European Raptor Biomonitoring Facility
Advice Hub

Measuring survival rates of raptors (after fledging)

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European Raptor Biomonitoring Facility

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Recommended citation: European Raptor Biomonitoring Facility Advice Hub Team, 2022. Measuring survival rates of raptors (after fledging). ERBF Advice Hub. EU COST Action 16224 (European Cooperation in Science and Technology). European Raptor Biomonitoring Facility: https://erbfacility.eu/

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This publication is based on work done under COST Action 16224 European Raptor Biomonitoring Facility supported by COST.

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April 2022

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MEASURING SURVIVAL RATES OF RAPTORS (AFTER FLEDGING)

Demographic parameters (e.g., population size, breeding success, productivity, age at first breeding, survival rates, longevity) have been shown to be crucial for understanding species population dynamics, since population trends solely can lead to misleading conservation conclusions. Sink populations can behave as stable populations but largely depend on immigrants despite high reproduction success, due to low survival of young or adult birds. In long-lived raptors, population growth rates have been shown to be more sensitive to adult survival than actual reproduction, and can provide important information on the underlying processes of population change as crucial contextual data for conservation management and environmental impact assessments, such as influence of contaminants. However, advanced raptor monitoring schemes that include monitoring of demographic parameters, such as survival rate, are scarce in Europe despite highly needed to be established at pan-European scale, although guidelines for establishing such schemes at local scales are available.

CHARACTERISTICS OF RAPTOR SURVIVAL

The longevity expectance in raptors highly differentiates between species from 6 to over 60 years, at least in captive conditions (Table 7). The survival rates of smaller sized raptors are generally lower than in larger raptors. Smaller species have estimated annual survival rates of adults mainly of 60-70%, medium species of 70-90% and in large species >90%. There is also age depended survival with survival rate of first-year birds being for 7-48 percentage points lower than of adult birds, due to inexperience, low social status and higher predation rate. Sex-specific differences in survival rates are in general lacking although found in some raptor species, while survival rate in later years of life is declining (Newton et al. 2016). Deviations of these expectations, especially in terms of decreasing survival rate, might indicate detrimental impacts caused by anthropogenic environmental influences, i.e., killing or poisoning, or indirect environmental changes due to local habitat alterations or global climate changes affecting prey availability or interaction conditions (Saurola & Francis 2018).

TABLE 7 –. Longevity records and survival estimates in European raptor species according to published data with maximal reliable age identification according to the plumage patterns is given.

Annual survival rates are supplemented after Newton et al. (2016), longevity records after EURING longevity list (https://euring.org/data-and-codes/longevity-list) and maximal reliable age ID according to the plumage after Demongin (2016). NA – no data available (additional data sources: Aebischer 2008, Brown 1997, Buechley et al. 2021, Castaño et al. 2015, Eriksson & Wallin 1994, Ferrer & Calderón 1990, Forsman 1999, Korpimäki & Hakkarainen 2012, Le Gouar et al. 2008, McGrady et al. 2015, Mebs & Scherzinger 2000, Mebs & Schmidt 2006, Mihoub et al. 2013, Mikkola 2012, Newton 1979, Poole 1989, Real & Mañosa 1997, Sarrazin et al. 1994, Saurola & Francis 2018, Saurola et al. 2013, Schaub et al. 2010,Taylor 1994, Väli 2017, Valkama et al. 2014, Watson 1997.

ENGLISH NAME	LATIN NAME	LONGEVITY RECORD IN WILD *(IN CAPTIVITY)*	MAX. RELIABLE AGE ID ACCORDING TO THE PLUMAGE *(POSSIBLE ONLY IN SOME BIRDS)*	ANNUAL SURVIVAL OF 1Y BIRDS	ANNUAL SURVIVAL OF OLDER (>1Y) BIRDS
Osprey	Pandion haliaetus	32	2 (3)	37-86 %	63-90 %
Black-winged Kite	Elanus caeruleus	6	3	NA	NA
Bearded Vulture	Gypaetus barbatus	32 (45)	5 (7)	8-99 %	90-97 %
Egyptian Vulture	Neophron percnopterus	17 (37)	5	55-78 %	75-94 %
Honey Buzzard	Pernis apivorus	29	2	49-87 %	78-92 %
Griffon Vulture	Gyps fulvus	9 (55)	4 (5)	74-86 %	96-99 %
Cinereous Vulture	Aegypius monachus	(39)	4 (5)	85-92 %	70-98 %
Short-toed Snake Eagle	Circaetus gallicus	18	3	NA	NA
Lesser Spotted Eagle	Clanga pomarina	26	3	65 %	65-92 %
Greater Spotted Eagle	Clanga clanga	NA	4	NA	NA

