

Crimes against raptors in Wales 1990-2019

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Crynodeb

Cyhaeddodd poblogaeth nythu nifer o rywogaethau o adar rheibus eu hisafbwynt yng Nghymru rhwng 1850 a 1950 oherwydd effaith pobl mewn tri modd uniongyrchol (i) erlid (megis saethu, trapio a difa nythod), (ii) dwyn wyau a (iii) dwyn cywion o nythod. Arweiniodd hyn at ddiflaniad dros dro rhai rhywogaethau ac effaith negyddol arwyddocaol ar ddosbarthiad a phoblogaeth eraill. Mae niferoedd y rhan fwyaf o rywogaethau yn awr yn cynyddu. Yn y papur yma, ceir crynodeb o ddigwyddiadau o'r math yma wedi eu cadarnhau a gasglwyd gan RSPB dros dri degawd (1990-99, 2000-09 a 2010-19). Mae dwyn wyau a chywion bron wedi dod i ben er 2010 a'r nifer o achosion o erlid wedi bod yn is er 2000 nag oedd yn y 1990au. Fodd bynnag, nid yw'r gostyngiad wedi parhau, ac mae'r nifer o achosion o gamddefnydd plaladdwyr/gwenwyn yn uwch yn y degawd diwethaf nag yn ystod y ddau flaenorol. Nid yw'r gostyngiad mewn erlid yn gyson ar draws pob rhan o Gymru. Cawsom fod perthynas gref rhwng y nifer o achosion o erlid adar rheibus mewn sgwariau 10-km a phresenoldeb tir a reolir ar gyfer saethu gyredig Ffesant *Phasianus colchicus*, Petrisen Goesgoch *Alectoris rufa* a Grugiar Goch *Lagopus lagopus*. Trafodir effaith erlid ar faint poblogaeth ac ar ddosbarthiad adar rheibus yng Nghymru.

Abstract

The breeding populations of many raptor species in Wales reached low points between 1850 and 1950 as a result of three direct forms of human impact: (i) persecution (such as shooting, trapping and nest destruction), (ii) the theft of eggs and (iii) the removal of chicks from nests. These activities led to the temporary eradication of some species and significant negative impacts on distribution and populations of others. Most species are now in recovery. This paper summarises confirmed incidents of these activities collected by the RSPB over three decades (1990-99, 2000-09 and 2010-19). The number of egg- and chick-thefts recorded has almost ceased since 2010 and the number of persecution incidents has been lower since 2000 than in the 1990s. However, the decreasing trend has not continued and the number of incidents involving the abuse of pesticides/poisons was highest in the most recent decade of the three reviewed. The rate of reduction in persecution is not uniform across all parts of Wales. We found a strong association between the occurrence of raptor persecution events in 10-km squares and the presence of land managed for driven shooting of Pheasant *Phasianus colchicus*, Red-legged Partridge *Alectoris rufa* and Red Grouse *Lagopus lagopus*. The role of persecution on population size and distribution of raptors in Wales is discussed.

Introduction

Populations of raptors in Britain were greatly reduced during the 19th century and recovered slowly during the 20th century. Goshawk *Accipiter gentilis*, Honey-buzzard *Pernis apivorus*, Marsh Harrier *Circus aeruginosus* and Montagu's Harrier *Circus pygargus* were extirpated from Wales prior to 1900 and Hen Harrier *Circus cyaneus* ceased to breed regularly during 1910-58. These populations recovered subsequently, although the return of Goshawk was reliant on introductions from captive stock (Kenward 2006) and the return of Montagu's Harriers proved to be localised and short-lived (Pritchard *et al.* 2021).

The major driver of these losses was human interference, designed to increase productivity from livestock and game-management, to obtain birds for falconry and to satisfy demand for the collection of eggs and skins. The scale of destruction in some parts of Wales is evident from records kept by gamekeepers, such as those on Penrhyn Estate, between Penmachno and Dolwyddelan in Caernarfonshire, who killed 1,988 Kestrels *Falco tinnunculus*, 735 Sparrowhawks *Accipiter nisus*, 228 Merlins *Falco columbarius* and 135 Buzzards *Buteo buteo* during 1874-1902 (Lovegrove 2007). In addition, rare birds – including several raptor species – were targeted for taxidermy and by egg-collectors, and birds of several species were removed from the wild for falconry purposes. For example, 21 of the 89 known Red Kite *Milvus milvus* nesting attempts in Wales during 1900-47 were robbed (24%), and the annual rate of loss remained high (12%) during 1948-59. This contributed to the species' near-extinction from Wales, and the slow rate of its recovery (Lovegrove *et al.* 1990).

Legislation to protect birds was introduced progressively from the late 19th century. The Wild Birds Protection Act 1896 gave powers to County Councils to protect birds, their eggs and specific habitats but local government resources were rarely available to enforce this protection even where Orders were introduced. The Protection of Animals Act 1911 was the first legislation aimed at protecting birds of prey, making it illegal to use poisons and poisoned baits in situations that put wild birds at risk of harm. The Protection of Birds Act 1954 made it illegal, for the first time, to kill or injure (most) wild birds, their nests and eggs, although protection for Sparrowhawk was only added in 1962.

The Wildlife and Countryside Act 1981 remains the backbone of wild bird legislation in Britain, initially implementing the European Union 'Birds Directive'. It secured more complete protection for all wild birds across Britain, introduced special protection measures for a select group of species, including 12 breeding raptor species and Barn Owl *Tyto alba*. It also required Special Protection Areas to be designated and managed for some species, including Short-eared Owl *Asio flammeus* and seven diurnal raptor species that breed regularly in Wales.

In the last 40 years, additional legislation has increased the penalties available to the judiciary, including custodial prison sentences. Increased penalties and improved enforcement, as well as changing social attitudes, led to an unmeasured reduction in the collecting of eggs and birds being killed for taxidermy. However, illegal persecution continues to be the most severe constraint on the populations of some raptors in Britain, notably Golden Eagle *Aquila chrysaetos* (Whitfield *et al.* 2008) and Hen Harrier (Murgatroyd *et al.* 2019).

Earlier reviews recorded approximately 48 raptors shot and four trapped in Wales during 1971-87 (Cadbury *et al.* 1988) and 70 poisoning incidents (Cadbury 1992) during 1979-90, although it is unclear whether consistent criteria were used to confirm incidents. Public awareness of illegal killing and the investigation of incidents by police and government agriculture departments were almost certainly lower during that period than subsequently, improvements to both having occurred as a result of campaigning and advocacy by the RSPB and others. Tackling raptor persecution is one of UK Government's seven wildlife crime priorities. The Raptor Persecution Priority Delivery Group (RPPDG) was established in 2009 and includes a range of statutory and non-statutory agencies (nwcu.police.uk/how-do-we-prioritise).

