MONITORING SUBADULT OCCUPANCY OF PEREGRINE TERRITORIES

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BACKGROUND

Peregrine populations have thrived in recent decades after being much reduced mid-century by organochlorine pesticides. It has become clear in retrospect that this wide-ranging predator, with its extraordinarily diverse diet, can be a valuable indicator of chemical contamination in avian food webs (Castagna et al. 2024). Mercury, for example, is commonly stored (Barnes et al. 2019), as are PCBs, halogenated flame retardants, and lead, although none of these are currently known to impact peregrine territory occupancy. It is quite possible, however, that because of the peregrine's tendency to bioaccumulation, a contaminant may arise with unanticipated properties that compromise survival or reproduction.

Monitoring the health of nesting peregrine populations is therefore valuable in ecosystem stewardship even where populations are stable. Early detection of adverse trends might be important, not only for peregrine conservation, but possibly for other species as well, given that a substance biomagnifying to critical levels in an apex predator population might later affect those of its prey. It would be prudent, therefore, to reestablish a tradition of territory monitoring designed to detect occupancy problems before they become critical.

Government support for peregrine occupancy monitoring, formerly widespread, has generally evaporated because the species has been doing so well. A surprising number of competent people in the landscape, however, enjoy watching peregrines at their local eyries. What is needed is a simple, inexpensive, locally applied system of data gathering and a way to pool information for analysis.

A factor underscoring a current need for monitoring is the scattered array of declines in peregrine territory occupancy in North America and Eurasia, together with lower migration and winter counts. Some of these losses may be caused by Highly Pathogenic Avian Influenza (HPAI). The virus was first detected in North American wild birds in winter 2014–2015 (Ramey et al. 2019), and a more pronounced outbreak began in 2021 (Caliendo et al. 2022). Even though evidence linking these events to declines in peregrine occupancy remains largely circumstantial in North America, there is evidence of cause and effect in bald eagle populations (Nemeth 2023) and in a variety of European raptors (see Günther et al. 2024).

If avian flu is the cause of the declines, its effect may be temporary, as is typical of other viruses, and in a sense, HPAI is not a conservation issue. But here is an opportunity to better understand the dynamics of peregrine population response to what appears to be gross and widespread mortality. I will therefore describe what I believe to be an efficient, low-cost method of monitoring peregrine population health over the long term—a coordinated system of territory monitoring that Carl Thelander and I are hoping will begin in California this spring.

Lastly, I will tell you what I am <u>not</u> proposing, and why. Monitoring territory occupancy in birds is normally directed at estimating breeding population size, quantifying trends thereof, detecting effects of habitat variability on population density and distribution, or properly estimating the reproductive rate at fledging time, the latter to be used in population viability modelling. To avoid various biases, the researcher randomly chooses plot-samples on a map grid, then monitors only what is within each plot over a period of years. This is a perfectly reasonable approach to the acquisition of such information, but it would be cumbersome and expensive for a species like the peregrine, and unnecessary to the specific purpose I will here explain.

FACTS ABOUT PEREGRINES THAT UNDERLIE THE LOGIC OF THIS PROTOCOL

Peregrines are highly territorial. In established populations, individuals fight members of their own sex over territory ownership, sometimes killing one another. Such engagements are thought to be the main cause of adult mortality in some studies. One might correctly deduce from this that peregrine territories are in short supply. The reason is that peregrine pairs discriminate in their choice of nesting places and refuse to settle at substandard locations. As populations grow, all acceptable sites become occupied, and surplus **adults** (floaters), unable to secure breeding territories, begin accumulating. Their numbers level off over a period approximating maximum peregrine lifespan (~18-20 years), and the population stabilizes (see Hunt 1998). Floaters ensure (buffer) the continuation of that stability by filling individual vacancies as they occur. There is much evidence, including historic reports of British gamekeepers shooting both pair members and seeing them replaced within hours or days. In one notable recollection, a pair is said to have raised young that neither member had parented. It is easy to see, therefore, why virtually all territorial pairs in healthy, established peregrine populations are adults.

If, however, survival and reproduction become insufficient to maintain a supply of floaters, then yearling peregrines (subadults) may become pair members, unopposed by adult competitors. A general increase in subadult pair membership, therefore, may signal that the floater buffer has been depleted by some factor affecting survival and/or reproduction. Given the existing number of human-related mortality agents, the new factor may simply be one too many—one that reverses the trend from buffered stability to decline.

SUBADULT OCCUPANCY MONITORING

1. In getting started, my first recommendation is to select a manageable group of familiar, observable, regularly occupied peregrine territories, preferably those with easily accessed observation points (OPs) from which all known or suspected alternate cliffs and nest sites (eyries) are visible.

2. The goal is to verify occupancy and to determine the age-class of each occupant, male and female. An ideal time to observe is during the weeks prior to egg-laying—late February and early March in most of California, but usually later at higher elevations. Missing that opportunity may require one to wait for a nest exchange which might require hours of uninterrupted viewing (but see Item 3, below). It is easy to lose patience and judge a territory unoccupied (or occupied by a single bird), and it is often necessary to revisit until all doubt is removed. That is one reason

why easy-to-access territories and early visits are preferable in this type of survey. Peregrines can be excessively quiet and secretive, especially during incubation.

3. I have not yet tried using a broadcast call to detect the presence of peregrines, but I think it could really save time in this type of survey. The technique, developed by Joe Barnes, Jef Jaeger, and Dan Thompson, is known to be highly effective in quickly revealing the presence of territorial peregrines and determining their ages (see Barnes et al. 2012).

