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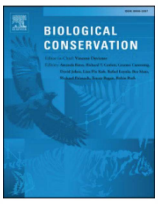

Review

Conservation assessment of raptors within the USA and Canada

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ABSTRACT

Raptors are of global conservation concern and thus country-level assessments of their status are needed. We review studies and conservation databases to determine priorities for raptor conservation within the USA and Canada. We specifically examine databases compiled by the International Union for the Conservation of Nature (IUCN), BirdLife International, Partners in Flight, the Raptor Population Index, state wildlife agencies, and NatureServe. Of the 56 breeding raptor species that IUCN considers to occur within the two countries, the most pressing conservation challenge is the California Condor (*Gymnogyps californianus*). This species is the only North American raptor that is Critically Endangered according to the IUCN, and the only one ranked as Critically Imperiled by NatureServe. Other priority species according to IUCN are the 'Io (*Buteo solitarius*; Near Threatened), the Spotted Owl (*Strix occidentalis*; Near Threatened), and the Snowy Owl (*Bubo scandiacus*; Vulnerable). Fifteen subspecies are listed as Imperiled or Vulnerable by NatureServe, and six of these are listed as either birds of conservation concern or are listed by the USA Endangered Species Act. Priority subspecies include residents of Haida Gwaii (formerly known as the Queen Charlotte Islands) and Puerto Rico, as well as the Northern Spotted Owl (*S. o. caurina*). Some abundant and widespread species are of conservation concern because of ongoing, continent-wide population declines. Vultures are the most abundant raptors in the USA and Canada and are increasing in number. The current status of raptors across the USA and Canada is generally secure, but there are some important conservation priorities.

1. Introduction

Conservation prioritizations are common and essential (Chaplin-Kramer et al., 2021). Resource scarcity forces conservationists to make difficult decisions regarding which taxa and places receive action or protection. Governments are generally responsible for conservation within their borders, so assessments at the national, state, and provincial levels are particularly useful. Conservation prioritizations within political boundaries should therefore be conducted for sensitive groups of species at intervals pertinent to biological and funding cycles.

The group of birds called 'raptors' consists of the orders Accipitriformes, Cariamiformes, Cathartiformes, Falconiformes, and Strigiformes (McClure et al., 2019). This group represents roughly 5 % of all birds, yet has an outsized effect on ecosystem function by regulating prey populations and consuming carrion (Markandya et al., 2008; Buechley and Şekercioğlu, 2016; Donázar et al., 2016). Raptors are of global conservation concern—18 % are threatened with extinction and over half have declining global populations (McClure et al., 2018; Buechley et al., 2019). Further, research attention has been biased among raptors with 10 species accounting for roughly one-third of raptor studies (Buechley et al., 2019). Therefore, prioritization of raptor research and conservation is a global priority.

Although the Global South is justifiably highlighted often as the area of greatest conservation and research need for raptors (McClure et al., 2018; Buechley et al., 2019; Santangeli et al., 2019), priorities outside of the Global South also deserve attention. Indeed, tropical countries tend to allocate less funding to conservation efforts than countries in the Global North (McClanahan and Rankin, 2016). Prioritization exercises for the Global North can therefore inform decisions about substantial conservation spending.

An in-depth assessment of raptor conservation status in the USA and Canada is needed. There have been several conservation assessments of

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the avifauna of these countries (Panjabi et al., 2005; Rosenberg et al., 2019; Will et al., 2020). The governments of the USA and Canada maintain lists of species of conservation concern. Further, each state within the USA lists taxa of concern within State Wildlife Action Plans. Despite the availability of such information, no study has specifically assessed the conservation status of all raptor taxa within both the USA and Canada and identified the most pressing issues. Sarasola et al. (2018) presented conservation assessments of raptors within Asia, Africa, and the Neotropics, but not North America. Farmer et al. (2008) reviewed the conservation status of species-level diurnal raptors across North America. Here, we update and build on the work presented by Farmer et al. (2008). We examine several studies and conservation databases to reveal which taxa and places are priorities for raptor conservation within the USA and Canada.

