Visual marking of animals to study their ecology and population dynamics is a common practice, especially in birds (Calvo & Furness 1992). Such markings are valuable because they allow individual recognition from a distance, with no need for physical recapture. In the context of capture–recapture studies, visual markers usually provide far higher ‘recapture’ rates (Ebbinge et al. 1991). Loss rate of individual markers should be minimized or estimated, otherwise marker loss may lead to underestimates of survival rate, e.g. neckband loss from geese Chen caerulescens caerulescens and Branta canadensis maxima (Johnson et al. 1995, Samuel et al. 2001, Collucci et al. 2002) and plastic leg ring loss by swans Cygnus spp. (Rees et al. 1990).

Nasal saddles and discs have long been the most widely used method of visual marking for individual recognition of dabbling ducks (Anatidae) (Sudgen & Poston 1968, Greenwood 1977, Blohm 1978, Rohwer 1985, Evrard 1996, Dzus & Clark 1997). However, in contrast to diving ducks (Brook & Clark 2002, Regehr & Rodway 2003), nasal marker loss rate has rarely been investigated in dabbling ducks other than through circumstantial evidence derived from a few hunted or recaptured individuals (Bartonek & Dane 1964, Sudgen & Poston 1968, Greenwood 1977, Rodrigues et al. 2001, Lokemoen & Sharp 1985, Evrard 1996). One possible reason for this is that nasal markers are primarily used for individual recognition of breeding females in North America (Arnold & Clark 1996), so there is generally no attempt to recapture marked hens physically and therefore no possibility to check whether ringed birds have lost their marker.

In a previous study (Guillemain et al. 2007), we studied the effects of nasal saddles on behaviour, body condition and dominance in both wild and captive dabbling ducks, especially Eurasian Teal Anas crecca, and found very little or no negative effects of these markers. Because we mark Teal continuously during winter, many live recaptures are also made in traps. Our aim was to take advantage of this situation to determine the proportion of Teal that lose their nasal saddles, and test whether this rate varied over time since the beginning of the ringing scheme (which would be expected if ringers gradually improve their marking skills).

Teal were caught in baited funnel traps at the Marais du Vigueirat in the Camargue, southern France (43°33’N 4°43’E). Three 16-m² traps were operated daily from mid-October to early March in four consecutive winters (2002/03 to 2005/06). Polyurethane nasal saddles similar to those described by Greenwood (1977) and used by Rodrigues et al. (2001) were fitted to about two-thirds of the birds, while all were given a numbered stainless steel ring (to test for effects of nasal saddles on survival in the future). The two categories are termed ‘saddled’ (birds with a ring and a nasal saddle) and ‘ringed’ (birds with ring only). Nasal saddle...
retention was examined only in birds recaptured alive in traps, because hunters who reported rings did not always mention whether shot ducks wore a nasal saddle. Membership of the ringing team remained unchanged over the study period. None of the members had fitted nasal saddles before, but all received the same basic ringing and marking training before the beginning of the programme.

In total, 1605 individuals were caught and ringed, of which 945 (59%) also received a nasal saddle. This produced 934 local live recapture events, from 322 different individuals: thus 20.1% of birds were recaptured at least once. There was a significant difference in recapture rate between saddled and ringed birds: while 157 (16.6%) of the 945 saddled birds were recaptured at least once, 165 (25.0%) of the 660 ringed birds were recaptured ($\chi^2 = 11.22, P = 0.0008$). Among the 157 birds initially saddled that were recaptured, 15 individuals had lost their marker, an average of 9.6% over the years (saddles found from birds having lost their marker in the traps were not considered here). However, this proportion varied significantly over time, decreasing from 31% for birds marked in the first year to 1% and 0% for birds marked during years three and four. Such a difference may be due to the markers gradually deteriorating over time so that loss rate for birds marked in the first years, having worn their saddle for a longer time, would be more likely to be high. To overcome this problem and take 'exposure' time into account, the Mayfield method was used to compute the daily marker loss rate (later transformed into annual loss rate for simplicity) and its 95% confidence interval (Johnson 1979). Saddle loss rate decreased markedly from relatively high values in the first two years to a value very close to zero thereafter (Fig. 1). The confidence interval of saddle loss rate could not be computed for birds marked in winter 2005/06, because no bird was found to have lost its marker over the study period.

