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COMING TO TERMS ABOUT DESCRIBING GOLDEN EAGLE REPRODUCTION

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ABSTRACT.—Clearly defined terms are essential for reporting and understanding research findings, and inconsistent terminology can complicate efforts to compare findings from different studies. In this article, we reiterate and clarify recommended terms for describing Golden Eagle (*Aquila chrysaetos*) territory occupancy and reproduction. Several authors have provided recommendations for reporting data on raptor reproduction, but our literature review showed that authors continue to use different, often ambiguous and undefined, terms. The inconsistent use of terminology by researchers has been continued and expanded by lawmakers, regulators, and managers, perpetuating confusion. We recommend that authors clearly define and reference all terminology that they use, and we caution against use of the term "active" to describe a nest or nesting territory, because it is tainted with a history of inconsistent use. We provide a glossary of recommended terms for Golden Eagles and other large, long-lived raptors.

KEY WORDS: *Golden Eagle*; Aquila chrysaetos; *methods*; *nest*; *nesting success*; *nest survival*; *reproduction*; *terminology*.

LLEGANDO A UN ACUERDO SOBRE LA DESCRIPCIÓN DE LA REPRODUCCIÓN DE *AQUILA CHRYSAETOS*

RESUMEN.—Los términos claramente definidos son esenciales para mostrar y comprender los resultados de las investigaciones, y la terminología inconsistente puede complicar los esfuerzos para comparar los hallazgos de diferentes estudios. En este artículo, reiteramos y clarificamos los términos recomendados para la descripción de la ocupación del territorio y la reproducción de *Aquila chrysaetos*. Diversos autores propusieron recomendaciones para mostrar los datos sobre la reproducción de las aves rapaces, pero nuestra revisión bibliográfica evidenció que los autores continúan utilizando términos diferentes y, a menudo, ambiguos y sin definición. El uso inconsistente de la terminología por parte de los investigadores ha sido replicado y expandido por legisladores, reguladores y gestores, perpetuando la confusión. Recomendamos que los autores definan de forma clara y referencien toda la terminología que utilizan, y advertimos sobre el uso del término "activo" para describir un nido o un territorio reproductivo, debido a que está marcado por una historia de uso inconsistente. Proporcionamos un glosario de términos recomendados para *A. chrysaetos* y otras especies de aves rapaces grandes y longevas.

[Traducción del equipo editorial]

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Hall et al. (1997) encouraged scientists to make a serious commitment to standardizing terminology. They predicted that by working together to define nebulous terms, scientists would develop terminology that is more science than art. Several articles have been published over the last 45 yr that provided guidance on using terminology to describe raptor reproduction. Postupalsky (1974) published the first article that attempted to standardize terminology about raptor reproductive success and the status of nests and territories. Postupalsky wrote that "Clear definitions of terms are essential if meaningful comparison of the data of different workers is to be made," and he encouraged raptor biologists to use terminology consistently. The chapter on assessing reproduction in the first *Raptor Management Techniques Manual* (Steenhof 1987) and an updated chapter in the revised manual on *Raptor Research and Management Techniques* (Steenhof and Newton 2007) followed and expanded upon Postupalsky's original recommendations. Later, Driscoll (2010) applied Postupalsky's (1974) terminology to a protocol for assessing Golden Eagle (*Aquila chrysaetos*) nesting territory occupancy and reproduction. Despite these recommendations, many raptor studies use a variety of terms, often undefined, to describe raptor reproduction. As Postupalsky (1974) noted, this results in problems when comparing data and results across studies. For instance, inconsistent terminology and different survey methods have complicated recent efforts to assess temporal, regional, and habitat-driven variation in reproduction of Golden Eagles across western North America (N. Paprocki, HawkWatch International Inc., pers. comm.). In particular, frequent and inconsistent use of the term "active" in the literature and in government regulations has caused confusion because of its ambiguity. Brennan and Millsap (2016) were able to use only 18 of 98 references on Bald Eagle (*Haliaeetus leucocephalus*) reproduction and only 12 of 70 references on Golden Eagles in their analysis of eagle productivity from 1995–2015. The rest could not be used due to inconsistencies in use of terms and in the way that authors calculated productivity.

The purpose of this report is to: (1) review the recommended terms to describe raptor reproduction, particularly for Golden Eagles and other large, long-lived raptors; (2) review when, how, and why some of these terms were established and used; (3) recommend consistent and standard definitions and terminology, and (4) describe how the lack of a consistent and standard definition for a term can render it confusing and ineffective. We highlight recommended terms in bold at their first mention in the text, and we define them in a glossary at the end of the article. Our main focus is on Golden Eagles, but our findings and recommendations should be relevant to most diurnal raptors, particularly large, long-lived species such as Bald Eagles, Gyrfalcons (*Falco rusticolus*), and Osprey (*Pandion haliaetus*) that nest in conspicuous locations and do not always lay eggs every year. Species that nest colonially and shorter-lived raptors that raise multiple broods in a single year may require different approaches.