The purpose of this analysis is to assess how the number of detected incidents of persecution, egg- and chick-theft has changed across Wales, spatially and temporally, over the last three decades.

Method

Collation of data

Data were collated from the most complete central dataset on offences against wild bird legislation in the UK, held by the RSPB, which focuses primarily on species of conservation concern. Information about potential crimes against birds comes from numerous sources, including members of the public, police forces, National Wildlife Crime Unit (NWCU), Welsh Government, Chemicals Regulations Directorate (CRD), Raptor Study Group fieldworkers, the RSPCA, The Zoological Society of London, Predatory Bird Monitoring Scheme, Food and Environment Research Agency (FERA) Science Ltd, and veterinary practices, in addition to incidents detected by RSPB field staff.

Information is recorded consistently and rigorously by the RSPB Investigations Team, a specialist unit that assists statutory agencies with the investigation and prosecution of crimes against wild birds. The team includes specialist officers with investigative (field-based) and intelligence (office-based) capability. The RSPB has been recording wildlife crime consistently for several decades, the results of which are published in an annual Birdcrime report (e.g. RSPB 2020). Confirmed raptor persecution incidents are also available via the RSPB's Raptor Persecution Map Hub (rspb.org.uk/raptormap).

We categorised the data under three broad headings: persecution, egg-theft (collecting), and egg-or chick theft (falconry). Annual records for incidents in Wales do not provide a clear trend, so we have treated the data in ten-year time series.

The data, commonly referred to as 'incidents of bird crime', are categorised by the RSPB based on certainty:

Confirmed: incidents typically substantiated by evidence such as post-mortem or toxicological analysis, or reliable eyewitness evidence. High confidence that the incident occurred (95% certainty and above).

Probable: circumstances indicate that the most likely explanation is that an illegal act has taken place. Medium confidence (50%-95%) that the incident occurred.

Unconfirmed: circumstances indicate that an illegal act has possibly taken place. Lower confidence (<50%) that the incident occurred.

For this review, only confirmed incidents were used due to their high evidential weighting; 'probable' or 'unconfirmed' incidents were excluded. For each incident, we collated details of the incident type, date, Ordnance Survey 10-km square, local authority and police force area, the numbers and species of bird involved and, for incidents of poisoning or the possession of poison, the type involved and/or the bait onto which it had been placed. The data extracted did not include any personal information or information relating to any subsequent investigation.

Incident categories are assigned by RSPB Investigations staff, who assess all the evidence and intelligence around an incident and record the data according to the strongest evidence. Most incidents of shooting or trapping of a bird, for example, involve a single dead or injured raptor, but circumstances will determine how other incident types are recorded. There can, for example, be multiple offences and victims of more than one species within one incident.

Persecution

Raptor persecution involves incidents relating to the illegal killing of raptors, the use or possession of traps, poisons and other items to target raptors, and attempts to commit such offences. This includes circumstances where raptors may not have been the intended target but were vulnerable to the offence committed (e.g. laying out a poisoned Rabbit *Oryctolagus cuniculus* bait for a Fox

Vulpes vulpes). The motivation for killing, or attempting to kill, raptors is normally associated with: desire to prevent or reduce predation of other animals valued by a sector of society. The primary conflict in the UK relates to land managed for gamebird shooting, but protection of livestock and domestic (racing) pigeons *Columba livia* is also relevant.

For simplicity, in this paper we refer to ‘poisoning’ as the abuse of pesticides or other substances, such as veterinary products. It does not include incidents of secondary poisoning typically associated with the use of rodenticides. Toxicology results from Welsh Government’s Wildlife Incident Investigation Scheme (WIIS) form the primary source of wildlife poisoning data. Exceptionally, toxicology results may be obtained *via* private analysis where victims or baits have not been accepted for analysis by the government scheme.

Poisoning incidents are counted as separate where a bait/victim or group of baits/victims are found on a different date; found sufficiently far apart to be represented by a different six-figure grid reference; or found at the same grid reference and on the same date but in circumstances that otherwise separate them (for example, if a very decomposed victim is found beside a fresh bait, the bait could not have been responsible for its death).

A bait confirmed to contain a poisonous substance may have affected no birds, a single bird or multiple individuals (and/or scavenging species of mammal or even a pet dog). Equally, a dead raptor confirmed to contain poison may represent the minimum affected by a bait, with other victims not discovered. The poisoning incidents classed as confirmed are where toxicology results, along with other information and intelligence, meet the evidential weighting of 95% confidence that raptors were victims, targeted or vulnerable.

Temporal changes in the number and type of persecution incidents, as well as the species affected, were examined by calculating these separately for each of the three decades (1990-99, 2000-09, 2010-19). Spatial patterns of persecution were assessed by calculating the number of persecution incidents in each decade for each (i) vice-county and (ii) British National Grid 10-km square. Finally, we examined whether there was any evidence of an association between the spatial distribution of persecution incidents and gamebird shooting. This was done using logistic regression to model the presence/absence of persecution events in 10-km grid squares as a function of whether there was also land managed for gamebird shooting in those squares. Information on the presence of shoots within 10-km squares was derived from the gunsonpegs.com website (retrieved January 2021), with shoots filtered to only include those where the quarry was Pheasant, Red-legged Partridge and Red Grouse driven towards guns. As only recent information was available for the spatial distribution of gamebird shoots, we restricted the analysis of persecution events to those in the most recent decade, 2010-19. Current shoot locations are not necessarily expected to be representative of those in the earlier decades considered by this study.

Egg-theft (collecting)

Unlike reports of persecution, egg-collecting data are frequently sourced from field studies and/or the subsequent discovery of eggs in a collection accompanied by data detailing dates and locations of the theft. Thus, it can be many years before thefts of clutches come to light; and some never will. Eggs taken for collections are normally at early stages of incubation when the eggshells are in better condition and the living contents are easier to remove (‘blow’). These are distinguished from egg-thefts for falconry in the analysis.

Egg- and chick-theft (falconry)

Nests robbed for falconry (most commonly Peregrine *Falco peregrinus*, Goshawk and Sparrowhawk) generally involve the theft of eggs at an advanced stage of incubation, which are more likely to be viable for hatching. It can also involve the removal of young chicks of a suitable size to be fitted with closed leg rings. Field data on nest site failure will often allow an assessment of the motive for targeting the nest site.