4. Be alert to incursions by floaters during territory visits as this is evidence of their existence in the population.

5. Subadults are easy to distinguish, but there are some contingencies. Replacement of contour feathers on the crop and upper breast usually begins in winter, and during the nesting season some subadults may vaguely resemble adults when perched and viewed from a distance. Subadults are much easier to identify in flight, however. They retain their brown streaking on the lower breast, belly, and upper tarsi long into the breeding season, and they are brown on the dorsum and show patches of bluish gray on their outer wings and back. There is also a high degree of contrast between juvenile flight feathers and the darker ones that emerge during the spring. The backs of most adults are bluish gray in California, although some may be weathered. Here is a link to some subadult photos by Nick Dunlop:

https://www.nickdunlop.com/Image-Galleries/Falcons/Peregrines/Sub-Adults

6. In some situations, reduced rates of reproduction (rather than survival) can be the main factor in the loss of a floater buffer, as was the case with DDT. Monitoring trends in annual nest success—the presence of large young in the eyrie—is normally part of an overall monitoring scheme, but obtaining such information is not a focus of this streamlined protocol. Even so, I recommend the recording of such information, and any other notable observations that might pertain to the welfare of territory occupants, e.g., local hazards. Peregrines are famously enjoyable to watch at their eyries, and I suspect that most people will return for verification of reproductive success, including fledgling counts. But <u>let's not forget to age the breeders</u>.

INTERPRETING THE DATA

1. Healthy peregrine populations typically display few, if any, subadult pair members because floaters (adults without territories) quickly replace dead breeders. So, if the overall frequency of subadult territory-holders in a fairly large sample of territories is, say, 3% or less per sex, then all is apparently well (see Zabala and Zuberogoitia 2014).

2. An increasing trend in subadult pair membership suggests weakness (or nonexistence) in the floater buffer because some widespread factor has reduced survival or reproduction (but see Item 7, below). The assumption, of course, is that yearling peregrines are no match for older, more experienced individuals competing for territories. A robust floater buffer can prevent subadults from occupying territories altogether, and that is the normal situation in a healthy population.

3. Subadult females are far more likely to hold breeding territories than males, although both sexes can do so and even reproduce. The reason concerns the role of each sex during most of the breeding season: the male forages while the female stays home and defends, along with all her other duties. That is why females are larger (see Schoenjahn et al. 2020). A yearling male might be far less capable of provisioning a female and her family, and she may not accept him (see Millsap et al. 2019).

4. If subadults are free to occupy territories, the fraction of subadult females holding them might, at least theoretically, approach the annual mortality rate of female breeders. But even so, we are not looking for a big proportion; and remember that subadults are subadults for only one year. Finding that, say, ~8% or more of female territory holders are subadults would suggest that something is amiss—a signal to further investigate (see Ferrer et al. 2003).

5. Subadults may occasionally obtain territories even in stable populations, especially in places where there are sudden breeder deaths unrelated to territorial fighting. There may, for example, be a nearby, uninsulated power-distribution line, or in urban environments, adults may die from random encounters with windows, wires, cars, and other hazards, including electrocution. These sudden vacancies, occasionally filled by subadults, tend to occur locally and do not necessarily reflect the age structure of the larger population.

6. Vacant, long-established territories are worrisome, especially a rising interannual trend without seeing mixed pairs (adult with subadult) or lone individuals in the interim; this is why territories are ideally monitored every year. An array of abruptly vacant territories might conceivably reflect a food problem, and the specter of drought comes to mind. But there are other contingencies to consider, and the one at the heart of this year's need for information is HPAI. The virus could quite suddenly yield a vacancy by killing both pair members simultaneously. Imagine a male delivering an infected bird to his mate who then feeds it to her young; the aftermath is almost certainly a vacant territory, at least temporarily. Or imagine both members of an arctic migrant pair dying during migration or winter. Under normal circumstances, floaters would settle the territory, and nothing would be out of the ordinary. But if the floater buffer has silently diminished, the territory might require an adult male to reactivate.

7. Remember that subadults can also occupy territories in an actively increasing population—for example, during the post-DDT recovery period when floater pools had not yet materialized (see Tordoff and Redig 1997). This is another reason to choose a sample of known, regularly occupied territories, and to share results within the larger geographical context.

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SUBADULT PEREGRINE OCCUPANCY MONITORING FIELD FORM

_______________________	____________	______	______
Territory Name	Date (M/D/Y)	Start obs.	End

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Territory Location (general or specific)

Substrate (circle one): Natural Man-made Describe____________________________

Reporter _______________________Email/Cell____________________________________

Observers ____

Territory-holders (circle one): Photo(s) available? Yes No

adult pair	single adult male
adult male/subadult female	single adult female
subadult male/adult female	single adult (unknown sex)
subadult pair	territory vacant

Confidence in the above choice: Confident Unsure (If unsure, revisit the site)
If "vacant" is circled, do you suspect an alternate nest site? Yes No Unsure

Breeding behavior (circle those observed):

None	Eyrie visits	Inc. exchange
Undetermined	Copulation	Prey delivery
Courtship	Food exchange	Feeding nestlings
Defense	Incubating	Other___

Nesting Phase:

None	Egg-laying	Nestlings (#__)
Unknown	Incubation	Fledglings (#__)
Pre-nesting	Egg failure	Young flying
Courtship	Re-nesting	Failed (discuss)

Vocalizations: Ee-chupping Wailing Chittering Cacking
Floater (i.e., adult) incursion(s)? YES NO If yes, describe: ____________________________

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NOTES: Write anything appropriate (use back of sheet if necessary)