

Channel Deepening Project

Expert Witness Statement of Tiana Jayne Preston

1 Name and address

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2 Area of expertise

(a) Little penguin ecology, specifically the St Kilda little penguin population that I am currently researching for my PhD.

(b) Qualifications:

- 1998-2000 Diploma of Environmental Management, Chisholm Institute
- 1998-2001 Monash University, Bachelor of Science, Marine and Freshwater Biology
- 2002-2003 Monash University, Marine Biology Honours, Bachelor of Science (Honours), First Class
- 2006 – Present Monash University (in conjunction with Phillip Island Nature Park), Doctor of Philosophy Candidate

3 Scope

3.1 Instructions

Data presented in this report was collected for my PhD titled “Relationships between foraging, diet and reproduction in the little penguin”. It is not the specific aim of this study is to investigate the CDP and its effects, but data collected in the first season (2006/07) on the foraging habits of breeding penguins is relevant to the CDP.

I was primarily responsible for data collection and analysis, but this project is a collaboration between Monash University, Phillip Island Nature Park and the National Institute of Polar Research (Japan). Collaborators from these institutions share ownership of the data and have been involved in its processing and interpretation.

This report is prepared by myself and details the data collected from satellite transmitters and time-depth recorders deployed on little penguins at the chick-guard¹ stage from St Kilda during the 2006/07 breeding season.

3.2 Methods

The foraging ecology of little penguins was studied on a three-dimensional scale by determining their position at sea using satellite tracking and their water column use measured by time-depth recorders.

¹ Chick-guard is the period of time after eggs hatch that one parent stays with the chick while the other forages for food for itself and it's chicks. Lasts for approximately 15 days.

3.2.1 Satellite tracking

During November and December 2006, 13 penguins at the chick-guard stage were fitted with satellite transmitters (attachment by water-proof tape which can be removed without damage to feathers, according to the methods of Wilson et al. 1997). These satellite transmitters are specially designed for little penguins and the locations (latitude and longitude) of the satellite transmitters are detected by the Argos satellite network at the water's surface. Location points detected by the satellites are graded according to the accuracy of the location as follows:

- Z no accuracy given, 1 satellite signal
- B no accuracy given, 2 satellite signals
- A no accuracy given, 3 satellite signals
- 0 no accuracy given, 4 satellite signals
- 1 ≤ 1 km of animal location, 4 satellite signals
- 2 ≤ 350 m of animal location, 4 satellite signals
- 3 ≤ 150 m of animal location, 4 satellite signals

Only locations from classes 1, 2 and 3 were used to guarantee accuracy of the location within 1 km.

Time spent by all penguins in locations was grouped in 1 km^2 grids and then analysed using the timeTrack package (Sumner) in the statistical package R (R Development Core Team 2005). Time between locations was interpolated every ten minutes assuming straight-line travel at constant speed between each location. Maximum speed between locations did not exceed 3.6 km hour, which is well within the swimming capability of little penguins (Bethge et al. 1997).

The mean amount of time spent (averaged across all penguins) in each of the 1 km^2 grid squares was subsequently mapped and plotted together with bathymetric details of Port Phillip Bay provided by PIRVic.

3.2.2 Time-depth recording

Miniature loggers that record time, depth and temperature (commonly referred to as time-depth recorders or TDRs) were fitted to 8 penguins at the egg-incubation stage and 2 penguins at the chick-guard stage between November 2006 and January 2007. Attachment methods were the same as for satellite tracking (refer to 3.1.1), and loggers were removed after the penguin returned from a trip at sea.

Data was downloaded from the loggers and automatically analysed using IGOR Pro version 5.0 (Wavemetrics Inc., USA). Based on the resolution of the logger, a dive threshold of 1.0 m was used. Diving activity was defined by the following parameters: maximum depth, dive duration, bottom phase (calculated as the period in the dive that starts and ends with an absolute value of $< 0.25 \text{ m s}^{-1}$ vertical speed), bottom phase depth amplitude, descent and ascent rates, and number of directional changes (Ropert-Coudert et al. 2006).

4 Results

4.1 Satellite tracking

Satellite locations were filtered to exclude locations with unknown accuracy (ie class 0, A, B and Z locations removed) and those that would be impossible for a little penguin to reach from its prior location based on published maximum swimming speeds (in this case there were none). After this filtering process was complete, a total of 11 penguins and 98 locations (from a total of 279) were left to be analysed.