Results

Persecution

During 1990-2019, 274 confirmed incidents were detected in Wales where a bird of prey was killed or was the target of persecution. The annual total has varied greatly, from just one in 2015 to 25 each in 1995 and 1996. The number of raptor persecution incidents was highest in the 1990s (n=133), which accounted for 49% of the total over the last 30 years. However, there was little difference in the number of confirmed incidents in 2000-09 (n=69) compared to 2010-19 (n=72; fig.1).

The nature of offences has changed substantially over this period (fig.2). Most notably, the proportion of incidents involving poisons has more than doubled, from 34% of the total in 1990-99 to 72% in 2010-19. Despite the overall reduction in raptor persecution incidents detected between those periods, the number of poisoning incidents was higher in 2010-19 (n=52) than in each of the previous two decades (n=43, 39).

The proportion of incidents that involved shooting fell slightly between 1990-99 and 2010-19 and the other types of incident reduced more substantially. In the most recent decade, there were only single incidents involving illegal pole/spring trapping, the illegal use of another trap, nest destruction, and of a person found to be in possession of items capable of being used to commit an offence.

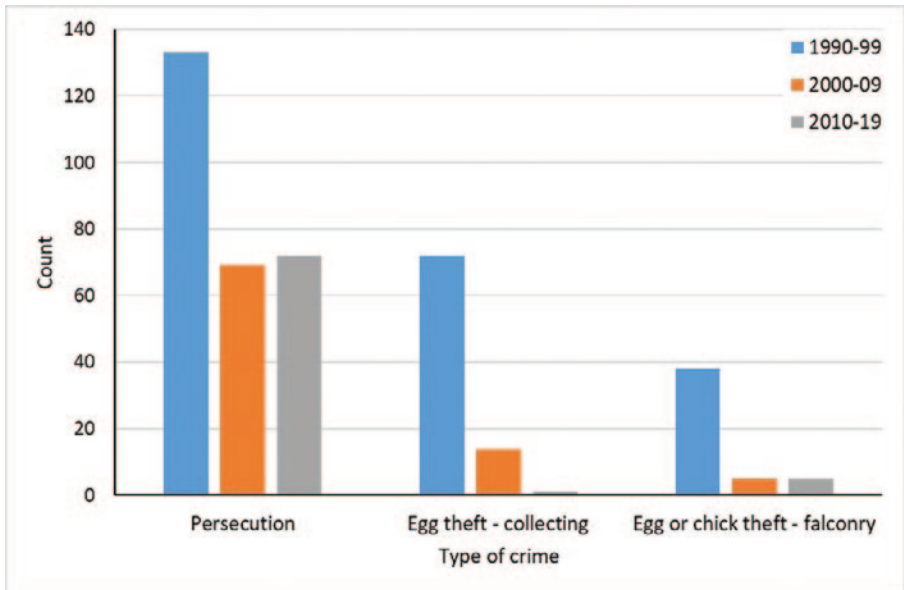


Figure 1. Confirmed incidents of raptor crime in Wales, 1990-2019.

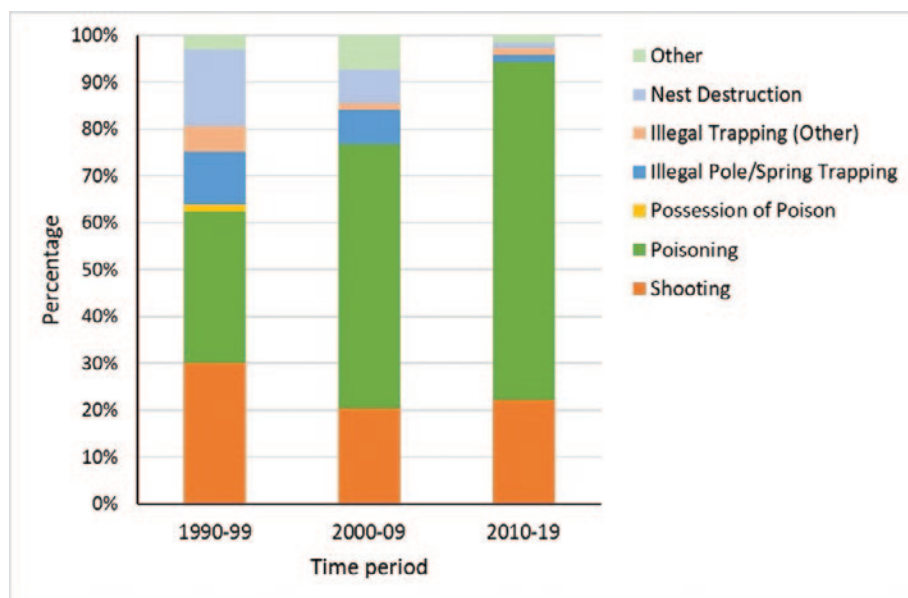


Figure 2. Proportion of confirmed incidents of raptor persecution in Wales assigned by incident type, 1990-2019.

In those incidents ($n=184$) where it was possible to identify a bird of prey victim of persecution, there was a total of 232 victims. Of these, Peregrine ($n=79$), Buzzard ($n=71$) and Red Kite ($n=52$) accounted for 87% of the total (fig.3). There were an additional 90 incidents where raptors were targeted but no dead birds were found, or where the precise number could not be determined (e.g. destruction of a nest where the number of eggs/chicks destroyed was not known, or where a pole trap was set and no victim was found). The reduction in the number of victims over time was greatest for Peregrine, whereas the number of Buzzards was similar in each decade and the numbers of Red Kites fluctuated. The number of incidents assigned to unknown species reduced to a lesser degree, consistent with the relative increase in the number of poisoning incidents, in which victims are frequently not found.

There were 22 types of pesticide or poison used to kill or target raptors in Wales during 1990-2019. In combination, there were 145 instances of a poison being used (fig.4), in 136 incidents. During the 1990s, fenthion (an organothiophosphate insecticide) was the most frequently abused substance, associated with baits used illegally to protect lambs from foxes and crows (RSPB 1990); fenthion accounted for 30% of confirmed poisoning incidents in that decade. During 2000-09, the compound most frequently abused was alphachloralose (a rodenticide), which accounted for 36% of incidents during that decade. Bendiocarb (a carbamate insecticide) was the most frequently encountered pesticide in 2010-19, involved in 50% of incidents, and was numerically the most significant during the 30-year review period. Bendiocarb featured in 23% of all poisoning incidents in Wales over the 30 years, and its abuse has increased significantly across Britain since 2010.

