

# Satellite Tagging of Golden Eagles in Scotland: Revealing Illegal Persecution

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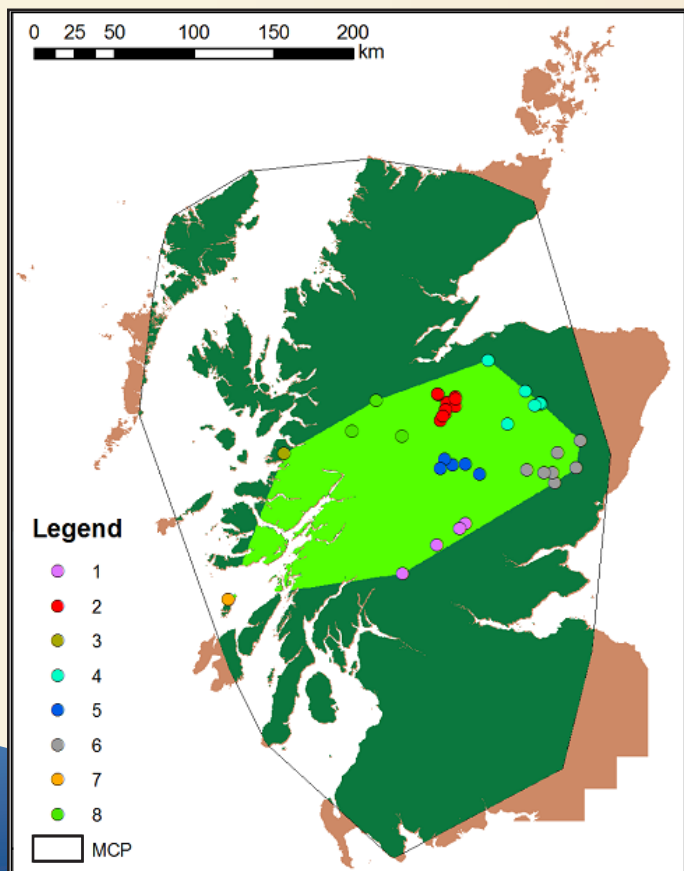


As documented by the late Jeff Watson's seminal monograph, the golden eagle (*Aquila chrysaetos*) has an extensive Holarctic distribution and has consequently received much research attention. In Scotland, Jeff's home, we and others have been satellite tagging golden eagles since 2004 to examine and illuminate many aspects of their behavior and ecology that could not be discovered by other methods. Up to mid-January 2017, 131 young eagles had been tagged as large nestlings to study their post-fledging dependency period, subsequent dispersal from natal territories and, hopefully, their settlement on a breeding territory.

Whilst researching these objectives, it was noticed that several tagged young eagles 'disappeared' suddenly in apparently concentrated locations. All transmissions had stopped, without prior warning signs of failure from tag engineering data, and searches at the last known locations failed to find any sign of birds or tags. This was unlike the end fate of several other tags where a dropped tag or a dead bird had been recovered on a search around the final fix location. Or, from transmitted data, showing a tag had likely reached its inherent lifespan or had prematurely stopped transmitting because of, notably, a terminal irrecoverable drain on the battery.

The suspicion of human intervention led the Scottish Government to commission analyses to investigate the final locations of these 'stop-no-malfunction' tag fates. The commission addressed a basic question: is there a pattern of suspicious activity surrounding the 'disappearance' of many satellite-tagged golden eagles?

Subsidiary analyses were required to investigate this question thoroughly. This involved examining over half a million location records and other data provided from over 13 years' tagging data. We made several independent checks on the tags' engineering data to ensure we had not inappropriately classified tags as having 'failed' unexpectedly because some transmitted sign of imminent failure was missed. This included forwarding engineering data to MTI experts. This was a 'blind' test since our own separate conclusions were not forwarded to MTI. All our checks agreed.



*As well as many suspicious tag fates, a handful of illegally killed tagged birds were recovered. This bird had been poisoned. Photo by Ewan Weston*

A simple cluster analysis revealed that final fixes from most 'stop-no-malfunction' tags were usually clustered. More sophisticated distance-based analyses randomly sampled 'virtual final fixes' and showed that 'suspicious' (mostly 'stop-no-malfunction') end points were closely associated at several spatial scales and significantly different to random expectations. Moreover, and importantly, repeating this analysis with the final fixes of 'non-suspicious' tags (e.g., natural deaths, dropped tags, failed tags, still-transmitting) found no difference from random expectations.

Hence, there was a pattern of suspicious activity surrounding the 'disappearance' of many satellite-tagged golden eagles. Alarming, such suspicious disappearances amounted to almost a third of our tagged birds (41 of 131). Such disappearances when equated to fatalities have a demonstrably marked detrimental

effect on golden eagle population dynamics and in reducing the capacity for a population to be in favourable conservation status.

We found no evidence that tagging caused physical, behavioural, or demographic problems. Notably, the survival of tagged birds with non-suspicious fates was high compared to other studies. Inherent tag reliability was also extremely high and no different to other researchers' findings. Our most frequently used tags were MTI GPS PTT models which had a similarly low malfunction rate to a large sample from the USA – only 2%. Our 'stop-no-malfunction' rate was 25 times higher than the USA sample. 'Suspicious' tags on Scottish golden eagles unusually, also suddenly, ceased transmitting well before their expected manufactured longevity.

Several lines of evidence indicated that many tagged young eagles were killed, and their tags and bodies removed and destroyed before discovery. The killing of tagged birds was concentrated in four parts of the Highlands of Scotland. The final locations of the suspicious final fixes were also significantly associated with the locations of confirmed illegal persecution records from an independent dataset.

Wind farms were examined as a source of potential lethality through collision with turbine blades. No dead golden eagles or any suspicious final fixes were near a wind farm, and only a tiny proportion of location records were near a wind farm; young golden eagles appeared to actively avoid wind farms.

The analytical finger for those largely responsible for illegally killing the tagged golden eagles pointed to people managing some moors for driven shooting of red grouse (*Lagopus lagopus scoticus*). Golden eagles eat red grouse and can disrupt the shooting of these gamebirds which are 'driven' by beaters across moors to be shot in large numbers by clients stationed in set locations or 'butts'. This is a practice unique to Scotland and England and requires intensive management of large tracts of uplands to generate the required high densities of grouse. Previous research highlighted managers of grouse moors to be persecutors of golden eagles in Scotland on a wider scale. The golden eagle continues to be absent from the grouse moors of England.

*Left: Cluster map of the final locations of the potentially and known suspicious tag fates. The dark green area shows the minimum convex polygon (MCP) enclosing all tag location records and the light green polygon shows the MCP enclosing the final locations of the potentially and known suspicious tag fates.*