

Little Penguin adoption of under-road culverts, Bruny Island 2017/18

Report to Department of State Growth, March 2018.
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Executive Summary

As part of the Department of State Growth's Bruny Main Road upgrade project, seven under-road culverts and associated penguin fences were installed before the 2017/18 Little Penguin *Eudyptula minor* breeding season at the Neck colony. As the numbers of returning penguins increased as the breeding season progressed, so did their adoption and use of the culverts, so that by the end of the season in January 2018, very few birds were recorded with cameras along the fence line on the roadside. Based on the data available presented in summary here, BirdLife Tasmania believes that the installation of culverts under the Bruny Island Main Road, associated roadside fencing and minor modifications throughout the Summer resulted in the adoption and use of the culverts by Little Penguins during the 2017/18 breeding season. The estimated penguin breeding population for the Neck in 2017/18 was 380 pairs, an increase of approximately 65% over the estimated 230 pairs in 2016/17. The results obtained in this study serve as a useful guide for future construction projects involving wildlife.



Little Penguin at the d'Entrecasteaux Channel entrance of Culvert 3, 17 October 2017.
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Introduction

The Department of State Growth delivered the Bruny Main Road Upgrade Project between July and November 2017. The project involved sealing a 2.5km stretch of road and installing a new sealed car park. The project involved significant investigation into the flora and fauna of the area, particularly the Little Penguin *Eudyptula minor* colony at the Neck. The design and implementation of the road and car park upgrade was managed to minimise impacts to the mixed species Little Penguin and Short-tailed Shearwater *Ardenna tenuirostris* colony, and to facilitate ongoing use of the habitat by penguins in particular.

As part of the Bruny Main Road upgrade, four circular 750mm diameter culverts were placed under the newly sealed section of road at the Neck specifically to facilitate Little Penguins access to the colony at the Neck. An additional three circular 375mm diameter under road culverts were also placed for drainage purposes (Figure 1). An additional culvert was installed to allow drainage from the car park, but the entrance was covered with wire mesh to prevent penguins entering.

In addition to the penguin culverts along Bruny Main Road, penguin fencing was also erected on both sides of the road (colony side and d'Entrecasteaux Channel side) for approximately 800m to prevent Little Penguins gaining access to the road. The fences were installed along the roadside shoulder, at a greater elevation than the under road culverts.

All culverts were fitted with a small (225 x 100 x 75 mm) solar-powered LED light at both ends, to slightly illuminate the entrances. The LED lights were attached to the ceiling of each culvert just inside the entrance. The lights installed were 'Solar Magic' 40 lumen SMD LED arrays. The lights contain two rechargeable batteries and the unit is triggered automatically at dusk and remains on until dawn or until the batteries are discharged.

The use of culverts to facilitate Little Penguin access to their colony was adopted based on the advice and experience of Dr P Agnew at the Blue Penguin Colony at Oamaru, New Zealand. At Oamaru, a 25m long culvert 450mm diameter was installed under the road approximately 100m from the main colony in 2016. The culvert was installed to reduce the numbers of penguins crossing the road leading to the Oamaru Blue Penguin colony's Visitor Centre.

This report presents a brief summary of the results of monitoring which was implemented to assess the adoption of the under-road culverts at the Neck by the Little Penguins. The monitoring was conducted by BirdLife Tasmania and commenced on completion of the penguin fencing in October 2017. The report also details modifications that were made during the monitoring period in light of observations made by the BirdLife Tasmania field personnel.

Methods

Figure 1 shows the location of the Neck colony, the Bruny Island Main Road and the locations of the culverts. The culverts were numbered 1 (Southernmost) to 7 (Northernmost), and excluded the one car park culvert whose ends were blocked with mesh.

Bird Life Tasmania monitoring commenced on Monday 16 October 2017 for two nights. This involved two or three observers on site along the Bruny Island Main Road between 8:00pm and 11:00pm (AEDST), recording all penguins and Short-tailed Shearwater *Ardenna tenuirostris* observations and vocalisations at the Neck colony and on the Bruny Island Main Road itself. Observers alternated between sitting close to culverts to record penguins and walking back and forth between Culverts 1 to 7, Figure 1.

Based on the low numbers of penguin observations made on those two initial nights, it was decided to use camera traps to record the movements of penguins at culvert entrances and at the roadside fence lines. Monitoring using camera traps was undertaken in five phases (Table 1) between 24 October 2017 and 1 February 2018 inclusive, in approximately 7 to 10 day periods. The use of camera traps greatly expanded the time period for monitoring the penguins' adoption of the under-road culverts, and associated behaviours.