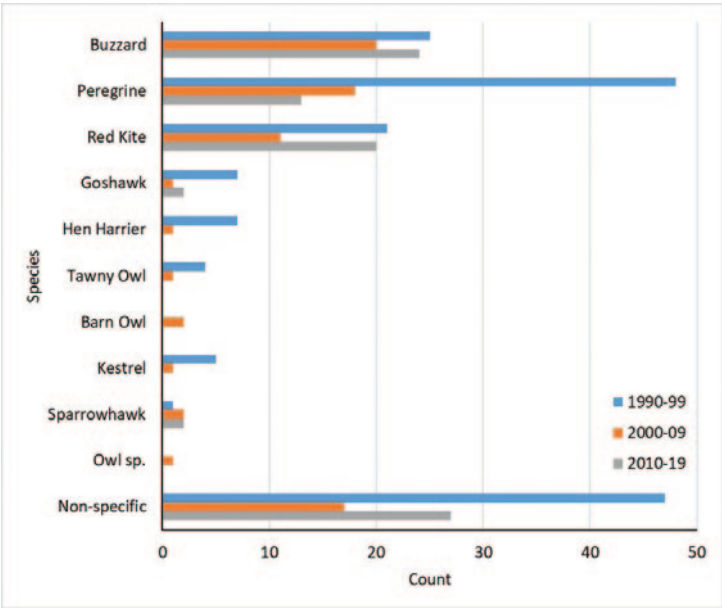


Figure 3. ‘Count’ is the number of persecution victims by species (where known) and the number of “non-specific” incidents where no victims found or where victim number is not known, 1990-2019.

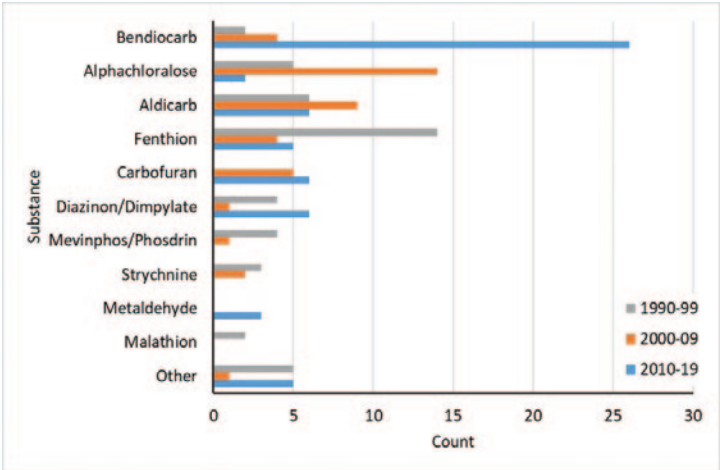


Figure 4. Substance analysis results in confirmed raptor persecution poison/pesticide abuse incidents recorded in Wales, 1990-2019. Some incidents involve multiple substances, so these figures are higher than total number of poisoning incidents. ‘Other’ comprises Brodifacoum (1), Benfuracarb (1), Carbaryl (1), Carbosulfan (1), Isofenphos (1), Methomyl (1), Endrin (1), Phosmet (1), Propetamphos (2), Oxamyl (1) and an anaesthetic used for dehorning cattle (1).

The number of confirmed persecution incidents was, across Wales, lower in the third decade of the study than the first, but the change was not uniform across the country (fig.5). During 1990-99, in order of magnitude, the vice-counties with the highest levels of raptor persecution were Denbighshire, Ceredigion, Montgomeryshire and Meirionnydd; together these four counties accounted for 51% of the total. Persecution levels in all four counties fell during the following two decades, and in 2010-19 those counties accounted collectively for 33% of the total. The change in areas that formerly had high rates of persecution has driven the reduction across Wales.

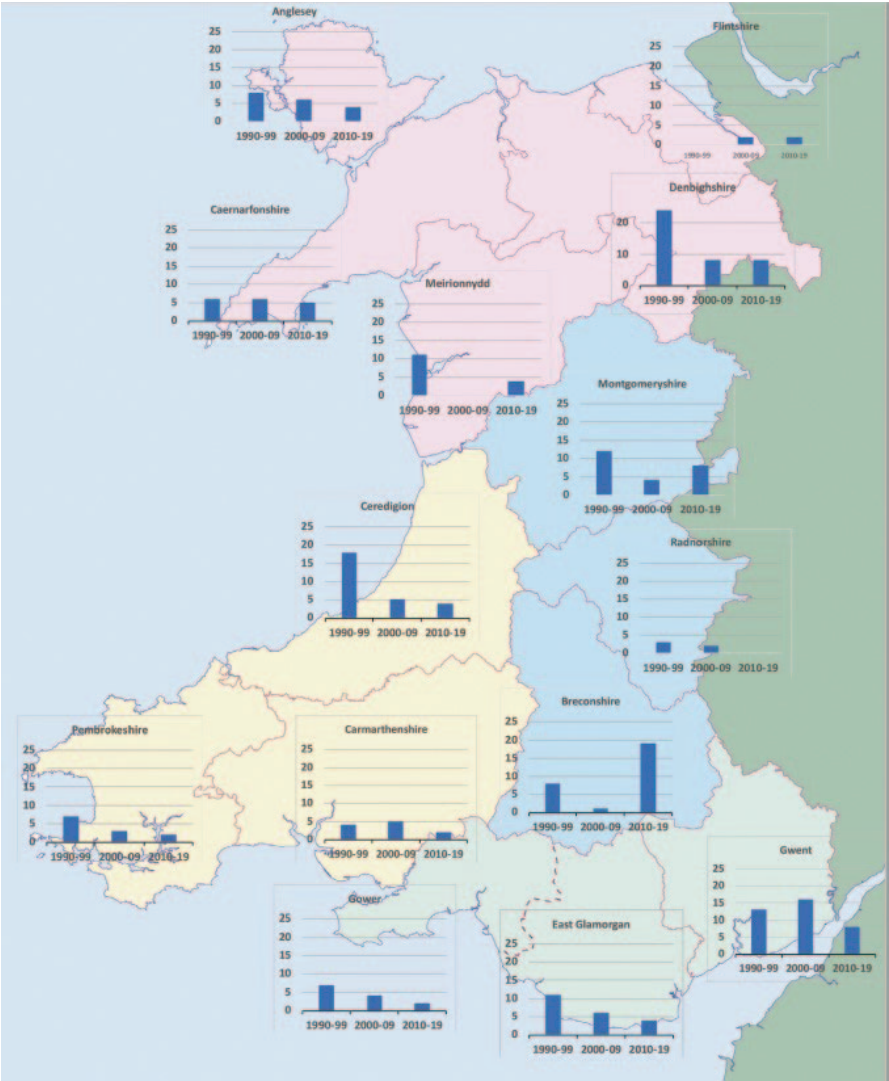


Figure 5. Number of confirmed raptor persecution incidents in Wales by vice-county, 1990-2019.