Teal in the Camargue showed a very high recapture rate of 20% during the present study, higher than that recorded over 35 years of ringing at the Station Biologique de la Tour du Valat in Camargue (12% of 59 086 Teals ringed; M. Guillemain & A.R. Johnson, unpubl. data). We assumed that the sample of recaptured Teal that had lost their saddle was representative of the entire group of birds that had lost markers. The fact that saddled birds had a lower recapture rate than ringed birds was unexpected and conflicts somewhat with earlier results that showed no adverse effect of the markers for dabbling ducks (Guillemain et al. 2007). It will be crucial in the future to determine whether this is linked with a lower survival of saddled versus ringed Teal, through a proper analysis of mortality rates based on both live recaptures and dead recoveries. Alternatively, it may be that the stress induced by the saddle, even if it has little or no consequence in terms of individual behaviour or condition (Guillemain et al. 2007), makes saddled birds become more trap-shy than ringed birds. However, this has to be considered in light of the high overall recapture rate in the present study, so that even our saddled birds were far more likely to be recaptured than Teal that were ringed only in the past in the Camargue at Tour du Valat. Any potential deleterious effect of the saddles is therefore likely to have only a limited consequence.

The few possible comparisons of the present saddle loss rate with published sources for dabbling ducks come from a range of species, of different origins (live recaptures versus dead recoveries), and for varying periods of time between nasal marking and recapture/recovery. Furthermore, only the raw proportion of birds that lost their saddle was to our knowledge provided in the past, so that only these values can be compared with our results (while our estimates using the Mayfield method provide a better estimate of true loss rate taking exposure time into account, see below). Previous results range from no marker loss from 49 Mallards (Rodrigues et al. 2001) or from 20 individuals from various species recaptured or recovered more than one year after marking (Greenwood 1977), to low values such as 4% of 44 Mallards and Blue-winged Teal Anas discors recaptured one or more years after marking (Evrard...
1996) to about 10% loss in other studies: 8.7% of 23 Saddled Shovelers Anas clypeata had lost their marker after between 31 and 245 days (Sudgen & Poston 1968), while 13% of 46 recaptured birds (various Anas spp.) had lost their marker after an unknown period (Lokemoen & Sharp 1985). The maximum value recorded was a 25% loss rate after 12–18 months for 16 recaptured Blue-winged Teal (Bartonek & Dane 1964). Despite the fact that our sample of marked Teal may not be representative of all dabbling ducks because of differences in behaviour of the birds and material used in various studies, this last value is similar to the one we obtained during our first two years of study, but is higher than our overall average (9.6%). However, when taking exposure time into account using the Mayfield method, nasal marker loss rate was higher in our study (and would most probably have been so in others, if the method had been applied). Nonetheless, the results clearly show an improvement in retention over time, as the annual loss rate was as high as 68% for birds marked in year one, but decreased to 6.5% for year three and even 0% for year four.

