BEFORE
THE OTAGO REGIONAL COUNCIL
AT DUNEDIN

IN THE MATTER	**Of the Resource Management Act 1991**
AND	
IN THE MATTER	**of an application for resource consents for Project Next Generation**
BY	**PORT OTAGO LIMITED** **Applicant**

BRIEF EVIDENCE OF THOMAS MATTERN, PhD
ON BEHALF OF THE YELLOW-EYED PENGUIN TRUST

14th April 2011

Brief of Evidence of THOMAS MATTERN

Introduction

1. My full name is Thomas Mattern. I have a PhD and a Master of Science in Zoology, both from University of Otago, and obtained a Diplom (MSc equivalent) in Marine Sciences at the University of Kiel, Germany.

2. I am New Zealand representative to the International Penguin Expert Group of the World Conservation Union (IUCN) Species Survival Commission (SSC). Until recently I was scientific representative in the Technical Advisory Group of the Oamaru Blue Penguin Colony.

3. From 2000 to 2007 I conducted research on the marine ecology of New Zealand penguins, first in the course of my MSc and PhD studies, later on as a contractor for the Yellow-eyed penguin Trust and the Ministry of Fisheries. I have studied foraging ranges and diving behaviour of Little Blue Penguins in the Marlborough Sounds and at Oamaru, Snares penguins on the subantarctic Snares Islands, and Yellow-eyed penguins at Oamaru, the Otago Peninsula and Stewart Island & Codfish Island. My studies of penguin foraging ecology focussed primarily on the examination of behavioural responses in penguins to physical dynamics of the marine environment and the presence of oceanographic features (e.g. frontal systems). My work on Yellow-eyed penguins further extended into investigations of the influence of commercial fisheries (bottom trawling off the Otago Peninsula, oyster dredging off Stewart Island). Between 2001 and 2008 I was furthermore involved in studies investigating the impact of human disturbance on Humboldt penguins in Chile and Yellow-eyed penguins on the Otago Peninsula. To date I have authored and co-authored nine peer-reviewed articles in high ranking international scientific journals such as Animal Behaviour, Biological Conservation, Marine Ecology Progress Series. I am author of two chapters on Snares and Fiordland

Penguins for compendium 'Biology and Conservation of the World's Penguins' soon to be published by the University of Washington Press. I have presented results of my research (19 oral presentations, 6 posters) at numerous national and international conferences including the last three International Penguin Conferences. References are listed in Appendix I.

4. I have read the Code of Conduct for Expert Witnesses contained in the Environment Court's Practice Note 2006. I have complied with the code when preparing the following evidence and agree to comply with it when giving this evidence.

5. My evidence will address the following matters:-

    a. The impact of modification of the benthic habitat on the exclusive bottom feeding Yellow-eyed penguins;

    b. The potential effects of disposal of silt over an extended time period at the proposed site A0 on local Yellow-eyed penguin colonies;

    c. Respond to evidence provided by witnesses on behalf of Port Otago Limited

    d. Conclusions

Impact of modifications of the benthic habitat on Yellow-eyed penguins

6. Penguins are a group of seabirds that has given up their ability to fly and evolved to be superb divers that forage in a marine environment that is off-limits to other flying seabirds. However, while their diving

capabilities give penguins an advantage, their flightlessness also represents an Achilles heel when it comes to foraging ranges. During the breeding season, when most penguin species (save for Antarctic penguins) have to return to their nest on a daily basis to feed their chicks, they cannot range too far away from their nest sites. Little Blue penguins and Yellow-eyed penguins, for example, usually stay within 15-20km of their nest sites (Mattern et al. 2007a; Mattern 2007). Snares penguins venture a bit further and can travel up to 50km away from their colonies during chick rearing (Mattern 2007; Mattern in press). Because of this, penguins rely on an adequate supply of food in the vicinity of their breeding colonies. While flying seabirds can easily extend their search radius if food supply is scarce, penguins must increase their foraging effort by diving deeper and longer.