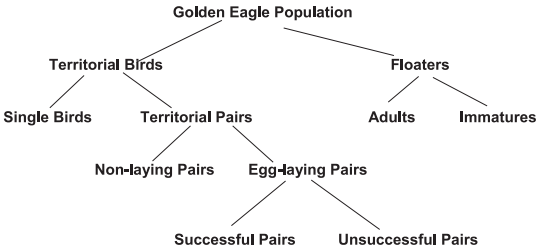


Figure 1. Components of a Golden Eagle population.

Nests, Pairs, and Nesting Territories. During the **nesting season**, a Golden Eagle population consists of **territorial birds**, which are associated with **nesting sites**, and **floaters**, which are not (Fig. 1). Typically, Golden Eagles occupy nesting territories as pairs (Watson 2010), but occasionally, as in Peregrine Falcons (*Falco peregrinus*), a single bird might occupy a nesting territory, particularly if it is awaiting a replacement for a lost mate (Ratcliffe 1993). Postupalsky (1974) noted the importance of distinguishing individual **nests** from groups of nests within what he called a "breeding territory." He recognized that some pairs of raptors have more than one nest, and that many represent **alternative nests** rather than abandoned territories with no birds. Postupalsky was not concerned with the exact size of a "breeding territory" or whether any part of it is defended. He suggested that those who may not feel comfortable using the term "territory" in this context because of its behavioral connotations, may prefer "breeding site." A problem with this recommendation is that the term "site" has been used interchangeably with **nesting site**, which we define as the substrate that supports the nest or the specific location of the nest on the landscape (Ritchie and Curatolo 1982, Millsap et al. 2015). Furthermore, some investigators have used the term "breeding" to denote egg-laying (see below). We

have concluded that "**nesting territory**" is the clearest term that makes most sense; "breeding area" (Driscoll 2010) and "breeding territory" (Postupalsky 1974) are commonly used alternatives, and "nest area" has been used as well (Pedrini and Sergio 2001). Newton and Marquiss (1982) provided a clear definition of a nesting territory as "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." Steenhof and Newton (2007) reiterated and endorsed this definition.

Postupalsky (1974) and Millsap et al. (2015) described an **occupied nest**, evidence for which could include not only eggs, young, or an incubating bird, but also a mated pair "on or near" the nest, as well as a nest that is currently being or has recently been repaired or decorated (e.g., with sprigs of fresh green vegetation). Evidence for an **occupied nesting territory** can be based on any of these criteria listed or observations of at least one eagle engaged in courtship, territorial defense, nest affinity, or other reproductive-related activity (Steenhof and Newton 2007). A **vacant nesting territory** is one that does not meet the criteria of an occupied territory in the current nesting season but for which there is evidence of occupancy in a previous year (Millsap et al. 2015). However, it is difficult to determine when a nesting territory is not occupied without repeated visits throughout the nesting season and good information on historical and potential nest locations. In some surveys, many territories will be classified as neither occupied nor vacant. The number of occupied nesting territories is equivalent to the number of **territorial pairs**; these terms are interchangeable depending on whether the focus is on the birds or their real estate.

Postupalsky (1974) stressed the importance of reporting reproduction per occupied nesting territory rather than per nest or **egg-laying pair**. Postupalsky did most of his research on Bald Eagles and Ospreys, and territorial females of these two long-lived species, like Golden Eagles and Gyrfalcons, do not always lay eggs every year (Postupalsky 1977, Hansen and Hodges 1985, Poole and Bromley 1988, Cartron 2000). Failure to lay eggs may be a response to environmental conditions that are not conducive to egg-laying (Postupalsky 1974, Nielsen and Cade 1990), and the proportion of pairs that lay eggs in different years can be an important measure of a population's response to changing food supplies (Steenhof et al. 1997).

