the January and February surveys, and the shore-based sightings suggest sei whales are present in higher numbers from January to April, with a strong peak in March, and Southern right whales in May and June (Weir, 2017). **Figure 9.23** shows the locations of all sightings from the shore-based surveys, with both sei whales and Southern right whales being sighted near Cape Pembroke, and Southern right whales within Port William (Weir, 2017).

During the aerial surveys, a total of 54 sightings, of five different species were made, with 64 individuals sighted on-effort, and 43 off-effort. In total, 15 sei whales were identified, and 10 Southern right whales. In addition, 27 unidentified large baleen whales were reported. Sei whales were recorded throughout the survey area, but the majority were within Berkley Sound, or the mouth of the Sound. Southern right whales were distributed in the more offshore areas of the survey area (Weir, 2017). **Figure 9.24** and **Figure 9.25** show the spatial distributions of sei whale and Southern right whale sighting groups.

During the boat-based surveys, a total of 357 sightings of cetaceans were made, with 1,051 individuals. Of those, 299 were sei whale, and 15 Southern right whale. The majority of the remainder of the sightings were Peale's dolphins (with 616 individuals recorded in total) (Weir, 2017). A total of nine unidentified baleen whales were also recorded. Sei whales were predominantly recorded inside and at the mouth of Berkeley Sound, while Southern right whales were distributed further offshore, in line with the results of the aerial surveys are described above. **Figure 9.26** and **Figure 9.27** show the spatial distributions of sei whale and Southern right whale sighting groups. Sightings of whales made during the boat-based survey were photographed extensively for the Photo-ID study. Of the sei whale sightings, the Photo-ID study has shown that at least 87 different individuals were sighted. This should be considered as an absolute minimum population size only (Weir, 2017).

Although surveys were only undertaken during the first half of the year, the results support previous reports of seasonal presence of sei whales, with all sightings occurring between January and May. The majority of animals observed were seen in water depths of 20-50m, with relatively few in water less than 15m in depth. It should be noted that over the majority of the area of Stanley Harbour, depth typically ranges between approximately 5m and 9m. Bathymetric and topographic survey data was collected in September 2020 in the immediate vicinity of the proposed scheme footprint (**Figure 7.2**), showing that FIPASS, and consequently the proposed scheme, is typically within water depths of around 3 - 5m. At the shore, the sea bed shelves steeply, reducing by around 5m in water depth (from +1m to -4m) over a length of around 175m. The water in Stanley Harbour is therefore shallower than that where the majority of animals were observed during the surveys.

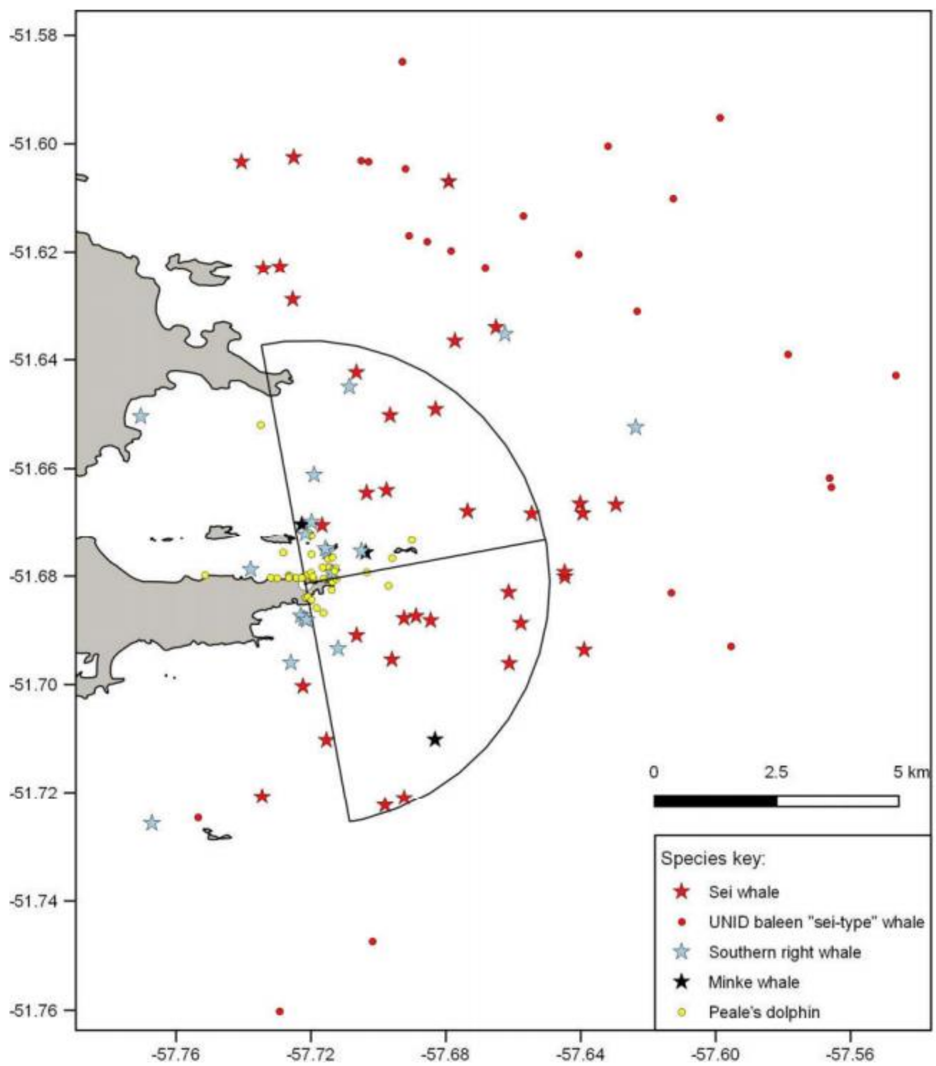

Figure 9.23 **All sightings made during the shore-based surveys at Pembroke Lighthouse, east of Stanley (Weir, 2017)**

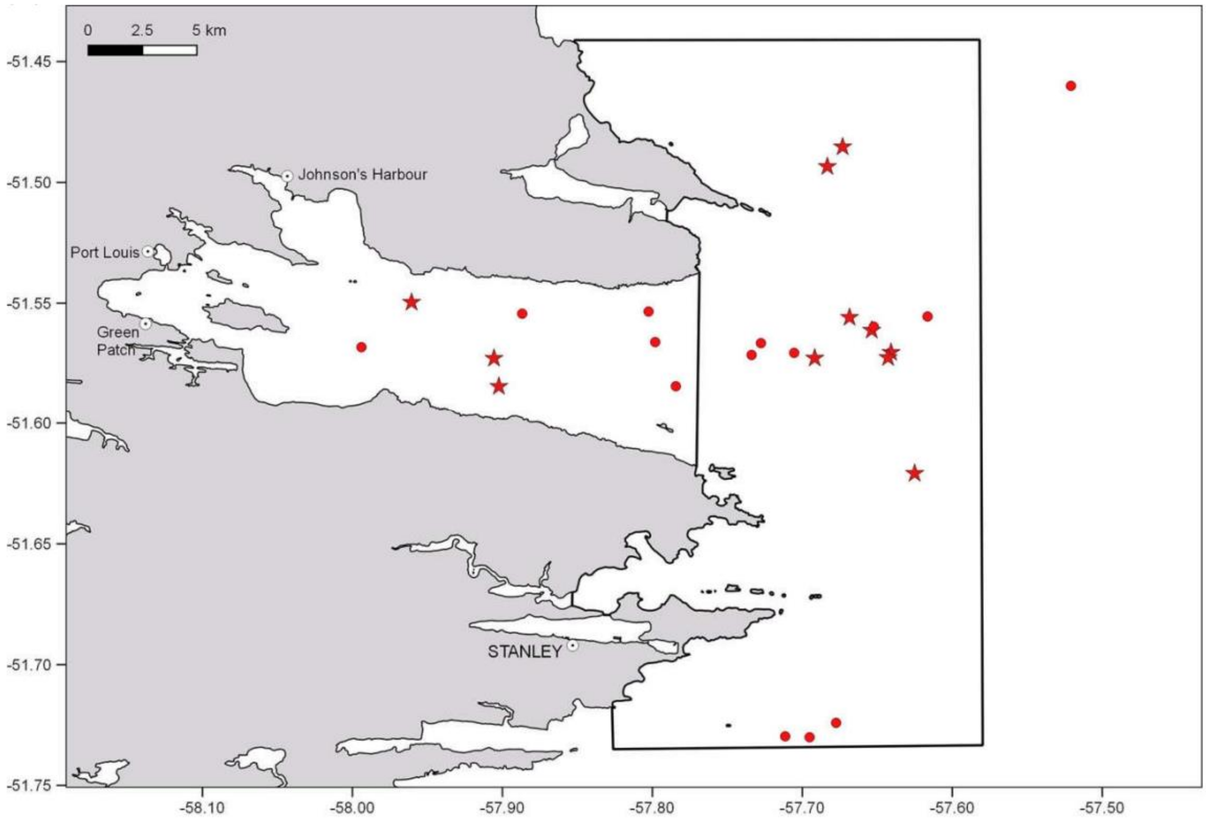

Figure 9.24 The spatial distribution of sei whales recorded during aerial-based surveys in Berkeley Sound [stars = confirmed sightings, circles = probable sightings] (Weir, 2017)

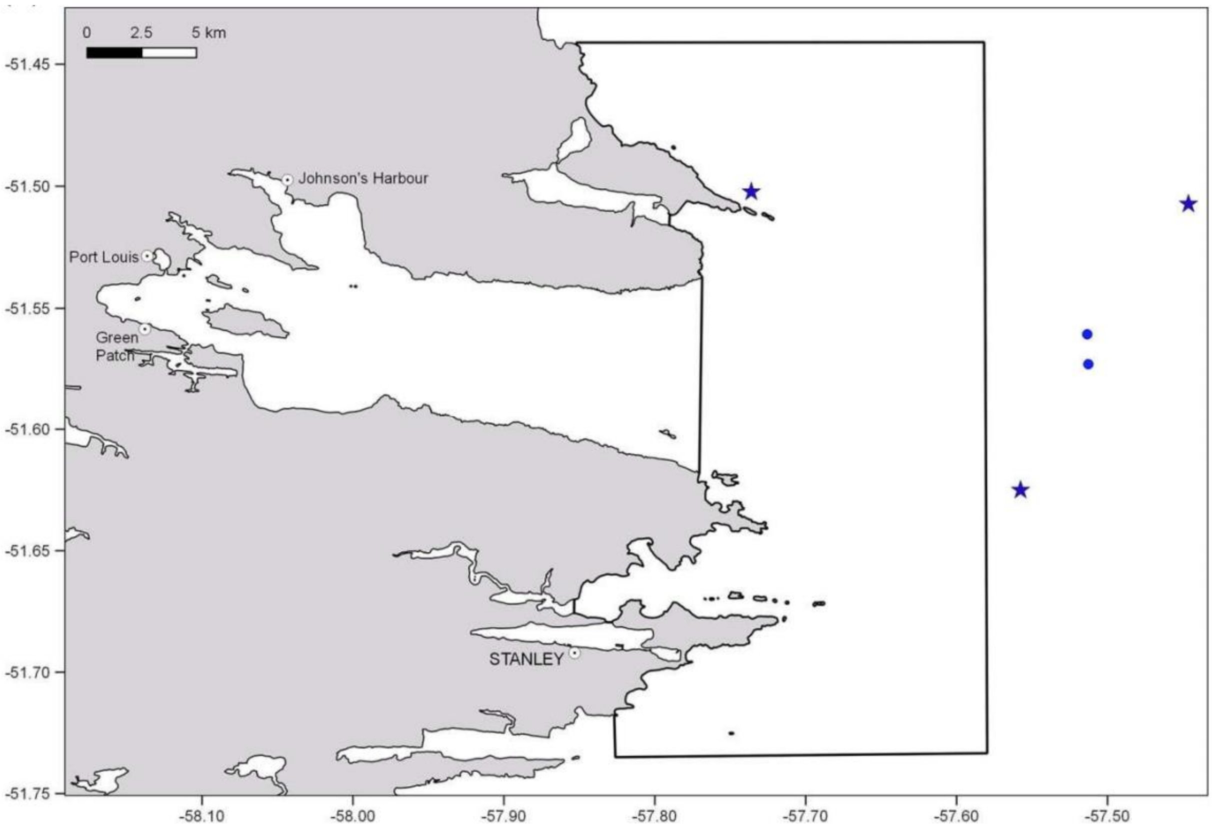

Figure 9.25 The spatial distribution of Southern right whales recorded during aerial-based surveys in Berkeley Sound [stars = confirmed sightings, circles = probable sightings] (Weir, 2017)

