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SURVIVORSHIP OF CAPTIVE-BRED AND WILD-CAUGHT REINTRODUCED EUROPEAN OTTERS *Lutra lutra* IN SWEDEN

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Abstract

Eleven wild-caught otters from Norway and 25 captive-bred otters from Sweden equipped with radio transmitters were reintroduced in an area in south central Sweden between 1989 and 1992. The objectives of the study were to compare the survival rate in the two groups, and to examine possible factors associated with differences in the survival rate. The survival rate one year after release was 79% in wild-caught otters and 42% in captive-bred otters. In captive-bred otters the period between removal from their mother and their release varied from 5 to 98 days. The offspring with short separation–release periods had a significantly higher survival rate than those with long separation periods. Copyright © 1996 Elsevier Science Limited.

Keywords: Lutra lutra, reintroduction, survivorship, conservation.

INTRODUCTION

The European otter *Lutra lutra* has declined throughout much of Europe during the last century, especially since the 1950s (Mason & Macdonald, 1986; Macdonald & Mason, 1994). Possible reasons for this decline are persecution (Chanin, 1985; Mason & Macdonald, 1986), overhunting (Erlinge, 1972; Erlinge & Nilsson, 1978), competition from mink *Mustela vison* (Erlinge, 1972), habitat destruction (Erlinge, 1972; Macdonald & Mason, 1983; Mason & Macdonald, 1986) and environmental pollutants (Erlinge, 1972; Erlinge & Nilsson, 1978; Chanin, 1985), of which the organochlorines especially have been suggested to cause the otter decline (Sandegren *et al.*, 1980; Olsson & Sandegren, 1984, 1991*a,b*; Mason & Macdonald, 1986).

Reintroduction has been considered useful as a means of bolstering populations which have declined or locally disappeared. The fate of otters reintroduced into English rivers was assessed by direct observations, from tracks and by using radio-telemetry methods on two males in 1983–84 (Jefferies & Wayre, 1984; Jefferies *et al.*, 1985; Wayre, 1991). Between 1984 and 1989, 19 breedings were claimed from released animals (Wayre, 1991). In North America, more than 900 river otters *Lutra canadensis* have been reintroduced and some of these have been traced by using radio-telemetry methods (Erickson *et al.*, 1984; Griess, 1987; McDonald, 1989; Polechla, 1990; Serfall *et al.*, 1993).

Otters were formerly common throughout Sweden. A population decline occurred between the 1950s and 1970s and was most apparent in southern Sweden where the otter became extinct throughout most of the area. High levels of PCB in the environment were considered the most probable reason for this (Olsson & Sandegren, 1991*b*). In 1987, the first otter release was carried out in southern Sweden, aimed to boost a low population density in an area where the environmental suitability for otters was judged to be good (Sjöåsen & Sandegren, 1992). The aim of the present study was to investigate the survival of such reintroduced otters.

METHODS

Study area

The study area, approximately 5200 km^2, is situated in the southern part of Sweden 100 km south-west of Stockholm. The area has an abundance of lakes and rivers and the majority of waters are productive with a high proportion of dense shoreline vegetation of willow *Salix* spp., alder *Alnus* spp. and dense reed *Phragmites communis* belts. Human habitation and industrial activities are sparse. Within the study area, there are five catchment areas, of which River Nyköpingsån (3624 km^2) forms the main one.

This area was in one of the few parts of southern Sweden where otters still remained during the 1980s. A survey of the study area in 1983, including some surrounding areas, showed that 4% of sites had signs of otters (Olsson & Sandegren, 1983*a*). At another survey in 1985, no signs of otters were found and the population was judged to be nearly extinct (Sjöåsen & Sandegren, 1992).

Roach *Rutilus rutilus* collected in the area at the end of the 1980s had low levels of PCB and were considered to be safe for otter consumption (M. Olsson, pers. comm.).