Figure 1. Map showing the Bruny Island Neck colony (green polygon), the Bruny Island Main Road and car park (lower centre), the locations of the eastern (colony) and western (d'Entrecasteaux Channel) entrances of Culverts 1 to 7 (south to north) and surface contours (10m increments). The numbers for each culvert denote their internal diameter (eg CULV 1 750: Culvert 1 has 750mm diameter); contour interval is 10m and scale bar shows 100m. Note it is believed that GPS noise is responsible for the wayward position data for the colony entrance to Culvert 1.

The camera trap units were DigitalEye™ Trail Cameras fitted with Sony DSC-W190 and Sony DSC-W55 cameras modified with motion-activated infrared flash and infrared sensors. The cameras deployed at the culverts were fixed to star pickets or wooden stakes with cameras positioned approximately between 400 and 750mm off the ground and aimed at culvert entrances.

The cameras deployed on the fence line were fixed to steel poles supporting traffic signs, set at ground level and aimed along the fence line. Cameras were programmed to take pictures (triggered by movement

within approximately 2m of the camera) between sunset and sunrise, and images were either colour or black and white. Images were approximately 4MB in size.

Results

1. Summary of effort

Surveys and monitoring of the culverts and fences was undertaken on a total of 41 days between 16 October 2017 and 1 February 2018. Camera traps were used from 24 October 2017 onwards; before then, two or three BirdLife Tasmania field personnel were present within the construction footprint during the evenings of 16 and 17 October 2017.

On 8 November 2017, nine cameras were deployed on one or both entrances of all culverts except culvert 2. The cameras were typically deployed for a week at a time, with varying degrees of success in obtaining images as a number of cameras malfunctioned for a number of reasons during their various deployments.

Images from approximately 220 camera trap-nights were obtained from cameras positioned at six of the seven culverts and at three points along the northwestern fence line along Bruny Island Main Road between 24 October 2017 and 1 February 2018, hereafter referred to as the 'study period'.



Figure 2. Photograph showing Little Penguin in Culvert 3 on 26 October 2017. Photograph ©2017 BirdLife Tasmania (image DSC02092.jpg).

2. Little Penguin colony dynamics

At the commencement of field observations in October 2017, there were very few penguins present in the colony. There were very few footprints observed on the northwestern foreshore (d'Entrecasteaux Channel) and no vocalisations were heard from the colony or from the foreshore. Fresh penguin splash (guano) was observed at the seaward entrance of Culvert 3 and along the newly-constructed fence line on the morning of 17 October 2017, indicating the presence of penguins ashore during the night.

The images from the trap cameras showed an increased number of penguins at the culverts during

November and December (Table 2), with peak numbers of penguins recorded at the culverts in early to mid-December 2017.

The timing (phenology) of the penguin colony at the Neck was similar to that of colonies being monitored in the Derwent Estuary by BirdLife Tasmania (BirdLife Tasmania unpubl. data). A subjective assessment of the colonies' phenologies in the Derwent River and at the Neck indicated similarities in relative abundances of birds ashore and in the timing of the breeding effort. It is believed that the construction of the road and car park had no noticeable impact on the colony dynamics for the 2017/18 season (Woehler 2017a).

Further supporting this subjective assessment is the colony estimate derived from BirdLife Tasmania's annual monitoring of the Neck and Whalebone Point colonies on Bruny Island (Woehler 2017b). The penguin population at the Neck colony was estimated to be approximately 380 ± 40 breeding pairs, up from the 230 ± 20 breeding pairs in the Neck colony in 2016/17 (Woehler 2017b). The 2017/18 breeding population estimate is approximately 65% higher than the 2016/17 estimated penguin breeding population at the Neck (BirdLife Tasmania unpubl. data).

3. Use of culverts

The lights in the culverts' entrances exhibited variable illumination due largely to dust settling on the solar panels, reducing their efficacy in charging the internal batteries. Some arrays failed to operate following installation, while others were weak and illuminated the entrances relatively poorly. Cleaning of the solar panels improved the illumination of the entrances by the LED arrays. Given the poor illumination of some culverts and the failure of some LED arrays, it is believed that the penguins adopted and subsequently used the two culverts closest to 'historical' access points to the colony (culverts 3 and 4), rather than favouring culverts that were illuminated (see below).