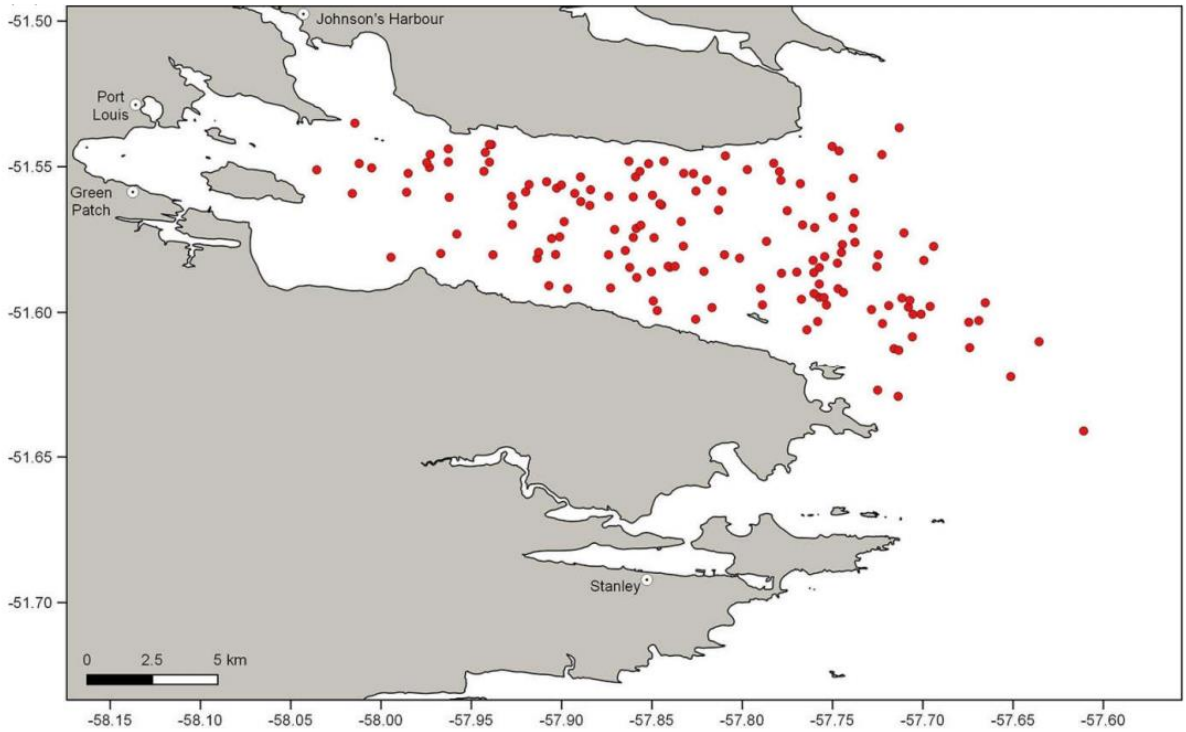

Figure 9.26 **The spatial distribution of sei whales recorded during boat-based surveys in Berkeley Sound (Weir, 2017)**

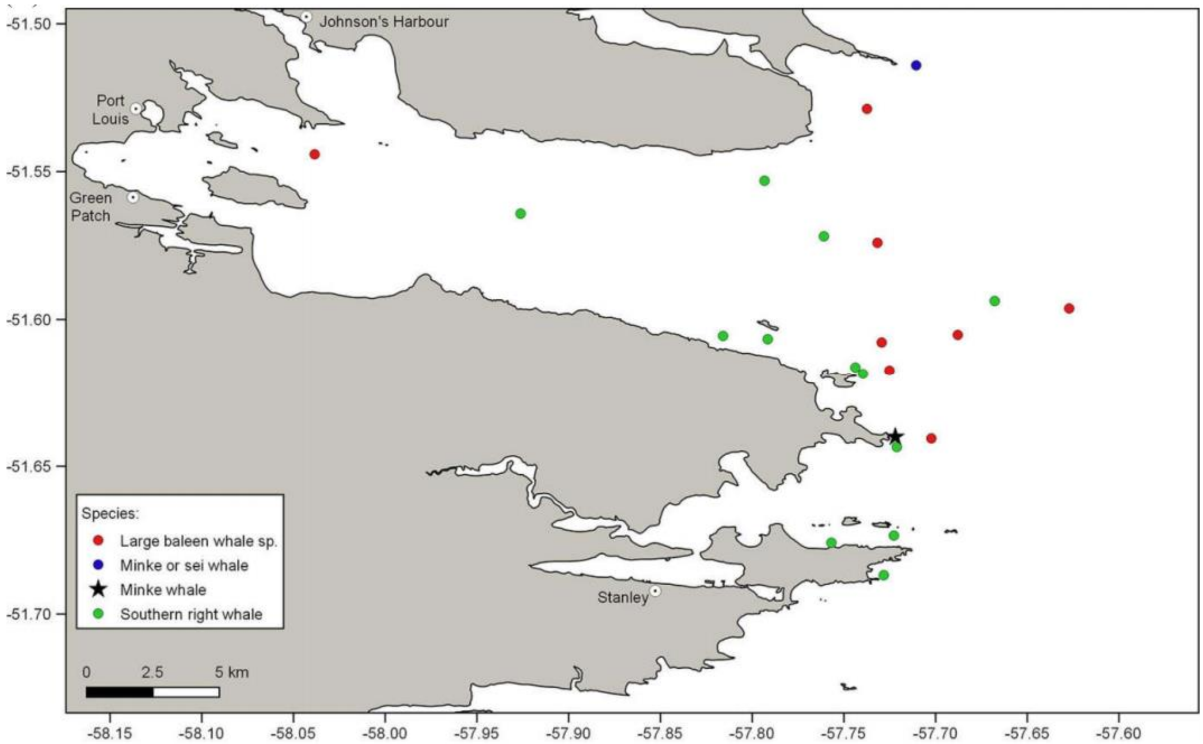

Figure 9.27 **The spatial distribution of Southern right whales recorded during boat-based surveys in Berkeley Sound (Weir, 2017)**

It should be noted that all surveys reported in **Figure 9.24** to **9.27** were focused on Berkley Sound and Port William; this is likely to be the reason that no individuals are shown within Stanley Harbour on **Figure 9.24** to **Figure 9.27.** The very narrow entrance into Stanley Harbour as well as the fact the entrance is a busy shipping lane may also limit the potential for whales to the present within the harbour.

During the 2018 sei whale surveys of West Falkland, out of 1,998 recorded marine mammals during the transit survey effort, a total of 559 sei whales, and 607 unidentified baleen whales were sighted (Weir, 2018). These data, along with the transect line data collected within the west Falklands, was used to determine density and abundances of marine mammal species wherever survey effort was sufficient. Within this analysis, it was assumed that all unidentified baleen whales were sei whales, as the most common species in the Falklands. As survey effort was not equal throughout the survey and transit areas, relative abundance and densities were calculated. For Port William, the estimated relative density of sei whale was estimated to be between 0.01 and 0.33 individuals per km^2 in the outer areas part, and for the inner area of Port William, was estimated to be less than $0.01km^2$. It should be noted however, that survey effort was lower within the inner areas of Port William and Stanley Harbour (**Figure 9.28**; Weir, 2018).

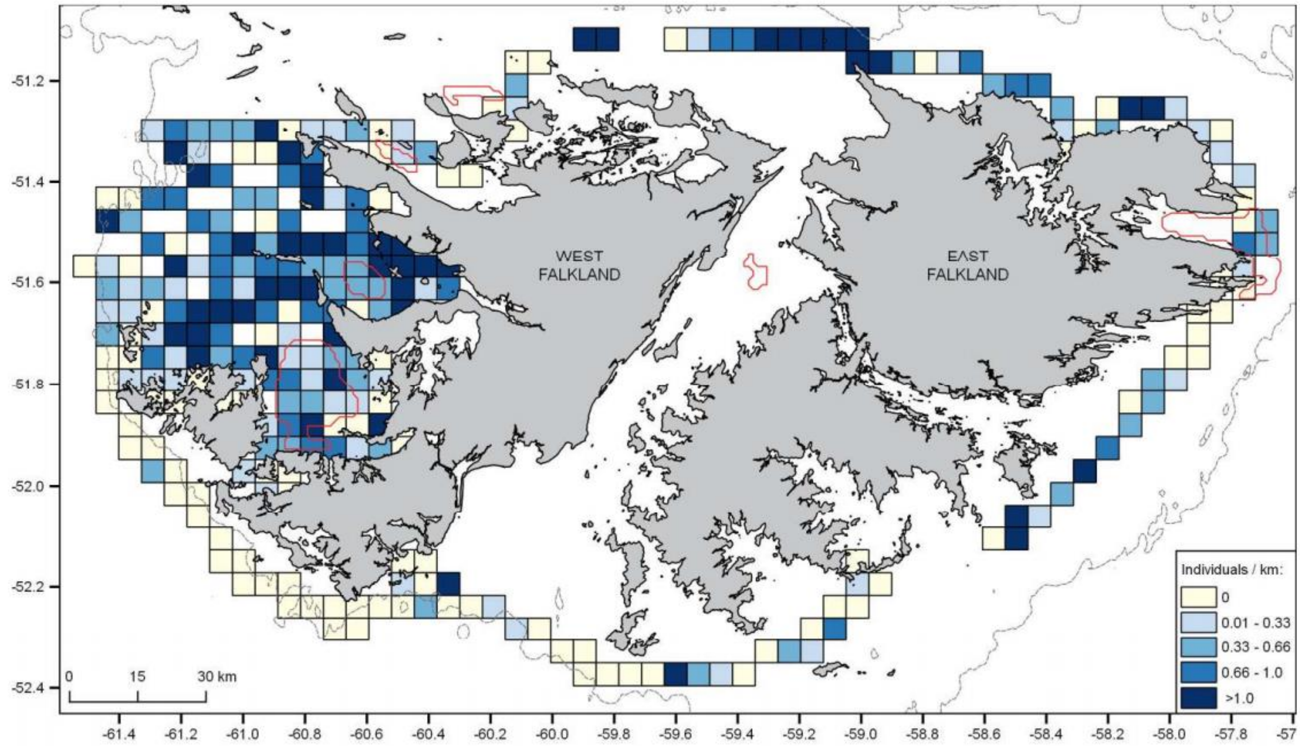

Figure 9.28 The estimated relative densities of sei whale (and unidentified baleen whales) in the Falklands (Weir, 2018)

During the sei whale surveys of Berkley Sound, faecal samples were taken in order to identity prey species. Results from a total of 19 samples taken from February to May 2017, show the main prey species to be lobster krill (*Munida gregaria*), and large variances in carbon isotope ratios suggests that they are feeding over a broad geographic area (Weir, 2017).