Satellite tracking showed that 10 of the 11 penguins made one-day trips, while one made a two-day trip. Of the penguins that made a 1-day trip, the maximum distance from the colony recorded was 22 km and the mean maximum distance from the colony was 14.2 ± 1.4 km. Time was spent in the north of Port Phillip Bay (Fig. 1, Appendix), including Hobsons Bay, which is different from the summer distribution of little penguins reported in the CDP SEES (Appendix 56, pp 44, Fig II.2-3). Penguins on one-day trips spent 32% of their time (derived from time assigned to locations generated by the time-spent in area analysis) within 1 km^2 grid squares that included and were on either side of the northern shipping channels (ie < 2 km of the channel, 22.5% of the grid squares covered in the 1-day trips). The one bird that made a 2-day trip went to Corio Bay (51 km from colony).

4.2 Time-depth recording

Trip duration of penguins fitted with TDRs ranged from 1-11 days, with a total of 48 foraging days and 32 690 dives from 10 birds. Penguins dived exclusively during daylight hours, with dive depth being greatest during the middle of the day. The mean maximum depth was 8.4 ± 0.6 m, the majority of dives conducted to depths of between 2 and 13 m (82.7%) (Fig. 2, Appendix).

Many of the penguins diving profiles had long bottom phases (Fig. 3a, Appendix). The bottom phase accounted for an average $49.7 \pm 2.3\%$ of the dive time, which is indicative of demersal diving (near the sea floor). Sudden depth changes in the dive profiles were common, indicating that penguins follow bathymetric variations (Fig 3b., Appendix).

4.3 Supporting information for research findings

4.3.1 Restricted distribution of breeding little penguins

(a) Radio-tracking study of little penguins by Mark Collins and Neil Blake, 1993, unpublished.

Please note that only the June/July winter distribution of little penguins from this study published in Nature Australia (Cullen et al. 1996) has been mentioned in the SEES. No data from this study during the breeding season has been reviewed in the SEES.

Methods: Little penguins from St Kilda, Phillip Island and Port Campbell were fitted with radio-receivers during June/July, Sept/Oct (penguins incubating eggs) and Nov/Dec/Jan (penguins feeding chicks) of 1993/94. The location of penguins was determined every day by flying over Port Phillip Bay and coastal waters between Phillip Island and Port Campbell while scanning for the penguin radio frequencies. Hand-held receivers were used to check the

penguin nests at the St Kilda breakwater every morning and evening to determine the length of their foraging trip.

Findings: The following quote appeared in the St Kilda Penguin Research Report 1993-94 prepared by Prof. Mike Cullen (deceased) and Neil Blake in July 1994 for the St Kilda Breakwater Advisory Committee (convened at that time by DSE)

“ [Radio] transmitters were put on half a dozen St Kilda adults [penguins] in July, September and December for a couple weeks at a time. Results showed that St Kilda birds foraged within 20 kms of the breakwater in all these months, which included times when the birds involved had eggs or chicks.” (Cullen & Blake 2001)

(b) Maximum foraging distance of breeding little penguins:

While it is true that little penguins are capable of travelling hundreds of kilometres at sea, their foraging range during the breeding season is greatly restricted. Penguins must return to their nest regularly to feed their chicks, which typically take up to nine weeks to rear (Reilly & Cullen 1981). When parents make extended foraging trips the offspring suffer through lower fledging weights, longer time before fledging and often death prior to fledging (Chiaradia & Nisbet 2006). Collins *et al.* (1999) determined that the average maximum distance travelled from the colony at Phillip Island by little penguins on a one day trip was 14.8 km.

4.3.2 Demersal diving patterns in little penguins

Little penguins commonly dive to mid-depths of the water column, but demersal diving has been reported previously at a colony surrounded by shallow water at Penguin Island, WA (Chiaradia *et al.* 2007). Table 1 (Appendix) compares the average amount of time spent in the bottom phase of a dive with the diving strategy.