7. The Yellow-eyed penguin *Megadyptes antipodes* is an unusual penguin. Unlike other penguin species that find their food in the entire water column, Yellow-eyed penguins forage almost exclusively at the seafloor. The species relies on the presence of an abundant benthic fauna within reach from their nest sites. Their main prey species are benthic fish like blue cod, red cod, or opal fish (Moore & Wakelin 1997). Foraging studies of Yellow-eyed penguins from Oamaru, the Otago Peninsula and Stewart Island found that more than 90% of all dives go down to the seafloor; shallower dives were only performed when the birds were travelling near the surface back to their colonies (Mattern et al. 2007a; Mattern 2007). Unlike other penguins that search for their prey in a dynamic environment that is dictated by currents, tides and wind drift, the benthic environment is spatially predictable. Reefs, oyster beds, and horse mussel fields are found at distinct locations and provide growth substrate for diverse benthic communities (Morrison et al. 2008). These areas are targeted by Yellow-eyed penguins which results in at times extremely consistent foraging patterns, where the birds tend to travel to and forage at the same locations year in and out (Mattern et al. 2007a). However, such a specialised foraging strategy makes Yellow-eyed penguins vulnerable to perturbations within their

foraging habitat. Especially anthropogenic modifications of the marine environment have been found to have significant effects on Yellow-eyed penguins.

8. The local population of Yellow-eyed penguins breeding along the North-east coast of Stewart Island has experienced drastic decline in the past decade. While at first the presence of potential terrestrial predators (cats) was suspected to be the cause of this decline, monitoring revealed that chick starvation and disease are the reason for this on-going trend (King 2009). A comparative study of the diet and foraging behaviour of Yellow-eyed penguins from Stewart Island (population declines) and Codfish Island (where the population is stable) showed significant differences. The prey diversity of penguins from Stewart Island was low, with birds bringing predominantly a single species of fish (blue cod) ashore. On Codfish Island, located a few kilometres form Stewart Island, the penguins landed with a much more diverse range of prey (Browne et al. 2011). Moreover, the foraging behaviour also differed significantly. While Codfish Island birds utilised most of the western Foveaux Strait and even reached Te Waewae Bay, the penguins from Stewart Island foraged in very confined areas. Individual birds from different Stewart Island breeding sites furthermore all targeted the same oyster banks to search for their prey (see Fig. 1). If the penguins from northern Stewart Island shared the same, spatially limited foraging grounds, the low abundance and diversity of prey in their diet therefore reflects strong competition for sparse food resources. These findings raised two questions. Firstly, why were the foraging ranges of the Stewart Island penguins so small compared to their Codfish Island conspecifics? And secondly, why did the penguins not forage in regions utilised by the Codfish Island birds?

9. Foveaux Strait is renowned for the Bluff Oyster which has been commercially extracted from the seafloor since 130 years (Cranfield, Michael & Doonan 1999).From the 1940s onward, landings of oysters increased at a steady rate and by the early 1990s around 100 million

oysters were extracted annually from Foveaux Strait. In the late 1980s an outbreak of a sporozoan parasite *Bonamia exitosa* resulted in mass mortality of oysters and the temporary closure of the fisheries (Cranfield et al. 2005). Oyster extraction continued from 1996 onwards, however, the fisheries shifted from the eastern ranges of Foveaux Strait further to the West and closer to the North-east coast of Stewart Island (Cranfield et al. 2003). The extraction of oysters is achieved by dredging oysters from the seafloor. Oyster banks act as biogenic reefs and represent an important substrate for all kinds of sedentary benthic fauna (e.g. sponges, ascidians, bryozoans) which in turn provides habitat for marine invertebrates and fish. These reef communities are destroyed when the oysters are extracted (Cranfield et al. 2003). The increased oyster dredging activities and subsequent destruction of biogenic reefs closer to the Stewart Island coast, therefore, is what limits the foraging habitat of the Yellow-eyed penguins.