Reintroduction

Otters for reintroduction were either captured along the Norwegian coast or were captive-bred from two breeding females kept at the Swedish Hunters Association

Table 1. Origin, sex (M, male; F, female) and serial number of 36 otters showing (even numbers in females and uneven numbers in males) year and month of release (1989–1992), fate and the number of radio tracking days (in parentheses). The time specified for the Kaplan-Meier estimates, is shown below

Otter	Days observed	Fate
Captive-bred otters; female no.1		
M01:89	___ (40)	Dead — drowned in fish trap
F02:89	_____ (685)	Expired transmitter
F04:89	____ (89)	Radio contact lost
M07:90	__ (59)	Dead — icterus
F10:90	_____ (115)	Radio contact lost
F14:90	_____ (219)	Radio contact lost
M19:91	___ (81)	Dead — drowned (probably in fish net)
F22:91	_____ (161)	Dispersed — radio contact lost
M29:92	_____ (124)	Radio contact lost — radio failure
M31:92	_____ (420)	Dispersed — radio contact lost
F34:92	_____ (466)	Dead — body decomposed
F36:92	_____ (676)	Expired transmitter
Captive-bred otters; female no.2		
M03:89	_____ (185)	Dead — traumatic injury
F06:89	_____ (127)	Dispersed — radio contact lost
F08:89	_____ (185)	Dead — rat poison ?
M11:90	__ (58)	Dead — ureamia
M13:90	_____ (99)	Dead — drowned in fish net
F16:90	_ (42)	Dead — emaciated
F18:90	___ (50)	Dead — emaciated
F20:91	.(18)	Dead — ureamia
F24:91	___ (31)	Dead — traumatic injury
M25:92	_____ (432)	Dispersed — radio contact lost
M27:92	_____ (159)	Dead — peritonitis
F32:92	_____ (686)	Expired transmitter
F38:92	_____ (173)	Dispersed — radio contact lost
Wild-caught otters		
M05:90	_____ (458)	Probably expired transmitter
M09:90	_____ (571)	Expired transmitter
F12:90	_____ (364)	Radio contact lost
M15:90	_____ (467)	Expired transmitter
M17:90	_____ (101)	Dead — icterus
M21:91	_ (25)	Dead — traumatic injury
M23:92	_____ (428)	Dead — traffic (car accident)
F26:92	_____ (691)	Expired transmitter
F28:92	_____ (672)	Expired transmitter
F30:92	_____ (702)	Expired transmitter
M33:92	_____ (205)	Radio contact lost

Feb Jun Oct Feb Jun Oct Feb Jun

time of Kaplan-Meier estimate

Table 2. Kaplan-Meier estimates (Pollock *et al.*, 1989) of the survival rate in otters for staggered entry of new animals and the variances of the estimates

Group of otters	Sample size	Survival rate	95% Confidence interval
All reintroduced otters	36	0.54	0.35–0.73
All males	17	0.45	0.20–0.69
All females	19	0.68	0.41–0.94
Wild-caught otters	11	0.79	0.54–1.00
Captive-bred otters	25	0.42	0.16–0.67
Offspring from female no.1	12	0.71	0.34–1.00
Offspring from female no.2	13	0.21	0.00–0.47
Short separation-release period (<49 days)	12 (7 from female no.1 : 4 from female no.2)	0.80	0.48–1.00
Long separation-release period (≥49 days)	13 (5 from female no.1 : 9 from female no.2)	0.13	0.00–0.35

otter breeding centre in central Sweden. Otters from Norway were caught in live-traps mainly near fish farms along the coast in an area with a high otter density.

Thirty-four otters were released in the catchment of Nyköpingsån and two otters in the catchment of River Lännaån during 1989–1992. At the time of release all captive-bred otters were nearly 1 year old and the age of wild-caught otters examined by a veterinarian was estimated also as about 1 year. All the otters, except for one male released in late November, were released in spring after the ice break-up from February to June. Spring was chosen for the releases, as it is the spawning season for the majority of fish species in the study area and the predominant species spawn in the littoral zone. Thus, the availability of food for otters would be higher during this period when fish could be caught in shallow waters.