In some studies, it is possible and important to distinguish pairs that lay eggs in a given year from pairs that do not (Watson 2010). Some authors (Watson 1957, Kochert 1972, Smith and Murphy 1979, U.S. Department of the Interior 1979, Margalida et al. 2007, Fasce et al. 2011) called these breeders and nonbreeders, respectively. However, the term "**nonbreeder**" is a collective term that describes both **floaters** and territorial pairs that do not produce eggs (Steenhof and Newton 2007). Therefore, we recommend using the more precise term **egg-laying pair** to refer to territorial pairs that lay eggs in a given year and thereby undertake a "**nesting attempt**," sometimes called a "**breeding attempt**." A nesting attempt with live eggs or young at any given point in time is a "**viable** nesting attempt." **Non-laying pairs** are territorial pairs that do not lay eggs in a given year, even though they may build or repair a nest. In many surveys, observers may not be able to distinguish laying pairs from non-laying pairs, which is why it is important to report reproduction on the basis of occupied nesting territories. Isaacs and Anthony (2011) distinguished nesting territories as "occupied with evidence of eggs" or "occupied with no evidence of eggs." Nests that contain an incubating bird, eggs, young, or any indication that eggs were laid constitute a specific subset of occupied nests, and have been described by a variety of adjectives in the literature: "active" (Postupalsky 1974, but see below), "used" (Kochert and Steenhof 2012, Watson et al. 2014, Millsap et al. 2015), and "**in-use**" (U.S.F.W.S. 2016). We have found these adjectives to be awkward, vague, and sometimes misleading, so we recommend that authors avoid using adjectives to describe the status of nests that contain a nesting attempt. Adjectives should be used to describe nesting territories (occupied or not) or pairs (laying or not).

Nesting Success and Reproduction. Postupalsky (1974) stressed the need for a minimum of two checks of each nesting territory in each **breeding season** to assess occupancy and document reproduction. The checks can be from the air or from the ground using a variety of platforms (i.e., aircraft, boats, vehicles, horseback, dogsled, snowmobile, foot travel, etc.). The first check should be made during early incubation to count the number of territorial pairs and egg-laying pairs, and the second should be made just prior to the time young are due to **fledge**, to count the number of young and ascertain nesting success (Fraser et al. 1983).



Figure 2. Photograph of a 51-d-old Golden Eagle nestling, first observed within 1 d of hatching. Photo by Jordan Harrison. See also Plate 12 in Driscoll (2010) for an image of a 7.5-wk-old eaglet.

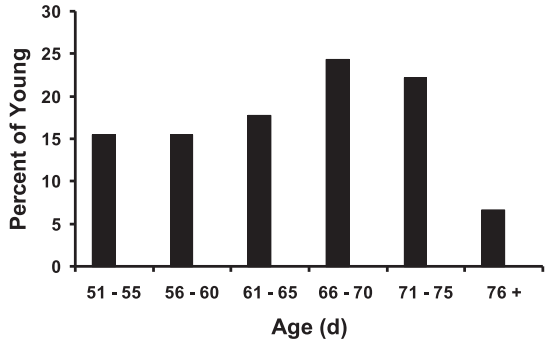


Figure 3. Percent of 46 young Golden Eagles fledging by age in d, in southwestern Idaho, 1970–1978. We restricted our analysis to 32 broods with a median age of ≤4 d when first observed and for which we were able to estimate fledging date for each young in the brood within 5 d.

Postupalsky (1974) defined a productive or **successful** nest as one from which at least one young fledged, or if actual fledging was not observed, one in which at least one young was raised to an advanced stage of development (i.e., near fledging age). Ideally, this advanced stage of development should be defined consistently within a species to allow valid comparisons among studies. It would be misleading to compare results from a study that considered nests with downy young to be successful (e.g., Moss et al. 2012) to one that classified nests as successful only if and when young actually fly from the nest on their own volition (e.g., Beecham 1970).

We recommend that a Golden Eagle nesting attempt be called **successful** if at least one young reaches 80% of the average actual fledging age (Steenhof 1987). The 80% of first-flight age criterion has been used to determine nesting success in studies of several other diurnal raptors (Steenhof and Newton 2007). The average fledging age for Golden Eagles in southwestern Idaho is 64 d ($n=101$ young, 61 broods; Kochert et al. 2002), and 80% of 64 d is 51 d. At 51 d, Golden Eagle young are almost fully feathered (Fig. 2) and large enough to be counted from a distance. At 51 d, the head should be at least 75% covered with dark feathers. Variation in plumage development occurs within and among broods, and it is difficult to age eaglets precisely to the nearest day. However, investigators should be able to estimate age of most nestlings to within a half week by comparing observations with photographic or illustrated aging keys (Hoechlin 1976, Nakajyo et al. 1983, Driscoll 2010). We recommend that researchers describe plumage and, if possible, photograph young at all visits because they may be able to age young more accurately during the earlier visits. We also recommend that researchers develop their own site-specific aging guides based on development of known-age nestlings within their own geographic areas of interest.

Young Golden Eagles left nests in southwestern Idaho as early as 45 d old and as late as 77 d (Kochert et al. 2002). An analysis of fledging age based on 46 young from 32 broods showed that by 55 d of age, 16% of the young had fledged. The number of young leaving the nest increased progressively until half (49%) of the young had fledged by 65 d of age, and by 70 d of age nearly 75% of the young had left their nests (Fig. 3). This analysis was restricted to broods with a median age of ≤4 d when first observed and for which fledging dates for each young were estimated within 5 d.