Other marine mammal species

During the Dolphins of the Kelp project, a number of less common marine mammal species were sighted. Of the 454 sightings made during the aerial surveys, 12 fin whale, two dwarf minke whale and two blue whale were recorded. Of these, only fin whale was recorded to the north-east of East Falkland (Costa and Cazzola, 2018). During the sei whale surveys of Berkley Sound (Weir, 2017), a total of three minke whale were recorded (although not to sub-species level due to distance) during the shore-based surveys. These minke whale were located in the mouth of Port William and in the offshore area (**Figure 9.23**; Wier, 2017). During the aerial surveys, a further four minke whale were recorded within the Berkley Sound and offshore areas. Within the boat-based surveys, two minke whale and one dusky dolphin were recorded. The minke whale was recorded in the offshore areas of the survey (**Figure 9.27**; Wier, 2017).

Marine mammal observations: September to November 2020 FIPASS

The data from the MMO (reported in **Table 9.2**) provides information regarding marine mammals in the FIPASS area. As outlined in **Table 9.2**, the number of animals sighted per day varied, but the average number of marine mammals seen per day was five, including both Commerson's dolphins and Southern sea lions. There were 13 out of 39 observation days where marine mammals were not observed, however it should be noted that observers were only making observations at pre-drilling and after any major stoppages (i.e. observations were not undertaken throughout the whole day). It should also be noted that no observations were undertaken during periods of downtime caused by weather. While this data provides a good indication as to the presence of some marine mammal species within Stanley harbour, it was not an effort based survey and marine mammals were not monitored for at all times, and therefore the information provided within the table should not be treated as an accurate indication of species and abundance levels within the harbour.

One major factor for attracting dolphins and prolonging the timeframe that they remained in the impact zone was the presence of moving boats involved with the drilling activity. Boat activity seemed to attract the dolphins regardless of the rig actively drilling or not. Commerson's dolphins showed a high degree of curiosity, often attracted to either the vessel or the ROV. It is therefore concluded that the data in **Table 9.2** may not be truly representative of the actual marine mammal populations in Stanley Harbour (as the drilling work which was ongoing at the time may have skewed the results due to the fact marine mammals were attracted to the presence of survey vessels).

Table 9.2 Results of the MMO undertaken from September to November 2020 at FIPASS

Date	MMO effort (hours: mins)	Species (SL = Sea Lion, CD = Commerson's Dolphin)	Number of adults	Number of juveniles	Bearing to animal from source	Range of animal to source (m)	Behaviour	Duration of encounter (hours:mins)
26/09/2020	05:45	SL	3	-	270	15	Slow/ normal swim, and resting / milling	00:20
28/09/2020	05:10	SL	2	-	255	33	Spy-hopping, slow/ normal swim, and resting / milling	00:35
		CD	3	-	250	Unknown	Bow-riding, and slow / normal swim	00:45
29/09/2020	03:04	SL	1	-	15	18	Spy-hopping, slow/ normal swim, and resting / milling	01:35
30/09/2020	00:41	CD	2	-	80	400	Slow/ normal swim	00:36
01/10/2020	01:36	SL	1	-	-	-	Slow/ normal swim	00:02
06/10/2020	00:59	SL	1	-	-	60	Slow/ normal swim	00:02
		SL	4	-	-	50	Fast swim, and leap / splashing	00:02
07/10/2020	04:43	SL	5	-	-	100	Slow/ normal swim	00:17
		SL	1	-	-	-	Slow/ normal swim	00:03
		SL	6	-	240	200	Slow/ normal swim, and feeding	03:09
		SL	1	-	180	60	Resting/ milling	00:01
		CD	3		-	3	Fast swim	00:07
		CD	3		90	1	Fast swim	00:17
		SL	1	-	90	30	Spy-hopping, and fast swim	00:02
08/10/2020	01:00	SL	1	-	180	150	Spy-hopping	00:02
09/10/2020	02:16	SL	4	-	90	200	Slow/ normal swim, feeding, and leaping	00:21

Date	MMO effort (hours: mins)	Species (SL = Sea Lion, CD = Commerson's Dolphin)	Number of adults	Number of juveniles	Bearing to animal from source	Range of animal to source (m)	Behaviour	Duration of encounter (hours:mins)
		SL	1	-	90	100	Slow/ normal swim, and resting / milling	00:31
12/10/2020	03:08	SL	3	-	180	30	Resting	01:24
		CD	6	-	240	70	Slow/ normal swim, and fast swim	01:09
13/10/2020	02:15	SL	3	-	180	30	Resting	00:50
14/10/2020	01:16	SL	1	-	0	50	Spy-hopping, slow/ normal swim, and resting / milling	00:08
16/10/2020	02:16	CD	3	-	-	-	Slow/ normal swim	00:18
19/10/2020	02:40	SL	1	-	180	60	Slow/ normal swim	00:01
23/10/2020	04:24	SL	2	-	-	60	Slow/ normal swim	00:04
		CD	4	1	-	20	Slow/ normal swim, and resting / milling	00:38
		CD	4	1	-	50	Slow/ normal swim, fast swim	00:38
		CD	4	-	-	10	Slow/ normal swim	00:16
25/10/2020	01:06	SL	3	-	-	25	Spy hopping, resting, and milling	00:16
		SL	2	-	-	250	Resting	00:12
		SL	1	-	-	10	Spy hopping, and slow, normal swim	00:04
26/10/2020	01:43	CD	2	-	-	5	Bow-riding, and Slow / normal swim	00:27
27/10/2020	01:26	SL	1	-	-	300	Resting/ milling	00:45
31/10/2020	02:20	CD	2	-	-	25	Slow/ normal swim, and bow riding	00:55
03/11/2020	03:48	CD	3	1	-	-	Slow/normal swim	03:02

Date	MMO effort (hours: mins)	Species (SL = Sea Lion, CD = Commerson's Dolphin)	Number of adults	Number of juveniles	Bearing to animal from source	Range of animal to source (m)	Behaviour	Duration of encounter (hours:mins)
		SL	2	-	-	150	Resting/ milling	00:03
		SL	1	-	-	250	Slow/ normal swim	00:04
04/11/2020	03:48	SL	1	-	-	30	Slow/normal swim, and resting	00:03
		SL	1	-	90	10	Resting/ milling	00:01
		CD	1	-	110	150	Slow/ normal swim, and feeding	00:20
		CD	1	-	145	80	Fast swim	00:04
05/11/2020	01:04	SL	1	-	-	100	Resting/ milling	00:01
09/11/2020	01:47	CD	3	-	-	50	Fast swim	00:04
		SL	1	-	-	25	Resting/ milling	00:38
		SL	1	-	-	25	Slow/ normal swim	00:06
10/11/2020	04:23	CD	3	1	-	1	Slow/ normal swim	00:19
		SL	1	-	-	10	Slow/ normal swim	00:01
		CD	2	2 (calves)	-	2	Slow/normal swim, resting, and fast swim	00:28
12/11/2020	04:30	CD	3	1 (calf)	-	-	Slow/ normal swim	00:02
		CD	6	1	-	-	Slow/normal swim, Resting, Fast swim, and Feeding	03:49
		SL	1	-	-	100	Slow/ normal swim	00:06
13/11/2020	01:32	CD	2	-	-	-	Slow/ normal swim	00:26
		SL	1	-	-	-	Slow/ normal swim	00:05

A9.2.4 Marine mammal protected sites

In May 2021, the importance of the Falkland inshore waters for sei whales was formally recognised through the designation of a sei whale Key Biodiversity Area (KBA) for the Falkland's inshore areas (http://www.keybiodiversityareas.org/site/factsheet/49174). The Berkley Sound KBA, which covers an area of 306ha is shown in **Figure 9.29**. It should be noted that whilst KBA's are a conservation tool, they do not offer statutory protection.

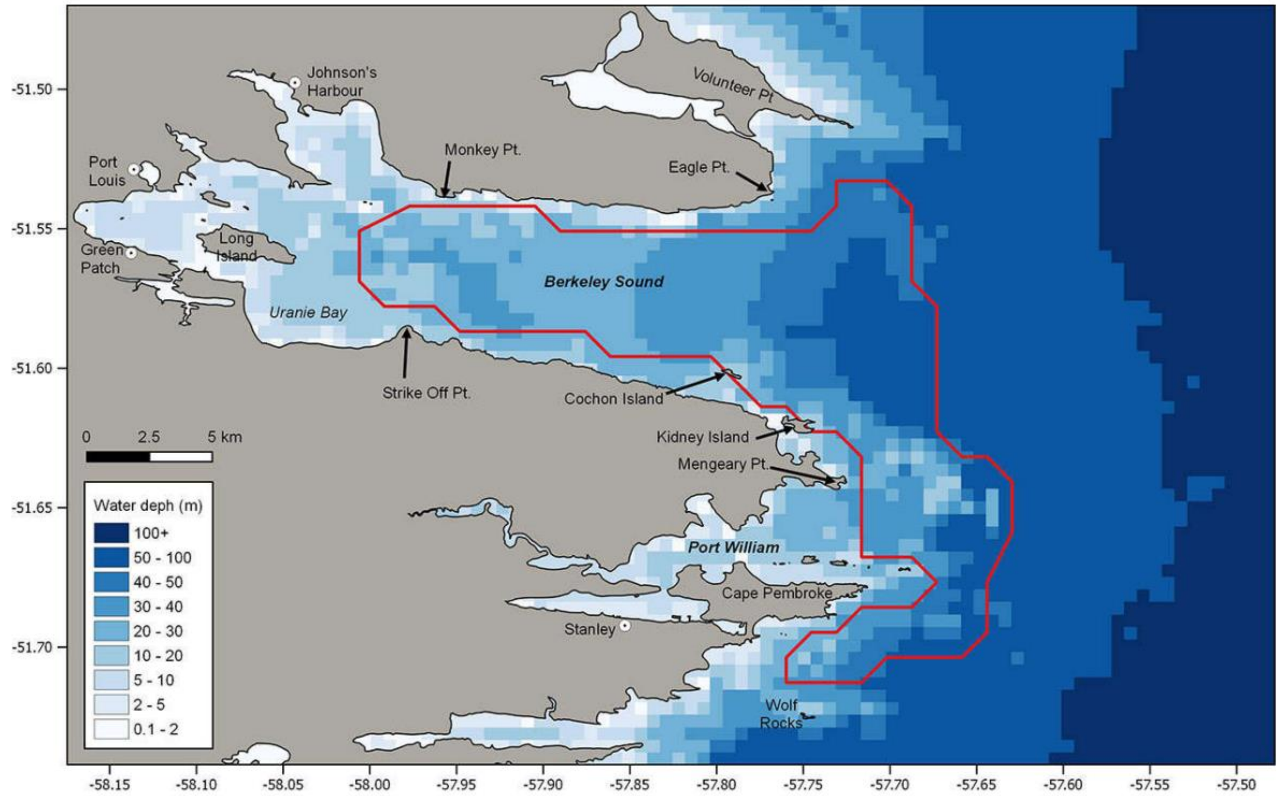

Figure 9.29 Location of the Berkley Sound KBA (Weir, 2017)

The Berkeley Sound KBA was recognised as a KBA (under the IUCN (2016)), due to the presence of more than 0.1% if the sei whale global population[2]. As described above, photo-ID studies of the sei whale population in Berkeley Sound estimate that there are at least 87 individuals in the population, which is approximately 0.3% of the current best global population estimate for sei whales of 29,000[3]. There is no evidence to support the site being a calving or nursery ground (Weir, 2017), however, observations of sei whales behaviour within the site indicate its importance as a feeding area, with surface feeding, and large shoals of squat lobster krill within the site (Weir, 2017).