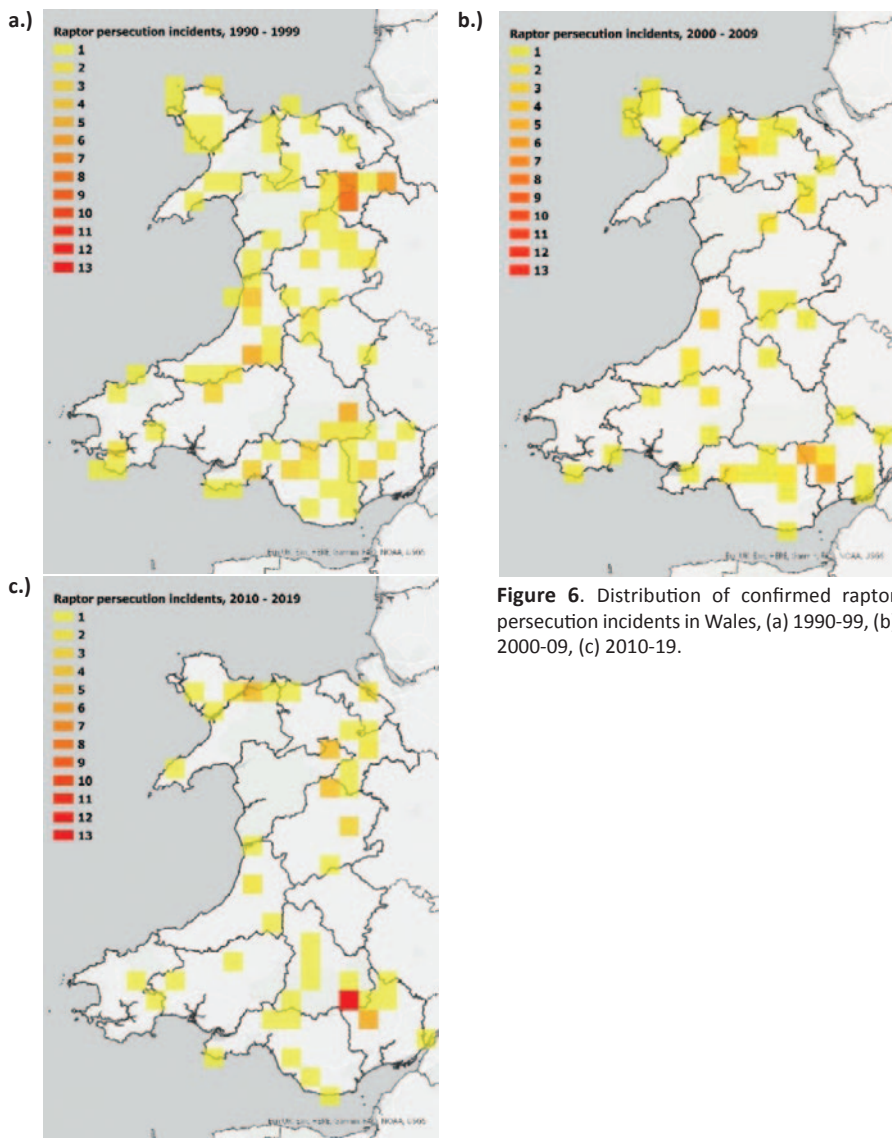


Figure 6. Distribution of confirmed raptor persecution incidents in Wales, (a) 1990-99, (b) 2000-09, (c) 2010-19.

Notable as the only county where an increase occurred over the three decades is Breconshire, where there were eight confirmed incidents in 1990-99 and 19 in 2010-19. Of those 19 incidents, 13 were in one area during 2012/13, which involved the discovery of seven Pheasants used as baits containing Bendiocarb, and five dead Red Kites and eight Buzzards that also contained Bendiocarb. This series of incidents resulted in SO11, centred on the Glanusk Estate, being the area with the worst record for illegal raptor persecution in Wales during the 30-year period. The areas with the next highest concentrations of confirmed incidents were the 10-km squares SJ13 (n=11) around Llanarmon Dyffryn

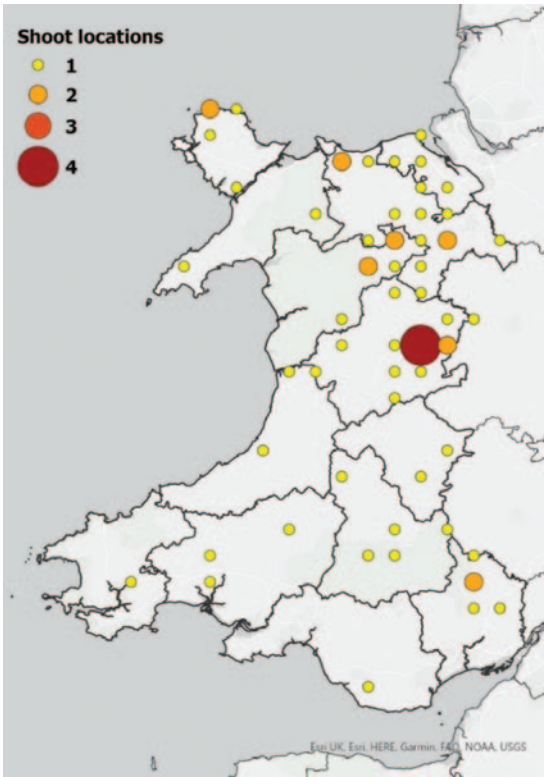


Figure 7. Distribution of ‘commercial’ shoots of Pheasant, Red-legged Partridge and Red Grouse by 10-km square, defined as those that sold shooting days on the website gunsonpegs.com in January 2021.

Ceiriog, Denbighshire, the adjacent SJ14 (n=8) around Llangollen, Denbighshire, and ST29 (n=8) west of Cwmbran, Gwent.

