The utility of closed aluminium and butt-ended stainless steel leg bands for Australian Pelicans *Pelecanus conspicillatus*

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Leg bands are one of the oldest and most widespread methods used to mark individual birds for study, but different kinds of bands may influence results obtained. We compared recoveries from closed aluminium and butt-ended stainless steel leg bands deployed on Australian Pelicans *Pelecanus conspicillatus* between 1968 and 2004. All 64 recoveries from the 2123 closed aluminium bands deployed exhibited wear, whereas none of the 162 recoveries from the 12 427 butt-ended stainless steel bands deployed were worn. Closed aluminium bands resulted in 2.3 times as many recoveries overall, but half the recoveries within one year of deployment compared to butt-ended stainless steel bands. Only butt-ended stainless steel bands were recorded as “band only found”, suggesting they became dislodged from pelicans. This was confirmed with pelicans that were simultaneously marked with leg bands and patagial tags. Together these data show that butt-ended stainless steel bands, while offering greater durability, result in less useful data than closed aluminium bands. A leg band that combines the durability of stainless steel bands and reliability of closed aluminium bands would provide a better proposition for the future studies of Australian Pelicans.

INTRODUCTION

A variety of techniques are now available to measure movements and longevity of birds, including patagial tags, leg flags, and radio or satellite telemetry (Strait and Sloan 1975; Schreiber and Mock 1988; Warmock and Takekawa 2003; Anderson and Anderson 2005; Fuller et al. 2005; Roshier et al. 2006; Coiffait et al. 2009; Martin and Major 2010). Numbered leg-bands (herein referred to as bands) are one of the oldest methods used to mark individual birds. While relatively few banded birds are recovered (Strait and Sloan 1975; Lawler et al. 1993; Webster et al. 2002; Lowe 1991), the large numbers of bands that have deployed in the past mean they provide an important source of data on fundamental aspects of bird biology. These data may also provide valuable information for conservation and management.

Several factors influence the reporting rate of recovered bands including species, band address, geographic location, the material from which a band is made and band design (Lensink, 1998; Lowe 1991; Anderson and Anderson 2005). Bands may deteriorate relatively quickly on birds that spend much time in and around water (Duwors et al. 1987; Lensink 1998). It is important to understand how these factors influence recovery rate and patterns because they have the potential to influence how data should be interpreted. In addition, worn bands may develop sharp scalloped edges which may injure birds (Duwors et al. 1987; Sedgwick and Klus 1997; Lensink, 1998; Berggren and Low 2003; Bedrosian and Craighead 2008).

Analysis of banding data has provided important information on pelicans internationally (Strait and Sloan 1975; Schreiber and Mock 1988; Crivelli et al. 1988; Anderson and Anderson 2005), but little is known about the movement of pelicans in Australia. As part of a larger study (Manning et al. in prep), we noticed differences in recoveries from two different kinds of bands that have been deployed on Australian Pelicans *Pelecanus conspicillatus*. This paper reports these differences in recoveries between closed aluminium bands and butt-ended stainless steel bands and tests whether the two types of bands offer equal utility in studies of movement and survival of Australian Pelicans.

MATERIALS AND METHODS

We analysed data from 14 550 Australian pelicans banded between 28 August 1968 and 20 November 2004. All bands were size 17 series, embossed with a unique number and supplied by the Australian Bird and Bat Banding Scheme (ABBBS). The 2123 bands deployed between 1968 and 1985 were closed (lock on) aluminium bands, whereas the 12 427 bands deployed between 1986 and 2004 were butt-ended stainless steel bands. The closed aluminium bands were similar in general design to the butt-ended band, except that they were closed with two flanges of unequal length. The longer flange was folded over the shorter flange, effectively locking the band in place (Figure 1).

Bands were deployed at six pelican breeding colonies in South Australia. Three thousand, five hundred and thirty-five bands were deployed at Lake Eyre South (29°24'S, 137°20'E,) as described by Waterman and Read (1992). A further 310 bands were deployed on Section Bank near Outer Harbour (34°47'S, 138°29'E) (Johnston and Harbison 2005; Johnston and Wiebkin 2008) and 128 bands at Reedy Point on Lake Alexandrina (35°27'S, 138°59'E) (Eckert 1965). The remaining 10 577 bands...
were deployed on North Pelican (36°03'S, 139°34'E), Seagull (36°05'S, 139°35'E) and Mellor Island (36°04'S 139°35'E) on the Coorong (Chapman 1963). The majority of birds banded were flightless downy chicks (Vestjens 1977). A small number of juveniles and adults were banded opportunistically, but these were not targeted.

ABBBBS records of band recoveries were used to compare recoveries, band survival and degree of wear between the two types of band. Bands recovered from dead pelicans or as “band only found” accounted for 95.2 percent of the recovery records. The remaining 4.8 percent of bands reported were read on free-living birds or on birds that were captured and released. Band recoveries were reported more than once for three birds (1.3%). Only data from the longest time to recovery was used for each individual pelican, so that each bird was included in the analyses only once. We used three measures of band survival. Firstly, we compared the proportion of bands recovered within one year of banding. This analysis avoided the confounding effect of different amount of time since the two kinds of bands had been deployed. Secondly, we compared the proportion of bands recovered in five year intervals (0-5 years, 6-10 years, 11-15 years and 16-20 years) following deployment. This analysis tested the utility of the two kinds of bands over a longer period of time. Thirdly, we compared the proportion the two types of bands that were reported as “band only found” over the entire data set. Statistical comparisons were made with $\chi^2$ tests (Sokal and Rohlf 1995).