2. Methods

We gathered data for all raptor taxa from each database or study we examined. These data included information regarding population status, trend, distribution, and status. We therefore assessed the conservation status of all raptor species, subspecies, or population segments within each information source. First, we analyzed BirdLife International's website (datazone.birdlife.org/country), which allows users to search by country. Birdlife International is the International Union for the Conservation of Nature's (IUCN) Red List authority for birds. We searched this website for all raptor species occurring in the USA and Canada. From these search results, we recorded the global conservation status of each species. IUCN lists species within ordinal categories of Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild, and Extinct. Note that all of the species returned from this search breed within the USA and Canada.

We also examined BirdLife International's online database for the Important Bird and Biodiversity Areas (IBAs) across the USA and Canada that are important for raptor species. IBAs are places that are internationally important for bird conservation (BirdLife International, 2014). To qualify as an IBA, places must harbor birds in sufficient numbers such that taxa qualify as 'trigger species' (BirdLife International, 2014)—i.e. the area must contain at least one biome-restricted, threatened, or restricted-range species, or contain at least 1 % of the global population of congregatory species (Hole et al., 2009). For each IBA, we recorded the number of raptor trigger species and noted whether the area was listed as 'in danger' from anthropogenic threats.

We next examined NatureServe listings. NatureServe is a source for information on rare and endangered species and ecosystems in the Americas. NatureServe provides the conservation status for species within each state and province, as well as the Navajo Nation. NatureServe lists taxa by conservation status within five categories—1 (Critically Imperiled), 2 (Imperiled), 3 (Vulnerable), 4 (Apparently Secure), and 5 (Secure). Taxa can also be listed as Possibly Extinct and Extinct. We considered taxa within categories from Critically Imperiled to Vulnerable as 'insecure'. We searched NatureServe's online database for each of our focal raptor species using the package natserv (Chamberlain, 2020) in R (R Core Team, 2021). We thus mapped the number of total and insecure species across Canada and the USA. NatureServe does not assess Puerto Rican taxa. We only assessed the status of species that are resident or during the breeding periods for migratory species. We did not map instances where a species was considered Possibly Extinct, Extinct, or 'Not Applicable'.

Then, we incorporated population losses reported by Rosenberg et al. (2019) for each species. These authors used trends in monitoring data, mostly from the North American Breeding Bird Survey (Sauer et al., 2017) and the Christmas Bird Count (Bock and Root, 1981), to estimate population losses of most North American bird species since 1970. We report their results as they did, in terms of losses, such that positive numbers indicate population declines. We also examined the Partners in Flight Population Estimates Database (Will et al., 2020), which mainly uses the North American Breeding Bird Survey (Sauer et al., 2017) from the decade 2006–2015 to estimate population sizes. From this database, we extracted the estimated population sizes within North America and the percent of each species' breeding range that occurs within the bounds of the USA and Canada, which is based on eBird relative frequencies.

We also incorporated values of the Research and Conservation Priority Index reported by Buechley et al. (2019). This index combines a species' Red List status with the number of scientific publications examining the species to create a single index of research and conservation priority. Research and Conservation Priority Index values can range from 0.1 to 1 with greater values indicating greater priorities for research and conservation. We considered species with Research and Conservation Priority Index values >0.5 to be global priorities for research and conservation.

We further incorporated data from the 2005 and 2015 USA State Wildlife Action Plans (SWAPs), which list the species of conservation concern for each of the 50 states and five US territories. The US Geological Survey maintains an online database (www1.usgs.gov/csas/swap/) that facilitates searches by species. We thus used this database to determine the number of SWAPs in which each raptor taxon was listed during 2005 and 2015. We considered the number of SWAPs in which a taxon was listed as a species of conservation concern in 2015 subtracted from the number in 2005 as an index of change in conservation status from 2005 to 2015. Thus, a negative value would indicate an increase in the number of SWAPs listing a given taxon and therefore represent a worsening in conservation status, whereas a positive value would indicate a decrease in the number of SWAPs listing a taxon and therefore represent an improvement of conservation status.

We then incorporated recent (2009–2019) migration count trends for diurnal species counted at watch sites across North America. We used the Raptor Population Index, which analyzes count data in a standardized way from sites that meet criteria of longevity, length of season, and daily effort. These data are reported online (www.rpi-project.org). The most recent analyses include data through 2019 and a trend summary index that ranges between -1 and 1, summarizing trends across North America for 28 species (Oleyar et al., 2021). A value closer to -1 indicates mostly declining counts, and a value closer to 1 indicates mostly increasing counts.