The reason for a consistent cut-off age or a "**Minimum Acceptable Age for Assessing Success**" prior to actual fledging is that fledging dates vary among nests and among individuals within nests. It is logistically impossible to be at all nests on the exact day that every young leaves the nest, and it is very difficult to find and count young after they have left the nest. The probability of being able to classify a nesting attempt as either viable or nonviable is very high until young Golden Eagles reach 51 d. After 51 d, that probability drops sharply because some

young have already left the nest. We recommend that survival after 51 d be considered part of post-fledging or juvenile survival.

The most important measure of a Golden Eagle population's **reproductive rate**, often called **productivity** by raptor biologists, refers to the number of young that reach ≥51 d, reported on the basis of territorial pairs or occupied nesting territories (Steenhof and Newton 2007). In situations with good information on historical nesting territories, but where it is difficult to distinguish occupied from vacant territories each year, alternative and useful measures of reproduction may be the number of young produced per territory surveyed or the percent of territories producing young (e.g., Kochert et al. 1999 and Steenhof et al. 2014). Number of young per egg-laying pair can be useful for some purposes, depending on the objectives of the study, because it includes information on unsuccessful laying pairs. However, because it does not include information on non-laying pairs, it is not an appropriate estimate of productivity for Golden Eagles. It is appropriate for species that lay eggs every year. **Brood size at fledging** (a synonym for young per successful pair or nest) is usually less variable than other measures of reproduction (Steenhof et al. 1997, McIntyre and Schmidt 2012), but it is less meaningful for assessing reproduction of a population. Estimates of reproduction based solely on brood size at fledging are misleading because they do not include information on non-laying pairs and unsuccessful pairs. In addition, successful pairs often produce average numbers of young even in years when most egg-laying pairs fail (Steenhof et al. 1997). However, brood size at fledging can be a useful measure for some purposes (see below).

The traditional way to estimate nesting success is to divide the total number of territorial pairs with known outcomes by the total number of successful pairs (Johnson and Shaffer 1990). This is known as **Apparent Nesting Success** (ANS). For many years ornithologists have recognized ANS as a biased metric because egg-laying pairs that fail early in the **nesting period** are more likely to be missed during surveys (Mayfield 1961). Successful nests are more conspicuous than nests that fail, and nesting attempts discovered later in the nesting period are more likely to survive to the end of the nesting period simply because they have less time to fail (Johnson 2007). As a result, ANS typically overestimates success rates.

Mayfield (1961) developed an approach to estimate nesting success that incorporates data from nesting attempts detected at various stages of the nesting attempt, by calculating a **daily survival rate** (DSR) during the time that a nesting attempt is under observation. When DSR is assumed to be constant over time and E is the nesting period in days, **nest survival** (the equivalent of nesting success) is DSR^E; otherwise nest survival is the product of each estimated DSR. For Golden Eagles, the nesting period is 101 days: 5 d pre-laying + 45 d incubation + 51 d brood-rearing. Golden Eagles are known to assume incubation posture 5 d before laying their first egg (Ellis 1979), so the nesting period for eagles must include a pre-laying stage because a bird in incubation posture is considered to be evidence for a nesting attempt. Nesting periods for other raptors may not require a pre-laying stage.

Recently, more sophisticated models have been developed to estimate nest survival (Dinsmore et al. 2002, Rotella et al. 2004, Shaffer 2004, Schmidt et al. 2010). The main advantage of nest survival models is that they allow evaluation of the influence of continuous covariates on nesting success. In particular, logistic-exposure models allow modeling of the variation in nesting success over time (Shaffer 2004). Unfortunately, some of the terminology proposed by those who developed recent nest survival models (Dinsmore et al. 2002) does not work well for raptors, because it was based on ground-nesting species whose reproductive biology differs from that of long-lived raptors. The terms "nest" and "success" have different connotations, because, unlike raptors, the species that nest on the ground have ephemeral nests, precocial young, very short pair bonds, and a high probability of re-nesting after failure.

At least two visits to assess the viability of nesting attempts each season are needed to use nest survival models, so studies following the recommendations of Postupalsky (1974) and Fraser et al. (1983) are suitable for modeling. Brown et al. (2013) compared various techniques for estimating Golden Eagle nesting success based on long-term data from southwestern Idaho. ANS was high whether based on all nesting territories known to be occupied, only those territories checked at least twice in the nesting period, or only those territories where egg-laying was confirmed during incubation. The latter restriction, recommended by Steenhof and Kochert (1982), lowered the estimate slightly, but not enough to match estimates from the nest survival models. Both the Mayfield model and Shaffer's logistic exposure

model produced estimates significantly lower than all of the ANS estimates.