In parallel studies (starting one year after the beginning of the Teal work concerning French diving ducks, and after six years of experience with Mallards marking for the independent Portuguese studies), we (A.C.) recorded only one nasal saddle loss out of 239 live recaptures of marked Common Pochard Aythya ferina, and no loss out of 55 live recaptures of saddled Tufted Duck Aythya fuligula in France. Similarly, none of the 114 live recaptures of Eurasian Wigeon Anas penelope marked by us (D.R. and M.F.) in Portugal were observed to have lost their nasal saddle. It is possible that differential microhabitat use by these species is linked with these differences in loss rates. Teal are known to forage mainly in shallow areas close to the banks of waterbodies (Tamisier 1974), where woody plants in which the saddle can get caught may be more abundant. Conversely, Pochards and Tufted Ducks mostly forage in open water for tubers and invertebrates within the sediment (Tamisier & Dehorster 1999, Werner et al. 2005), while Wigeon forage either on hydrophytes or in pastures on dry land (Campredon 1982). Saddles may be less likely to get caught and break in the latter two cases. Brook & Clark (2002) did not report any nasal marker loss in breeding Lesser Scaup Aythya affinis. Blums et al. (1997) documented a lower web tag loss rate in Aythya spp. (diving ducks) than in Anas spp. (dabbling ducks) ducklings, a difference that they attributed to different behaviour or microhabitat use by diving ducks.

Circumstantial evidence provided by saddles lost in the traps suggested that the main cause of saddle loss was breakage of the nylon pin rather than the culmen above the nostrils (i.e. we only found ‘opened’ markers in traps). Such limitation was also noted by D.R. and M.F. on old saddles, as upon recapture of one individual Wigeon five years after marking, the nylon pin had to be changed because its extremities were nearly ruptured. This was also observed in a long-term Mallard nasal marking study (D.J.C. Rodrigues et al. unpubl. data), and led to the nylon pin of saddles being changed normally after five years of wear by ducks. Whatever the reason for these interspecific differences, loss rate decreased markedly in Teal after a couple of years, suggesting that the ringers gradually improved their skills in fitting the markers. In particular, they apparently mastered the ability to bead the nylon pin extremities into a bulb shape rather than flattening it completely, a cause of later nylon pin weakness in experimental tests (M. Lepley & M. Guillemaun, pers. obs.). Reinforcing this idea, D.R. and M.F. had six years of nasal saddling experience with Mallard before starting to mark Wigeon and A.C. had one year of experience with Teal before marking diving ducks, which may explain the low loss rates in these species. In most cases, nasal markers will fall off birds before their death, in particular because of gradual erosion of the nylon pin (Greenwood 1977). This could be the case especially with Teal, for which a thinner nylon pin is used than for the other species (1.0 mm for Teal, 1.4 mm for the other species). However, the lower proportion of birds losing their saddles in 2004/05 and 2005/06 compared to earlier years cannot be attributed to a bias linked with the shorter time elapsed since fitting of the saddle, because marker loss rate after the Mayfield method takes exposure time into account. Furthermore, ten of the 15 birds that lost their marker were recaptured within 370 days after fitting the saddle, and six of 15 within 30 days. The 2004/05 low saddle loss rate, and the 2005/06 one to a certain extent, are thus robust from this point of view. For studies expected to last more than five years the use of stainless steel rather than nylon pins (Lokemoen & Sharp 1985) should be evaluated, as the nylon pin durability seems to be the limiting factor in the useful life of polyurethane saddles.

The main conclusion from this analysis is that depending on nasal marking experience of ringers, data derived from the observation of duck nasal markers should be considered with caution during the first two years after the beginning of a marking scheme, while
the rate of saddle loss quickly decreases to values close to zero in subsequent years. Duck nasal saddle loss should therefore not be assumed to be nil or fixed, and an effort should be made to quantify this rate, especially in the first years of long-term studies. Individuals with limited nasal saddling experience should learn with experienced ringers to minimize marker loss rate as much as possible, and/or specific training on nasal saddling should be proposed to candidate duck markers during ringing courses.

ACKNOWLEDGEMENTS

We are grateful to Professor R.W. Furness and an anonymous referee for very constructive comments on an earlier version of the manuscript. We would also like to thank M. Chambouleyron, J.-B. Nogués, C. Lucas, C. Arzel and C. Pin for their help during fieldwork, and J-L. Lucchesi and N. Hecker for providing such good ringing conditions in the Marais du Vigueirat.

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(MS received 22 January 2007; revised MS accepted 15 June 2007)