Finally, we recorded which raptor taxa were listed as birds of conservation concern by the US Fish and Wildlife Service and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Within the USA, birds of conservation concern include those listed on the US Endangered Species Act, but also include additional taxa considered to be a conservation priority. Within Canada, we determined which species are listed as either of the ordinal categories: special concern, threatened, or endangered.

Working with multiple taxonomies presents analytical challenges (McClure et al., 2020), which further complicated our analysis. Several taxa were listed in SWAPs or by the Endangered Species Act but were not recognized by NatureServe. Between 2005 and 2015 some states seemed to disagree on the taxonomic levels of some raptors in their SWAPs. For example, the state of Florida listed the Everglade Snail Kite (*Rostrhamus sociabilis plumbeus*) in 2005 and the Snail Kite (*Rostrhamus sociabilis*) in 2015. The Everglade Snail Kite is listed by the ESA, but NatureServe assessed the Snail Kite. We observed similar taxonomic issues for the Aplomado Falcon (*Falco femoralis*) and the Northern Pygmy-owl (*Glaucidium gnoma*). In these cases, we recorded information for the taxon as listed and avoided assuming which taxonomic concept (Lepage et al., 2014) was being used.

3. Results

We examined the conservation status of 107 raptor taxa, including 56 species, 46 subspecies, and five population segments. All data are presented in Appendix 1. NatureServe and IUCN both list 56 species.

However, it is not simple to determine which raptor species occur within these countries. Although the Mottled Owl (*Ciccaba virgata*) is considered by IUCN to occur in the USA, the IUCN range map shows it not to occur within the country. We therefore do not consider the Mottled Owl to occur within the USA or Canada. Similarly, NatureServe considers the White-tailed Eagle (*Haliaeetus albicilla*) to occur within the USA because of breeding records from an Aleutian island in the 1980's. Because no other authority considers the White-tailed Eagle as native to the USA or Canada, we have excluded this taxon from our assessment.

According to the IUCN, the California Condor (*Gymnogyps californianus*) is the only North American raptor that is Critically Endangered. Other priority species according to the IUCN are the 'Io (*Buteo solitarius*; Near Threatened), the Spotted Owl (*Strix occidentalis*; Near Threatened), and the Snowy Owl (*Bubo scandiacus*; Vulnerable). NatureServe listed the conservation status of 90 taxa (including species and subspecies). The states or provinces with the most total raptor species and the most insecure species were Arizona ($n = 39$) and Texas ($n = 38$; Fig. 1; Appendix 1). Hawaii contained the fewest overall raptor species ($n = 2$) and tied with Prince Edward Island and the Northwest Territories for the fewest insecure raptor species (n = 2; Fig. 1). Most ($n = 65$) of the raptor taxa were listed as either Apparently Secure or Secure (Fig. 2). Three species-level taxa were insecure—the California Condor (Critically Imperiled), the 'Io (Imperiled), and the Spotted Owl (Vulnerable). Most NatureServe assessments were conducted in 2016 with the earliest conducted in 1994 (Mountain Pygmy-Owl; *Glaucidium gnoma gnoma*) and the latest conducted in 2020 (Snowy Owl; *Bubo scandiacus*; Fig. 2; Appendix 1).

There were 36 IBAs triggered by raptors within the USA and Canada (Fig. 3). Tadoussac (Quebec) was triggered by the most raptor species ($n = 4$), followed by Grand Canyon (Arizona) and Zion (Utah) National Parks, which were both triggered by the California Condor and Spotted Owl. All other IBAs were triggered by single species. Seventeen IBAs were in Puerto Rico and the only raptor they were triggered by was the Puerto Rican Screech-Owl (*Megascops nudipes*). The only IBA considered to be in danger from anthropogenic pressures was Caño Tiburones (Puerto Rico).