10. There is little oyster extraction activity in the western regions of Foveaux Strait, i.e. those regions utilised for foraging by Yellow-eyed penguin from Codfish Island. Those regions should theoretically be within reach of the penguins from Stewart Island. Yet, the foraging ranges of penguins from both islands do not overlap (Fig. 1). There are explanations why the Stewart Island penguins do not forage in western Foveaux Strait. Firstly, it could be that the currents and tides make commuting to those regions energetically unviable. And secondly, the food the adult penguins manage to obtain within their traditional, spatially limited foraging grounds is of poor quality but still adequate enough for self-sustenance. However, the food brought ashore to their chicks clearly is not enough to successfully raise their offspring (Browne et al. 2011). Hence, there is no recruitment of young penguins into an ageing population, which causes a steady decline that is likely to lead to extinction of Yellow-eyed Penguins in Northern Stewart Island (Mattern 2008; Mattern, Ellenberg & Davis 2007b).

11. The proposed large scale disposal of silt in Blueskin Bay has potential to cause similar population developments in Yellow-eyed penguins breeding in the area of Blueskin Bay.

Potential effects of disposal of silt over a long time period in Blueskin Bay

12. The number of penguins breeding within close range of the proposed dredge spoil disposal site A0 is significant. The largest colonies are located on the northern tip of the Otago Peninsula. All in all up to 90 breeding pairs have been recorded in the past in Kumukumewhero Bay, Omihi Beach, Pipikaretu, and Ryans Beach (see Fig 2). It should be noted that these locations are part of two prominent penguin viewing tourism operations, *Penguin Place* and ***Nature's Wonders***. Directly adjacent Blueskin Bay, there are between four and six breeding pairs resident in Aramoana, and a further two pairs at Kaikai Beach.

13. To which extent Blueskin Bay is being utilised by Yellow-eyed penguins is unknown. The presence of horse mussel fields in northern Blueskin Bay (Willis et al. 2008) makes this region potentially very attractive for Yellow-eyed penguins. Similar to the oysters banks of Foveaux Strait (see above), horse mussels provide hard substrate for sedentary benthic fauna and as such form the basis of diverse seafloor communities (Cummings 2001) (see Fig 3). Yellow-eyed penguins from Oamaru have been found to specifically target such horse mussel aggregations to forage (Mattern et al. 2007a). In fact, individual penguins were found to re-visit the same horse mussel patches not only on different foraging trips, but even in different years. This underlines the important role horse mussel patches play for the sustenance of Yellow-eyed penguins.

14. There is very little information on the foraging ranges of Yellow-eyed penguins from any of the sites close to Blueskin Bay. In December

2004, three penguins from Ryan's Beach were fitted with GPS data loggers (Mattern, unpublished data). Two of the birds, foraged due east of their breeding colonies. The third bird travelled North-east and traversed the A0 region (Fig 2). The small sample size does not allow us to draw any conclusions. However, the continental shelf drops to depths >100m just a few kilometres off Cape Saunders, thus, spatially limiting foraging grounds of Yellow-eyed penguins breeding north of the Cape (see Fig 2). As such it seems reasonable to assume that the Blueskin Bay region may represent an important foraging region for penguins from the northern peninsula.

15. It is unclear how the Blueskin Bay horse mussel fields will be affected by the proposed dumping of dredge spoil. However, horse mussels have a limited tolerance and are detrimentally affected by suspended sediments (Cummings 2001). Exposure to on-going sedimentation has the potential to significantly reduce the benthic biodiversity, particularly if horse mussels are affected (Morrison et al. 2008).

16. If the Blueskin Bay horse mussel patches play a vital role for Yellow-eyed penguins any negative effect the dumping of dredge spoil might have on horse mussels will translate to the penguins. Depending on the level of importance of the Blueskin Bay horse mussel fields, a worst case scenario could occur comparable to what has been observed on Stewart Island – reduced reproductive success, ageing and decline of the resident populations of Yellow-eyed penguins

Responses to evidence provided by witnesses on behalf of Port Otago

17. **Willis et al. (2008). NIWA report. Benthic offshore surveys of proposed dredge spoil disposal sites off Otago Peninsula (POL08401)**

