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SHORT NOTE

Marking penguins with implanted transponders

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Individual marking of birds is required in many studies. Lance Richdale pioneered marking of penguins in the 1930s (Richdale 1951, 1957). His most reliable method was punching holes in the feet, but he also used home-made aluminium leg bands which had to be replaced every three years because of wear. Subsequently, researchers reported that leg bands used on Antarctic penguins caused injuries and that they experienced difficulties reading them in the field. Thereafter, flipper bands became the standard method for marking penguins (Sladen 1958). If applied correctly, these bands cause no visible injury other than some feather abrasion. Increased mortality over the winter was attributed to bands which were too narrow and restricted blood flow when the flipper swelled during moult (Ainley *et al.* 1983: 191). A different design with projecting fasteners caused serious injury, possibly death in a particular study (Sallaberry & Valencia 1985). In the latter case, a chinstrap penguin (*Pygoscelis antarctica*) colony of 180–210 nests declined to 40 nests within 11 years after birds in the colony were first banded (Valencia & Sallaberry 1993). Studies of energetics showed that the additional drag caused by flipper bands led to a 24% increase in energy expenditure during swimming in an artificial channel (Culik *et al.* 1993). However, no differences were detected in adult mortality, breeding success, or chick growth between flipper-banded and control royal penguins (*Eudyptes schlegeli*) over one year (Hindell *et al.* 1996). In conditions of abundant food supply, penguins may be able to compensate for the drag caused by flipper bands (Hindell *et al.* 1996) but problems may appear during times of poor food availability.

An alternative for long-term marking of penguins is a subcutaneously implanted transponder (also known as "passive integrated transponder", PIT-tag). Transponders are invisible from the outside and do not interfere with the external body shape. Transponders have been used in zoos for more than 10 years without apparent problems (Behlert 1989). Because there are no moving parts and no battery within the tag, a transponder should function for the lifetime of the bird. Potential dangers of this technique include migration of the tag to other parts of the body, which could damage internal organs, and infection. Histological examination of animals that died of causes unrelated to transponders showed a slight connective tissue reaction around transponders and, in one instance, a bacterial film (Clarke & Kerry 1998). Active inflammation was recorded neither in captivity (Behlert & Willms 1992) nor in the wild (Clarke & Kerry 1998).

Marking wild birds with transponders is a relatively new technique and few results have been published so far (Clarke & Kerry 1998). Here we report on the experience of marking blue penguins (*Eudyptula minor*)

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Table 1 Total numbers and re-sightings of blue penguins (*Eudyptula minor*) marked with implanted transponders on Motuara Island, Marlborough Sounds.

	Total marked	Seen in 1995 only	Seen in 1996 not in 1998	Seen in 1998	Never seen again
Breeder 1995	135	32	50	44	9
Non-breeder 1995	29	3	10	8	8
Chick 1995	3	3			
Breeder 1996	88	61	23	4	
Non-breeder 1996	9	5	3	1	
Chick 1996	7	7			

on Motuara Island, Marlborough Sounds, New Zealand, with transponders over a 2-year study.

Adult penguins were caught on the nest or at night after feeding their chicks. We used Texas Instruments TIRIS™ transponders (Fig. 1) (23 mm × 4 mm, mass 0.6 g) to individually mark 263 adults. A veterinarian provided initial instruction on the application procedure. The injection needle was cleaned and sterilised with 10% iodine solution before each injection, while an assistant held the bird on their lap. Feathers around the injection spot were moistened with the iodine solution to avoid feathers getting caught by the needle. We then lifted the skin slightly and inserted the needle almost parallel to the back under the skin in the upper back.

Generally, the application of transponders was straightforward for adults. Slight bleeding was observed in some adults, but this stopped within a few minutes. In many juveniles, the skin on the back was very tight, with little subcutaneous fat, making it more difficult to place a transponder between muscle and skin. For this reason, we marked only the largest chicks with transponders. A twitch, indicating some pain, was observed when injecting the transponder into most juveniles, but was only rarely evident in adults.

Transponders could be monitored from a distance of up to about 400 mm, but to be sure a bird was not tagged it was advisable to bring the antenna right on to its back (Fig. 2). Accidentally, one bird was tagged with three transponders in 1995 (we failed to double-check for the presence of a transponder before the second application and then, because we did not get a reading because the two transponders were too close together, assumed a malfunction and injected a third transponder). This bird was breeding successfully in 1996 and was seen rearing two chicks during December 1997. Though all three transponders could be read, their close proximity caused interference and it was difficult to get a reading at all.

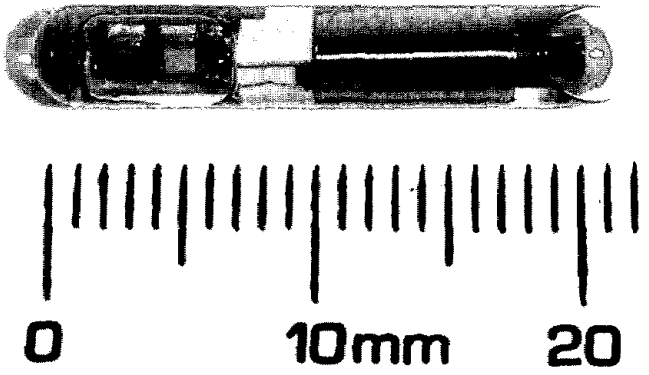

Fig. 1 Tiris™ transponder as used in this study for marking blue penguins (*Eudyptula minor*). Note the microchip on the left and the copper coil antenna on the right.

Fig. 2 Transponder number being read from a blue penguin breeding in the open (*Eudyptula minor*).

Most birds marked in 1995 were found again in 1996 and 1998 or at least were re-sighted in 1995 (Table 1) indicating a low rate, if any, of tag loss. If a transponder was not lost during the first few days after implantation it apparently stay in the bird for life. All of the breeding birds never seen again after marking in 1995 were caught during the post-guard stage. As with to non-breeders, birds in the post-guard stage rarely stay on land during the day and, because we checked nests mostly during daylight hours, they would have had a low chance of being

re-sighted. All chicks marked with transponders were re-sighted while still in the nest, but none had returned to the island for breeding by December 1997.

We found that the application of skin cement to close the small hole left after injection, as used by other researchers (Chiaradia 1996), was unnecessary since there was no evidence of tag loss. The injection site on the back of the bird avoids the risk of misplacing a transponder into the pectoral muscle, which can happen when applying transponders to the side of the neck (Clarke & Kerry 1998), and decreases the chance of its migration into body cavities. Injection into the pectoral muscle could cause injury and is likely to reduce swimming speed (Wilson & Culik 1995).

Transponders are not suitable for population studies or those that rely on recoveries by the general public because a transponder is invisible from the outside. Further drawbacks are their high cost (NZ$10-15 each) and the need for an expensive and delicate, battery-powered, reading device. However, for studies of burrow-nesting seabirds which require frequent nest checks there is no better alternative because nests can be checked with minimal disturbance. Also, there is the potential for automated registration of activities and body mass (Handrich *et al.* 1995; Olsson 1997).

We conclude that transponders are safe and reliable to use. Most importantly, transponders will not interfere with the fine-tuned hydrodynamic shape of penguins as has been reported for flipper bands.

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