The height between the beach and culvert entrances increases from north (Culvert 7) to south (Culvert 1), with the d'Entrecasteaux Channel entrance of Culvert 1 more than 5m above the beach at low tide. It is believed that this elevation discourages penguins from using the culvert, given the limited data available (Table 2).

Fresh penguin splash was present in Culvert 1 on 17 October, three sets of penguin footprints were present in Culvert 7 on 24 October, and numerous footprints were observed amongst the culverts on the evening of 25 October. These observations suggest relatively rapid adoption and use of the culverts by the penguins as the breeding season commenced.

Culverts 3 and 4 (opposite the new car park and closest to the previous car park) were the two culverts used most frequently by penguins over the study period. These two culverts were placed closest to two main access points of the colony for penguins on the d'Entrecasteaux Channel aspect of the colony. It is expected that these culverts will remain the primary access routes under the roadway.

The periods of 7 to 14 December 2017 and 24 January to 1 February 2018 inclusive provide the best comparative data on the relative uses of the culverts and penguins recorded along the fence line (Table 2). The period coincided with the peak and a decrease in penguins attending the colony during the study period, with the peak in numbers recorded using three culverts (38 on 9 December 2017) similar to the peak in numbers of penguins recorded along the fence line (10 on 10 December 2017). The much lower numbers of penguins recorded along the fence line in January 2018 is believed to reflect the adoption and usage of the culverts by penguins during the breeding season.

Overall, the use of culverts increased during the study period based on the camera data (Table 2), reflecting both the increase in penguins breeding in the colony over the study period and their adoption of the

culverts. It is impossible to separate the relative contribution of these factors based on the data available. Based on the experiences at Oamaru, once the penguins had accepted and adopted the culvert as an access route to the colony, they willingly used the culvert with less hesitation over time (P Agnew pers. comm.); a similar situation is expected to occur at Bruny Island. Illumination of the seaward end of the culvert at Oamaru was found to reduce the hesitation of penguins in entering the culvert (P Agnew, pers. comm.).

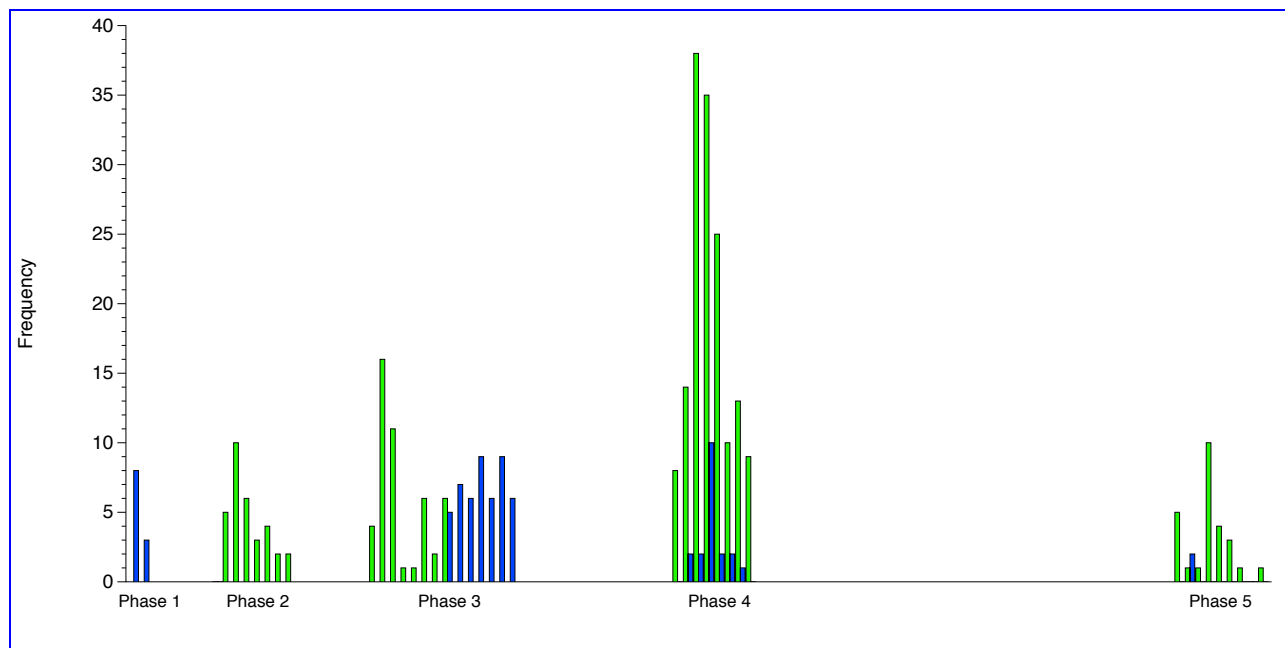


Figure 3. Graph showing the frequencies of Little Penguins photographed at the culverts (green bars) and along the roadside fence lines (blue bars), Bruny I Neck colony 2017/18 (see Table 1 for dates of monitoring phases and Table 2 for raw nightly data).