The authors of this report commissioned by Port Otago appear to paint a somewhat distorted picture of horse mussels. In the "Executive

Summary" (page iv, paragraph 4, also on page 5, paragraph 1) it is stated that

> *"Horse mussels (Atrica zelandica) appeared to occur in patches northwest of Box A, though no definitive images were obtainable due to poor water visibility in the areas".*

Furthermore, the caption to figure 4 (page 7) states that

> *"Water clarity tends to be low in these areas because of suspended sediment"*

These statements may give the impression that horse mussels are tolerant to higher levels of water turbidity. However, exactly the opposite is true. Morrison et al (2008) state:

> *"Human activities, both on land and in the sea, may result in damage to biogenic habitats and the fish they support, reducing overall productivity and fisheries yield. Such stressors do not operate independently from each other, and may be synergistic in their effects.*
>
> *The main land-based stressors are thought to be sedimentation [...]. Several 'mechanisms of impact' may be operating:*
>
> - *Suspended sediment adversely affects filter-feeding animals that form biogenic habitat; these include horse mussels, green-lipped mussels, oysters, bryozoans, and sponges.*
> - *Reduced light levels through increased water turbidity and direct smothering compromise photosynthesis in plants such as seagrass, kelps/seaweeds, and maerl/rhodoliths.*
> - *Changes in the physical properties of the seafloor itself, such as increased 'muddiness', make it difficult for larvae*

of these species to settle and survive through to their adult forms."

Similarly, Cummings (2001) concludes

> *"Our work shows that increased concentrations of suspended sediments have negative effects on the condition of horse mussels, some of them sublethal, such as reduced reproductive output or ability to cope with disease, leading, ultimately, to death. This has implications for animals associated with horse mussels, and could potentially lead to a reduction in the biodiversity of some soft-sediment areas."*

18. **Paul Michael Sagar, NIWA, Affidavit, 4th April 2011**

The Paul Sagar's affidavit contains several incorrect statements regarding Yellow-eyed penguins which need clarification.

> *"However, most seabirds found in the areas off Otago feed well offshore [...] or are predominantly bottom feeders at depths over 40m (e.g. [...] Yellow-eyed penguins) and so the affected area represents a relatively small proportion of their foraging area."* (page 6, paragraph 13)

This statement represents an undue generalisation of the foraging behaviour of Yellow-eyed penguins. At Oamaru, Yellow-eyed penguins were observed to forage at water depths of less than 20m (Mattern et al. 2007a). Likewise, dive data collected on Yellow-eyed penguin from Stewart Island shows that those birds forage at maximum depths of 25m (Mattern 2008). As pointed out above there is reason to believe that the affected area might in fact be an important foraging ground for Yellow-eyed penguins, despite being at depths <40m.

Similarly, after correctly pointing out the potential impacts of the dredge spoil disposal might have on the foraging and breeding success of Yellow-eyed penguins in paragraphs 29.4.2 and 29.4.3 (pages 23&24), in paragraph 29.4.4 the witness states

> *"However, Yellow-eyed Penguins tend to forage on small fish such as sprat, red cod, silverside, blue cod, which they obtain mostly at depths greater than 40-80 m and up to 160m [...D]isposal site A0 lies in depths of 25-30 m, and so Yellow-eyed Penguins are likely to occur mostly well offshore from this area. Consequently, they are unlikely to be affected by New Era or Major Capital Dredging."*

As before the incorrect assumption that Yellow-eyed penguins forage only at depths >40m leads to a potentially wrong conclusion.

In paragraph 39.4, in response to a request for monitoring of population developments and foraging behaviour (via GPS data loggers) of Yellow-eyed penguins from Aramoana and Kaikai Beach, the witness states

> *"There is an increasing body of literature that indicates significant effects of flipper banding and the deployment of devices on penguins (e.g. Saraux et al. 2011). Consequently, deployment of such devices may have significant adverse effects on the survival of the individual monitored birds and their breeding performance."*

This statement is incorrect, provides an inaccurate summary of the literature cited, and draws an untenable conclusion. While it is correct that the findings of Saraux *et al.* (2011) show that flipper bands are likely to have an adverse effect on penguins, the publication does not at all touch on the subject of "the deployment of devices on penguins". As such it is misleading to cite this paper in order to dismiss the use of GPS data loggers to investigate the foraging ranges of Yellow-eyed penguins. In contrast, neither the deployment of large VHF transmitter packs (Moore 1999) nor the use more recent use of GPS data loggers (Mattern et al. 2007a) showed any adverse effect on Yellow-eyed penguins or their breeding performance.