A number of key potential impacts to sei whales, as a result of human have been described, and potential mitigation measures identified (Weir, 2018). These potential effects are described in further detail below, and

[2] The IUCN (2016) Global Standard for the designation of KBAs is that for any area that supports *'≥0.1% of the global population size AND ≥5 reproductive units of a species assessed as endangered due only to population size reduction in the past or present'*.

[3] The latest IUCN assessment for sei whales indicated an estimated global mature population size of approximately 29,000 individuals in 2007

any identified potential mitigation measures, in line with those identified for the Berkley Sound KBA, are considered.

A9.2.4.1 Summary of marine mammal species

A number of marine mammal species could be present near Stanley Harbour and as a precautionary approach have been assessed to determine the potential for any significant effects. The species to be considered in further and a summary of the relevant data on each species is included in **Table 9.3**. As noted above, it is considered that there is a low likelihood of sei whale presence within Stanley harbour, however, their relatively high abundance nearby in Berkeley Sound, and the lack of site-specific survey data for Stanley harbour means a precautionary approach has been taken, and sei whale are therefore screened in for assessment.

Table 9.3 Summary of marine mammal receptors and key baseline information

Marine mammal species / receptor	Estimated density in Port William	Predicted population of the Falklands	Key sensitive periods	Justification for inclusion
Southern sea lion	Unknown	7,500 [Crespo *et al.*, 2012]	Pupping from mid-December to early February. [Baylis *et al.*, 2015]	Reported within Stanley Harbour
South American fur seals	0.001-0.0019/km^2 [White *et al.*, 2002]	Unknown	Pupping in December, moulting from December to May.	Reported within Stanley Harbour
Commerson's dolphin	Highest density estimate = 0.001-0.09/km^2 [White *et al.*, 2002]	5,789 (CV = 0.18) [Costa and Cazzola, 2018]	Reproductive peak in February and March, new borns observed until July [Costa and Cazzola, 2018]	Reported within Stanley Harbour
Peale's dolphin	Highest density estimate = up to 2.0/km^2 [Weir, 2018]	1,896 (CV = 0.33) [Costa and Cazzola, 2018]	Reproductive peak in January. [Costa and Cazzola, 2018]	Reported near Stanley Harbour
Sei whale	Highest density estimate = 0.01-0.33/km^2 [Weir, 2018]	148 (CV = 0.31) [Costa and Cazzola, 2018]	Higher presence from January to April [Weir, 2017]	Expected low presence within Stanley Harbour, but relatively high numbers in nearby Berkeley Sound, and presence of nearby KBA means species is screened in under precautionary approach.

Marine mammal species / receptor	Estimated density in Port William	Predicted population of the Falklands	Key sensitive periods	Justification for inclusion
Southern sea lions at Seal Point breeding colony	Unknown	93 (at minimum) [Baylis *et al.*, 2015]	Pupping from mid-December to early February. [Baylis *et al.*, 2015]	Haul-out site is near to the proposed scheme, and Southern sea lion known to be present in Stanley Harbour.
Sei whale within Berkeley Sound KBA	Highest density estimate = 0.01-0.33/km^2 [Weir, 2018]	87 [Weir, 2017]	Higher presence from January to April [Weir, 2017]	If any sei whale are present within Stanley Harbour, then it is considered highly likely that they would be from the Berkeley Sound KBA due to its proximity.

A9.2.5Future evolution of the baseline in the absence of the proposed scheme

In the absence of the proposed scheme, there is no reason to believe that the marine ecological environment within Stanley Harbour is likely to materially change from the present-day conditions.

A9.3 Potential impacts during construction

A9.3.1 Loss of habitat caused by infilling, installation of the quay walls and rock armour placement

A causeway is proposed to provide vehicular access from the land to the quay. The causeway will be constructed using mass fill sourced from the quarry, with a rock armour layer constructed on top of the mass fill on its side slopes.

It is proposed that the quay be constructed as a mass fill structure, supporting a roller compacted concrete deck.

The placement of construction materials and disturbance of the seabed will directly impact on:

- benthic fauna due to direct crushing of sessile or sedentary organisms; and
- biodiversity via habitat modification and removal of marine growth.

Direct impacts include the crushing of sessile or sedentary organisms which cannot move away. There will also be a requirement to locally remove marine growth present on the seabed within the footprint of the construction area. These effects will be immediate, very localised to the footprint of the construction activities and will affect the area directly covered by the structure and possibly the immediate vicinity in which the activity occurs.

The seabed footprint is small relative to the area of Stanley Harbour and the areas that will be impacted by the proposed scheme comprise gravelly muddy sands, muddy gravel and slightly gravelly muddy sand. There is also surficial silt present underneath FIPASS (and within the wider bay) which has accumulated due to the discharge of raw sewage into the harbour and which would be removed to enable construction of the quay. The proposed new quay structure is proposed to overlap with a large proportion of the FIPASS footprint.

Infaunal communities to the north of the location of the proposed scheme are dominated by the abundance of the polychaetes *Aphelochaeta magellanica*, *Aglaophamus macroura*, *Mediomastus* sp.1, the Cumacean crustacean *Leucon* sp1 and the amphipod *Proharpinia antipoda*. To the south and in the area of the proposed causeway, the infaunal communities are characterised primarily by a high abundance of the polychaete *Capitella* sp.2. These areas contain low species diversity.

Similarly, epibenthic communities are of low diversity. Four community groupings were ascertained over the survey area; those around the proposed scheme location include communities dominated by high abundance of *Bryopsis* sp. and other red seaweeds and filamentous and foliose algae such as *Ulva* sp. The Tessellated rock cod (*Patagonotothen tessellata*) was seen hovering above seaweed turf to the west and south. To the north and east of the proposed scheme footprint, the area is of a lower diversity and is largely dominated by the invasive vase tunicate.

The communities present are fairly representative of the Stanley Harbour environment and other sheltered enclosed harbours in the Falkland Islands. The exception for the proposed scheme and existing FIPASS location is that the sediments are modified and the area contains two conspicuous invasive species; the vase tunicate and plumose anemone.

Construction of the quay and rock armour placement will disturb the seabed through direct species and habitat loss via crushing. The zone of influence around the proposed scheme footprint is small and many, if not all, of the species affected colonise the surrounding area. Consequently, the sensitivity of the receptor overall to crushing, is considered low. The area directly affected by construction is relatively small and, therefore, the magnitude of the effect is considered low.

The overall significance of the potential impact is considered to be **negligible**.

A9.3.1.1 Mitigation and residual impact

The direct effect of construction of the quay is not possible to mitigate and, given the negligible predicted impact, no mitigation measures are required. The residual impact is predicted to be of **negligible** significance.

A9.3.2 Removal of marine species due to decommissioning and removal of the existing causeway and FIPASS facility

The decommissioning and removal of the existing causeway and FIPASS facility will remove man-made habitat that will inevitably be colonised by marine species (including invasive species).

Artificial structures within bays and harbours in the Falkland Islands, as elsewhere, have unique flora and fauna communities. Generally constructed from metal, but also occasionally wood, these structures include boats and pier piling and range in age from the 19th century wrecks to recently launched boats.

Subject to succession, a climax community is generally a dense assemblage dominated by ascidians. Algae and sponges are present and the three dimensional community also supports crustaceans and echinoderms. In harbours in the Falkland Islands, artificial structures are vulnerable to invasive species and, indeed, the introduced parchment worm (*Chaetopterus variopedatus*) and the vase ascidian (*Ciona intestinalis*) are often dominant, and this is especially evident on FIPASS.

The removal of FIPASS and causeway will result in the disappearance of these communities. However, the construction of the proposed scheme will offer new habitat for colonisation on the rock armouring of the causeway and rock and metal structures of the quay.

The removal of FIPASS and its causeway will also remove an artificial structure which is understood from previous surveys to be colonised by invasive species (including Vase tunicate and Parchment worm).

The sensitivity of the receptor to removal of artificial habitat is considered low considering a new structure will replace FIPASS and the areas will be re-colonised. Therefore, the magnitude of the effect is considered low. The overall significance of potential impact is considered to be **negligible**.

A9.3.2.1 Mitigation measures and residual impact

No mitigation measures are required. The residual impact is predicted to be of **negligible** significance.

A9.3.3 Removal of marine mammals haul out opportunities through the removal of the causeway and FIPASS facility

As noted in **Section A9.2.3.1**, the Southern sea lion regularly hauls out on Stanley's wharfs and pontoons. The removal of the FIPASS facility and its causeway therefore removes the option for Southern sea lion (and potentially other pinnipeds) to haul out at this location. As noted in **Section A4.2.15**, the proposed construction phase is envisaged to last approximately 2.5 years, with the proposed new quay being constructed (and the FIPASS removed) in a phased manner over that time. However, the construction of the proposed scheme will offer new habitat that could be used as a haul out site by pinnipeds (including the rock armour to be placed along the length of the causeway and on the rear of the quay).

The pontoon to be constructed as part of the proposed scheme is to be located in the lee of the quay and causeway, and therefore the new pontoon is likely to offer a sheltered haul out location. Overall, the sensitivity of the receptor to removal of artificial habitat is considered low, as they have other nearby haul out sites in Stanley Harbour and the new structure replacing FIPASS will offer new haul out opportunities. The magnitude of effect is also considered to be low. The overall significance of potential impact is considered to be **negligible**.

A9.3.3.1 Mitigation measures and residual impact

No mitigation measures are required. The residual impact is predicted to be of **negligible** significance.

A9.3.4 Localised smothering of benthic habitats and effects on fish from increased suspended sediment concentrations

During the construction processes (primarily dismantling of the FIPASS facility, removal of low density surficial silts, construction of the quay structure and placement of rock armour), seabed sediments will be disturbed and become suspended into the water column, potentially leading to impacts on benthic habitats and fish, particularly when disturbed sediment resettles on the seabed. While larger, more mobile, animals, such as crabs and fish may be able to avoid areas of resuspended sediment, the suspension of sediment can cause clogging, smothering or abrasion of sensitive feeding and respiratory apparatus in sedentary or slow moving organisms (Nicholls *et al.,* 2003).

The degree of the impact on filter feeders depends upon the duration of exposure to suspended sediments. For instance, experiments have shown that the filter feeding scallop *Pecten novaezelandiae* was unaffected by exposure to 250mg/l of sediment in suspension for a single week, but decreased growth was observed in individuals exposed to lower concentration suspensions for periods longer than one week (Nicholls *et al.,* 2003). An increase in the suspended sediment concentration in the water column would increase turbidity and reduce the depth of water that light can penetrate and, therefore, the amount of light available for primary production by phytoplankton and marine algae. At high levels and/or for prolonged periods of time, an increase in suspended sediment concentrations can inhibit or prevent benthic organisms from feeding by clogging feeding apparatus (e.g. filter feeding molluscs). In addition, high concentrations of suspended sediment may impact upon fish through clogging of gill lamellae, potentially leading to death, whilst lower concentrations can result in sub-lethal stress or avoidance reactions.

The main sessile / filter feeders in the survey area included large abundances of the saffron sea cucumber, invasive plumose anemone (*M. senile*), giant tunicate (*Paramogula gregaria*), popcorn sponge (*Haliclona (Soestella) chilensis*), purple hair bryozoan (*Alcyonidium austral*) and the invasive vase tunicate (*C. intestinalis*).