According to Rosenberg et al. (2019), there was a vast range in levels of population losses of raptor species since 1970 (Fig. 2). The species with the greatest population losses were American Kestrel (*Falco sparverius*; loss = 1,878,754 individuals; 95%CI = 1,595,457–2,174,950), Short-eared Owl (*Asio flammeus*; loss = 563,323; 95%CI = 309,858–806,621), and Great Horned Owl (*Bubo virginianus*; loss = 527,838; 95%CI = 169,393–873,174). The species with the greatest population gains (i.e. negative losses) were Turkey Vulture (*Cathartes aura*; gain = 7,063,505, 95%CI = 6,085,736–8,098,500), Black Vulture (*Coragyps atratus*; gain = 2,326,573; 95%CI = 1,796,159–2,932,660), and Barred Owl (*Strix varia*; gain = 2,129,260; 1,721,838–2,605,653).

The range of estimated population sizes of raptors within North America and outlying US territories was also large (Fig. 2). The least abundant raptor species in North America were the Hook-billed Kite (*Chondrohierax uncinatus*; population = 50 individuals; no CI estimate), Aplomado Falcon (population = 100; no CI estimate), and California Condor (population = 250; no CI estimate). The most abundant raptors in North America were the Black Vulture (population = 9,600,000; 95% CI = 7,100,000–12,000,000), Turkey Vulture (population = 8,400,000; 95%CI = 7,700,000–9,200,000), and Great Horned Owl (population = 3,800,000; 95%CI = 3,300,000–4,300,000). The amount of a species' breeding range that occurs in North America ranged from 100 % for Bald Eagle (*Haliaeetus leucocephalus*) and Ferruginous Hawk (*Buteo regalis*) to <0.001 % for the Aplomado Falcon, Hook-billed Kite, and Ferruginous Pygmy-owl (*Glaucidium brasilianum*).

RCPI values ranged from 0.1 for the Barn Owl to 0.64 for the California Condor (Fig. 2). All species except the 'Io (RCPI = 0.53) and the California Condor had RCPI values <0.5, indicating that they are relatively lower priority species globally as determined by this index.

