Colour rings with individual numbers increase the number of ringing recoveries of small waders

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Meissner, W. & Bzoma, S. 2011. Colour rings with individual numbers increase the number of ringing recoveries of small waders. *Wader Study Group Bull.* 118(2): 114–117.

Keywords: Dunlin, autumn migration, colour marking, ringing recoveries

This study compares the ringing recovery rate and resighting rate obtained using stainless steel rings and coloured numbered rings respectively in 828 Dunlins caught at a southern Baltic stopover site. Birds were colour-ringed between 25 Jul and 17 Sep 2010 and 41 had been resighted by 30 April 2011. The resighting rate was significantly higher than the steel ring recovery rate obtained from Dunlins ringed during 2008–2010. Both ringing recovery and resighting rates differed significantly among age groups, being much lower in adults. However in the case of steel rings the recovery rate of juveniles was eight times higher than in adults, but the difference in resighting rate of juveniles was only four times that of adults. Our study shows that even small colour plastic rings can be read in the field and adding them to the normal metal ring greatly increases the recovery rate. Using colour rings with individual codes facilitates more detailed studies of wader movements.

INTRODUCTION

The use of unique colour-ring and/or flag combinations is a widespread and important technique that has been used for many years for studying wader movements (e.g. Masero *et al.* 2009, Minton *et al.* 2006, Remisiewicz 2005), site fidelity (e.g. Burton 2000, Leyrer *et al.* 2006), survival (e.g. Bearhop *et al.* 2003, Rice *et al.* 2007) and different aspects of bird behaviour (e.g. Puttick 1981, Schamel *et al.* 2004). In recent years the number of different colour ringing schemes has increased (*www.cr-birding.be*). The main benefit of using colour rings over standard metal rings is the possibility of obtaining a recovery without catching the bird. However, only a few ring colours are available that are easy to recognise from a distance. Therefore in projects involving the individual marking of hundreds or thousands of birds it has sometimes been necessary fit up to seven rings on one bird (*www.cr-birding.be*).

One solution that has been used on large waders, such as the Eurasian Oystercatcher *Haematopus ostralegus*, is to fit plastic rings engraved with a unique field-readable code. However, in the past it was difficult to produce engraved rings that were small enough to deploy on small waders, but now such rings with an internal diameter of 3.3–3.5 mm are available. This study aimed to compare ringing recovery and resighting rates obtained by using stainless steel rings and colour numbered rings respectively in an investigation of the migration routes of Dunlins *Calidris alpina* departing from a southern Baltic stopover site.

MATERIAL AND METHODS

Birds were caught using walk-in traps (Meissner 1998) during autumn migration between 25 Jul and 17 Sep 2010 in the mouth of Vistula River on the Baltic coast of Poland (54°21.37'N, 18°56.56'E; Fig. 1). A numbered stainless steel ring was fitted to the left tarsus of each bird and an engraved plastic ring (white with black inscription, one letter and two numbers) was fitted to the right tarsus (Fig. 2). The engraved plastic colour rings were provided by Interrex (*www.colour-rings.eu*). Altogether 828 Dunlins were caught and aged according to Meissner & Skakuj (2009): 271 adults, 181 second-years and 376 juveniles.

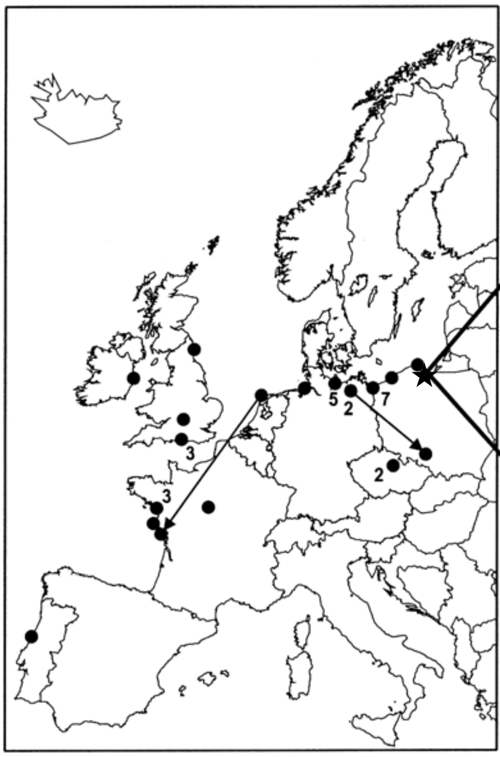
Here we evaluate all recoveries and resightings >20 km from the ringing site reported up to 30 Apr 2011. In the case of birds seen more than once at a given site, only the first record is used. Two colour ringed Dunlins were trapped and these are treated as recoveries of a bird with a steel ring. The remainder of the birds recorded away from the ringing site were resighted and the number on the colour ring was read by an observer and reported to us.

