CHAPTER 2

Terminology

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2.1 Introduction

Postupalsky (1974) offered standard terms that defined raptor reproductive success and the status of nests and territories. Steenhof (1987) and Steenhof and Newton (2007) expanded upon the original recommendations offered by Postupalsky (1974), but despite these recommendations, use of some common terms within raptor biology remains imprecise, resulting in challenges when comparing results among studies (Steenhof et al. 2017). We echo the sentiments of other authors (Postupalsky 1974, Hall et al. 1997, Steenhof and Newton 2007, Steenhof et al. 2017) who have encouraged the use of consistent terminology to: 1) facilitate comparisons of data over time and space, 2) reduce confusion, and 3) clearly communicate results.

Here, we provide definitions that describe territory occupancy and nesting activities based on recommendations made by Steenhof and Newton (2007) and Steenhof et al. (2017). We also include definitions for terms that apply to other components of raptor nesting ecology and nesting phenology. For example, we present definitions for terms associated with breeding phenology to encourage researchers to account for these factors in their analyses; Lamarre et al. (2017) showed that early arrival combined with good body condition in female Peregrine Falcons is a key determinant of early laying dates, and it has long been known that hatching dates are linked to increased survival in birds (Lack 1947, Verhulst and Nilsson

2008) including raptors (Anctil et al. 2014). We also include definitions for terms specifically related to studies involving pre-laying phenology because of the importance of pre-laying body condition in females (Lamarre et al. 2017) and the survival advantage conferred to nestlings for early laying females (Anctil et al. 2014).

2.2 Definitions

Active nest — Steenhof and Newton (2007) strongly recommend against the use of this term owing to its ambiguous meaning. See Steenhof et al. (2017) for examples of the inconsistent use of this term.

Alternative nest — One of potentially several nests within a nesting territory that is not being used for laying eggs in the current or a given year (Millsap et al. 2015).

Apparent nesting success (ANS) — The ratio of number of successful pairs to the total number of known territorial pairs with known outcome in a population (Steenhof et al. 2017) .

Arrival date — First day of a breeding season that an individual occupies a nesting territory (see *occupied nesting territory*). Not usually recorded or measured, but must be distinguished from pre-laying interval for studies involving breeding phenology.

Asynchrony — The phenomenon in which eggs in a clutch do not hatch at the same time, but over several days. When used as a metric, the number of days between consecutive hatched eggs.

Body condition — Degree to which an organism's physiological state influences its performance (Brown 1996). Can be estimated using physiological measures (e.g., beta-hydroxybutyric acid and triglyceride, metabolites known to reflect short term changes in fasting and fattening, respectively) or morphology (e.g., *scaled mass index*).

Breeding attempt — A synonym for *nesting attempt* (Steenhof et al. 2017).

Breeding season — A synonym for *nesting season:* the time from courtship through dispersal (independence) of young (Steenhof and Newton 2007, Steenhof et al. 2017).

Brood rearing period — For purposes of data collection and analysis; the time in days from appearance of the first hatched nestling to the date on which the last hatched nestling reaches minimum acceptable age for assessing success. For biological purposes, the time between hatching of the first egg and the time the first young leaves the nest of its own accord (Steenhof and Newton 2007).

Brood size — The actual number of young hatched from a single nesting attempt by a pair of birds. For studies in which mortality occurring between hatching and the first observation of the brood is unknown, it is appropriate to report brood size (i.e., number hatched) only for broods ≤ 10 days of age. For broods older than 10 days of age, see brood size ≥ 10 days

Brood size ≥ 10 days — The number of young hatched from a single nesting attempt by a pair of birds; for studies in which mortality occurring between hatching and the first observation of the brood is unknown, and nestlings are ≥ 10 days of age.

Brood size at fledging — The number of young raised to minimum acceptable fledging age (see *minimum acceptable age for assessing success*) by successful pairs (Steenhof and Newton 2007, Steenhof et al. 2017).

Clutch initiation — The day on which the first egg of a clutch of eggs is laid.

Clutch size — The number of eggs laid in a single nesting attempt by a single pair of birds.

Cumulative exposure period — The period during which a nesting attempt is under observation (Brown et al. 2013).

Cumulative nest survival — The probability that a nesting attempt survives from initiation (laying of the first egg) to the minimum acceptable age for assessing success. Note: because a bird in incubation posture is considered to be evidence for a nesting attempt, the exposure period must consider a pre-laying period (Steenhof et al. 2017).

Daily survival rate (DSR) — The probability that at least one young or egg in a nest will survive a single day (Dinsmore et al. 2002, Steenhof and Newton 2007).