The spatial distribution of persecution incidents (fig.6) shows that raptor persecution has become less widespread over time, although importantly the rates of detection in each area are not known. In the latter decade of the study period (2010-19), there was a strong association between the occurrence of persecution events in 10-km squares and the presence of land managed for game shooting (fig.7) (logistic regression: est. = 1.40, s.e. = 0.365, $p = 0.0001$). The predicted probability of a persecution event occurring in a 10-km square during this period (fig.8) was three times higher in squares with game shoots (0.31, 95% CIs: 0.202-0.442) than those without (0.10, 95% CIs: 0.067-0.145).

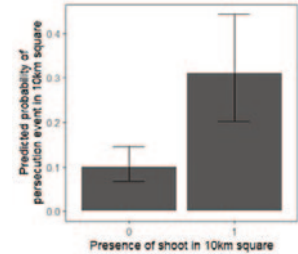


Figure 8. Predicted probability of a persecution event occurring in a 10-km square without driven gamebird shooting (0) and with driven gamebird shooting (1), based on data shown in figs 6c and 7.

Egg-theft (collecting)

There were 144 incidents of thefts (or attempts to take eggs) from nests in Wales recorded on the RSPB database during 1990-2019, of which 87 involved nests of birds of prey. Notably, of the remainder, 36 were thefts of clutches from Chough *Pyrhhorcorax pyrrhhorcorax* nests between 1991 and 2008.

The 87 incidents involving birds of prey include two where it is uncertain whether it was eggs or chicks that were removed from Peregrine nests, and one unsuccessful attempt to take eggs from a Red Kite nest. The vast majority (83%) of incidents occurred during 1990-99, and there was only a single known egg-theft in the third decade of the review, a clutch of three Red Kite eggs taken in 2010 (fig.1).

Peregrine (51%) and Red Kite (38%) are the two species most targeted by egg-collectors, with Goshawk (9%) being the only other species for which multiple egg-theft was recorded (fig.9). Nest locations were known for 85 incidents, which occurred in all vice-counties except Gower, Pembrokeshire and Meirionnydd (fig.10). The counties with the greatest number of incidents were Ceredigion (25% of known locations), Caernarfonshire (15%) and Denbighshire (14%). The species targeted within each county reflect the strongholds of each species at the time. For example, 28 of the 33 Red Kite nests targeted were in Ceredigion, Breconshire and Radnorshire, which were the core counties for the species' presence during the 1990s (Gibbons *et al.* 1993). Peregrine distribution was more widespread than Red Kite, but nests in North Wales suffered higher levels of detected theft: 29 of the 45 (64%) incidents occurred in Caernarfonshire, Anglesey and Denbighshire, counties that held 26% of the population in 1991 (Williams 2018). It is evident that some nest sites were targeted repeatedly. Twelve Peregrine territories lost clutches in more than one year, as did seven Red Kite and two Goshawk territories.

Egg- and chick-theft (falconry)

There were 49 incidents of chick or egg thefts from nests in Wales during 1990-2019 where there was strong evidence that the motivation was use or sale into the falconry or aviculture trade. Of these, 48 involved raptors, the other being the removal of three chicks from a Chough nest, in 1997. The pattern over time was similar to that for egg theft, with 79% of the total occurring during 1990-99 (fig.1). Only one incident, involving a Red Kite nest in East Glamorgan in 2019, has been detected since 2010. Peregrines were particularly targeted, accounting for 83% of the total. Unlike egg-collecting, the counties with the highest number of incidents were all in the southeast: 50% of the total was in Gwent, East Glamorgan and Breconshire.

Discussion

We have taken a highly conservative view by using data only on confirmed incidents, which had to pass a high threshold to be included in the analysis. Despite this, it is important to acknowledge that using data of this nature to document temporal and spatial changes in the incidence of persecution comes with challenges and makes certain inherent assumptions.

- (i) The dataset was collected through opportunistic findings by members of the public or RSPB staff.
- (ii) The effort invested to detect persecution events has not been standardised between years or across different regions of Wales, and some of the temporal and spatial patterns found here will reflect this variation in effort.
- (iii) The likelihood of detecting persecution events may have changed over time, and by location. It is possible that individuals perpetrating crimes against raptors have become more adept at hiding the evidence, so that it is less likely to be found and reported by members of the public. Our experience is that where there is sufficient evidence for the police to obtain a search warrant, this

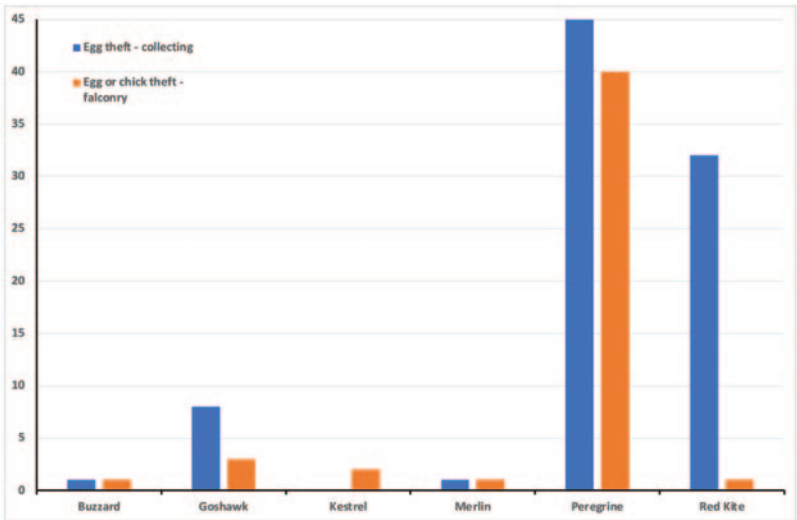


Figure 9. Birds of prey nests from which eggs and chicks were taken, by species, 1990-2019. Categorisation based on evidence described in Method. These include one failed attempt and two incidents in which it is uncertain whether eggs or small chicks were removed.