In order to compare recovery rates obtained from normal steel rings with resighting rates from engraved colour rings, we used ringing data collected during 2008–2010, but limited to those recoveries reported by 30 Apr of year after the year of ringing. All ringing recoveries are from birds ringed in the Vistula Mouth by the Waterbird Research Group KULING.

RESULTS

By 30 Apr 2011, a total of 41 resightings of colour ringed Dunlins had been reported; 29 had been ringed as juveniles, seven as second-years and five as adults. Two juveniles were resighted at two different sites. The highest number of colour ringed Dunlins was observed on the south-eastern Baltic coast at Świnoujście (seven birds), where local birdwatchers spent a lot of time making observations and on Langenwerder Island (five birds) where there is a wader ringing station (Fig. 1).

The resighting rate of the birds fitted with engraved plastic rings in 2010 was significantly higher than the recovery rate



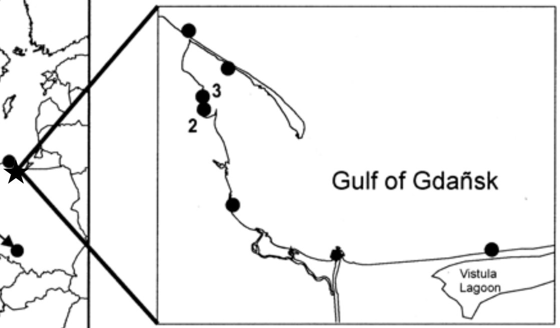


Fig. 1. Distribution of resightings of Dunlins colour ringed during Jul–Sep 2010 at the Vistula River mouth, Poland (shown by the ★ symbol). Numbers of different birds seen at each site are shown (apart from singles). Arrow indicates resightings of the same bird.

of birds fitted with steel rings in 2008 ($\chi^2 = 36.01$, df = 1, $P < 0.001$), in 2009 ($\chi^2 = 73.25$, df = 1, $P < 0.001$) and in 2010 ($\chi^2 = 35.60$, df = 1, $P < 0.001$) (Table 1). It is worth noting that another wader ringing site was operating at Lisewo Malborskie, 30 km south of the Vistula mouth, in 2008 and 11 Dunlins from the Vistula were trapped there. This resulted in the higher recovery rate that year (Table 1); without these the 2008 recovery rate was only 0.25%.

Both ringing recovery and resighting rates differed significantly among age groups ($\chi^2 = 10.78$, df = 2, $P = 0.005$ for ringing recovery rates and $\chi^2 = 12.10$, df = 2, $P = 0.002$ for resighting rates), being highest in juveniles and lowest in adults (Table 2). However, the recovery rate of juveniles was eight times that of adults, whereas the resighting rate of juveniles was only four times that of adults (Table 2).

DISCUSSION

The distribution of colour-ring resightings obtained in this study is generally similar to that found using recoveries of steel rings (Gromadzka 1983, 1989), with individual birds following both coastal and inland migration routes. It is widely accepted that using colour rings increases recovery rates, especially in the case of larger birds, when the inscription on the ring is big enough to be read easily from a distance (Arizaga *et al.* 2010, Bregnballe *et al.* 1997, Rock 1999). However, in studies of the St Helena Wirebird *Charadrius sanctaehelenae* it was found that there was a lower probability of correctly identifying the engraved numbers on leg flags compared with colour-ring combinations (Burns *et al.* 2010), but in that study ×8 binoculars were used instead of a telescope, which might have influenced the results.

For Dunlins migrating through the Baltic, the recovery rates of birds with metal rings have ranged from 1.18% (Meissner & Remisiewicz 1998) to 1.64% (Gromadzka 1989) and are similar to the 1.25% recorded in the Mediterranean region (Serra *et al.* 1998). The recovery rate of 0.56% recorded in this study is about half, which must be due to the shorter period in which recoveries were recorded (the 9.5 months from mid-June to April). Nevertheless the resighting rate is much higher than any ringing recovery rate reported for Dunlin using steel rings.

Foraging Dunlins usually allow an observer with a telescope to approach close enough to read the engraved plastic colour rings used in this study quite easily. However, in areas where birds forage in soft mud, the inscriptions can be impossible to read due to coating of the rings with mud (Fig. 3). This might be a reason for the low number of resightings in the tidal areas of the North Sea, where Dunlins ringed in autumn on the Baltic coast of Poland have been recovered in large numbers (Gromadzka 1983, 1989). Thus, the type of habitat a bird uses may have an influence on its resighting probability. Other problems with reading inscriptions on colour rings relate to the quality of optics and observer experience (Mitchell & Trinder 2008). Misreading digits can occur frequently if a bird is continually moving or its distance from the observer is great. Digital photographs may be helpful in such cases, because short shutter times can "freeze" a running bird and allow its number to be read. In this study 19 resightings (47.5%) were obtained from a digital photo provided by the observer.