Suspended sediments have the potential to impact fish gills; however, fish are generally highly mobile and therefore are likely to move from the area of disturbance. The fish species found in the area include:

- Tessellated rock cod (*Patagonotothen tessellata*)
- Blue-spotted rock cod (*P. cornucola*)
- Kelp rock cod (*P. squamiceps*)
- Humped rock cod (*P. sima*)
- Orange fin rock cod (*P. brevicauda*)
- Mullet (*Eleginops maclovinus*)
- Smelt (*Odontesthes smitti* and *Odontesthes nigicans*).
- Falklands sprat (*Sprattus fuegensis*)
- Spiny plunderfish (*Harpagifer palliotatus*)

The sensitivity of the benthic community within and adjacent to the footprint of the proposed scheme to resuspended sediments is considered to be low given the mixed nature of the seabed sediments in the area and the fact that there is a significant layer of very low density surficial silt at the location of the proposed quay. The low tidal currents at the footprint of the proposed scheme mean that any sediment that is resuspended (e.g. by the ongoing shipping activity within the harbour and at FIPASS) is not likely to disperse over significant distances and, therefore, any deposition effect beyond the immediate vicinity of the construction footprint is likely to be very minor (in the order of millimetres).

The overall construction period is predicted to be in the order of 2.5 years and, therefore, some disturbance of the seabed is likely to occur throughout this period. However, any effect is likely to be short-term, with any affected habitats likely to recover within a period of several months of any disturbance caused by localised smothering. Overall, the magnitude of the effect is considered low.

The overall significance of potential impacts with regard to increase concentration of resuspended sediments and subsequent deposition on the seabed is considered to be **negligible**.

A9.3.4.1 Mitigation measures and residual impact

No mitigation measures are required. The residual impact is predicted to be of **negligible** significance.

A9.3.5 Injury and disturbance to marine mammals from underwater noise generated by demolition and construction activities

There is the potential for underwater noise impacts from a number of different sources through the construction phase. These include piling, removal of surficial silts, dismantling of existing infrastructure and the presence of vessels associated with the work (albeit in very low numbers given the proposals to utilise predominantly land based plant).

For the purposes of this EIS, the following assumptions have been made with regard to the various sources of underwater noise:

- Piling:
  - Tubular piles of 1,270mm diameter for the construction of the quay, to be driven until rock is reached, followed by drilling to required depth.
  - Infill sheet piles to be installed between tubular piles to form a wall, and anchor wall sheet piles to be installed to rear of quay, installed using impact piling.
  - Construction of the new quay would be split into two phases, to ensure adequate berthing availability is maintained at all times.
- Removal of biologically contaminated surficial silts:
  - Using suction techniques from a vessel.
  - Indicative quantity of 50,000m^3 (wet volume) of material to be removed.
  - Expected to take place from June 2023 to October 2024.
- Dismantling of existing infrastructure:
  - Cutting of existing piles to steelwork dolphins that moor FIPASS.
  - Expected to take place from March to June 2023.
- Vessels:
  - Safety boat during construction activities and multi-cat vessel to remove surficial silt.

An unexploded ordinance (UXO) risk report (**Ref. 8**) identified a low risk of any device being present within the site that would requiring clearing during construction, and therefore is not expected to be required and has not been assessed further.

Impact piling has long been established as a source of high-level underwater noise (Caltrans, 2001; Nedwell *et al.,* 2003; 2007; Parvin *et al.,* 2006; Thomsen *et al.,* 2006). If a marine mammal is located very close to the piling sound source, the high peak pressure sound levels have the potential to cause death or physical injury, with a severe injury having the potential to lead to death, without mitigation. High exposure levels from underwater noise sources (such as impact piling) can cause permanent auditory injury or hearing impairment, through permanent loss of hearing sensitivity (PTS); and / or from a temporary loss in hearing sensitivity (TTS).

All species of cetaceans rely on sonar for navigation, finding prey and communication; they are therefore highly sensitive to permanent hearing damage (Southall *et al.,* 2007). As such, sensitivity to PTS is assessed as very high for Commerson's dolphin, Peale's dolphins, and sei whale. Pinnipeds use sound both in air and water for social and reproductive interactions (Southall *et al.,* 2007), but not for finding prey. Therefore, Thompson *et al.* (2012) suggest damage to hearing in pinnipeds may not be as sensitive as it could be in cetaceans; however, using the precautionary approach, Southern sea lion and South American fur seal are also given a sensitivity of very high for the potential of PTS. The impact would be permanent, marine mammals within the potential impact area are considered to have very limited capacity to avoid such effects and would be unable to recover from the effects.

Marine mammal species are assessed as having medium sensitivity to TTS onset. The sensitivity of each receptor to TTS is assumed to be the same as fleeing response / likely disturbance. For all species, a fleeing response is assumed to occur at the same noise levels as TTS and the potential impact is also described as 'likely disturbance'. The behavioural response of individuals to a noise stimulus will vary, and not all individuals will respond at all, or in the same way, however, for the purpose of this assessment, it is assumed that at the 'likely disturbance' range (of TTS onset), 100% of the individuals exposed to the noise stimulus will respond and flee the area.

As a precautionary approach, marine mammals within the potential disturbance area are considered to have limited capacity to avoid such effects, although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound. It should be noted however that the area is already subject to disturbance from ongoing shipping movements and operational of FIPASS and the TDF.

The potential for permanent or temporary auditory injury is not just related to the level of the underwater sound and its frequency relative to the hearing bandwidth of the animal, but is also influenced by the duration of exposure. The level of impact on an individual is related to the Sound Exposure Level (SEL) that an individual receives.

For marine mammals, a fleeing response is assumed to occur at the same noise levels as TTS. As outlined in Southall *et al.* (2007) the onset of behavioural disturbance is proposed to occur at the lowest level of noise exposure that has a measurable transient effect on hearing (i.e. TTS onset). Although, as Southall *et al.* (2007) recognise that this is not a behavioural effect per se, exposures to lower noise levels from a single pulse are not expected to cause disturbance. However, any compromise, even temporarily, to hearing functions could have the potential to affect behaviour. Therefore, any fleeing response from mammals would be the same as for TTS onset, and would be within the assessment for TTS as outlined below.

Potential underwater noise impact ranges

In order to determine the potential for underwater noise impacts on marine mammal species, it is important to relate the potential noise of the activity to the known thresholds of impact for different marine mammal species, and to determine the range at which both injurious (e.g. PTS) and behavioural (e.g. disturbance) impacts may occur over in relation to the source location.

Underwater noise modelling has been conducted to determine the maximum potential impact ranges for vibro piling and impact piling (Ref 20). The most recent marine mammal underwater noise effect thresholds from National Marine Fisheries Service (NMFS) (2018) and Southall *et al.* (2019), were used in for the underwater noise modelling. These thresholds are presented in **Table 9.4**.

A desk-based review of reported impact ranges for other activities has been undertaken (**Appendix 6**), and the worst-case and most relevant impact range will be taken forward for the assessment (**Table 9.5**).

Table 9.4 Marine mammal underwater noise injury thresholds (NMFS, 2018)

Species	Activity and noise type	Potential impact	Threshold
Otariid species [Sea lions and fur seals]	Impulsive noise (e.g. piling)	Permanent auditory injury (PTS)	232 dB re 1 µPa SPL_{peak} unweighted
			203 dB re 1 µPa^{2}s SEL_{cum} weighted

Species	Activity and noise type	Potential impact	Threshold
		Temporary auditory injury (TTS)	226 dB re 1 µPa SPL_{peak} unweighted
			188 dB re 1 µPa²s SEL_{cum} weighted
	Non-impulsive noise (e.g. dredging)	Permanent auditory injury (PTS)	219 dB re 1 µPa²s SEL_{cum}
		Temporary auditory injury (TTS)	199 dB re 1 µPa²s SEL_{cum}
Pinnipeds[4]	Impulsive noise (e.g. piling)	Permanent auditory injury (PTS)	218 dB re 1 µPa SPL_{peak} unweighted
			185 dB re 1 µPa²s SEL_{cum} weighted
		Temporary auditory injury (TTS)	212 dB re 1 µPa SPL_{peak} unweighted
			170 dB re 1 µPa²s SEL_{cum} weighted
	Non-impulsive noise (e.g. dredging)	Permanent auditory injury (PTS)	201 dB re 1 µPa2s SEL_{cum}
		Temporary auditory injury (TTS)	181 dB re 1 µPa2s SEL_{cum}
Commerson's and Peale's dolphins	Impulsive noise (e.g. piling)	Permanent auditory injury (PTS)	230 dB re 1 µPa SPL_{peak} unweighted
			185 dB re 1 µPa²s SEL_{cum} weighted
		Temporary auditory injury (TTS)	224 dB re 1 µPa SPL_{peak} unweighted
			170 dB re 1 µPa²s SEL_{cum} weighted
	Non-impulsive noise (e.g. dredging)	Permanent auditory injury (PTS)	198 dB re 1 µPa²s SEL_{cum}
		Temporary auditory injury (TTS)	178 dB re 1 µPa²s SEL_{cum}
Sei whale	Impulsive noise (e.g. piling)	Permanent auditory injury (PTS)	219 dB re 1 µPa SPL_{peak} unweighted

[4] To be used if no modelling available for otariid species, and the more precautionary thresholds

Species	Activity and noise type	Potential impact	Threshold
			183 dB re 1 µPa²s SEL_{cum} weighted
		Temporary auditory injury (TTS)	213 dB re 1 µPa SPL_{peak} unweighted
			168 dB re 1 µPa²s SEL_{cum} weighted
	Non-impulsive noise (e.g. dredging)	Permanent auditory injury (PTS)	199 dB re 1 µPa²s SEL_{cum}
		Temporary auditory injury (TTS)	179 dB re 1 µPa²s SEL_{cum}

Table 9.5 Potential impact ranges (and areas) used to inform the assessment of underwater noise impacts on marine mammals

Species	Activity and parameters modelled	Potential impact	Impact range (and area*)	Project (source)
		Drilling		
Sea lions and fur seals	Percussive drilling 24 hour period	Permanent auditory injury (PTS) (cumulative)	9m (0.00025km²)	Wylfa Newyyd Nuclear Power Plant (Horizon Nuclear Power, 2018)
		Temporary auditory injury (TTS) (cumulative)	240m (0.18km²)	
Commerson's and Peale's dolphins	Percussive drilling 24 hour period	Permanent auditory injury (PTS) (cumulative)	<1m (<0.000003km²)	
		Temporary auditory injury (TTS) (cumulative)	10m (0.0003km²)	
Sei whale	Percussive drilling 24 hour period	Permanent auditory injury (PTS) (cumulative)	120m (0.045km²)	
		Temporary auditory injury (TTS) (cumulative)	1.5km (7.07km²)	
		Suction dredging		

Species	Activity and parameters modelled	Potential impact	Impact range (and area*)	Project (source)
Sea lions and fur seals	Trailer Suction Hopper Dredging (TSHD) 24 hours	Permanent auditory injury (PTS) (cumulative)	<10m (<0.0003km²)	Victoria Harbour, Hartlepool, UK (Royal HaskoningDHV, 2018)
	Cutter suction dredging 24 hour period	Temporary auditory injury (TTS) (cumulative)	70m (0.015km²)	Wylfa Newyyd Nucler Power Plant (Horizon Nuclear Power, 2018)
Commerson's and Peale's dolphins		Permanent auditory injury (PTS) (cumulative)	1m (0.000003km²)	
		Temporary auditory injury (TTS) (cumulative)	10m (0.0003km²)	
Sei whale		Permanent auditory injury (PTS) (cumulative)	10m (0.0003km²)	
		Temporary auditory injury (TTS) (cumulative)	280m (0.25km²)	
Vessel noise				
Sea lions and fur seals	Medium vessels 24 hour period	Permanent auditory injury (PTS) (cumulative)	<1m (0.000003km²)	Wylfa Newyyd Nucler Power Plant, UK (Horizon Nuclear Power, 2018)
		Temporary auditory injury (TTS) (cumulative)	9m (0.0003km²)	
Commerson's and Peale's dolphins		Permanent auditory injury (PTS) (cumulative)	<1m (0.000003km²)	
		Temporary auditory injury (TTS) (cumulative)	<1m (0.000003km²)	
Sei whale		Permanent auditory injury (PTS) (cumulative)	3m (0.00003km²)	
		Temporary auditory injury (TTS) (cumulative)	130m (0.053km²)	

**based on the area of a circle, with the impact range as the radius*

**based on the area of a circle, with the impact range as the radius*

Underwater noise modelling

The highest peak underwater noise levels generated during the proposed marine works will arise from piling. The maximum impact piling scenario is for the marine works to comprise up to 4 tubular piles to be installed each day, involving up to approximately 2 hours of impact driving per day in a 12 hour shift. Each tubular and sheet pile will require approximately 0.5 hours of vibro piling. The maximum vibro piling scenario is for the marine works to comprise up to 4 tubular piles and 4 sheet piles to be installed each day, involving up to approximately 4 hours of vibratory driving per day in a 12 hour shift.