Egg-laying pair — A territorial pair that lays at least one egg in a given year, as evidenced by eggs, young, or a bird in incubation posture.

Egg laying period — The range of dates in the breeding season during which eggs are laid (at the population level).

Failed nest, nesting attempt, or pair — At an occupied nesting territory, zero nestlings reach the minimum acceptable age for assessing success.

Fledge — To leave the nest voluntarily for the first time. (Watson 2010, Steenhof et al. 2017)

Fledgling — A fully-feathered young that has voluntarily left the nest but has not dispersed from the nesting territory (Steenhof et al. 2017).

Fledging date — The date on which a nestling fledges.

Floaters — Birds in either subadult or adult plumage that are not associated with specific nesting territories and do not reproduce. Floaters may be physiologically capable of breeding, but are prevented from doing so by lack of a territory or nesting site. They are usually unpaired (Steenhof and Newton 2007).

Hatching date — The date on which a nestling hatches.

Hatch order (within brood) — The sequence in which nestlings hatch (e.g., first, second, third, fourth).

Home range — The area traversed by an individual in its normal activities of food gathering, mating, and caring for the young. Occasional sallies outside the area, perhaps exploratory in nature, should not be considered part of the home range (Burt 1943).

Incubation period — The time in days from the onset of incubation to hatching of the last egg, during which eggs are kept at or near body temperature by the parent. The incubation period for Gyrfalcons in the wild is generally 35 days (Platt 1977).

Irregular territory — A known nesting location occupied only in certain years out of many (Steenhof and Newton 2007). Compare with *regular territory.*

Laying date — The date on which each egg within a clutch of eggs is laid.

Median laying date — For studies in which the actual laying date is not practical or required, it is appropriate to report median laying date (i.e., the date that lies at the midpoint of date range across which laying occurs).

Minimum acceptable age for assessing success — A standard nestling age at which a nest can be considered successful. An age when young are well grown but not old enough to fly and at a stage when nests can be entered safely and after which mortality is minimal until actual fledging: 80% of the age that young of a species normally leave the nest of their own volition for many species, but lower (65–75%) for species in which age at fledging varies considerably or for species that are more likely to leave the nest prematurely when checked (Steenhof and Newton 2007). For Gyrfalcons the minimum acceptable age for assessing success is 36 days (80% of 45 days; [Booms et al. 2008]).

Nest — The structure made or the place used by birds for laying their eggs and sheltering their young (Steenhof and Newton 2007) regardless of whether eggs are laid in the nest in a given year or in any year (Millsap et al. 2015, Steenhof et al. 2017). See *scrape* for falcons, owls, and New World vultures.

Nest survival — The probability that a nesting attempt survives over the complete nesting period. When Daily Survival Rate (DSR) is assumed to be constant over time and E is the nesting period (usually expressed in days), nest survival is DSR^{E}; otherwise nest survival is the product of each estimated Daily Survival Rate. For raptors nest survival is the equivalent of nesting success for egg-laying pairs (Steenhof et al. 2017).

Nesting attempt — Any activity involving egg-laying as determined by the presence of an egg attended by an adult, an adult in incubation posture, or other evidence indicating recent use of a nest for incubation of eggs or rearing of young (Steenhof et al. 2017).

Nesting period — The interval used to calculate nesting success from estimates of daily survival rates. It is usually calculated as the sum of the minimum acceptable age for assessing success, the mean incubation period, and the mean time between laying of the first egg and the onset of incubation (Steenhof et al. 2017); 77 days for Gyrfalcons assuming a 4-egg clutch.

Nesting season — The time from courtship through dispersal of young (Steenhof et al. 2017).

Nesting site — The substrate that supports the nest or the specific location of the nest on the landscape (Ritchie and Curatolo 1982, Millsap et al. 2015, Steenhof et al. 2017).

Nesting success — The proportion of territorial pairs or laying pairs that raise at least one young to the minimum acceptable age for assessing success (Steenhof and Newton 2007). Can be estimated either by *apparent nesting success* or *nest survival* (Brown et al. 2013, Steenhof et al. 2017).

Nesting territory — An area that contains, or historically contained, one or more nests within the home range of a mated pair. A confined locality where nests are found, usually in successive years, and where no more than one pair is known to have bred at one time (Newton and Marquiss 1984, Steenhof and Newton 2007). Note that a nesting territory may or may not be defended (Postupalsky 1974), and probably does not include all of a pair's foraging habitat (Newton and Marquiss 1982, Steenhof and Newton 2007).

Nestling — A young raptor that has not fledged from the nest. The term "young" is a broader term that can be used to describe either nestlings or fledglings. The term "chick" should be avoided because of the potential confusion with the word "chicken" for people whose first language is not English and because the term is more appropriate for precocial young (Steenhof et al. 2017).