Raptor species were the most-listed species in the SWAPs with the

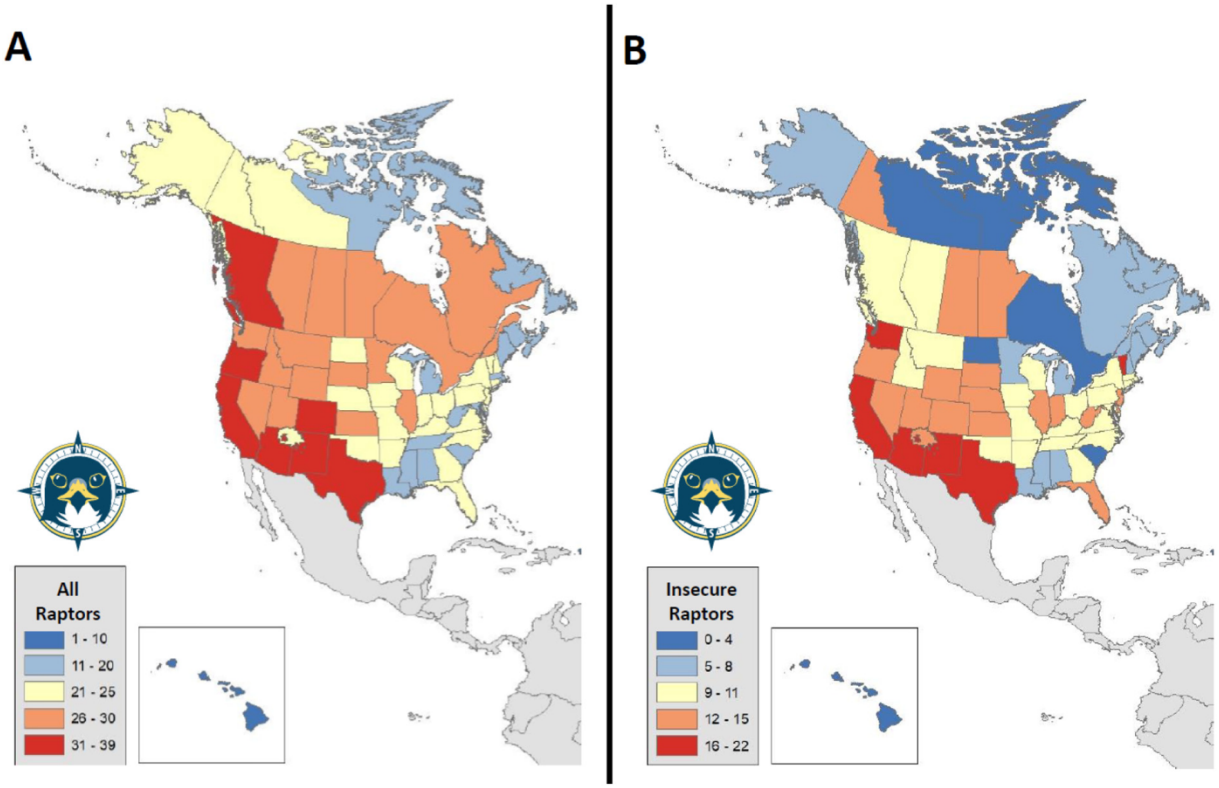

Fig. 1. Map depicting A) the number of species that are listed by NatureServe within the boundaries of USA states, Canadian provinces, or the Navajo Nation; and B) the number of species listed by NatureServe as Critically Imperiled, Imperiled, or Vulnerable within those same territorial boundaries. We only mapped resident or breeding species and did not map species listed as extinct or 'not applicable'.

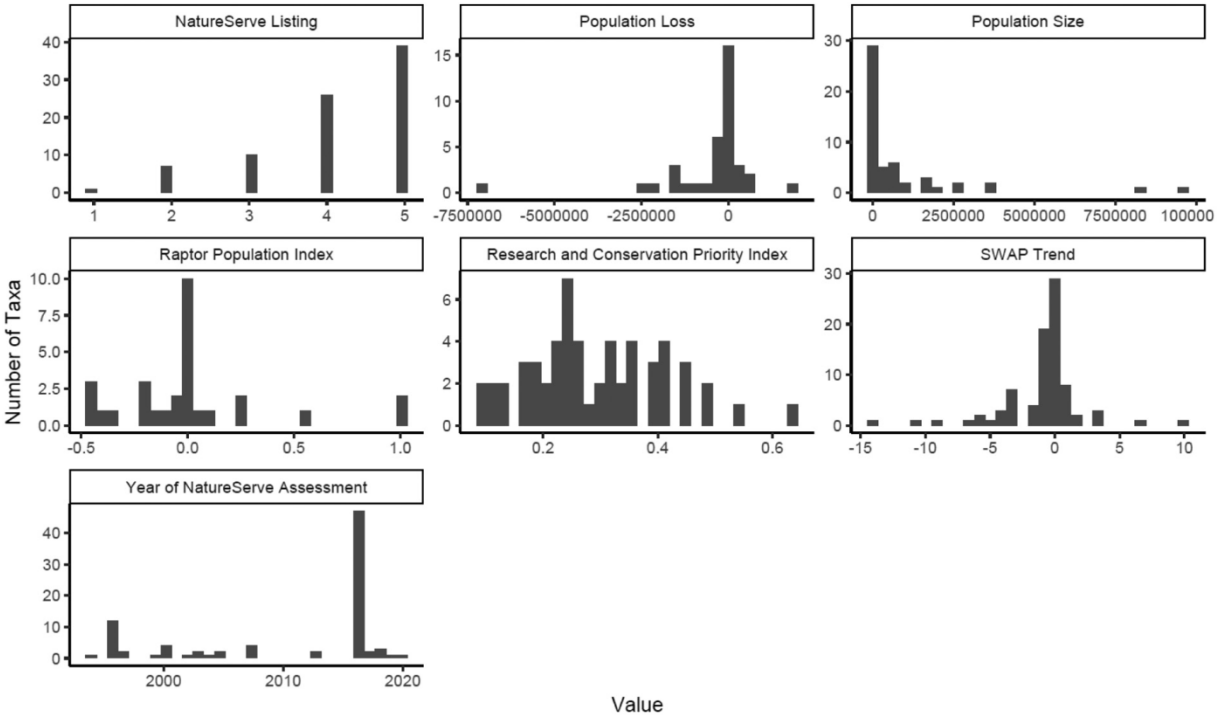

Fig. 2. Histograms of all raptor taxa in the USA and Canada depicting the distributions of NatureServe listings, population losses according to Rosenberg et al. (2019), population sizes within the USA and Canada according to Will et al. (2020), Raptor Population Indices calculated by Oleyar et al. (2021), Research and Conservation Priority Indices from Buechley et al. (2019), differences between the number of US states and territories species were listed between 2005 and 2015, and the year in which taxa were assessed by NatureServe.