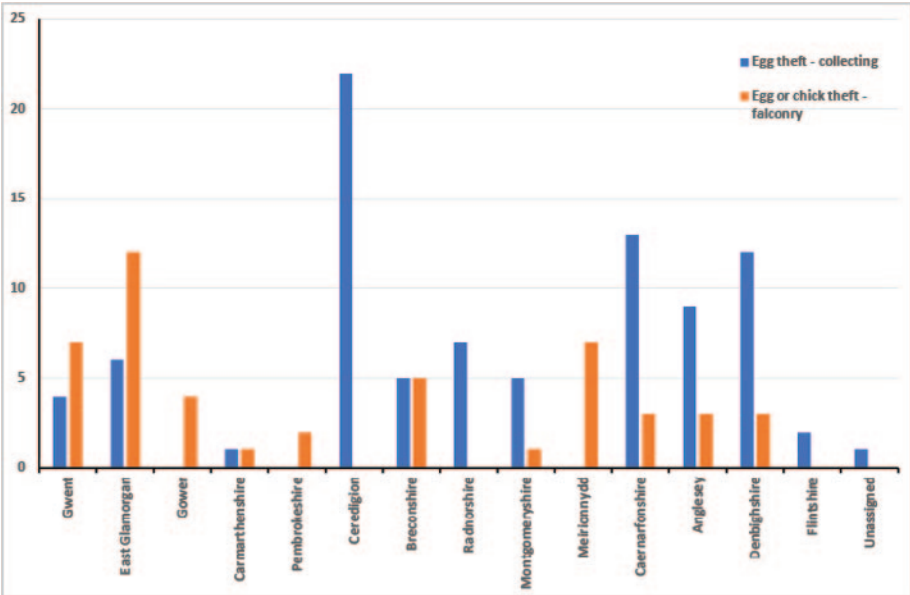


Figure 10. Confirmed egg- and chick-theft incidents involving birds of prey by vice-county, 1990-2019. Categorisation based on evidence described in Method.

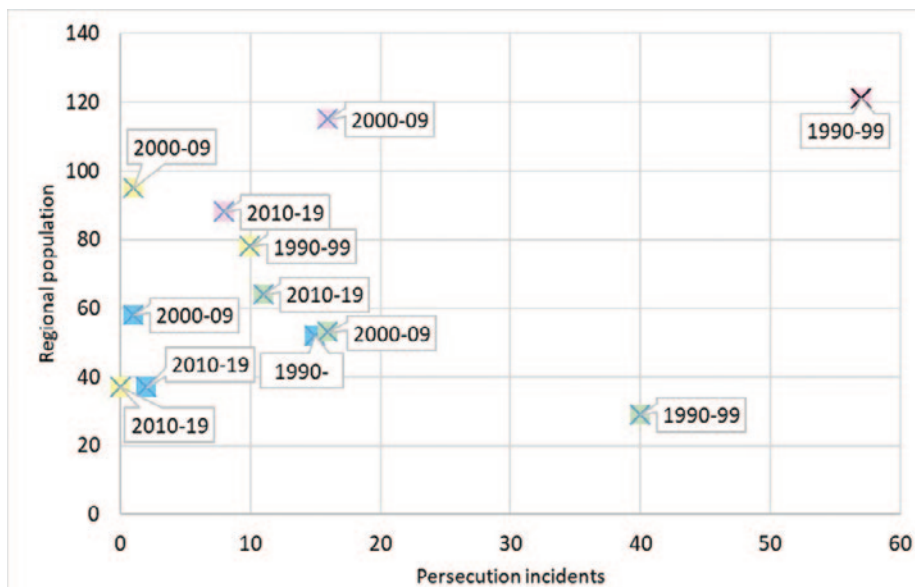


Figure 11. Relationship between incidents of all types involving Peregrine (in 1990-99, 2000-09 and 2010-19) and population estimates in four regions of Wales within each period (1991, 2002 and 2014). Pink = North, Blue = Mid, Yellow = West, Green = South (see fig.5).

results in a localised 'spike' in detected confirmed incidents (illustrated by the Glanusk Estate example above). These caveats should be borne in mind when contemplating the changes documented in this study.

Scale of persecution

Assessing the true scale of illegal persecution is challenging. Reported incidents are frequently described as the 'tip of the iceberg', but while we can measure the size of that 'tip', the number of offences not recorded remains unknown, since offences routinely take place in remote, quiet and private locations. However, long-term raptor monitoring and the use of satellite technology have shown that persecution continues to have a profound impact on numbers, distribution and breeding success of several raptor species in the UK, as illustrated below.

Intelligence received by the RSPB Investigations Team is not always possible to confirm, but includes, for example, reports of extensive persecution of Goshawks around Pheasant pens in South Wales as young raptors disperse from natal sites in mid-summer. Detailed information provided to the RSPB from gamekeepers and others within the shooting community suggest that more raptors are killed, undetected, each year on single 'worst' estates than are detected and confirmed as bird of prey persecution incidents for the entire UK. Based on GS's experience, the annual total of confirmed incidents in the UK is likely to be less than 1% of those taking place.

The poisoning of raptors continues to be of concern, both for the increase in incidence and its indiscriminate nature, as a single bait can kill multiple scavenging species of bird including Red Kite and Buzzard, wild mammals and household pets. The 'poison of choice' has changed by decade: strychnine in the 1980s (Cadbury 1992), fenthion in the 1990s, alphachloralose in the 2000s and

bendiocarb in the 2010s. While the sale and use of the pesticide products most regularly abused to poison raptors have been banned during the last three decades, products remain in circulation for many years and other poisons are available when stocks run out. The most concentrated formulation of bendiocarb was banned in December 2020 but is expected to remain a problem for many years. Effective enforcement of pesticide abuse continues to be necessary and tighter controls on possession of certain pesticides would be welcome.

We found a strong association between the occurrence of raptor persecution events in 10-km squares and the presence of land managed for driven shooting of Pheasant, Red-legged Partridges and Red Grouse. There may be unrelated explanations for this, which is worthy of further investigation. One hypothesis is that shooting interests are complicit in the illegal persecution of birds of prey in Wales, and there is a large body of evidence documenting the role of intensive management for gamebirds in the illegal persecution of raptors in the UK (e.g. Murgatroyd *et al.* 2019). Given the opportunistic way in which persecution events have been recorded, the data are potentially subject to currently unknown temporal and spatial biases, some of which may yield inadvertent associations between persecution events and the presence of shoots (e.g. greater efforts devoted to locating persecuted raptors near gamebird shoots). Quantifying the nature of such biases may allow greater confidence in attributing illegal persecution to shooting interests.

Egg-theft (collecting)

Egg-collecting was formerly a contributory factor to the loss or slow recovery of rare birds. During 1960-89, when the Red Kite population was far smaller than today, 72 clutches were known to have been taken in Wales, equating to 8.5% of all nesting attempts and assessed to have slowed down the rate of population growth by 0.6% each year (Bibby *et al.* 1990). Egg-theft has declined to vanishingly small levels, with no confirmed incidents in Wales since 2010, which reflects a huge reduction evident across the UK. The introduction of custodial sentences in 2001 and the subsequent high-profile imprisonment of several egg collectors seems to have had a dramatic deterrent effect.