Nestling rearing period — See *brood rearing period*.

Non-breeders — A collective term to describe both floaters and territorial pairs that do not produce eggs (Steenhof and Newton 2007).

Non-laying pair — A mated pair that fails to lay at least one egg in a given year (Steenhof et al. 2017).

Occupancy — The quotient of the count of occupied nesting territories and the count of known nesting territories that were fully surveyed in a given breeding season.

Occupied nest — A nest containing eggs, young, or an incubating bird. Also includes a mated pair on or near the nest as well as recently repaired (or decorated) nest (Postupalsky 1974, Millsap et al. 2015).

Occupied nesting territory — A nesting territory occupied by a pair of birds as evidenced by an occupied nest, territorial behavior, or reproductive-related activity. Evidence for occupancy can include observations of eggs, young, an incubating bird, a mated pair on or near the nest, a pair copulating, or at least one bird engaged in nest defense (Steenhof et al. 2017).

Phenology — The study of cyclic and seasonal natural phenomena, especially in relation to climate and plant and animal life (Demaree and Rutishauser 2011).

Post-fledging period — The time between fledging of young and their becoming independent of parental care. Sometimes measured from the time young are banded or are older than the minimum acceptable age for assessing success (Steenhof and Newton 2007).

Pre-incubation period — The time between laying of the first egg and onset of incubation (Steenhof and Newton 2007).

Pre-laying interval — The period of time (in days) from capture of a pre-laying female (including gravid birds) to appearance of the first egg (Lamarre et al. 2017).

Pre-laying period — The period of time from arrival at a nesting territory to appearance of the first egg (Lamarre et al. 2017). Not usually recorded or measured, but must be distinguished from pre-laying interval for studies involving breeding phenology.

Prey delivery rate — The frequency (e.g., items/nestling/day) or biomass of prey delivered to a nestling each day (e.g., g/nestling/day; Robinson et al. 2017).

Productivity — The number of young that reach the minimum acceptable age for assessing success; usually reported as the number of young produced per territorial pair or per occupied territory in a particular year (Steenhof and Newton 2007, Steenhof et al. 2017).

Regular territory — Known nesting territory in use every, or almost every, year (Steenhof and Newton 2007). Compare with *irregular territory.*

Relative hatch date— The number of days relative to the median hatch date (0 = the yearly median) that each nestling within a population of nestlings hatches.

Reproductive rate — A general term for measures of reproduction but most importantly a synonym for *productivity* (see above); usually reported on an annual basis (Steenhof et al. 2017).

Roost — A location where birds settle to rest or sleep; a roost may contain recent evidence of use (e.g., fresh mutes, fresh prey remains, plucks, recently molted down or feathers, tracks in snow; Platt 1976).

Scaled mass index — A measure of stored somatic reserves calculated following Peig and Green (2009):

$$SMI_i = M_i\left[\frac{WL_0}{WL_i}\right]^{b_{SMA}}$$

where M_i and WL_i indicate body mass and wing length of individual i respectively; WL_0 is the mean wing length of the sampled females; and b_{SMA} is the scaling exponent of the standardized major axis regression of body mass on wing length.

Scrape — A site where falcons, owls, and New World vultures (species that do not construct nests) lay eggs; the depression in substrate (rotting wood chips, old pellets, dust, sand, or gravel) where eggs are deposited (Steenhof and Newton 2007).

Successful nest, nesting attempt, or pair — One in which at least one young reaches the minimum acceptable age for assessing success (Steenhof et al. 2017).

Territorial birds — Individuals that occupy a nesting territory (Steenhof et al. 2017).

Territorial pair — A pair of breeding-age birds that occupies a nesting territory. Note that breeding-age birds can include birds in pre-definitive or immature plumage (Steenhof et al. 2017).

Unsuccessful nest, nesting attempt, or pair — A laying pair that failed before nestlings reached the minimum acceptable age for assessing success.

Vacant nesting territory — A nesting territory that does not meet the criteria of an occupied territory in the current year but for which there is evidence of occupancy in a previous year (Millsap et al. 2015). Applies only to nesting territories with good historical information on nest locations and adequate survey intensity (repeated visits throughout the nesting season). In some surveys, many nesting territories will be classified as neither occupied nor vacant (Steenhof et al. 2017).

Viable nesting attempt — A nesting attempt with live eggs or young at a given point in time (Steenhof et al. 2017).

Young — A general term that describes raptors from the time of hatching through dispersal; includes nestlings and fledglings (Steenhof et al. 2017).

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