One notable limitation of typical nest survival models is that they do not address the probability of territorial pairs laying eggs and thus do not address the complete raptor reproductive cycle. In addition, they do not consider survival of individual eggs or young and therefore do not estimate productivity per pair (but see Schmidt et al. 2010). One approach is to calculate the reproductive rate as the product of nest survival, percent of pairs laying, and brood size at fledging. Calculating the variance of this estimate can be problematic (but see Powell 2007 for the delta method, and Brown and Collopy 2013 for propagation of uncertainty within a Bayesian integrated population model framework). However, nesting success has been a very good predictor of Golden Eagle productivity in southwestern Idaho. Over 43 yr in the Morley Nelson Snake River Birds of Prey National Conservation Area, percent of territorial pairs successful correlated strongly with mean number of young per occupied nesting territory (r= 0.934; U.S. Geological Survey, Snake River Field Station, unpubl. data). McIntyre and Schmidt (2012) observed a similar relationship ($r = 0.989$) with Golden Eagles nesting in Alaska during a 23-yr period. When time and money are short, monitoring success at occupied nesting territories could be a practical shortcut to monitoring reproduction in some areas.

Inconsistent Use of an Ambiguous Term. The term "active" has been used to describe nests and territories in many different ways. The word "active" is defined as "Engaging or ready to engage in physically energetic pursuits" (Oxford Dictionaries 2017). Common synonyms are "lively, vigorous, and energetic." The problem is that authors often use the shorthand term without describing the type or level of activity. The term is not unique to raptor researchers; it has been used by many other ornithologists as well (e.g., Burger 1987, Daily 1993). The earliest use of the term "active" that we could find in the raptor literature was from Charles Broley in 1947, but Broley (1947) did not define the term. The key point of confusion has been whether or not there must be evidence of egg-laying to characterize a nest or a territory as "active." This confusion started when Joseph C. Howell published a series of articles in the *Au*k from 1954 to 1973 on Florida's nesting Bald Eagles (Howell 1954, 1958, 1962, 1967, 1968, 1973). Howell's 1954 paper categorizes nests as either occupied "if they contained eggs or young (such nests nearly always have an adult sitting on them)" or active "where an adult or a pair of adults was seen but at which no nest is found or at which the nest was judged not to contain eggs or young." Howell used the terms consistently from 1954 through 1973, but Troyer and Hensel (1965) published an article (also in the *Auk* and also about Bald Eagles) that used the completely opposite definitions: "Nests were considered active when occupied by incubating birds or when they contained eggs and an adult was nearby."

Postupalsky (1974) perpetuated the Troyer and Hensel definition that an "active" nest was a nest in which eggs had been laid in a given breeding season. However, he argued that reproductive success should be reported on the basis of "the entire territorial population of potential breeders," not just "active nests." Postupalsky clarified and reiterated his recommendations in the North American Osprey Symposium Proceedings (Postupalsky 1977) and in the Northern States Bald Eagle Recovery Plan (Postupalsky 1983). His 1977 article encouraged references to occupied nests and territories; he advised that the category "active" should be used only in those few studies where sufficient early observations had been made at each nest to determine whether eggs had been laid or not. By 1983, he wrote that the term "active" had been used under such a variety of conditions by different workers that it was potentially too ambiguous and should not be used any further (Postupalsky 1983). Steenhof (1987) concurred that the term "active" had become meaningless and urged that it not be used. Steenhof and Newton (2007) labeled the term "active" as ambiguous and recommended that the term be avoided unless clearly and carefully defined.

We reviewed scientific articles, letters, and short communications with information about nesting raptors published in *Raptor Research* and *The Journal of Raptor Research* from 1975 (the year following Postupalsky's first terminology article) to 2013 to assess the frequency with which authors used and defined the term "active." We found 116 articles on more than 50 species that used the term "active" to describe a nest, nesting territory, pair, or nest box. Only 37 (32%) of these reports provided a definition of the term active. We also reviewed articles about nesting raptors published in other major ecological and ornithological journals from 2008 to 2013. We found 57 articles on >40 raptor species that used the term "active," and only 6 (11%) of these defined the term. We observed no evidence that use of the term

or the rate at which it was not defined had declined over time. Most of the 43 articles that defined the term "active" used Postupalsky's (1974) definition of an active nest or territory (one in which eggs were laid as evidenced by eggs, young, or an incubating bird). However, 13 (30%) used other definitions. Eleven of these expanded the definition of active to include criteria such as fresh nesting material, adults present on or near the nest, or defense by one or more adults. These definitions were similar to Postupalsky's (1974) concept of "occupied" nests or territories.