5 Relevance to the CDP

5.1 How these research findings relate to the CDP

Breeding little penguins on one-day foraging trips were found in project area 1 and project area 2. Penguins make one-day trips during their critical chick-rearing stages, when their foraging range is restricted to around 20 km from the colony. Penguins from St Kilda can breed any time between July and March, which coincides with the proposed northern operations of the CDP. It is not possible to predict the number of penguins that will be breeding during the CDP as there is inter-annual variation in timing of the breeding season.

As penguins dive demersally, they require light penetration through the whole water column to forage efficiently since they hunt by sight. Therefore, areas affected by the turbidity plume caused by the CDP will be unsuitable for foraging by little penguins and consequently they are likely to be displaced from foraging in these areas.

The foraging area of penguins at this stage of their life-cycle appears to include and cross the northern shipping channels. Of the total time spent at sea by penguins on one-day trips, over 30% of this was <2 km from the

shipping channels. This proximity to the shipping channels exposes penguins to turbidity plumes that will arise and extend from the CDP in this region. Penguins at the chick-guard stage will need to either cross or work their way around the turbidity plume caused by the CDP in the north of the bay to reach their main foraging areas. If penguins spend more time at sea (ie 2 or 3 days rather than 1 day), it is likely that clutches will fail (Chiaradia & Nisbet 2006).

It is reasonable to assume that penguins feed in areas where they spend time in at sea, thus penguin distribution reflects prey distribution (Davoren 2007). Anchovy comprise over 90% of the diet of penguins from St Kilda (Chiaradia et al. 2004) and are a major dietary item of the penguins from Phillip Island (Cullen et al. 1992). Behavioural changes, physiological damage, recruitment failure and mortality are predicted for anchovy as a result of the CDP in project areas 1 and 2 (Jenkins & McKinnon 2006). It is predicted that anchovy populations in the north of the bay will be reduced as a result of the CDP, which in turn reduces the local food resource for penguins. If penguins cannot find food within their restricted foraging range during the breeding season, their population viability may be affected through lower reproductive success and increased mortality due to starvation. Such effects have been reported previously on little penguins after a massive mortality of pilchards and for other penguin species elsewhere (Crawford 1998; Crawford & Dyer 1995; Dann et al. 2000).

5.2 Recommendations to the CDP review panel

- Because foraging penguins are likely to be displaced by the CDP turbidity plume, the plume should be minimised as much as possible. This would include measures such as using non-overflow dredging techniques and avoidance of dredging during storm events.
- Avoidance of dredging in northern areas of the bay during summer and early autumn would help to avoid periods of anchovy spawning and times when penguins are breeding and moulting. These are the periods where both species are most vulnerable and the likelihood of impacts on population viability (through increased mortality and reproductive failure) is greatest.
- The response of little penguins to the turbidity plume is largely unknown. If the turbidity plume acts as a barrier that penguins cannot pass through, their whole foraging area will be reduced (including penguins from Phillip Island that use Port Phillip Bay also). Monitoring of penguins foraging ranges with best-practise techniques during the period of the CDP is recommended to help understand the effects of the CDP on penguins.
- As little penguins at St Kilda feed almost exclusively on anchovy (Chiaradia et al. 2004) and anchovy is also an important prey species for penguins at Phillip Island (Cullen et al. 1992), any effects of the CDP on this fish species are likely to affect both penguin populations. In order to fully assess the effect of the CDP on anchovy, the

recommendations for study and monitoring made in the anchovy literature review (Coutin 2005) should be followed.

- Little penguins are a top predator so they are sensitive to changes at the lower levels of the food web. Little penguins from St Kilda are restricted to Port Phillip and therefore they are ideal to study the effects of the CDP on the local area. A dietary study of the penguins before, during and after the CDP is recommended to fully understand the effect of the CDP on both penguins and prey species, and their recovery from any effects. Dietary study on penguins from Phillip Island is also suggested as they commonly forage inside Port Phillip Bay during winter and spring.
- To fully understand the effect of the CDP on the penguins population viability, monitoring of reproductive success, and where possible adult mortality, should be conducted at St Kilda and Phillip Island before, during and after the CDP.

5.3 Conclusions

The data presented in this report shows that little penguins from St Kilda at the chick-guard stage have a limited foraging range and use the whole water column when diving. The foraging range of the little penguins at this stage of their life-history overlaps some areas of Port Phillip Bay to be affected by the CDP.

The effect of the CDP on little penguins is dependent on two factors:

- a) penguins response to the turbidity plume caused by dredging
- b) effect of the CDP on anchovy.