ENGLISH NAME	LATIN NAME	LONGEVITY RECORD IN WILD *(IN CAPTIVITY)*	MAX. RELIABLE AGE ID ACCORDING TO THE PLUMAGE *(POSSIBLE ONLY IN SOME BIRDS)*	ANNUAL SURVIVAL OF 1Y BIRDS	ANNUAL SURVIVAL OF OLDER (>1Y) BIRDS
Booted Eagle	Hieraaetus pennatus	(12)	3	NA	NA
Steppe Eagle	Aquila nipalensis	(41)	5	NA	NA
Spanish Imperial Eagle	Aquila adalberti	(40)	5	16-42 %	92-99 %
Eastern Imperial Eagle	Aquila heliaca	25 (44)	5	30 %	80 %
Golden Eagle	Aquila chrysaetos	39 (57)	7	15-90 %	91-97 %
Bonelli's Eagle	Aquila fasciata	(20)	3	13-50 %	84-97 %
Levant Sparrowhawk	Accipiter brevipes	NA	2	NA	NA
Eurasian Sparrowhawk	Accipiter nisus	20	3	30-50 %	33-73 %
Northern Goshawk	Accipiter gentilis	22 (29)	3	27-71 %	62-83 %
Marsh Harrier	Circus aeruginosus	20	3	48-50 %	54-75 %
Hen Harrier	Circus cyaneus	17	2 (3)	14-38 %	40-90 %
Pallid Harrier	Circus macrourus	13	2	NA	NA
Montagu's Harrier	Circus pygargus	16	2 (3)	31-44 %	56-82 %
Red Kite	Milvus milvus	30 (38)	2 (3)	37-95 %	77-95 %
Black Kite	Milvus migrans	24 (28)	3	40 %	60-79 %
White-tailed Eagle	Haliaeetus albicilla	36 (50)	5	37-95 %	71-97 %

ENGLISH NAME	LATIN NAME	LONGEVITY RECORD IN WILD *(IN CAPTIVITY)*	MAX. RELIABLE AGE ID ACCORDING TO THE PLUMAGE *(POSSIBLE ONLY IN SOME BIRDS)*	ANNUAL SURVIVAL OF 1Y BIRDS	ANNUAL SURVIVAL OF OLDER (>1Y) BIRDS
Rough-legged Buzzard	Buteo lagopus	19	2	48-50 %	70-73 %
Long-legged Buzzard	Buteo rufinus	NA	2	NA	NA
Common Buzzard	Buteo buteo	28 (30)	2 (4)	20-97 %	68-91 %
Barn Owl	Tyto alba	29 (34)	3 (4)	25-50 %	36-72 %
Boreal Owl	Aegolius funereus	15	3 (5)	43-57 %	46-75 %
Little Owl	Athene noctua	16 (18)	2 (3)	6-65 %	36-75 %
Northern Hawk Owl	Surnia ulula	16 (10)	2	36 %	60 %
Eurasian Pygmy Owl	Glaucidium passerinum	6 (7)	2	27-73 %	42 %
Eurasian Scops Owl	Otus scops	6 (12)	2 (3)	NA	NA
Cyprus Scops Owl	Otus cyprius	NA	NA	NA	NA
Pallid Scops Owl	Otus brucei	NA	NA	NA	NA
Long-eared Owl	Asio otus	28	2 (3)	42-52 %	63-69 %
Short-eared Owl	Asio flammeus	21	2 (3)	29 %	64 %
Snowy Owl	Bubo scandiacus	11 (35)	3 (4)	NA	85-92 %
Eurasian Eagle Owl	Bubo bubo	27 (68)	4 (5)	9-70 %	61-80 %