The inconsistent use of terminology by researchers has been continued and expanded by lawmakers, regulators, and managers. We reviewed several widely distributed documents published by the U.S. Fish and Wildlife Service (U.S.F.W.S.) to examine how the term "active" was used, and if it was used consistently across these documents. In 1978, the Bald and Golden Eagle Protection Act was amended to allow mining operators and others to remove "inactive" Golden Eagle nests. In 1983, the *Federal Register* outlined procedures under which "inactive" Golden Eagle nests could be removed, and these procedures became officially incorporated into the regulations concerning the eagle permit process. The regulations defined an "inactive nest" as one "that is not currently used by Golden Eagles as determined by the absence of any adult, egg, or dependent young at the nest during the 10 d before the nest is taken."

The National Bald Eagle Management Guidelines (U.S.F.W.S. 2007) define an active nest as one that was attended (built, maintained, or used) by a pair of Bald Eagles during a given breeding season, whether or not eggs were laid. An alternate nest was defined as a nest that is not used for "breeding" by eagles during a given breeding season (Table 1). The guidelines did not provide a definition for an inactive nest, but the term was used twice in the document.

In 2009, regulations that cover taking, possessing, and transporting of Bald Eagles and Golden Eagles (50 CFR 22.3) were amended. Here, the term active was not explicitly defined, but the term "inactive" was. The document retained the within-season temporal component of the definition used in the earlier regulations in which an inactive nest was a Bald Eagle or Golden Eagle nest characterized by the "continuing absence of any adult, egg, or dependent young at the nest for at least 10 consecutive days immediately prior to, and including, at present. An inactive nest may become active again and remains protected under the Eagle Act" (Table 1). According to this definition, a nest could be inactive and active in the same nesting season. What had been called an active nest by others was now labeled a "nesting attempt" but only for Golden Eagles, not Bald Eagles. The regulatory definition required that a nesting attempt involve both egg-laying and incubation, and it did not recognize that immatures as well as adults may lay eggs and raise young.

The Bald Eagle Post-delisting Monitoring Plan (U.S. Fish and Wildlife Service 2009), published in the same year as the updated regulations, used the old established definition of "active" as a nest where eggs have been laid (Table 1). The plan defined "breeding" eagles as those associated with an "active" nest and noted that this "category excludes non-nesting territorial pairs or eagles that may go through the early motions of nest building and mating, but without laying eggs." The plan cited Postupalsky (1974), Fraser (1978), Steenhof and Kochert (1982), and Steenhof (1987) in asserting that standard terminology for describing the status of Bald Eagle nests and territories is essential, especially if a meaningful comparison is to be made of the data collected by different researchers over many years and throughout the nation. However, the plan acknowledged that its definitions ". . . are entirely separate from, and should not be substituted for, definitions in other Bald Eagle documents developed by the Service."

The Interim Golden Eagle Inventory and Monitoring Protocols (Pagel et al. 2010) recognized the regulatory definition of "active," (the 10-d rule), but they noted that this definition should be used only for permits to remove (take) eagle nests (Table 1). For monitoring purposes, they advocated the term "occupied nest." According to their definition, an occupied nest is one used for breeding in the current year by a pair. It may have eggs or young, but those are not necessary. The presence of an adult, eggs, young, freshly molted feathers or plucked down, or current year's mutes (excreta, "whitewash") also indicates occupancy. This definition is not inconsistent with Postupalsky (1974), but it overlooks Postupalsky's emphasis on the territory rather than the individual nest. The protocol also introduces more ambiguity and confusion when it states that "all breeding sites within a breeding territory are deemed occupied while raptors are demonstrating pair bonding activities and developing an affinity to the given area. If this culminates in

Table 1. Definitions concerning the word "active" in U.S. Fish and Wildlife Service documents, 2007–2013.