A level of uncertainty remains regarding these two factors, and as such the precautionary principal should be applied to minimise any potential effects to both species and monitor the effect of this project.

Monitoring of penguins' foraging range, reproductive success and diet is needed to understand the effect of the CDP on this species.

I have made all the inquiries that I believe are desirable and appropriate and that no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.

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7th June 2007

8 References

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9 Appendix Figures and Tables

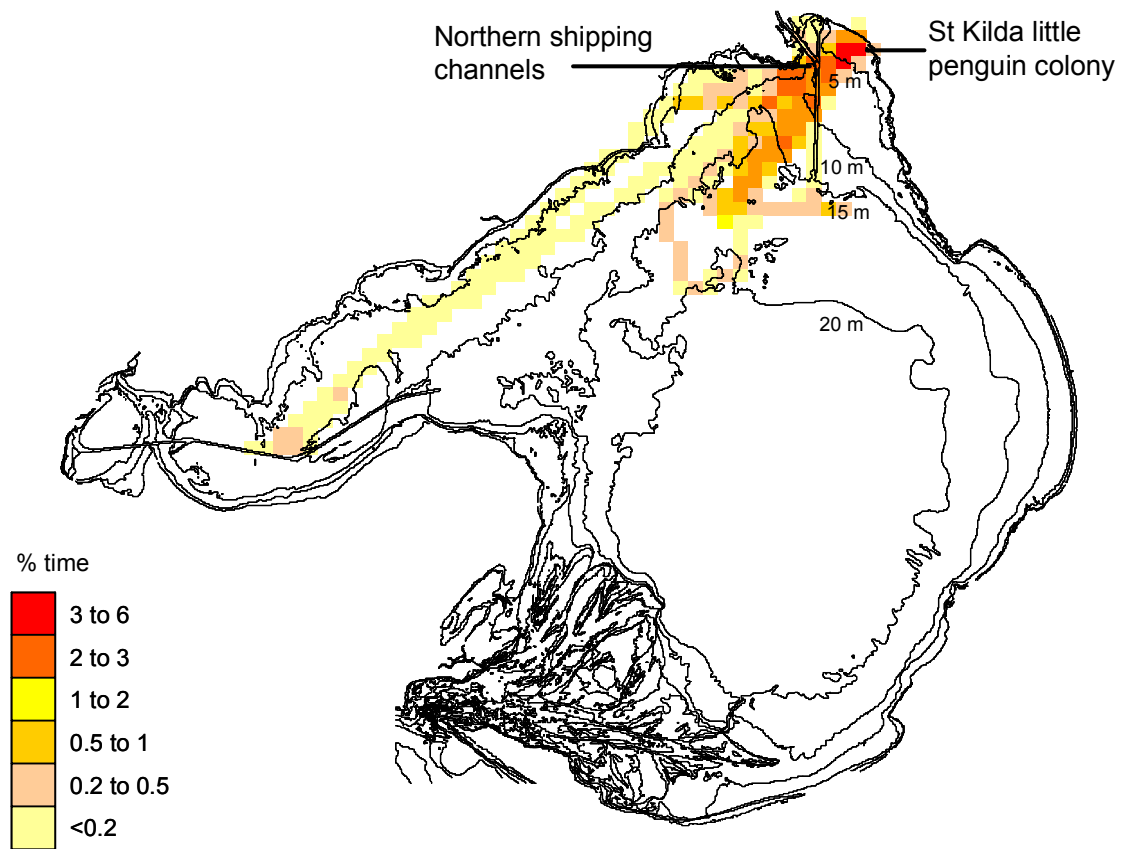


Figure 1: Time-spent in area analysis of little penguins at the chick guard stage from St Kilda. Extended foraging to the western channel area was made by one penguin. Percentage of time in each 1 km² grid square is averaged over all penguins with an equal contribution from each (ie 2-day trip has equal weight as 1-day trips).