It should also be noted that flipper bands are not the only way to mark and monitor penguins. The use of subcutaneous transponders ("microchipping") has proven to be a reliable method that has no adverse effects on the penguins whatsoever. Thus, the potentially negative effects of flipper banding should not be used to dismiss any efforts to monitor the population developments of Yellow-eyed penguins throughout the execution of the proposed project.

Conclusions

19. Based on the evidence provided above I conclude that there is potential for a considerable portion of the local Yellow-eyed penguin populations to be affected by dredge spoil disposal in Blueskin Bay. The Yellow-eyed Penguin is of considerable economic significance to Dunedin and is high-profile species that receives a lot of attention in the public. As such I would recommend the following steps to ensure that the best possible information is available to mitigate any negative impacts the Project Next Generation might have:

20. (A) Establish to which extent the horse mussel fields in Blueskin Bay are being utilised by penguins from Kaikai Beach, Aramoana and the northern Otago Peninsula. For

21. (B) Initiate an annual monitoring programme of foraging and breeding success of Yellow-eyed penguins from the same sites to assess whether reproductive performance is compromised during the execution of Project Next Generation.

Figure 1. Foraging ranges of Yellow-eyed penguins from Stewart Island and Codfish Island. Pink and orange shaded regions indicate foraging grounds. Note the substantial spatial limitation of the Stewart Island foraging grounds as a result of commercial oyster dredging (oyster beds shades grey) and the associated destruction of biogenic reef communities. (Reproduced from Mattern et al. 2007a)