All otters were fitted with an implanted radio-transmitter (IMP/400/L S6A, Telonics, Mesa, Arizona, USA or TXP-2(H)-M, Televilt, Storå, Sweden) as described by Melquist and Hornocker (1979*a*,*b*, 1983). After surgery, the animals were kept in a quiet place with minimal human disturbance and observed for 5–7 days before they were released in the study area. The transmitter used had a pulse rate of 40–48 beats/min with a mortality sensor doubling the pulse rate when an animal died. The life-time of the transmitters was approximately 2 years. The intention was to examine position, activity and habitat selection of the otters on a daily basis. In practice, this was not possible because at times they were difficult to locate. The otters were observed on 64% of all possible radio-tracking days from release to death, transmitter expiry, or when radio contact was lost. Dead specimens were sent to the Swedish Museum of Natural History for autopsy.

Survival

In order to compare data from this study with other published data, the survival rate was calculated for the first 12-month period after release when the main mortality rate was expected according to results from otter releases in North America (Erickson *et al.*, 1984; McDonald, 1989). However, radio-tracking of surviving otters continued after the first 12 months to study their fates. Kaplan-Meier estimates of survival rates (Krebs, 1989; Pollock *et al.*, 1989*a*,*b*) were made with a staggered entry of new animals (Pollock *et al.*, 1989*b*). Variances of the estimates were calculated (Cox & Oakes, 1984; Krebs, 1989) and an approximate 95% confidence interval was obtained (Pollock *et al.*, 1989*b*). In this Kaplan-Meier estimation, animals lost in radio contact do not change the survival rate but increase the variance.

Log-rank tests to compare the survival functions of the Kaplan-Meier estimations were made by an approximate chi-square test with 1 degree of freedom (Pollock *et al.*, 1989*b*). Captive-bred otters versus wild-caught otters as well as offspring of female no.1 versus offspring of female no. 2 were tested.

Long separation-release periods, i.e. the time between separation of the offspring from the mother to the time of release in the study area, were mainly used in 1989–91, but in 1992 there was a deliberate change in the handling of the offspring to reduce the separation-release time. Thus, in order to study whether the length of the separation-release period had a significant effect on the fate of reintroduced animals, data for separation-release time of captive-bred otters were divided into two groups — short and long separation-release periods — and analysed with the log-rank test described above. The maximum separation-release time was 98 days and the chosen point of the division was half this, i.e. <49 days and ≥49 days.

To test whether the *age* of the offspring at the time of separation and at the time of reintroduction was important for the survival of captive-bred otters, they were divided into two groups — alive or dead 12 months after release. In both cases an ANOVA was used for the test.

A two-way ANOVA was used to test if the origin (the breeding female) or the length of the separation-release period in captive-bred otters was the primary factor for their survival. Otters lost in radio contact were excluded in this analysis.

RESULTS

Fate of released otters

Sixteen out of 36 otters died during the study, most of them during the first four months after release (Table 1) and two after the first 12 months. Three otters drowned in fishing gear, three died of traumatic injury, two otters died because of icterus, two of uraemia, one of peritonitis, two were emaciated and another died probably due to rat poison (K. Wahlström, pers. comm.). One otter was killed by traffic 14 months after release and another died from unknown causes (the body was decomposed) 16 months after release. There was no evidence of injury caused by the implanted radio transmitters in any of the animals. Radio contact was lost with seven otters and one otter was lost possibly due to radio failure.

Survival

The mean survival rates are presented in Table 2. The comparisons of the survival functions showed that captive-bred otters had a significantly lower survival rate than wild-caught otters ($\chi^2 = 5.13$, d.f. = 1, $p < 0.025$). Further, among the captive-bred animals, offspring from female no.2 had a significantly lower survival rate in comparison with the offspring of female no.1 ($\chi^2 = 4.00$, d.f. = 1, $p < 0.05$).

The length of the separation-release period varied from 5 to 98 days. A log-rank test showed that otters with short separation-release periods (<49 days) had a significantly higher survival rate than otters with long separation-release periods (≥49 days) (Table 2) ($\chi^2 = 8.13$, d.f. = 1, $p < 0.01$), while there was no difference between otters with short separation-release periods and wild-caught otters (Table 2) ($\chi^2 = 0.29$, d.f. = 1, $p > 0.05$).