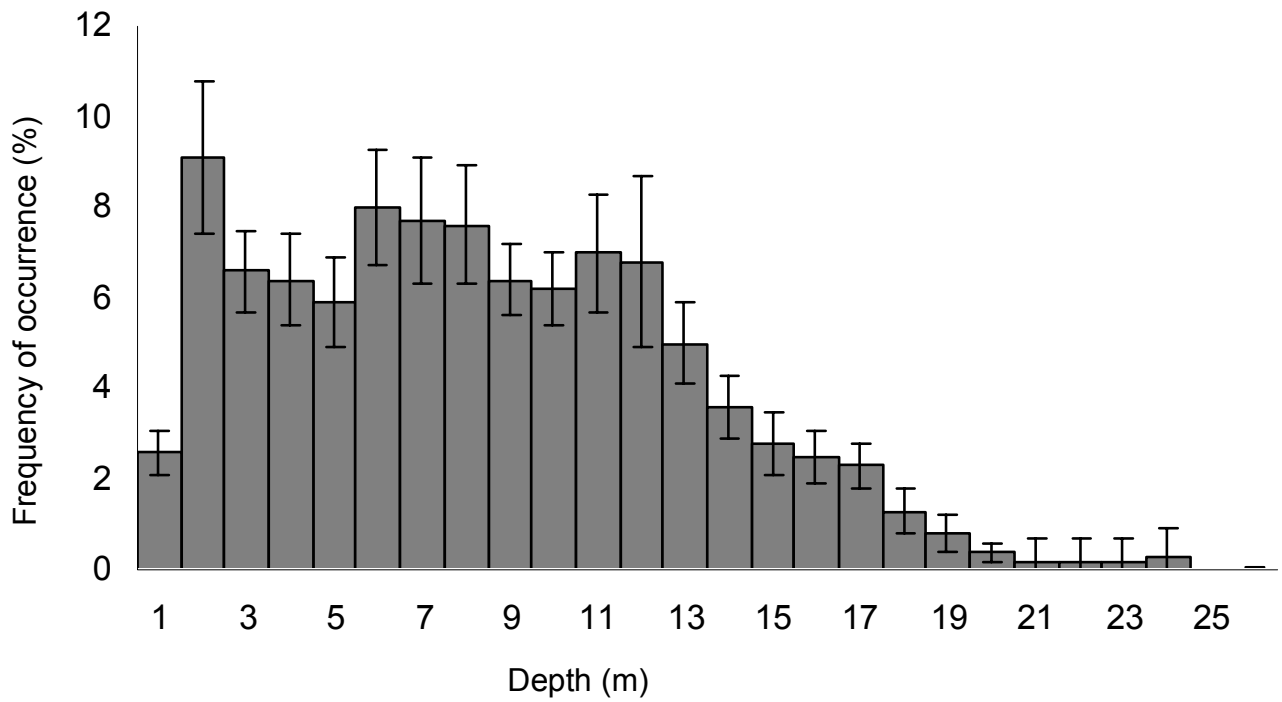


Figure 2: Frequency of dives to each maximum depth (mean of all penguins with one standard error).