Juveniles are easier to catch than adults, due to their lower awareness and greater naivety (Meissner 2007, Meissner & Huzarski 2006). That is probably why the recovery rate of juveniles obtained in this study was eight times higher than in adults, whereas the resighting rate was only four times higher (Table 2). Thus, catching may be particularly prone to bias towards a high proportion of juveniles, but there is less or no such bias in resighting rates.

Our study shows that even small engraved colour rings can be read in the field quite easily and that adding them to normal metal rings greatly increases recovery rates. According to observers' reports, the three digit inscription on the rings could be read from a maximum distance of 60–70 m depending of the quality of telescope and the individual skills of the observer.

Using colour rings with individual codes facilitates more detailed studies of wader movements than are possible using metal rings alone. During 1983–2010, WRG KULING obtained about 500 long-distance ringing recoveries of Dunlin caught in the Gulf of Gdańsk and among them there are none relating to an individual caught twice during one

Fig. 2. Adult Dunlin with 6P3 colour ring at Vistula River mouth, Poland. (Photo: Piotr Kendzierski.)

Fig. 3. Adult Dunlin observed in Poland on the bank of the Bug River near Cupel with colour ring partly coated by mud. (Photo: Tomasz Krawczyk.)

Table 1. Recovery and resighting rates of Dunlins fitted with stainless steel rings or engraved plastic rings between mid July and the end of September in the Vistula River mouth, Poland, and recovered/resighted by the end of April the following year.

Year caught	Stainless steel rings		Engraved plastic colour rings	
	Number ringed/recovered	Ringing recovery rate (%)	Number ringed/resighted	Resighting rate (%)
2008	1576 / 15	0.95	–	–
2009	2067 / 7	0.34	–	–
2010	966 / 4	0.41	828 / 41	4.95
Total	4609 / 26	0.56	–	–

Table 2. Recovery and resighting rates of Dunlins fitted with stainless steel rings or engraved plastic rings in three age groups of Dunlins ringed in Vistula River mouth, Poland, during 2008–2010.

Age group	Stainless steel rings		Engraved plastic colour rings	
	Number ringed/recovered	Ringing recovery rate (%)	Number ringed/resighted	Resighting rate (%)
Juveniles	2035 / 19	0.93	376 / 29	7.71
Second year birds	915 / 5	0.55	181 / 7	3.87
Adults	1659 / 2	0.12	271 / 5	1.85

migration period. However, two among our 41 colour ringed Dunlins were resighted twice at sites distant from the ringing location in a single season (Fig. 1). The development of networks of birdwatchers and fast internet communications lead to favourable conditions for studies based on resighting of colour ringed birds, not only in respect of large-sized species. Moreover, resightings of colour ringed birds at the ringing site can also produce more accurate results needed for studies of stopover ecology of migrant passerines and waders (Salewski *et al.* 2007).

There is no doubt that the use of inscribed colour rings or flags is a real advance. Rings are usually put on the tarsus, while flags are put on the tibia and the choice between them depends on the species studied and the habitat. In species with relatively short tibias, like Dunlin and Red Knot *Calidris canutus*, flags on the tibia are often covered by feathers, so rings on the tarsus may be preferred. However, flags seem to be the better option in the case of species with long tibias that often wade in deep water, such as godwits *Limosa* spp. and Greenshank *Tringa nebularia*. In muddy habitats the inscription on the ring is often impossible to read due to coating by mud, so better resighting rates are obtained from inscribed flags (N. Clark pers. comm.).

ACKNOWLEDGEMENTS

We are grateful to all colleagues from WRG KULING and especially to ringers who worked at the Vistula Mouth ringing site. Observations of colour ringed birds were given by: S. Beuch, A. Błąd, A. Boldt, S. Bone, U. Brenning, T. Chmielewski, A. Cubaixo, P. Faria, M. Fouquet, S. Guentzel, N. Hallam, A. Hegemann, C. Herve, A. Johnson, L. Jomat, Z. Kajzer, S. Karpicki, A. Köhler, T. Krawczyk, Ł. Ławicki, A. Ochmann, D. Pasieka, A. Schnell, O. Sigauds, R. Szymański, J. Vrána, G. Wagner, M. Wierzbicki, W. Woch, P. Zięcik, H. Zimmermann. Piotr Kendzierski and Tomasz Krawczyk kindly provided Dunlin photographs. Special thanks to Nigel Clark for useful comments on earlier version of the manuscript. This study was undertaken by the Waterbird Research Group KULING (Publication no. 146).

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