4. Efficacy of roadside fencing and modifications made

The fencing was constructed along the roadside edge on both sides of the road to prevent penguins' access to the road. The fence line is typically 1m or higher in elevation between the culvert entrances, and if the penguins 'miss' the entrances on arrival and departure, they continue up the riprap until they encounter the fence, where they were observed and recorded walking along the fence line outside of the road surface.

Several modifications were made to guide the penguins towards the culvert entrances at both ends and to encourage their adoption and use of the culverts:

- a square 'return' was added to the ends of the fences that guided the penguins through 180° back towards the culvert entrances within the fencing extent (Figure 4),
- sand and small gravel was added to the culvert entrances as a transition from the riprap to the smooth concrete of the culverts (Figure 5),
- the riprap material was slightly rearranged below the culvert entrances with beach sand placed to form a pathway to direct penguins towards the culvert entrances (Figure 6),
- rocky 'guides' were constructed from the roadside fence line to the culvert entrances on the rip rap to divert penguins from the fence line to the culvert entrances on the d'Entrecasteaux Channel side of the road (culverts 3, 4, 5, 6 and 7) (Figure 7), and
- all rock 'guides' were subsequently replaced with posts and fencing material identical to that used along the roadside; this was done by PWS/pakana services.

These modifications increased the efficacy of the culverts and their adoption by the penguins.

5. Handling and ushering of penguins

A low number of penguins were located on the roadside by members of the construction crew in mid-October shortly after the fencing was completed. The penguins were picked up and placed on the d'Entrecasteaux Channel side of the fence (P Vertigan, pers. comm.). A total of eight penguins was observed along the d'Entrecasteaux Channel fence line on the evening of 16 October, and all were ushered into the nearest culvert (PV and RB, pers. obs). Three penguins were ushered into culverts on the evening of 17 October 2017. Thereafter, no penguins were handled by the BirdLife Tasmania field team for the remainder of the study period. Ushering was used only for a brief period at Oamaru following the installation of the culvert (P Agnew, pers. comm.).

6. Other species observed by camera

The camera traps recorded an additional five species at the culvert entrances and along the fence lines (Table 3). The species recorded comprise Tasmanian Pademelon, Eastern Quoll, feral/domestic cat, Brush-tailed possum and European Rabbit, and were recorded on 21 instances. It is believed that the brush-tailed possum and cat(s) were investigating the culverts while on foraging trips to and around the penguin/shearwater colony. No predation events were recorded, and no images of these species carrying carcasses were made.

7. Nocturnal patterns in penguin observations

The camera trap images apparently show a greater level of penguin activity at the culverts departing the colony and heading to the d'Entrecasteaux Channel compared to those using the culverts arriving at the colony, based on the times involved. This interpretation is based on 'arrival' times being inferred to occur following dusk and extending to the early hours of the following morning (eg 1:00am), and 'departing' birds recorded in the hours before dawn. Further investigations, including tracking studies, would provide additional data to confirm whether the inferred arrival/departure periods are appropriate, or if some other factor(s) may be involved.

Conclusions and recommendations

1. Limitations to the study

In light of the camera malfunctions, the data shown in Table 2 represent the *minimum* numbers of penguins present at the culverts and along the fence line. Had all the cameras worked on all nights, it is highly likely that additional penguins would have been photographed at the entrances of the culverts and along the fence line. Further, had additional cameras been available for deployment, additional monitoring of the fence line and all culvert entrances would have been possible, providing additional data to provide a more complete synthesis of the numbers of penguins using the culverts and reaching the fence line throughout the study period.

2. Adoption of culverts, efficacy of roadside fencing

This is the second time culverts have been placed under a roadway in Tasmania to facilitate access to a breeding colony of Little Penguins. The earlier effort was at Eaglehawk Neck by the Tasman Council, but no studies were undertaken to assess the use of the culvert there. Anecdotal records suggest the penguin colony on the inside of the road has persisted to the present.

The Bruny Neck colony is thus the only colony in Tasmania (and believed to be second only to the Oamaru colony in New Zealand) where observations have been undertaken following the installation of under-roadway culverts for Little Penguins.