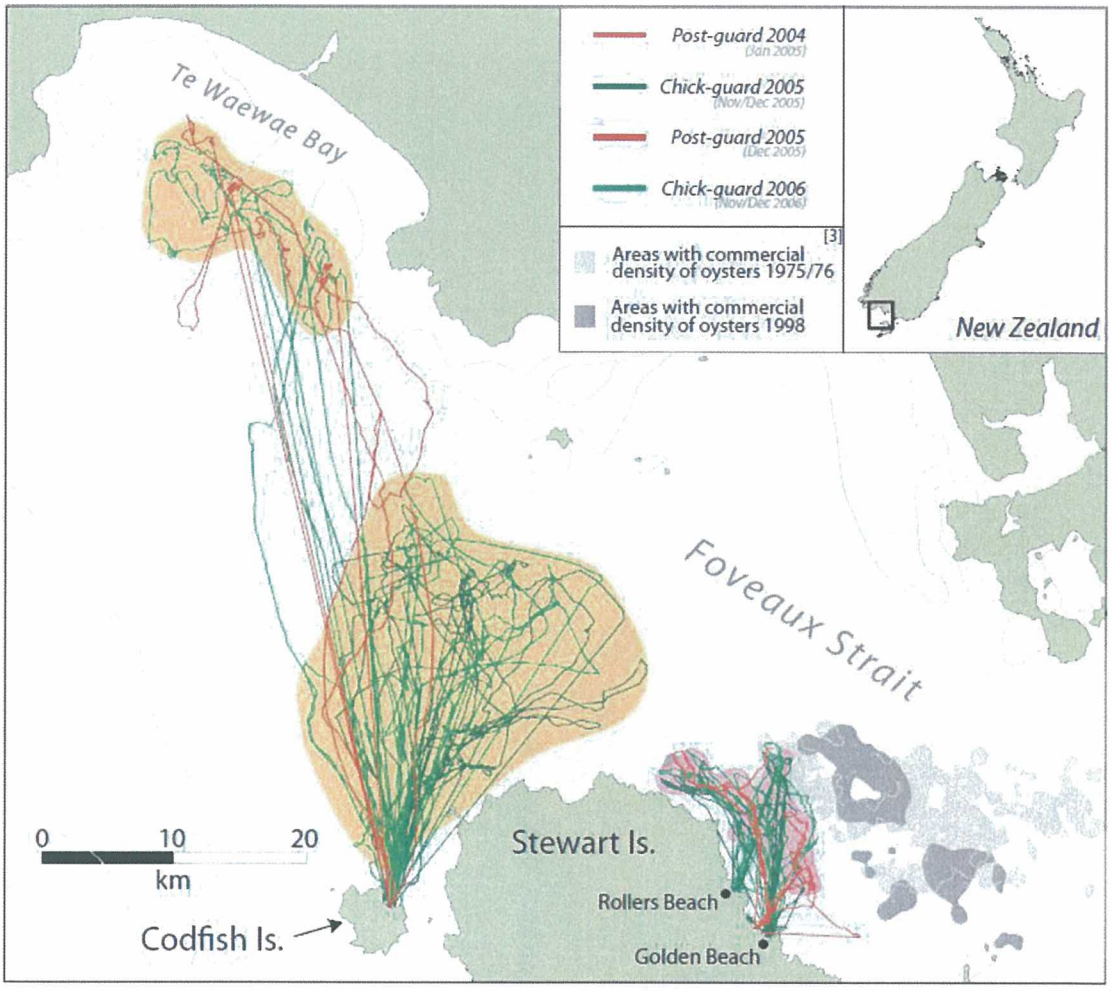
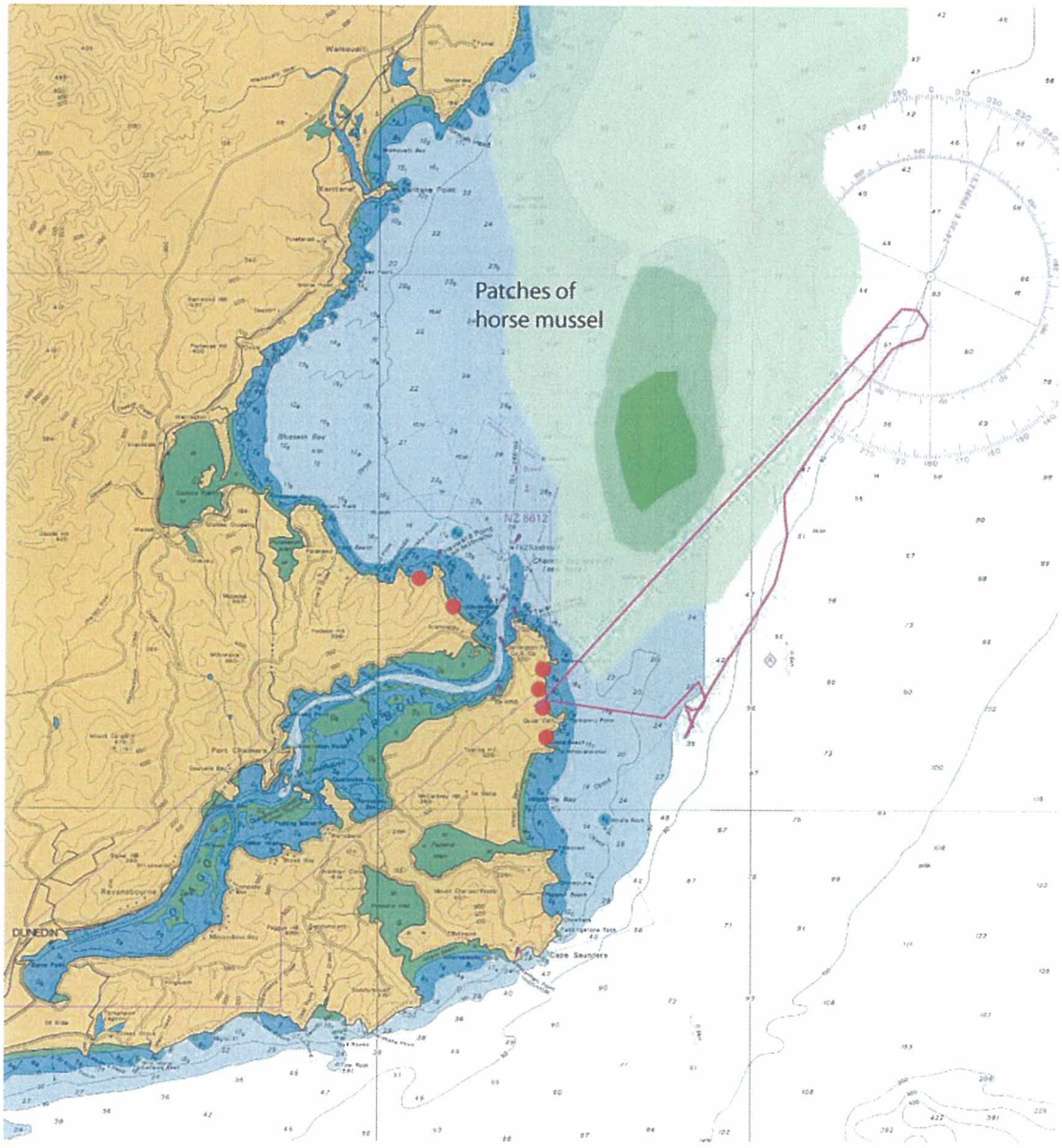