ENGLISH NAME	LATIN NAME	LONGEVITY RECORD IN WILD *(IN CAPTIVITY)*	MAX. RELIABLE AGE ID ACCORDING TO THE PLUMAGE *(POSSIBLE ONLY IN SOME BIRDS)*	ANNUAL SURVIVAL OF 1Y BIRDS	ANNUAL SURVIVAL OF OLDER (>1Y) BIRDS
Pharaoh Eagle Owl	Bubo ascalaphus	NA	NA	NA	NA
Brown Fish Owl	Ketupa zeylonensis	NA	NA	NA	NA
Tawny Owl	Strix aluco	22 (27)	3 (4)	8-48 %	52-87 %
Desert Owl	Strix hadorami	NA	NA	NA	NA
Ural Owl	Strix uralensis	23 (30)	3 (4)	27-60 %	62-90 %
Great Grey Owl	Strix nebulosa	17 (27)	4 (5)	36 %	76 %
Lesser Kestrel	Falco naumanni	10 (11)	2	14-57 %	61-83 %
Common Kestrel	Falco tinnunculus	20 (12)	2 (3)	30-61 %	45-70 %
Red-footed Falcon	Falco vespertinus	13 (13)	2	NA	NA
Eleonora's Falcon	Falco eleonorae	16	2 (3)	13-22 %	78-87 %
Sooty Falcon	Falco concolor	NA	2	6-57 %	57-66 %
Merlin	Falco columbarius	13 (8)	2 (3)	5-23 %	62-70 %
Eurasian Hobby	Falco subbuteo	15	2	33-46 %	59-83 %
Lanner Falcon	Falco biarmicus	(17)	2	25 %	NA
Saker Falcon	Falco cherrug	15 (23)	2	23 %	82 %
Gyrfalcon	Falco rusticolus	13 (19)	2	50 %	90 %
Peregrine Falcon	Falco peregrinus	18 (25)	2 (3)	9-86 %	63-93 %

TRUE & APPARENT SURVIVAL

Estimates of survival rates are influenced by several biases, such as distinguishing between mortality and permanent emigration, detectability of mortality in different age classes, low site fidelity effects, immigration, small sample sizes, and differential survival impacts of markings (i.e., tags) (Newton et al. 2016). Therefore, different methods for survival estimates deliver different valued estimates. Local studies conducted at restricted small-scale areas usually provide apparent annual survival estimates, which are biased due to emigration and thus cannot differentiate between death and emigration. Apparent annual survival estimates are the product of true survival and site fidelity, and only in species with high site fidelity the estimates closely approach true annual survival rate (Newton et al. 2016). True survival estimates can thus be estimated only in methods that can split deaths vs. emigration and reproduction vs. immigration. Newton et al. (2016) pointed out that population growth estimates based on apparent survival without accounting for immigration, might end up with misleading conclusions.

HOW TO ASSESS SURVIVAL RATES OF RAPTORS

There are six monitoring methods for assessing survival estimates identified (see Newton et al. (2016) for details):

1. Ring recovery monitoring
2. Observational monitoring with and without individual identification
3. CMR (capture-mark-recapture) monitoring
4. Ring recapture and recovery data monitoring
5. Remote tracking monitoring
6. Integrated population monitoring

ORGANIZING MONITORING SCHEMES TO MONITOR RAPTOR SURVIVAL

Advanced monitoring schemes of raptors should be organized in order to obtain sufficient amount of data for assessing annual survival rate and other demographic parameters in the scope of integrated population monitoring. Within such schemes, the following activities should be conducted on annual and citizen science basis:

1. Survey of occupied territories (total vs. occupied number of territories) by fieldworkers (volunteer or professional fieldworkers)
2. Survey of breeding attempts/active nests (total vs. occupied number of nests checked) (volunteer or professional ringers)
3. Survey of productivity (clutch and brood size) (volunteer or professional ringers)
4. Ringing of nestlings (volunteer or professional ringers)
5. Ringing and recapture of ringed adults at nests (females, males) (volunteer or professional ringers)
6. Recovery of ringed birds found dead (collecting reports from general public)

Additionally, the monitoring of main prey species should be conducted in order to relate demographic data with natural prey fluctuations, what can distinguish between expected or natural fluctuations in demographic parameters from independent anthropogenic impacts.

ANALYSIS OF DEMOGRAPHIC DATA TO ASSESS RAPTOR SURVIVAL

The simplest calculation of survival rate is to calculate age ratio among recovered dead birds ringed as nestling. However, such an approach does not meet several assumptions and might provide only apparent survival rate, especially when site fidelity is low and when recovery rate is age biased.

To build up integrated population model for the estimate of survival, recapture and recovery probabilities the joint recapture and recovery model in a hierarchical Bayesian framework can be used. Specific analysis procedure and examples are available in the suggested bibliography where four classes of parameters are estimated:

- Survival (the probability that the bird is alive at the beginning of the year will be alive in the following year);
- Recapture (the probability that alive and marked individual will be recaptured in a particular year);
- Recovery (the probability that marked individual, which died in a particular year, will be found and its ring reported);
- Fidelity (the probability that a marked alive individual that was in a local population in the previous year is still in the population in the current year and potentially possible to be recaptured).

All parameters are included into hierarchical Bayesian models fitted using Markov chain Monte Carlo option in the software MARK (https://sites.warnercnr.colostate.edu/gwhite/program-mark/).

USEFUL LINKS & REFERENCES

https://www.worldlifeexpectancy.com/

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FIGURES AND CHARTS

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