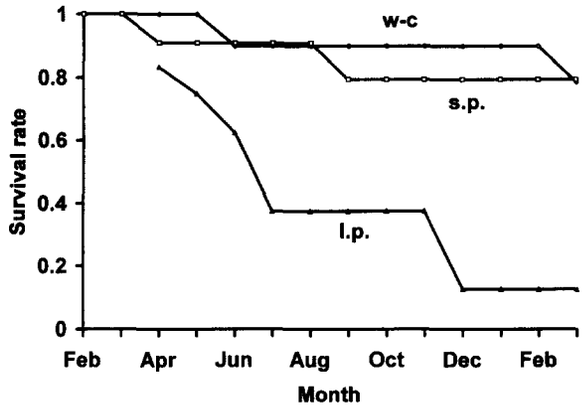

Fig. 1. Survival graphs based on Kaplan-Meier estimates of the survival rate with staggered entry of new animals in wild-caught (w-c) otters *Lutra lutra*, captive-bred offspring with short separation-release periods (s.p.) and captive-bred offspring with long separation-release periods (l.p.).

The mean *age* at the time of separations did not differ significantly between surviving and dead otters after the first 12 months (alive: 232 days, dead: 226 days; $F_{(1, 14)} = 0.04$, $p = 0.85$). Likewise, the mean *age* at the time of release did not differ significantly between otters surviving or dead after the first 12 months (alive: 251 days, dead: 292 days; $F_{(1, 14)} = 2.24$, $p = 0.15$).

The analysis to test whether the origin (breeding female) or the length of the separation-release period was the main factor in the survival of captive-bred reintroduced otters showed a significantly higher survival rate in otters with short separation-release periods (mean = 0.71) compared to otters with long periods (mean = 0.17; $F_{(1, 14)} = 7.57$, $p < 0.05$), while there was no significant difference between the offspring from female no.2 (mean = 0.33) compared to the offspring from female no.1 (mean = 0.54; $F_{(1, 14)} = 1.12$, $p = 0.31$).

DISCUSSION

The separation-release period appears to be the main factor to influence the subsequent survival rate of reintroduced captive-bred otters. Otters with short separation-release periods had a higher survival rate compared to otters with long periods. Until the separation, all cubs were living together with their mother in the enclosure. Human contact was insignificant as the only potential contact was when the keeper fed the otters by entering the enclosure once a day. Thus, the difference in the survival rate cannot be explained by handling before separation as all cubs were treated in a similar way. The major change in the handling of captive-bred otters occurred after separation from the mother. Otters with a separation-release period of more than 5–6 days were kept between separation and release in enclosures considerably smaller (75–130 m^2) than the enclosure where they were born (2000–4000 m^2) . Otters from the same mother were kept together. A reduction of the time spent in these smaller enclosures in the later experiments may have reduced the stress factors associated with this new environment. Shorter separation-release periods may also have led to a more 'natural' mother-cub separation, perhaps comparable to the dispersal of subadults from their native areas in free-living populations (Jenkins, 1980). Changing the separation-release handling of captive-bred otters to short periods seemed to give these otters a chance of survival similar to wild-caught otters in this study (Fig. 1). The results are comparable to reintroduction projects in North America with yearly survival rates between 46% and 91% (Erickson *et al.*, 1984; Griess, 1987; McDonald, 1989) and to natural wild otter populations in Shetland (about 85%) (Kruuk & Conroy, 1991) and western Oregon, USA (about 75%) (Tabor & Wight, 1977).

The deaths among otters in this study were not due to one particular cause but to several different agents. Among otters that died soon after release most died of non-traumatic causes (Table 1) and several of these animals had long separation-release periods.

During the study period (1989–1994), there were strong indications of reproduction in the study area. Tracks in the snow of adults and young otters together were observed on three different occasions (Sjöåsen, unpublished data), and at least two of these observations can be associated with reintroduced females. It is likely that another released female gave birth but probably failed to rear the cubs. An observation of tracks in the snow of one adult with three young otters in the area has also been reported. However, tracking conditions during this study were poor due to lack of snow for most of the time. It is therefore important to continue the study by surveys of otter signs (spraints and tracks) in order to assess the development and distribution of the population, and to confirm whether reproduction occurs in the area.

From the perspective of conservation, reintroduction is clearly possible in order to augment a population provided that environmental or habitat problems which caused the original decline have been removed. If captive-bred otters are used in future reintroduction projects, the separation-release handling process is an important factor which requires consideration to increase the survival of animals.

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