Figure 2. Overview of Yellow-eyed penguin colonies (red points) potentially affected by dredge spoil disposal and the approximate location of the horse mussel fields in Blueskin Bay that might represent important foraging grounds for these penguins. Violet line shows a one day foraging track recorded on a Yellow-eyed penguin from Pipikaretu ("Penguin Place") in December 2004. Predicted Plume propagation is reproduced from Fig 4.1b in Bell and Reeve (2010).



References

Mattern, T., Ellenberg, U., Houston, D. & Davis, L. 2007a. Consistent foraging routes and benthic foraging behaviour in yellow-eyed penguins. *Marine Ecology Progress Series*, 343, 295-306.
Mattern, T. 2007. Marine ecology of offshore and inshore foraging penguins: the snares penguin *Eudyptes robustus* and Yellow-eyed penguin *Megadyptes antipodes*., University of Otago.
Mattern, T. in press. Snares penguin *Eudyptes robustus*. In: *Biology and Conservation of the World's penguins* (Ed. by P. G. García-Borboroglu & B. P.D.). Seattle, USA: University of Washington Press.
Moore, P. J. & Wakelin, M. D. 1997. Diet of the Yellow-eyed Penguin Megadyptes antipodes, South Island, New Zealand, 1991-1993. *Marine Ornithology*, 25, 17-29.
Morrison, M., Consalvey, M., Berkenbusch, K. & Jones, E. 2008. Biogenic habitats and their value to New Zealand fisheries. *Water & Atmosphere*, 16.
King, S. 2009. A Survey of Yellow-eyed Penguins on Stewart Island/Rakiura. p. 27. Dunedin: Department of Conservation/Yellow-eyed Penguin Trust.
Browne, T., Lalas, C., Mattern, T. & van Heezik, Y. 2011. Chick starvation in yellow-eyed penguins: Evidence for poor diet quality and selective provisioning of chicks from conventional diet analysis and stable isotopes. *Austral Ecology*, 36, 99-108.
Cranfield, H. J., Michael, K. P. & Doonan, I. J. 1999. Changes in the distribution of epifaunal reefs and oysters during 130 years of dredging for oysters in Foveaux Strait, southern New Zealand. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 9, 461-483.
Cranfield, H. J., Dunn, A., Doonan, I. J. & Michael, K. P. 2005. Bonamia exitosa epizootic in Ostrea chilensis from Foveaux Strait, southern New Zealand between 1986 and 1992. *ICES Journal of Marine Science*, 62, 3-13.
Cranfield, H. J., Manighetti, B., Michael, K. P. & Hill, A. 2003. Effects of oyster dreging on the distribution of bryozoan biogenic reefs associated sediments in Foveaux Strait, southern New Zealand. *Continental Shelf Research*, 23, 1337-1357.
Mattern, T. 2008. The tip of the iceberg? The decline of Stewart Island yellow-eyed penguins indicates serious problems at sea. In: *6th Oamaru Penguin Symposium*, pp. 297-303. Oamaru: New Zealand Journal of Zoology.
Mattern, T., Ellenberg, U. & Davis, L. 2007b. Decline for a Delicacy: are decreasing numbers of Yellow-eyed penguins on Stewart Island a result of commercial oyster dredging? In: *6th International Penguin Conference*. Hobart, Tasmania.
Willis, T. J., Bradley, A., Handley, S. J., Paavo, B., Page, M. J. & James, M. 2008. Benthic offshore surveys of proposed dredge spoil disposal sites Off Otago Peninsula. Nelson: NIWA.
Cummings, V. 2001. Horse mussels enhance biodiversity in coastal soft sediments. *NIWA Biodiversity Update*, 2, 5.
Moore, P. J. 1999. Foraging range of the Yellow-eyed Penguins *Megadyptes antipodes*. *Marine Ornithology*, 27, 49-58.