Egg- and chick-theft (falconry)

In the 1980s and early 1990s, the taking of eggs and chicks for falconry was a significant problem for Peregrines and Goshawks in Britain. Taken from the wild, birds were reared, declared as 'captive-bred' and laundered into the falconry market. With each bird worth up to £1,000, substantial profits could be made. The RSPB pioneered the use of genetic profiling to challenge captive-breeding crimes (Shorrock 1998), which exposed widespread criminality and numerous individuals were convicted of laundering these two species. The high-profile imprisonment of two falconers for laundering large numbers of Peregrines appeared to have a strong deterrent effect, and taking offences for falconry significantly declined. Since 2000, there has been a huge increase in the sport of falcon-racing in the Middle East, which has increased the demand for raptors. In 2010, a man was intercepted at Birmingham Airport *en route* to Dubai with 14 Peregrine eggs taken from four nests in Wales, and was later jailed for smuggling offences. He reportedly stood to make £5,000 per bird.

Impact on raptor populations

In broad terms, the trends in human interference of raptors in Wales is similar to that across the rest of Europe. Direct mortality by humans on six migratory or partial-migratory raptor species reduced from 39% during 1906-79 to 8% in 1980-2014 (De Pascalis *et al.* 2020). During 1990-2019, the populations of most species listed in fig.3 have generally been stable or declined in Wales.

There has been a significant and welcome recovery in Red Kites in Wales, by 413% since 1995 (Harris *et al.* 2020), although it could have recovered earlier in the absence of persecution and egg-collecting.

In Wales, 20 Red Kites were poisoned during 1971-89 (Lovegrove *et al.* 1990) which, although fewer than in 1990-91, occurred at a time when the population was smaller and less resilient. One might expect, with a larger Red Kite population and increased public awareness, more poisoned birds to be recovered if the impact of pesticide abuse on populations was constant.

The Peregrine population increased from 280 occupied territories in 1991 to 321 in 2002 but subsequently reduced to 279 in 2014 (Williams 2018). There was no obvious relationship in mid- or West Wales between the regional Peregrine population in 1991, 2002 and 2014 and the number of confirmed incidents (of all three types) targeting Peregrines during that decade (fig.11). In North Wales the population fell by 27% between 1991 and 2014 and the number of confirmed incidents detected has fallen by 91%. In South Wales, an increase in Peregrine numbers was concurrent with a reduction in the number of confirmed incidents detected. In 2000-19, of 917 breeding attempts monitored by the South Wales Peregrine Monitoring Group, 697 were successful (76%). Of all attempts, 6.5% (n=46) were attributed to illegal disturbance, most of which were intentional (Colin Richards *in litt.*). The breeding population in the SWPMG study area reduced by 15% during that period, but analysis was unable to assess the impact of human activity on breeding success (Dixon 2006).

Buzzard numbers in Wales declined by 8% during 1995-2019 (Harris *et al.* 2020). Elliott and Avery (1991) showed that illegal persecution of Buzzards was more likely to be reported at the edge of its range, which at the time was restricted largely to the uplands of western Britain. Their study, which pre-dates this review, found that 39 Buzzards were killed illegally in Wales during 1975-87, of which 29 were poisoned, eight shot and five killed by pole-trap. This suggests that illegal persecution had been detected at a similar level in the decade or so preceding 1990-99.

The species whose population is at the greatest risk from illegal persecution in Britain is Hen Harrier, particularly where they nest or hunt on moorland managed for driven grouse-shooting (e.g. Murgatroyd 2019). Hen Harriers re-established as a breeding species in Wales in the 1960s following a half-century absence resulting from persecution. The population increased from 27 pairs in 1989 to 57 pairs in 2010 and then fell back to 32 pairs in 2016 (Wotton *et al.* 2018). Interference with nests in Wales was associated with sites where gamekeepers were employed, but appeared to cease in the late 1990s onwards, concomitant with an increase in both productivity and population abundance (Whitfield and Fielding 2009). During 2017-19, 12 chicks that fledged in North and mid-Wales were fitted with tags, of which 11 died before the following breeding season. Seven were judged to have died of natural causes and the cause of death of another was uncertain. Of the other four, one was almost certainly killed illegally and another two ('Heulwen' and 'Aalin') disappeared in highly suspicious circumstances near Ruabon Mountain, Denbighshire, in 2018 (Pritchard *et al.* 2021). The sample size is small but suggests that illegal persecution contributes to low survival rates of Hen Harriers in Wales in their first year.

Of the other raptor species that have been victims of crime, Goshawk has increased its breeding range, and presumably its numbers, significantly since its re-establishment (Balmer *et al.* 2013). Populations of Sparrowhawk and Kestrel have fallen since 1995, by 22% and 35% respectively in the UK, but no data are available separately for Wales (Harris *et al.* 2020). The proportion of Tawny Owl territories occupied in Wales has fallen from 62% in 1989 to 53% in 2018 (BTO Tawny Owl Point Survey, unpubl. data) and the number of Barn Owls is thought to be stable (Pritchard *et al.* 2021).

Raptor crime-related prosecutions in Wales

Although it did not form part of the analysis, other data from the RSPB show that of 14 convictions

for raptor persecution in Wales relating to this period, six were employed as gamekeepers, two were farmers and one was a builder; of the five for which employment was not known, three were involved in pigeon-racing. There were a further two convictions during this period for the possession of illegally-killed raptors, where the persecution (incident) date and location within Wales are unknown. There were 16 convictions relating to the taking of eggs and chicks in Wales during the period: 12 classed as egg-theft (collecting) and four as egg- and chick-theft (falconry). Nine of the 16 (56%) occurred during 1990-99 and only two convictions were during 2010-19, reflecting the reduction in these types of incidents.

In conclusion, the number of confirmed incidents indicates the virtual cessation of egg- and chick-theft and there has been a welcome decrease in levels of detected illegal persecution across most of Wales. The number of confirmed persecution incidents in Wales is around 10% of the total for Britain over this 30 year period, and has been reducing relative to England and Scotland. Welsh incidents comprised 15% of the UK total in 1990-99, 7% in 2000-09 and 8% in 2010-19. The effort in monitoring nesting raptors and the resources applied to wildlife crime detection in Wales may have varied over time and been lower than in other parts of Britain.

There remains a persistent problem, especially of illegal poisoning, that requires government attention, more coordinated enforcement effort and consideration of new legislation and sanctions. The continued abuse and misuse of pesticides and poisons is worrying, and as populations of several raptor species have declined in Wales over the last 10-25 years, even if for other reasons, the removal of small numbers from their populations may have consequences for their resilience.

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Peregrine with chicks: Chris Gomersall (rspb-images.com)