Despite the low number of cameras (see above), it is clear that the penguins have adopted the culverts under the Bruny Island Main Road to access the colony from the d'Entrecasteaux Channel. Details on the

rate of adoption and use are unavailable, but by the end of January 2018, approximately 3.5 months after their installation, it is clear the culverts are being used and very few penguins are being recorded along the fence line (Table 2).

Modifications to the fences (curved returns at the ends of fences), the placement of rock and fence guides from the fences to the culverts' entrances and the spreading of sand and gravel in culverts' entrances all contributed to the adoption of the culverts by the penguins.

The illumination of the entrances by the LED arrays likely contributed, but based on the limited data available (several arrays failed to operate), it is unclear to what extent these lights contributed to the adoption of the culverts. Based on the experience at Oamaru, where illumination reduced the hesitation by penguins in entering the 25m culvert, it is likely illumination for the shorter (9m) culverts at Bruny Island may not have been as critical (P Agnew, pers. comm.).

The culverts and fences were installed before the 2017/18 breeding season, so penguins were confronted with the new infrastructure on their return to the colony landing site(s) on the d'Entrecasteaux Channel side of the colony. As the numbers of returning penguins increased as the breeding season progressed, so did their adoption and use of the culverts so that by the end of the season in January 2018, very few birds were recorded along the fence line on the roadside.

Further evidence in support of the adoption of the culverts by the penguins is the estimate for the annual breeding population of penguins in the colony. The breeding populations of Short-tailed Shearwater and Little Penguins have been monitored annually at the Neck and Whalebone Point on Bruny Island since 2011/12 (Woehler 2017b). The estimated penguin breeding population for the Neck in 2017/18 was 380 pairs, an increase of approximately 65% over the (relatively low) estimate of 230 pairs in 2016/17 (BirdLife Tasmania unpubl. data).

Based on the data available presented in summary here, BirdLife Tasmania believes that the installation of culverts under the Bruny Island Main Road, associated roadside fencing and associated modifications resulted in the adoption and use of the culverts by Little Penguins during the 2017/18 breeding season. With the infrastructure in place, it is expected that penguins not yet experienced with the culverts and fencing will follow experienced birds in future, with fewer novice birds arriving at the colony and encountering the culverts and fencing over time.

Consideration should be given to modifications for the d'Entrecasteaux Channel entrances to Culverts 1 and 2. At present, there appears to be minimal Little Penguin activity at these culverts, likely due to their relatively high elevation above the foreshore. Providing easier access over the riprap is likely to result in greater penguin use of these culverts at the southern end of the Neck colony.

Minor modifications to the guides leading to the culvert entrances over the riprap may be required over the 2018 Winter following periods of high seas. It is not expected that further modifications are required for the roadside fencing at this point beyond adding curvature to the 'returns' (Figure 4). Minor maintenance involving replacing sand in the culverts' entrances may be required if it has been washed away. Conversely, culvert entrances that are filled with vegetation or sand following poor weather will need to be cleared to ensure the culverts are usable for the penguins.

The results obtained in this study serve as a useful precedent and guide for future construction projects involving wildlife, particularly Little Penguins throughout their range. The penguins' relatively rapid adoption and use of the culverts following their installation was facilitated and encouraged with fencing and minor on-ground modifications made during the breeding season. The costs associated with the culverts and

fencing were negligible with respect to the total cost for the road sealing, thereby eliminating any impediment to their inclusion in similar projects elsewhere.

Acknowledgements

Our thanks to Dr Philippa Agnew, Oamaru Blue Penguin Colony for her willingness to share her knowledge and experience of penguin culverts. Jill Jones (Department of State Growth) initiated the study and supported the project beyond its original time frame. Brendan Moore (Andrew Walter Construction) strongly supported BirdLife Tasmania's involvement in the project; he and his construction team adopted all recommendations made by BirdLife Tasmania on site during the study period. pakana services modified the fences and culvert access guides.