Peregrine Falcon (42 SWAPS; *Falco peregrinus*) and Bald Eagle (40 SWAPs) listed more than any other animal in 2015. The changes in SWAP listings between 2015 and 2005 ranged from 14 for the Osprey (*Pandion haliaetus*), 11 for the Cooper's Hawk (*Accipiter cooperii*), and 9 for the Bald Eagle, indicating improving statuses of these species, to −10 for the American Kestrel, −7 for the Golden Eagle (*Aquila chrysaetos*), and − 3 for the Peregrine Falcon, Broad-winged Hawk (*Buteo platypterus*), and Northern Saw-whet Owl (*Aegolius acadicus*; Fig. 2), indicating declining statuses of these species according to this metric.

Regarding government or advisory panel lists, there were 27 raptors of conservation concern according to the US Fish and Wildlife Service, 12 of which were species-level taxa (Appendix 1). COSEWIC listed three taxa as Special Concern, six taxa or populations as Threatened, and three taxa or populations as Endangered (Appendix 1).

Raptor Population Index values from migration counts for 2009 to 2019 ranged from −0.46 to 1.00. Species with negative values, indicating decreasing abundance at count sites, included Northern Goshawk (*Accipiter gentilis*; −0.46), Sharp-shinned Hawk (*Accipiter striatus*; −0.46), and Rough-legged Hawk (*Buteo lagopus*; −0.43). Species with overall increasing abundances at count sites included White-tailed Kite (*Elanus leucurus*; 1.00), Crested Caracara (*Caracara cheriway*; 1.00), and Bald Eagle (0.54). Species with mostly stable counts from 2009 to 2019 included Peregrine Falcon, Golden Eagle, and Merlin (*Falco columbarius*; Appendix 1). Some species (Appendix 1) had trends for a limited number of sites and, while potentially informative, they should be interpreted with caution.

4. Discussion

Our study reveals the conservation status of raptor taxa within the USA and Canada, however several caveats must be considered when interpreting our results. For example, the Peregrine Falcon and Bald Eagle are the most-listed species of conservation concern on SWAPs. This listing across so many SWAPs is not because the overall conservation status of these species is poor, but likely in part because they are widespread, occur at low densities, and have a history of needing direct conservation action (e.g. Cade and Burnham, 2003; Sorenson et al., 2017). Changes in SWAP listings are also more likely to be a useful index for widespread species because species ranging across few states have few opportunities to be listed. Further, the results of our analysis of SWAP listings might need to be treated with caution because of potential differences in methodology across states and time periods.

Another caveat is that the Red List and the Research and Conservation Priority Index are intended to set priorities at a global scale. A species could therefore be secure globally but at risk of extirpation from the USA or Canada. Global classifications should therefore be interpreted with respect to the percent of the species' range that occurs within the two countries. For example, the Whiskered Screech-Owl (*Megascops trichopsis*) is listed as a bird of conservation concern within the USA, yet <1 % of its range is within this country. The Northern Aplomado Falcon (*F. f. septentrionalis*) and Everglade Snail Kite (*R. s. plumbeus*) are similarly listed by the US Endangered Species Act, yet <1 % of the ranges of these species occur within the USA. That the USA is responsible for such a small fraction of these species' global population, perhaps somewhat lessens the pressure to conserve these species within its borders. However, the distinctiveness of a population should also be considered when setting conservation priorities. Conversely, the Ferruginous Hawk (*Buteo regalis*) only breeds within the USA and Canada, is a bird of conservation concern within the USA, and a species of special concern within Canada. These two countries therefore have full responsibility to conserve the Ferruginous Hawk.