Underwater noise modelling has been used to derive PTS ranges for impact and vibro piling for all marine mammal species groups and is outlined in the underwater noise assessment (Ref. 20).

Table 9.6 presents the maximum PTS and TTS ranges during vibro piling for the piles being installed at FIPASS. If the propagation of underwater noise from vibro piling were unconstrained by any boundaries, the maximum predicted PTS range for cumulative exposure during pile installation is up to 123m for low frequency cetaceans such as the sei whale, 16m for dolphin species and 9m for or Southern sea lion and South American fur seal (otarrids).

Table 9.6 Approximate distances marine mammal response criteria are reached during vibro piling (SELcum)

Marine Mammal Hearing Group	Tubular Piles		Sheet Piles	
	PTS	TTS	PTS	TTS
• Mid-frequency (MF) cetaceans Peale's dolphin & Commerson's dolphin	16m	212m	2m	31m
• Low-frequency (LF) cetaceans Sei whale	123m	1.6km	18m	234m
Otarrids (OW) and other non-phocid marine carnivores in water (sea lions) • Southern sea lion & South American fur seal	9m	115m	1m	17m

Table 9.7 presents the maximum PTS and TTS ranges during impact piling for the piles being installed at FIPASS. If the propagation of underwater noise from impact piling were unconstrained by any boundaries, the maximum predicted PTS impact range for cumulative exposure (SEL_{cum}) is 1.4km for low frequency cetaceans such as the sei whale, 85m for dolphin species and 92m for Southern sea lion and South American fur seal (otarrids).

Table 9.7 Approximate distances marine mammal response criteria are reached during impact piling

Marine Mammal Hearing Group	PTS		TTS	
	SEL_{cum}	SPL_{peak}	SEL_{cum}	SPL_{peak}
Mid-frequency (MF) cetaceans • Peale's dolphin & Commerson's dolphin	85m	N/A	586m	2m
Low-frequency (LF) cetaceans • Sei whale	1.4km	4m	9.6m	9m
Otarrids (OW) and other non-phocid marine carnivores in water (sea lions)	92m	N/A	632m	2m

• Southern sea lion & South American fur seal				

N/A = not applicable as Sound Level (SL) is below the threshold

The outcome of the underwater noise modelling will be applied to any mitigation requirements. The impacts from underwater noise have been assessed on the worst case ranges from the underwater noise modelling.

Underwater noise impact assessment

Permanent auditory injury

The worst-case impact ranges (and areas) based on the underwater noise modelling, as shown in **Table 9.5, Table 9.6 and Table 9.7**, indicate that for the majority of noisy activities, any marine mammal would have to remain in close proximity (i.e. less than 120m) of the sound source for an extended period of time to be exposed to levels of sound that are sufficient to induce PTS, based on the NMFS (2018) and Southall *et al.* (2019) threshold criteria. The exception for this is for sei whale, where an impact range of up to 1.4km is possible due to cumulative exposure (SEL_{cum}) during impact piling, if exposed for an extended period of time.

The number of Southern sea lions, South American fur seal, Commerson's dolphin, Peale's dolphin, and sei whale that could be at risk of PTS, as a result of underwater noise during construction activities (**Table 9.8**) has been assessed based on the maximum number of animals that could be present in the maximum impact areas for each activity, based on the densities of marine mammals in the area as shown in **Table 9.3**.

As a precautionary worst-case approach, the areas have been calculated based on the area of a circle, with radius of maximum impact range, and do not take into account overlap with land.

Table 9.7 Maximum number of marine mammals (and % of the Falklands population) that could be at risk of any permanent auditory injury (PTS) as a result of underwater noise from the construction activities

Potential Impact	Marine mammal species	Estimated number of individuals in impact area (% of the population)	Magnitude
Piling			
Risk of instantaneous PTS during piling	Southern sea lions	No available density estimate for this species, but not expected to be any individuals at risk as sound level for impact piling is below PTS SPL_{peak} threshold level.	Negligible magnitude
	South American fur seal	Not expected to be any individuals at risk as sound level for impact piling is below PTS SPL_{peak} threshold level.	Negligible magnitude
	Commerson's dolphin	Not expected to be any individuals at risk as sound level for impact piling is below PTS SPL_{peak} threshold level.	Negligible magnitude
	Peale's dolphin	Not expected to be any individuals at risk as sound level for impact piling is below PTS SPL_{peak} threshold level.	Negligible magnitude

Potential Impact	Marine mammal species	Estimated number of individuals in impact area (% of the population)	Magnitude
	Sei whale[5]	0.00000005 individuals (0.00000003% of population; 0.00000006% of Berkeley Sound KBA).	Negligible / very low magnitude
Risk of PTS during extended periods of piling	Southern sea lions	No available density estimate for this species, but not expected to be a significant number of individuals at risk based on the very low potential impact range of 9m for vibropiling and relatively low impact range of 92m for impact piling.	Low / very low magnitude
	South American fur seal	0.00003 individuals. No available population estimate for this species, but not expected to be significant based on the very low number and very low potential impact range of 9m for vibropiling and relatively low impact range of 92m for impact piling.	Low / very low magnitude
	Commerson's dolphin	0.002 individuals (0.00004% of population).	Low / very low magnitude
	Peale's dolphin	0.05 individuals (0.003% of population).	Low / very low magnitude
	Sei whale[5]	2 individuals (1.4% of population; 2.3% of Berkeley Sound KBA).	Medium
Drilling			
Risk of PTS during extended periods of drilling	Southern sea lions	No available density estimate for this species, but not expected to be a significant number of individuals at risk based on the very low potential impact range of 9m.	Low / very low magnitude
	South American fur seal	<0.000001 individuals (no available population estimate for this species, but not expected to be significant based on the very low number at potential risk).	Low / very low magnitude
	Commerson's dolphin	<0.000001 individuals (<0.000001% of population).	Low / very low magnitude
	Peale's dolphin	0.000006 individuals (<0.000001% of population).	Low / very low magnitude
	Sei whale[5]	0.015 individuals (0.01% of population; 0.02% of Berkeley Sound KBA).	Low / very low magnitude

[5] Unlikely to be in area, but included on a precautionary approach

Potential Impact	Marine mammal species	Estimated number of individuals in impact area (% of the population)	Magnitude
Suction dredging			
Risk of PTS during extended periods of suction dredging	Southern sea lions	No available density estimate for this species, but not expected to be a significant number of individuals at risk based on the very low potential impact range of less than 10m.	Low / very low magnitude
	South American fur seal	<0.000001 individuals (no available population estimate for this species, but not expected to be significant based on the very low number at potential risk).	Low / very low magnitude
	Commerson's dolphin	<0.000001 individuals (<0.000001% of population).	Low / very low magnitude
	Peale's dolphin	0.000006 individuals (<0.000001% of population).	Low / very low magnitude
	Sei whale[5]	0.0001 individuals (0.00007% of population; 0.0001% of Berkeley Sound KBA).	Low / very low magnitude
Construction vessels			
Risk of PTS during extended periods of vessel presence	Southern sea lions	No available density estimate for this species, but not expected to be a significant number of individuals at risk based on the very low potential impact range of less than 1m.	Low / very low magnitude
	South American fur seal	<0.000001 individuals (no available population estimate for this species, but not expected to be significant based on the very low number at potential risk).	Low / very low magnitude
	Commerson's dolphin	<0.000001 individuals (<0.000001% of population).	Low / very low magnitude
	Peale's dolphin	0.000006 individuals (<0.000001% of population).	Low / very low magnitude
	Sei whale[5]	0.0001 individuals (0.00007% of population; 0.0001% of Berkeley Sound KBA).	Low / very low magnitude

The magnitude of the potential impact of PTS as a result of construction noise is negligible for instantaneous PTS from piling, low / very low, for all species and activities, with the exception of piling over an extended period of time, which has been assessed as having a medium magnitude of impact for sei whale (**Table 9.8**). This however could be reduced by the implementation of mitigation measures, which would ensure that there are no marine mammals within the vicinity of piling activities prior to the commencement. It is also considered highly unlikely that any sei whale (or other marine mammal) would remain within the area required for any length of time, and therefore would not be at risk of permanent auditory injury (for example, a sei whale would have to remain within 1.4km of the piling activity, for an extended period of time, in order to be at risk of a PTS).

Temporary auditory injury / fleeing response

The worst-case impact ranges (and areas), as shown in **Table 9.8**, indicate that for the majority of noisy activities, any marine mammal would have to remain in close proximity (i.e. less than 40m) of the sound source for an extended period of time to be exposed to levels of sound that are sufficient to induce instantaneous TTS, based on the NMFS (2018) and Southall *et al.* (2019) threshold criteria. For the potential for TTS or a fleeing response due to extended exposures, any individual would have to remain within 690m of the activity for an extended period of time. The exception for this is for sei whale, where an impact range of up to 1.5km or 7.0km is possible due to drilling or impact piling respectively, if exposed for an extended period of time.

The number of Southern sea lions, South American fur seal, Commerson's dolphin, Peale's dolphin, and sei whale that could be at risk of TTS or fleeing response, as a result of underwater noise during construction activities (**Table 9.8**) has been assessed based on the maximum number of animals that could be present in the maximum impact areas for each activity, based on the densities of marine mammals in the area as shown in **Table 9.3**.