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Phase	Start	End	Cul 1	Cul 2	Cul 3	Cul 4	Cul 5	Cul 6	Cul 7	Fen1	Fen2	Fen3
1	24 Oct	31 Oct			EW	EW						
2	8 Nov	15 Nov	W				W	E	EW			
3	15 Nov	22 Nov								W	W	W
4	7 Dec	14 Dec			EW	EW			EW	W	W	
5	24 Jan	1 Feb			EW	EW				W	W	

Table 1. Camera monitoring of culvert use by Little Penguins, Bruny Island Neck 2017/18. Cul 1 to Cul 7 denotes the seven culverts (south to north), see Figure 1. E denotes a camera placed on the eastern (colony) end of the culvert, W denotes a camera on the western (d'Entrecasteaux Channel) end of the culvert. All fence cameras were deployed on the d'Entrecasteaux Channel (W) side of the Bruny Island Main Road. Fence 1 was adjacent to Cul 3 and faced north, Fence 2 was opposite the northern end of the newly constructed car park (approx. 5m north of Cul Mesh Cover) and faced south, and Fence 3 was adjacent to Cul 4 and faced south.

Date/ camera	Cul 1	Cul 2	Cul 3	Cul 4	Cul 5	Cul 6	Cul 7	Fen 1	Fen 2	Fen 3	Total culverts	Total fence
24-Oct-17											0	0
25-Oct-17			3	2							5	
26-Oct-17			6	4							10	
27-Oct-17			6	0							6	
28-Oct-17			2	1							3	
29-Oct-17			3	1							4	
30-Oct-17			2	0							2	
31-Oct-17			2	0							2	
8-Nov-17			1	3							4	
9-Nov-17	0		1	13	0	0	2				16	
10-Nov-17	0		8	1	0	0	2				11	
11-Nov-17	0		1	0	0	0	0				1	
12-Nov-17	0		0	0	0	0	1				1	
13-Nov-17	0		1	3	0	0	2				6	
14-Nov-17	0		0	0	0	0	2				2	
15-Nov-17	0		5	0	0	0	1	0	5	0	6	5
16-Nov-17								1	6	0		7
17-Nov-17								0	6	0		6
18-Nov-17								0	9	0		9
19-Nov-17								0	6	0		6
20-Nov-17								0	9	0		9
21-Nov-17								0	6	0		6
7-Dec-17			6	2			0	0	0		8	0
8-Dec-17			11	3			0	1	1		14	2
9-Dec-17			29	9			0	1	1		38	2
10-Dec-17			22	13			0	6	4		35	10
11-Dec-17			17	7			1	1	1		25	2
12-Dec-17			10	0			0	1	1		10	2
13-Dec-17			8	5			0	1	0		13	1
14-Dec-17			7	2			0	0	0		9	0
24-Jan-18			0	5				0	0		5	0
25-Jan-18			1	0				1	1		1	2
26-Jan-18			1	0				0	0		1	0
27-Jan-18			1	9				0	0		10	0
28-Jan-18			4	0				0	0		4	0
29-Jan-18			3	0				0	0		3	0
30-Jan-18			1	0				0	0		1	0
31-Jan-18			0	0				0	0		0	0
1-Feb-18			1	0				0	0		1	0

Table 2. Numbers of Little Penguins recorded at Culverts 1 to 7 (excluding Culvert 2) and at three points along the northwestern fence line (d'Entrecasteaux Channel foreshore) by trap-cameras between October 2017 to February 2018.

Species	Date(s) recorded, 2017/18
Pademelon	12 Nov, 12 Dec
Cat	26 Oct, 10 Nov, 14 Nov, 7 Dec, 8 Dec, 26 Jan
Brush-tailed Possum	28 Oct, 9 Nov, 10 Nov, 11 Nov, 13 Nov, 14 Nov, 15 Nov, 8 Dec, 12 Dec
Quoll	13 Dec, 14 Dec
Rabbit	29 Jan

Table 3. Other species recorded on cameras at the Bruny Island Neck colony during the study period 24 October 2017 to 1 February 2018 (see Table 1 for dates of camera deployments).



Figure 4. Photograph showing the square ‘return’ that was added to the ends of the fences to guide the penguins through 180° back towards the culvert entrances within the fencing extent. Photograph ©2018 Peter Vertigan.



Figure 5. Photograph showing the sand and small gravel that was added to the culvert entrances as a transition from the riprap to the smooth concrete of the culverts. A camera trap is shown *in situ*. Photograph ©2018 Peter Vertigan.



Figure 6. Photograph showing the path through the rearranged riprap material below the culvert entrances with beach sand placed to form a pathway to direct penguins towards the culvert entrances. Photograph ©2018 Peter Vertigan.



Figure 7. Photograph showing the rocky 'guides' that were constructed from the roadside fence line to the culvert entrances on the rip rap to divert penguins from the fence line to the culvert entrances on the d'Entrecasteaux Channel side of the road. Photograph ©2018 Peter Vertigan