Other caveats stem from the methodology used to survey raptors. The estimates of population loss reported by Rosenberg et al. (2019) are largely calculated from the Breeding Bird Survey, which uses roadside point counts to monitor birds across much of North America (Hudson et al., 2017). This program is not ideally designed for monitoring raptors because these birds generally occur at low densities and are difficult to detect during point counts (Fuller and Mosher, 1981; Kirk and Hyslop,

Fig. 3. Map of the Important Bird and Biodiversity Areas (IBAs) within the USA and Canada that were triggered by (i.e. identified as important because of) raptor species. Note that all IBAs except Tadoussac (n = 4), Grand Canyon National Park (n = 2), and Zion National Park (n = 2) have a single trigger species.

1998; Dunn et al., 2005; Farmer et al., 2007). We therefore interpret Rosenberg et al.'s (2019) absolute results for raptors with caution, but consider their estimates useful for a relative ranking of species by population losses.

Migration counts must also be interpreted carefully. The Raptor Population Index monitors changes in detections of diurnal raptors at migration count sites across North America. However, raptors might be 'short-stopping' or otherwise altering migration due to climate change or other anthropogenic changes (Viverette et al., 1996; Paprocki et al., 2014). Indeed, the results show that the species that have the sharpest declining count trends inhabit more northerly latitudes and may be short-stopping their migrations (i.e. Northern Goshawk, Sharp-shinned Hawk, and Rough-legged Hawk), whereas the species that have the sharpest increasing count trends inhabit more southerly latitudes and may be moving northward with climate change (i.e. White-tailed Kite, Crested Caracara). All methods for monitoring birds should be scrutinized for changes in phenology, distribution, and behavior (Simons et al., 2007; McClure et al., 2011, 2017; Paprocki et al., 2014).

Several of the NatureServe assessments are decades old. Each of these assessments was accompanied by a warning that the status needs review. We thus echo NatureServe in urging caution when interpreting old assessments and recommend reassessment in such cases. However, the majority (65 %) of assessments are <10 years old, thus our overall assessment using NatureServe is relatively current.

Our review revealed some contrasting indicators of conservation status, in most cases associated with status assessments reported from different periods of the species' annual life cycle. For example, several species, including Cooper's Hawks, Peregrine Falcons, Red-shouldered Hawks, and Red-tailed Hawks, have experienced population increases from their breeding or wintering ranges according to Rosenberg et al. (2019), yet the Raptor Population Index for these species indicates decreasing counts during migration. Such cases highlight the pitfalls of relying on a single population indicator for policy or species management.

4.1. Conservation recommendations

Despite the above caveats, our review provides a thorough assessment of priorities for raptor conservation in the USA and Canada. The spatial distribution of insecure raptor species mirrors taxonomic richness with a few exceptions (Fig. 1). It is unsurprising that the highest diversity is in the southwest USA because this area is at the northern edge of many subtropical species' ranges. As mentioned above, the relative priority of investing in conservation of such populations could be weighted by the proportion of a species' range within a given political boundary. However, there may be justification for focusing conservation actions at the edges of species' ranges (Rehm et al., 2015; Steen and Barrett, 2015). Raptor-focused conservation and monitoring programs might thus focus efforts in the southwestern USA. Washington and Vermont also have relatively high incidence of insecure species, likely because these states lie at the edges of many species' ranges.

Our analysis of IBAs highlights places that are particularly important for global raptor conservation. Although Tadoussac was triggered by the most raptor species, all four of these species are relatively secure. Conversely, Grand Canyon and Zion National parks were triggered by the California Condor and Spotted Owl—two species that are of global

conservation concern (Critically Endangered and Near Threatened, respectively). The Puerto Rican IBAs were all only triggered by a single, Least Concern species. However, some Puerto Rican IBAs, such as El Yunque, Carite, and Maricao forests harbor the Puerto Rican Sharp-shinned Hawk (*Accipiter striatus venator*), a highly endangered subspecies, and thus the conservation of these areas is deemed especially important. It is encouraging that only one IBA within the USA and Canada that was triggered by raptors was considered 'in danger' due to anthropogenic threats (Caño Tiburones, Puerto Rico), out of 227 in danger worldwide.