RESULTS

Overall 226 (1.6%) bands were recovered of the 14 550 deployed. A higher percentage of closed aluminium bands were recovered (64 recoveries or 3.0% of 2 123 deployed) than butt-ended stainless steel bands (162 recoveries or 1.3% of 12 427 deployed) ($\chi^2 = 31.34, P < 0.001$).

In contrast, a smaller percentage (39.1% = 25 of 64) of closed aluminium bands were recovered within one year of being deployed than butt-ended stainless steel bands (75.9% = 123 of 162) ($\chi^2 = 25.98, P < 0.001$). Over longer periods of time there were no differences in proportional recoveries between the two band types, except for the period between five and ten years after deployment (Table 1). Then 17.2 percent (11 of 64) of Aluminium bands were recovered versus 5.6 percent (9 of 162) of Stainless Steel bands ($\chi^2 = 5.95, P < 0.025$; Table 1). None of the 64 (0%) closed aluminium bands deployed were recovered as “band only found”, whereas 20 of 162 (12.3%) butt-ended stainless steel bands deployed were recovered as “band only found” ($\chi^2 = 7.21, P < 0.01$).

All closed aluminium bands recovered exhibited band wear. The degree of band wear on closed aluminium bands increased with time, to the extent that abrasion on the margins of the band was evident and often the band number was barely visible after three years. One live Australian Pelican with a readable closed aluminium band was reported 15 years after banding, although the digits had eroded substantially. After 15 years no closed aluminium bands were recovered (Table 1). In comparison, none of the butt-ended stainless steel bands exhibited band wear. Indeed, four butt-ended stainless steel bands recovered from dead chicks that had failed to fledge showed no evidence of wear, even though they had lain in the salt crust of Lake Eyre South for twenty years.

**Table 1**

<table>
<thead>
<tr>
<th>Period following deployment (years)</th>
<th>Aluminium</th>
<th>Stainless Steel</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>49</td>
<td>142</td>
<td>0.941</td>
</tr>
<tr>
<td>6-10</td>
<td>11</td>
<td>17.2</td>
<td>5.952*</td>
</tr>
<tr>
<td>11-15</td>
<td>4</td>
<td>6.2</td>
<td>1.875</td>
</tr>
<tr>
<td>16-20</td>
<td>0</td>
<td>7</td>
<td>2.763</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>64</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

**DISCUSSION**

Closed aluminium bands and butt-ended stainless steel bands differed in their utility for studies of movement and survival of Australian Pelicans. The legibility of embossed numbers was reduced due to wear on closed aluminium bands, whereas stainless steel bands showed no evidence of wear or loss of legibility. In this respect stainless steel bands would seem preferable to aluminium bands. However, aluminium bands resulted in 2.3 times as many recoveries overall and half the recoveries within one year of deployment compared to stainless steel bands. Furthermore all recoveries recorded as “band only found” involved stainless steel bands. Together these data show that adjustable stainless steel bands, while offering greater durability, result in less useful data than closed aluminium bands.

It is important to note that the two types of bands were not deployed simultaneously, so differences in recovery between the two types of band are temporally confounded. While a study properly designed *a priori* for this purpose would take this into account, this problem was unavoidable in this *post hoc* study.

The higher recovery rate of closed aluminium bands could be attributed by the greater time available for this band type to be recovered (almost 36 years) compared to 19-years for the adjustable stainless steel bands. This does not explain the difference in bands recovered within a year of deployment, though. Nor does it explain the difference in the proportion of “band only found” recoveries. The closed aluminium bands had
a seamless seal, which did not allow bands to dislodge from a bird’s leg once deployed. On the other hand adjustable stainless steel bands relied on tensile strength to keep them attached to a bird’s leg. The high incidence of butt-ended stainless steel bands recovered within a year of deployment and as “band only found”, suggests they were prone to becoming dislodged. This possibility has been confirmed with Australian Pelicans that were simultaneously marked with patagial tags and butt-ended stainless steel leg bands (Johnston, unpub. data). Several of those pelicans lost their leg band within a year of deployment, but were identifiable from the patagial tag.

The decision by ABBBS to change to stainless steel bands in 1985 was made because aluminium bands were subject to wear and because worn aluminium bands had the potential to injure birds (Lowe, pers. comm. with M. Waterman). While we found no evidence of injuries from worn aluminium leg bands in the data set available to us, we confirmed a previous observation by Henny (1972 – cited in Schreiber and Mock 1988) that stainless steel bands showed no band wear.

The design and material used to construct leg bands clearly influences their recovery rate and utility for bird studies. Several studies have deployed leg bands on pelicans (Strait and Sloan 1975; Schreiber and Mock 1988; Anderson and Anderson 2005; Murphy 2005; Vanspall et al. 2005), but none of these studies refers to the band material and/or band design used. Bands used on Australian Pelicans in the past have either suffered from wear (closed aluminium bands) or increased likelihood of becoming dislodged (butt-ended stainless steel bands). A leg band that combines the characteristics of durability of stainless steel bands and reliability of closed bands would provide a better proposition for the future studies of Australian Pelicans. To this end the ABBBS now uses side opening stainless steel bands for Australian Pelicans.

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REFERENCES