Table 9.8 Maximum number of marine mammals (and % of the Falklands population) that could be at risk of any temporary auditory injury (TTS) or fleeing response as a result of underwater noise from the construction activities

Potential Impact	Marine mammal species	Estimated number of individuals in impact area (% of the population)	Magnitude
Piling			
Risk of instantaneous TTS / fleeing response during piling	Southern sea lions	No available density estimate for this species, but not expected to be a significant number of individuals at risk based on the very low potential impact range of 42m.	Very low magnitude
	South American fur seal	<0.00001 individuals (no available population estimate for this species, but not expected to be significant based on the very low impact range of 2m).	Very low magnitude
	Commerson's dolphin	0.000001 individuals (<0.000001% of population).	Low / very low magnitude
	Peale's dolphin	0.00003 individuals (0.000001% of population).	Low / very low magnitude
	Sei whale[5]	0.000008 individuals (0.000006% of population; 0.00001% of Berkeley Sound KBA).	Low / very low magnitude
Risk of TTS / fleeing response during extended periods of piling	Southern sea lions	No available density estimate for this species, but not expected to be a significant number of individuals at risk based on the low potential impact range of 632m.	Low / very low magnitude

Potential Impact	Marine mammal species	Estimated number of individuals in impact area (% of the population)	Magnitude
	South American fur seal	0.001 individuals (no available population estimate for this species, but not expected to be significant based on the low number at potential risk).	Low / very low magnitude
	Commerson's dolphin	0.1 individuals (0.002% of population).	Low / very low magnitude
	Peale's dolphin	2.2 individuals (0.11% of population).	Low / very low magnitude
	Sei whale[5]	96 individuals (65% of population; 100% of Berkeley Sound KBA). However, it is highly unlikely that this number of sei whales could be at risk of TTS / fleeing response, given the very low number (if any) of whales in the port. Also, area is based on worst-case including overlap with land.	High – although likely to be low / very low taking into account number of whales in the port area.
Drilling			
Risk of TTS / fleeing response during extended periods of drilling	Southern sea lions	No available density estimate for this species, but not expected to be a significant number of individuals at risk based on the very low potential impact range of 9m.	Low / very low magnitude
	South American fur seal	0.0003 individuals (no available population estimate for this species, but not expected to be significant based on the very low number at potential risk).	Low / very low magnitude
	Commerson's dolphin	0.00003 individuals (<0.000001% of population).	Low magnitude
	Peale's dolphin	0.0006 individuals (0.00003% of population).	Low / very low magnitude
	Sei whale[5]	2.3 individuals (1.6% of population; 2.7% of Berkeley Sound KBA).	Low magnitude
Suction dredging			
Risk of TTS / fleeing response during extended periods of suction dredging	Southern sea lions	No available density estimate for this species, but not expected to be a significant number of individuals at risk based on the very low potential impact range of less than 10m.	Low / very low magnitude

Potential Impact	Marine mammal species	Estimated number of individuals in impact area (% of the population)	Magnitude
	South American fur seal	0.00003 individuals (no available population estimate for this species, but not expected to be significant based on the very low number at potential risk).	Low / very low magnitude
	Commerson's dolphin	0.00003 individuals (<0.000001% of population).	Low / very low magnitude
	Peale's dolphin	0.0006 individuals (0.00003% of population).	Low / very low magnitude
	Sei whale[5]	0.08 individuals (0.06% of population; 0.09% of Berkeley Sound KBA).	Low / very low magnitude
Construction vessels			
Risk of TTS / fleeing response during extended periods of vessel presence	Southern sea lions	No available density estimate for this species, but not expected to be a significant number of individuals at risk based on the very low potential impact range of less than 1m.	Low / very low magnitude
	South American fur seal	<0.000001 individuals (no available population estimate for this species, but not expected to be significant based on the very low number at potential risk).	Low / very low magnitude
	Commerson's dolphin	<0.000001 individuals (<0.000001% of population).	Low / very low magnitude
	Peale's dolphin	0.000006 individuals (<0.000001% of population).	Low / very low magnitude
	Sei whale[5]	0.02 individuals (0.01% of population; 0.02% of Berkeley Sound KBA).	Low / very low magnitude

The magnitude of the potential impact of TTS or fleeing response as a result of construction noise is low / very low, for all species and activities, with the exception of piling or drilling over an extended of time, which has been assessed as having a high and low magnitude of impact, respectively, for sei whale (**Table 9.8**). This however could be reduced by the implementation of mitigation measures, which would ensure that there are no marine mammals within the vicinity of piling activities prior to the commencement. It is also considered highly unlikely that any sei whale (or other marine mammal) would remain within the area required for any length of time, and therefore would not be at risk of permanent auditory injury (for example, a sei whale would have to remain within 7km of the piling activity (or within the Stanley Harbour area), for an extended period of time, in order to be at risk of a temporary auditory injury (TTS) or fleeing response).

A9.3.5.1 Mitigation and residual impact

The mitigation measures are based on the JNCC guidelines for piling (JNCC, 2010). The mitigation requirements are detailed in a Marine Mammal Observation Plan (MMOP) (**Appendix 7**) for piling activities, informed by site-specific underwater noise modelling. The MMOP defines the instantaneous PTS impact ranges and details appropriate mitigation to ensure no marine mammals are at risk of instantaneous PTS from the maximum hammer energy for piling.

An overview of the mitigation in the MMOP, based on the '*Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise'* (JNCC, 2010), that would be implemented during construction of the proposed scheme, to reduce any significant impacts as a result of underwater noise from piling, are:

- Establishment of a pre-piling monitoring zone around the piling source.
  - This will be greater than the instantaneous PTS impact range and would therefore reduce the potential for any impact to all marine mammal species.
- Pre-piling observations of the monitoring zone prior to piling:
  - Prior to soft-start, ramp-up and piling activities that commence in periods of daylight and good visibility, at least one dedicated Marine Mammal Observer (MMOb) will monitor the entire monitoring zone.
  - Prior to soft-start, ramp-up and piling activities that commence at in periods of poor visibility, the monitoring zone will be light up to allow visual observations of the area (and to allow work on site). Therefore the use of PAM will not be required. .
- The soft-start and ramp-up procedure will consist of a gradual increase in construction noise in the aquatic environment, commencing with the starting of land based plant such as cranes and hydraulic piling generators, proceeding to low power piling and culminating in piling at full power.
- If any marine mammal is within the monitoring zone after 20 minute watch period, the soft-start and ramp-up procedure will commence to encourage them to move out pf the area.
- If any marine mammal is detected within the monitoring zone during soft-start procedure, the soft-start procedure will be completed and ramp-up of piling will commence (where piling hammer energy will be ramped up, starting at low hammer energy with gradual increase to full hammer energy).
- If a marine mammal enters or remains in the monitoring zone during the soft-start and ramp-up procedure or if marine mammals enters or remains in the monitoring zone after the soft-start and ramp-up procedure has been completed, they will be deemed to have done so 'voluntarily' and piling will continue.
- During piling, if there is a break of more than 10 minutes, then the pre-piling monitoring, soft-start and ramp-up procedures should be undertaken, as outlined above, before piling commences.
- If piling is commencing at night or in conditions of poor visibility and the entire monitoring zone is not visible then the soft-start and ramp-up procedure will be undertaken for a minimum of 20 minutes.

The training, mitigation, and reporting requirements intent, as set out within the JNCC piling mitigation guidelines (JNCC, 2010), will be observed, in line with the site specific MMOP (**Appendix 7**).

The mitigation outlined above is relevant for piling activities only.

A9.3.5.2 Impact significance

Taking into account the high receptor sensitivity for PTS, the medium receptor sensitivity for TTS, and the potential magnitude of the effect, the impact significance for any auditory injury as a result of underwater noise on all marine mammal species has been assessed as **negligible** with mitigation (**Table 9.9**).

Table 9.9 Assessment of impact significance for marine mammals from underwater noise during construction

Potential Impact	Marine mammal species	Sensitivity	Magnitude	Significance	Mitigation	Residual impact
Risk of instantaneous permanent auditory injury (PTS) during piling	All species	High	Negligible / very low	Negligible	Mitigation for piling activities as set out above.	Negligible
Risk of permanent auditory injury (PTS) during extended periods of piling	All species except sei whale		Low / very low	Minor to negligible		Negligible
	Sei whale		Medium	Moderate		Negligible
Risk of permanent auditory injury (PTS) for extended periods of drilling / suction dredging / vessels	All species		Low / very low	Minor to negligible	None required.	Negligible
Risk of instantaneous temporary auditory injury (TTS) / fleeing response during piling	All species	Medium	Low / very low	Minor to negligible	Mitigation for piling activities as set out above.	Negligible
Risk of temporary auditory injury (TTS) / fleeing response during extended periods of piling	All species except sei whale		Low / very low	Minor to negligible		Negligible
	Sei whale		High	Moderate		Negligible
Risk of temporary auditory injury (TTS) / fleeing response during extended periods of drilling	All species except sei whale		Low / very low	Minor to negligible	None required.	Negligible
	Sei whale		Low	Minor		Negligible
Risk of temporary auditory injury (TTS) / fleeing response during extended periods of suction dredging / vessel presence	All species		Low / very low	Minor to negligible		Negligible

Relevance for the Berkeley Sound KBA

As described above, there is the potential for impacts to sei whale as a result of noisy activities during construction. The most impactful of these activities would be due to piling, with the potential for instantaneous PTS within 10m of the piling source, permanent auditory injury from extended exposure of piling at up to 2km from the source. There is also the potential for TTS or fleeing response to occur during extended periods of piling at up to 7km from the pile location.

It should be noted, however, that these impacts will occur within the Stanley Harbour only, with very little sound expected to propagate into Port William and the wider marine area, due to the enclosed nature of the site and the limits of the Narrows. The Berkeley Sound KBA is located approximately 9km at closest point to the proposed scheme, and therefore there will be no direct impact within the site itself. As described above, mitigation will be undertaken during piling activities, to ensure that no marine mammals are at risk of instantaneous PTS, and to reduce the potential for TTS and fleeing response.

Taking into account the mitigation that will be undertaken, the distance between the proposed scheme and the Berkeley Sound KBA, and the overall negligible impact to sei whale, it is not expected that there would be any significant impact to the KBA, and the population of sei whale it is designated for.

A9.3.6 Indirect impacts to marine mammals due to changes in prey availability and/or water quality

Any impacts on prey species and / or water quality has the potential to indirectly affect marine mammals. As outlined above, the potential impacts on fish species during construction can result from:

- Physical disturbance and temporary loss of seabed habitat.
- Increased suspended sediment concentrations and sediment redeposition.
- Remobilisation of contaminated sediment.
- Underwater noise.

As outlined above, potential changes in water quality during construction are from the:

- Increase in suspended sediment concentrations/turbidity during construction; and
- Release and dispersion of potentially biologically and chemically contaminated sediment during construction.

As marine mammals feed on a number of different prey sources, they are given a sensitivity of low to medium for any indirect impacts relating to a change in prey availability.

Marine mammals often inhabit turbid environments, and cetaceans utilise sonar to sense the environment around them, and there is little evidence that turbidity affects cetaceans directly (Todd *et al.,* 2014). Seals are not known to produce sonar for prey detection purposes; however, it is likely that other senses are used instead of, or in combination with, vision. Studies have shown that vision is not essential to seal survival, or their ability to forage (Todd *et al.,* 2014).

Increased turbidity is unlikely to have a substantial direct impact on marine mammals that often inhabit naturally turbid or dark environments. This is likely because other senses are utilised, and vision is not relied upon solely. Therefore, all marine mammals are considered to have a very low sensitivity to increases in suspended sediments during construction. Any direct impacts to marine mammals as a result of any contaminated sediment during construction activities are unlikely, as any exposure is more likely to be potential indirect impacts via prey species. Therefore, marine mammals have a very low sensitivity to any direct impacts from contaminated sediment during construction activities.

Impacts to prey species have all been assessed as low magnitude, and all water quality impacts as negligible. A magnitude of very low to low is therefore expected for all impacts for fish species and water quality.

Taking into account the very low to medium sensitivity of all species to change in prey availability and water quality, the very low to low magnitude of impact, the impact assessment for the potential for indirect impacts is **negligible**, and is therefore not significant.