DOCUMENT	DEFINITION	REFERENCE
Bald Eagle Management Guidelines	**An active nest** is a nest that is attended (built, maintained, or used) by a pair of Bald Eagles during a given breeding season, whether or not eggs are laid.	U.S.F.W.S. 2007
50 CFR 22	**Inactive nest** is one not currently used by Golden Eagles as determined by the absence of any adult, egg, or dependent young at the nest during the 10 d before the nest is taken.	
50 CFR 22.3 (as amended)	**Inactive nest** means a Bald Eagle or Golden Eagle nest that is not currently being used by eagles as determined by the continuing absence of any adult, egg, or dependent young at the nest for at least 10 consecutive d immediately prior to, and including, at present. An inactive nest may become active again and remains protected under the Eagle Act.	U.S.F.W.S. 2009
Bald Eagle Post-delisting Monitoring Plan	**Active nest** (breeding): a nest where eggs have been laid. Activity patterns are diagnostic of breeding eagles (or those with an "active" nest). This category excludes non-nesting territorial pairs or eagles that may go through the early motions of nest building and mating, but without laying eggs.	U.S.F.W.S. 2009
Interim Golden Eagle Inventory and Monitoring Protocols	**Active nest** (from the regulations): a Golden Eagle nest characterized by the presence of any adult, egg, or dependent young at the nest in the past 10 consecutive d immediately prior to, and including, at present. Applies only to applications for permits to take eagle nests. **Occupied nest:** a nest used for breeding in the current year by a pair. Presence of an adult, eggs, or young, freshly molted feathers or plucked down, or current years' mutes (whitewash) suggest site occupancy. Additionally, for purposes of these guidelines, all breeding sites within a breeding territory are deemed occupied while raptors are demonstrating pair bonding activities and developing an affinity to the given area. If this culminates in an individual nest being selected for use by a breeding pair, then the other nests in the nesting territory will no longer be considered occupied for the current breeding season. A nest site remains occupied throughout the periods of initial courtship and pair-bonding, egg laying, incubation, brooding, fledging, and post-fledging dependency of the young.	Pagel et al. 2010
Eagle Permit Definitions	**Active nest:** a nest that is attended, built, maintained or used by a pair of eagles during a given breeding season, whether or not eggs are laid. **Inactive nest:** an eagle nest that is not currently being used by eagles as determined by the continuing absence of any adult, egg, or dependent young at the nest for at least 10 consecutive d immediately prior to, and including, at present. An inactive nest may become active again and remains protected under the Bald and Golden Eagle Protection Act. An alternate or inactive nest is a nest that is not used for breeding by eagles during a given breeding season.	U.S.F.W.S. 2012
Eagle Conservation Plan Guidance	**Active nest:** see occupied nest. **Occupied nest:** a nest used for breeding in the current year by a pair of eagles. Presence of an adult, eggs, or young, freshly molted feathers or plucked down, or current year's mutes (excreta, whitewash) suggest site occupancy. In years when food resources are scarce, it is not uncommon for a pair of eagles to occupy a nest yet never lay eggs; such nests are considered occupied.	U.S.F.W.S. 2013

an individual nest being selected for use by a breeding pair, then the other nests in the nesting territory will no longer be considered occupied for the current breeding season" (Table 1). The glossary in the Interim Protocol does not define "site" or "breeding."

In 2012, the U.S.F.W.S. updated its website on permits. The website (U.S.F.W.S. 2012) defined an "active" nest as one "attended, built, maintained or used by a pair of eagles during a given breeding season, whether or not eggs are laid." It goes on to define an "inactive" nest according to the regulatory definitions: the absence of eagles for 10 consecutive d. The website notes that an inactive nest may become active again. According to these definitions an occupied but unsuccessful nest could be both active and inactive in the same nesting season. The same website includes information that defines an inactive (or alternate) nest in a completely contradictory way: a nest not used for breeding during a given breeding season (Table 1).

The most recent U.S.F.W.S. document that we reviewed was The Eagle Conservation Plan Guidance (U.S.F.W.S. 2013). The glossary in the plan defines an active nest by cross-referring to "occupied nest," and an occupied nest is one used for "breeding" in a current year (Table 1). Apparently "breeding" in this case does not mean egg-laying, because "whitewash, freshly molted feathers" suggest "site" occupancy. Again, it is unclear if the term site refers to a nest or a territory. The glossary in the plan does not define either "site" or "breeding."

Conclusions and Recommendations

Our literature review showed that there are inconsistencies in terminology used to describe raptor reproduction, and many authors continue to use ambiguous and undefined terms. Despite recommendations (Postupalsky 1983, Steenhof 1987, Steenhof and Newton 2007), the term "active" is still widely used in the peer-reviewed literature and management documents, often without a clear definition. This has resulted in confusion and difficulties comparing results of studies and guiding management actions. The inconsistent or inaccurate use of terms could have negative ramifications in legal contests (see Hall et al. 1997).

We recommend that authors clearly define and reference all terminology that they use. We recognize that differences in species' breeding biology will preclude the use of the same terms in all circumstances and that there is a need for flexibility. However, use of terms that are consistent with, and not contradictory to, widely accepted definitions will facilitate comparisons of data over time and space and reduce confusion. Authors should consider using the terms and definitions we have recommended in the glossary below, particularly if they are writing about Golden Eagles and other long-lived species. The manual on *Raptor Research and Management Techniques* (Steenhof and Newton 2007) provides additional definitions that may be more appropriate for other species. If those definitions are not appropriate, we recommend using clear terms that are not tainted with a history of inconsistent use.

If we cannot communicate within our own scientific discipline, then we cannot expect to communicate with regulators, policy makers, members of the public, or with scientists in other disciplines. As Hall et al. (1997) noted: "wildlife scientists have to use words correctly to communicate with each other. . . there is a deep-seated problem in the ecological sciences: we use terms haphazardly, either without providing definitions, or providing definitions that are full of vague, non-operational terms."