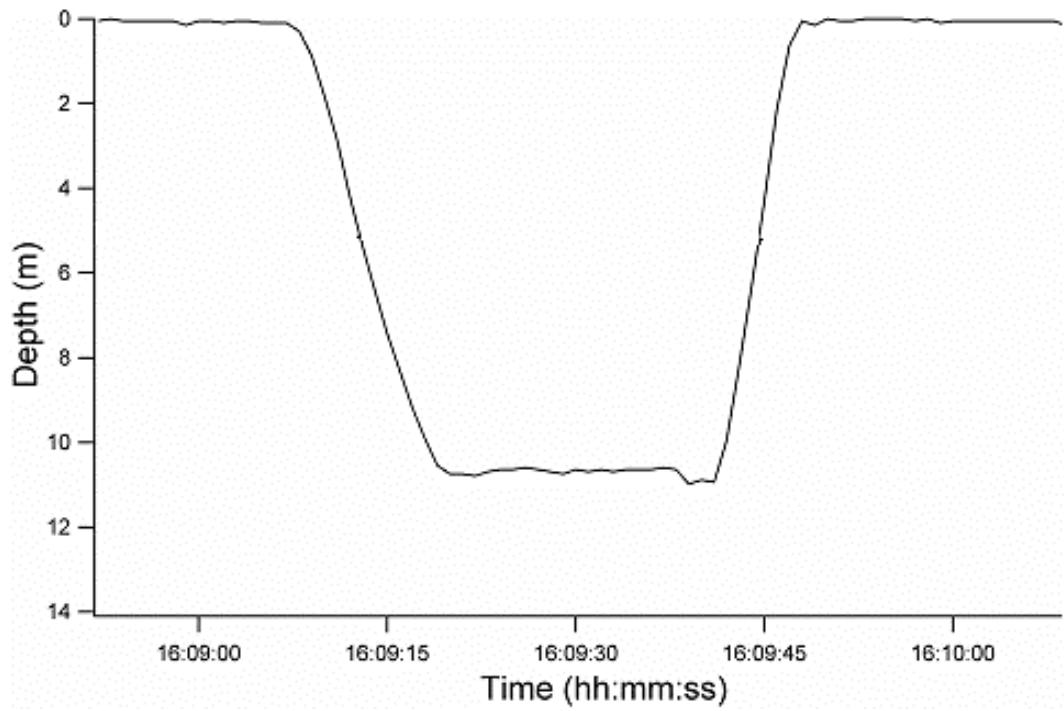


Figure 3a: Long time at the bottom phase of the dive indicates that penguins dive near the sea floor.

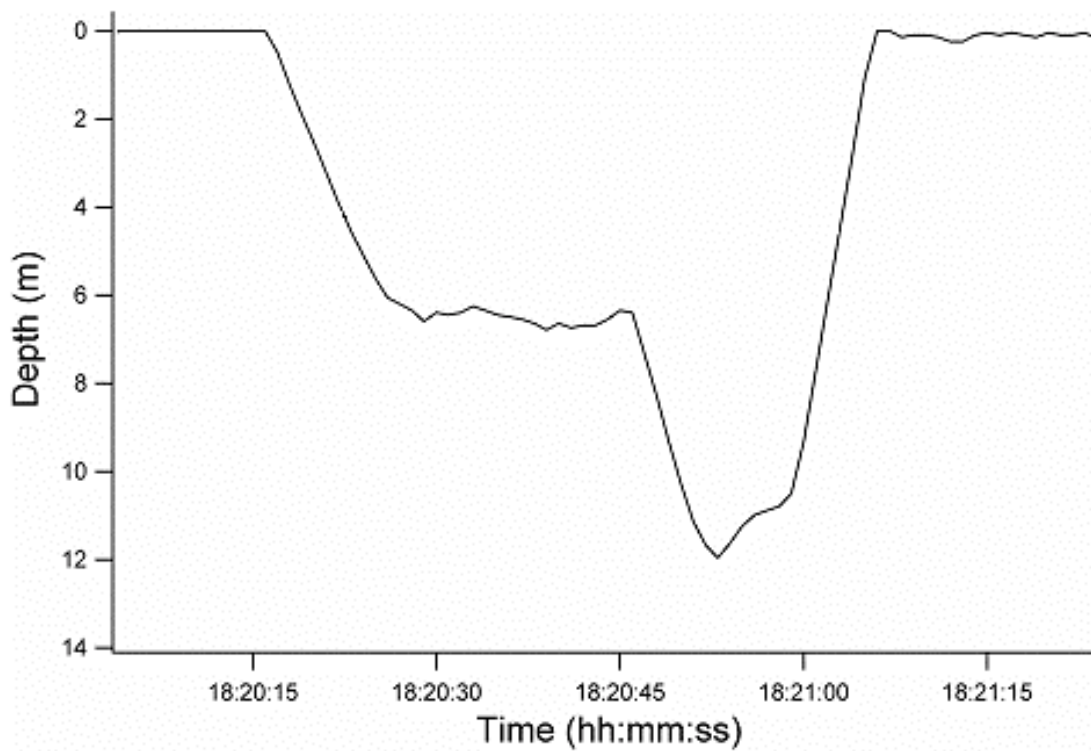


Figure 3b: Sudden depth changes in the dive profile indicate bathymetric variation.

Table 1: Average bottom phase (% of total dive time) of little penguins from five different colonies and their diving strategy (adapted from Chiaradia et al. 2007).

Colony	Bottom Phase	Diving Strategy
<i>St Kilda, VIC</i>	50%	<i>Demersal</i>
Penguin Island, WA	47%	Demersal
Oamaru	34%	Mid-water
Motuara Island, NZ	32%	Mid-water
Phillip Island, VIC	22%	Mid-water