Taking into account the mitigation that will be undertaken, the distance between the proposed scheme and the Berkeley Sound KBA, and the overall negligible impact to sei whale, it is not expected that there would be any significant impact to the KBA, and the population of sei whale it is designated for.

A9.3.6.1 Mitigation and residual impact

No mitigation measures are required and the residual impact is predicted to be of **negligible** significance.

A9.4 Potential impacts during operation

A9.4.1 Noise and visual disturbance to hauled out marine mammals

Increased operational activity, including an increase in vessel movements and human activity, has the potential to disturb sea lions and fur seals while they are at haul-out sites, particularly during sensitive periods such as the breeding season and moult period and, at significance levels, has the potential to lead to site and pup abandonment. The Southern sea lion pupping period is from mid-December to early February, and the South American fur seal pupping period is December, followed by the moult from December to April the following year.

Disturbance from vessel transits to and from Stanley Harbour also has the potential to disturb individuals at haul-out sites, depending on the route and proximity to the haul-out sites; however, vessel movements to and from the site will be incorporated within existing vessel routes and would not be expected to pass within close proximity of the coastline and therefore any seal haul-out sites. The predicted increase in number of vessels of approximately 200 vessels per year is a relatively modest increase over the numbers which berthed at FIPASS on an annual basis from 1999 to 2019.

The closest Southern sea lion haul-out site (outside of those used in Stanley Harbour), at Seal Point, is approximately 18.5km around the coast, or 5.5km across land, and the closest South American fur seal haul-out site is approximately 20km from the proposed scheme. Given the distances between the proposed scheme and the nearest haul-out sites; there is very little potential for any direct disturbance.

It is likely that individuals hauled-out along vessel routes and in the area of the proposed scheme would be habituated to the noise, movements and presence of vessels.

While a small number of sea lions are known to use the pontoons and wharfs within Stanley Harbour to haul-out, the area is already a busy port area, with activities and high vessel usage, and therefore, these individuals would be well used to high levels of noise and activity, and are therefore not expected to be significantly affected. The sensitivity of the receptor is high and the magnitude of impact is assessed as very low.

Taking into account the high sensitivity, and the very low magnitude of impact, the impact assessment for the potential for disturbance to seals at haul-out sites is assessed as being of **negligible** significance.

A9.4.1.1 Mitigation and residual impact

No mitigation measures are required and the residual impact is predicted to be of **negligible** significance.

A9.4.2 Increase in risk of collision with marine mammals

Marine mammals are able to detect and avoid vessels. However, vessel strikes are known to occur, possibly due to distraction whilst foraging and socially interacting, or due to the marine mammals' inquisitive nature (Wilson *et al.,* 2007). Therefore, increased vessel movements, especially those out-with recognised vessel routes, can pose an increased risk of vessel collision to marine mammals.

Collisions of marine mammals with vessels have been documented since the rise of commercial shipping (Laist *et al*., 2001), with the risk of collisions likely to increase as commercial shipping levels increase. Vessel collisions with whale species have been documented from all types of vessels, including ferries, cruise ships, cargo vessels, tankers, dredgers, fishery boats, and recreational vessels (Laist *et al*., 2001). The potential for collision risk is higher in areas where distribution ranges of whale species overlap with major shipping routes and entrances to ports (Thomas *et al.,* 2016).

Few instances of vessel collision with sei whale have been reported, but records include in the US with individuals brought into port on the bow of vessels (Laist *et al.,* 2001), and the level of sei whale presence within the Falklands suggest there is a risk of collision with increasing vessel usage.

Studies have shown that larger vessels are more likely to cause the most severe or lethal injuries, with vessels over 80m in length causing the most damage to marine mammals (Laist *et al.,* 2001). Vessels travelling at high speeds are considered to be more likely to collide with marine mammals, and those travelling at speeds below 10 knots would rarely cause any serious injury (Laist *et al.,* 2001). As noted in **Section A4.4.1**, it is predicted that the vast majority of vessels using FIPASS during operation would be fishing vessels.

Port William is already one of the busiest vessel areas in the Falklands, with reported visits from vessels of 463 in 2014, 465 in 2015, and 349 in 2016 (Alan Henry, FIFD, pers. comm., *cited in* Weir, 2017). Wier (2017) reported that there have been no reported instances of collision of sei whales with vessels in the Falklands, although stranded individuals are not investigated for causes of standings, and there have been incidental reports of physical contact, and potential collisions, with sei whales (Wier, 2017) indicating there is the potential for collision to occur. This level of usage of the area would indicate that sei whales and other marine mammal species, and the lack of any reported confirmed collision events, indicates that individuals are somewhat habituated to the presence of vessels, and are adapted to the avoidance of vessels.

During the operational phase of the proposed scheme, it is predicted there would be an increase of approximately 200 vessels per year over the numbers which berthed at FIPASS on an annual basis from 1999 to 2019. Vessels would be slow moving and, therefore, it is considered unlikely that would be any increased risk of increased collision with marine mammals, and a magnitude of very low is assigned. In addition, the '*Cetacean code of conduct for the Falkland Islands*'[6] will be adhered to by all vessels. While this was developed for cetacean species, the measures should be implemented for all marine mammal species, including sea lions and fur seals. The measures in place through '*Cetacean code of conduct for the Falkland Islands*' include:

- Slow down – when in the presence of any cetacean, vessel speeds should be reduced to a **maximum of ten knots**, and should **pass no closer than 500m** to the individual.
  - If possible, the vessels course should be adapted to provide any individuals with a wider berth.
- **Maintain speed and course** – if whales are observed ahead of a vessel, course should be altered to provide as wide a berth as possible.
  - For dolphins approaching a vessel for the purpose of bow-riding, vessels should maintain speed and course, with no sudden changes in heading or speed.

[6] https://falklandsconservation.com/wp-content/uploads/2020/08/FI_Cetacean_Code_Conduct_20200729.pdf

  - For whale species approaching a vessel, vessel should gradually slow down and place the engine in neutral until they have passed.
- Approach to cetaceans – individuals should never be approached from directly ahead or behind, but pass from the side.
  - Individuals should never have their course cut off from ahead, or be 'chased' from behind.
- **Observations for works in harbours** – Dolphin species are frequently found within harbours and jetties, and may swim under and around a vessel propellor. During vessel manoeuvres in harbours, observation should be made for any individual in the area, including directly below the vessel, prior to any manoeuvres that are unpredictable in movement.

Taking into account the low sensitivity of all species, the very low magnitude of impact, and the implementation of the '*Cetacean code of conduct for the Falkland Islands*' for the avoidance of collisions, the impact assessment for the potential for an increase in collision risk is **negligible** for all species, and is therefore not significant.

Taking into account the mitigation that will be undertaken, the distance between the proposed scheme and the Berkeley Sound KBA, and the overall negligible impact to sei whale, it is not expected that there would be any significant impact to the KBA, and the population of sei whale for which it is designated.

A9.4.2.1 Mitigation and residual impact

No mitigation measures are required and the residual impact is predicted to be of **negligible** significance.

A9.4.3 Light spill and glare acting as an attractant to marine life and birds (i.e. behavioural changes)

The following average illuminance levels will be provided within the various areas of the proposed scheme during the operational phase:

- Quay – 50 lux average maintained horizontal level.
- Work area on the quay – 20 lux average maintained horizontal level.
- Causeway – 20 lux average maintained horizontal level.

Lighting on FIPASS currently provides an average illuminance of 20 to 27 lux; this level of lighting does not meet current required standards for operational port areas. As a result, vessels berthed at FIPASS need to utilise their on-board lights to provide sufficient lighting during loading and unloading operations at night. Such lighting is directed landwards, providing a source of lighting disturbance to Stanley (i.e. lighting on FIPASS is not directional as it relies on lighting from vessels when berthed at night). Light glare / glow is noticeably greater when there is a vessel berthed at FIPASS during the night time (compared to when there is no vessel berthed at FIPASS at night). It should also be noted that FIPASS currently operates 24 hours a day, and therefore use of lighting at night on FIPASS (and from the vessels berthed at FIPASS) is a regular occurrence. It should also be noted that new streetlights have been installed along FIPASS Road, and the coastal footpath is also lit (and therefore there is already artificial light in the area).

The illuminance levels arising from the proposed scheme will be greater than existing levels at FIPASS given the need to provide a lighting scheme that meets current health and safety requirements for operational ports.

The predicted light spill due to the proposed lighting design for the proposed scheme has been modelled and compared with that at FIPASS. This is discussed further in **Section A15.0**, which includes contour plots of the existing lux levels associated with light spill at FIPASS and the proposed scheme. A number of measures have already been built into the scheme design as embedded mitigation in order to minimise the impacts of lighting on human and ecological receptors; further detail regarding such measures is provided in **Section A15.4**.

During the operational phase, the system for Aids to Navigation will not change to those currently used on FIPASS; new lights will be provided at either end of the proposed new quay structure in a like for like replacement to that currently present on FIPASS.

Artificial light is likely to affect zooplankton, fish and squid, seabirds and marine mammals in Stanley Harbour. The environment in Port William and adjacent coastal areas are essentially dark at night and the above receptors have evolved to function with a diurnal cycle with predictable periods of darkness and light. This is not the case of Stanley Harbour; the town itself and current FIPASS structure all emit artificial light.

Literature reviews found no evidence that marine mammals would be attracted to artificial light directly. There may, however, be indirect impacts on marine mammals if they are attracted to feed on prey that are concentrated due to the presence of artificial light.

Comparison of the light spill associated with FIPASS with that predicted for the proposed scheme shows that, while the location of spill would be different due to the different positions of the facilities, the extent of light spill is not predicted to be substantially different for the two facilities. The 1 lux contour does not extend a significant distance beyond the proposed scheme footprint; for context, a lux level of 0.2 to 2 is generally considered to represent a moonlit night. In addition, the lighting proposed to be used during operation is intended to light the surface of the quay rather than the surrounding environment.

With regard to bird collisions, globally, there are issues regarding the interaction between birds and anthropogenic light sources. Birds can be impacted directly by a wide range of artificial light sources within marine environments. However, there is little evidence that regular bird strike occurs at FIPASS currently. There is recent anecdotal evidence for some seabirds (e.g. Sooty shearwaters, *Ardenna grisea*; white-chinned petrels, *Procellaria aequinoctialis*) observed in the Cape Pembroke and the Stanley area.

There is a low diversity and abundance of seabirds (noting that terrestrial birds will not be active at night) that utilise the Stanley Harbour. The extent of light spill is also limited, and not significantly different to that currently experienced at FIPASS.

The sensitivity of the receptor to artificial light is considered to be low. The magnitude of the effect is considered low. The overall significance of potential impact with regard to artificial light is considered to be of **negligible** significance.

A9.4.3.1 Mitigation and residual impact

No mitigation measures are required and the residual impact is predicted to be of **negligible** significance.

A9.4.4 Indirect impact to marine ecology due to presence of the port facility and changes to the sedimentary regime

As noted in **Section A7.4.3**, there is potential for deposition of sediments in the lee of the harbour during the operational phase of the proposed scheme. Such an effect could indirectly impact the marine ecology within the deposition area due to smothering. However, as shown in **Figure 9.6**, the sediments within the lee of the proposed quay (at sampling point 17) are slightly gravelly muddy sand. The predicted very minor reduction in current speeds within the lee of structure are very localised (as shown on **Figure 7.18**); as a result, the magnitude of effect to marine ecology would be low, resulting in an impact of **negligible** significance.

A9.4.4.1 Mitigation and residual impact

No mitigation measures are required and the residual impact is predicted to be of **negligible** significance.