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Appendix
Glossary of Recommended Terms

Alternative Nest. One of potentially several nests within a nesting territory that is not being used for laying eggs in current or given year (Millsap et al. 2015). Note that recent research suggests that alternative nests are important components of a nesting territory (Kochert and Steenhof 2012, Watson et al. 2014, Millsap et al. 2015).

Apparent Nesting Success. The ratio of the number of successful pairs to the total number of pairs in a population with known outcomes. (Can be based on all territorial pairs or only laying pairs; Steenhof and Newton 2007).

Breeding Season. A synonym for nesting season: the time from courtship through dispersal of young.

Breeding Attempt. A synonym for nesting attempt (see below).

Brood Size at Fledging. The number of young raised to minimum acceptable age for assessing success by successful pairs. Synonymous with young per successful pair or successful nest (Steenhof and Newton 2007).

Daily Survival Rate (DSR). The probability that at least one egg or at least one young in a nest will survive a single day (Dinsmore et al. 2002 as modified by Steenhof and Newton 2007).

Egg-laying Pairs. Territorial pairs that lay at least one egg in a given year, as evidenced by eggs, young, or a bird in incubation posture. Egg-laying pairs use what Postupalsky (1974) called "active" nests or territories.

Fledgling. A fully-feathered young that has voluntarily left the nest but has not dispersed from the nesting territory.

Fledge. To leave the nest voluntarily for the first time (Watson 2010).

Floaters. Birds in either immature or adult plumage that are not associated with specific nesting territories during the nesting season 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).

In-Use Nest. A nest where eggs were laid, as evidenced by an incubating bird, eggs, young, or any other indication that eggs had been laid in the current year (i.e., a nest in which a nesting attempt occurred; U.S.F.W.S. 2016). Note that this term is best reserved for regulatory and management purposes; we recommend avoiding it when reporting research results.

Minimum Acceptable Age for Assessing Success. A standard nestling age (51 d of age for Golden Eagles) at which a nesting attempt can be considered successful. An age when young are well grown but not old enough to fly: often defined as 80% of the age that young of a species normally leave the nest of their own volition, but may be 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 disturbed (Steenhof and Newton 2007).

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).

Nesting Attempt. Any activity involving egg-laying as determined by observation of an egg, young, a bird in incubation posture, or other evidence indicating recent use of a nest for incubation of eggs or rearing of young (modified from 50 CFR 22.3, as amended).

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. Golden Eagles begin incubating as soon as the first egg is laid (Watson 2010), but they are known to assume incubation posture 5 d before laying their first egg (Ellis 1979). Thus, the nesting period for eagles must include a pre-laying rather than a pre-incubation stage because a bird in incubation posture is considered to be evidence for a nesting attempt. For Golden Eagles, the nesting period is 101 d: 5 d pre-laying + 45 d incubation

+51 d brood-rearing (modified from Dinsmore et al. 2002, Steenhof and Newton 2007, Brown et al. 2013).

Nesting Season. The time from courtship through dispersal of young.

Nesting Site. The substrate which supports the nest or the specific location of the nest on the landscape (Ritchie and Curatolo 1982, Millsap et al. 2015).

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), which we define as 51 d of age, for Golden Eagles. Can be estimated either by apparent nesting success or nest survival.

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. 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 eagle that has not fledged from the nest. The terms "eaglet" or "young" can be used as substitutes for nestling. 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.

Nest Survival. The probability that a nesting attempt survives over the complete nesting period. When 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 DSR. For raptors, nest survival is the equivalent of nesting success calculated on the basis of laying pairs.

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

Non-laying Pair. A territorial pair of eagles that does not lay at least one egg in a given year.

Occupied Nest. A nest that contains eggs, young, or an incubating bird, or has a pair of birds on or near it, or has been recently repaired or decorated (Postupalsky 1974, Millsap et al. 2015).

Occupied Nesting Territory. A nesting territory inhabited by a pair of birds, as evidenced by an occupied nest (see above) or a pair of birds copulating, displaying, or defending a nest.

Productivity. The number of young that reach the minimum acceptable age for assessing success (51 d for Golden Eagles); usually reported as the number of young produced per territorial pair (occupied nesting territory) in a particular year (Steenhof and Newton 2007).

Reproductive Rate. A general term for measures of reproduction, but most importantly, a synonym for productivity (see above), usually reported on an annual basis.

Successful (nest, nesting attempt, or pair). One in which at least one young reaches the minimum acceptable age for assessing success (Steenhof and Newton 2007), suggested as 51 d for Golden Eagles.

Territorial Birds. Individuals that occupy a nesting territory.

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.

Vacant Nesting Territory. A nesting territory that does not meet the criteria of an occupied nesting territory in the current nesting season, 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.

Viable Nesting Attempt. A nesting attempt with live eggs or young at a given point in time.

Young. A general term that describes raptors from the time of hatching through dispersal. Includes both nestlings and fledglings.