Appendix 1: Relevant publications of Thomas Mattern

Mattern T (in press) Snares penguin, *Eudyptes robustus*. In Biology and Conservation of the World's penguins (García-Borboroglu, P.G. and Boersma P.D. eds.) University of Washington Press, Seattle U.S.A.

Mattern T (in press) Fiordland penguin, *Eudyptes pachyrhynchus*. In Biology and Conservation of the World's penguins (García-Borboroglu, P.G. and Boersma P.D. eds.) University of Washington Press, Seattle U.S.A.

Browne T, Lalas C, **Mattern T,** van Heezik Y (2010) Chick starvation in yellow-eyed penguins: Evidence for poor diet quality and selective provisioning of chicks from conventional diet analysis and stable isotopes. Austral Ecology, DOI: 10.1111/j.1442-9993.2010.02125.x

Mattern T, Houston DM, Lalas C, Setiawan A, Davis LS (2009) Diet composition, continuity in prey availability and marine habitat – keystones to population stability in the Snares penguin *Eudyptes robustus,* Emu 110: 204-213

McGraw K, Massaro M, Rivers TJ, **Mattern T** (2009) Annual, sexual, size- and condition-related variation in the colour and fluorescent pigment content of yellow crest feathers in Snares Penguins (*Eudyptes robustus*). Emu 109(2): 93-99

Ellenberg U, **Mattern T**, Seddon PJ (2009) Habituation potential of yellow-eyed penguins depends on sex, character and previous experience with humans (Featured Article). Animal Behaviour 77: 289-296

Mattern T, Ellenberg U, Houston DM, Davis LS (2007) Consistent foraging routes and benthic foraging behaviour in the Yellow-eyed penguin. Marine Ecology Progress Series 243:295-306

Chiaradia A, Ropert-Coudert Y, Kato A, **Mattern T**, Yorke J (2007) Diving behaviour of Little Penguins from four colonies across their whole distribution range: bathymetry affecting diving effort and fledging success. Marine Biology DOI 10.1007/s00227-006-0593-9

Ellenberg U, **Mattern T**, Seddon PJ, Luna-Jorquera G (2006) Physiological and reproductive consequences of human disturbance in Humboldt penguins: The need for species-specific visitor management. Biological Conservation 133: 95-106

Mattern T, Ellenberg U, Luna-Jorquera G, Davis LS (2004) Humboldt Penguin Census on Isla Chañaral, Chile: Recent Increase or Past Underestimate of Penguin Numbers? Waterbirds 27(3): 268-276

Mattern T, Ellenberg U, Luna-Jorquera G (2002) A South American Marine Otter *Lontra felina* preys upon Chicks of the Peruvian Diving Petrel *Pelecanoides garnotii*. Marine Ornithology 30: 95-96