The California Condor is the most pressing raptor conservation challenge in North America. It is the only North American raptor that is Critically Endangered according to the IUCN, the only species ranked as Critically Imperiled by NatureServe, and has the greatest Research and Conservation Priority Index score. Mortality due to lead poisoning limits the global population of California Condors (Finkelstein et al., 2012). The conservation plight of the California Condor is generally recognized—it is on the US Endangered Species List, there is an intensive captive breeding and release operation, and there are several programs to reduce the threat of lead poisoning within the species' range (Finkelstein et al., 2020). These conservation efforts are therefore deemed well-justified and should be expanded to ensure self-sustaining populations of the California Condor.

Other raptor species of particular conservation concern are the 'Io, the Spotted Owl, and the Snowy Owl. The 'Io is rarely examined, being the subject of eight past studies, whereas the Snowy Owl has been the subject of 96 studies (Buechley et al., 2019). The Spotted Owl is one of the most studied raptor species in the world (452 studies; Buechley et al., 2019). However, most of the research on the species has been conducted on the northern subspecies (*S. o. caurina*; ERB personal observation), leaving the California (*S. o. occidentalis*) and Mexican (*S. o. lucida*) subspecies far less understood.

There are several subspecies of conservation concern in the USA and Canada. Indeed, 15 subspecies are listed as Imperiled or Vulnerable by NatureServe, and six of these are listed as either birds of conservation concern or by the US Endangered Species Act. The Northern Spotted Owl is listed by both the US Endangered Species Act and COSEWIC. Haida Gwaii (British Columbia; previously known as the Queen Charlotte Islands) harbors two threatened subspecies (*A. g. laingi* and *Aegolius acadicus brooksi*) that are listed as Imperiled by NatureServe, making raptor conservation on this relatively small archipelago a high priority. Subspecies of the Puerto Rican archipelago are also of particular concern. The Virgin Islands subspecies of the Puerto Rican Screech-Owl (*M. n. newtoni*) is a bird of conservation concern and is likely extinct (Gallardo and Thorstrom, 2019). The Puerto Rican Broad-winged Hawk (*B. p. brunnescens*) and Puerto Rican Sharp-shinned Hawk are both listed by the US Endangered Species Act. In 2017, Hurricane Maria devastated Puerto Rico and substantially reduced the population of Sharp-shinned Hawks on the island (Gallardo and Vilella, 2017). Conservation of this taxon is deemed especially important given that it is considered by some authorities to be a full species (Catanach et al., 2021).

Some species are relatively abundant and are ranked as Least Concern by the IUCN and Secure by NatureServe but should be considered of conservation concern because of population losses and increases in SWAP listings. For example, the American Kestrel had the greatest increase in SWAPs, the greatest population losses according to Rosenberg et al. (2019), and a negative Raptor Population Index. Further, population declines of American Kestrels across much of North America are well-known from numerous monitoring programs (Smallwood et al., 2009; McClure et al., 2017). Similarly, the Short-eared Owl experienced the second-most population losses (Rosenberg et al., 2019) and is listed in Canada by COSEWIC (also see Booms et al., 2014, Gahbauer et al., 2021). The Gyrfalcon is currently secure but is predicted to be negatively affected by climate change (Booms et al., 2011). Researchers should investigate causes of decline for these species before their conservation status worsens.

Regional raptor populations also deserve conservation attention. For example, the American Kestrel is declining sharply in the northeastern USA (Smallwood et al., 2009, McClure et al., 2017), the Golden Eagle is considered a species of concern in western North America (Collopy et al., 2017), and the Short-eared Owl is nearly extirpated from the state of Pennsylvania (LJG unpublished data). Both the eastern and western populations of Barn Owls in Canada are listed by COSEWIC. A cursory examination of the state and provincial rankings on NatureServe reveals substantial variation in the conservation status of raptors regionally. Such results emphasize the importance of sub-national governments, local non-profits, and individuals in conservation efforts.

Several raptor species are especially secure. The Black and Turkey vultures are the most abundant raptors in the USA and Canada, experienced the greatest population gains, and had increasing Raptor Population Index values. This is in contrast to Accipitrid vultures across Africa and Eurasia, which are among the most threatened birds on earth (Buechley and Şekercioğlu, 2016; McClure and Rolek, 2020). Black and Turkey vultures might have a more favorable conservation status than Accipitrid vultures because they generally have shorter generation times and perhaps feed on smaller carcasses, which may be less likely to be poisoned (Buechley and Şekercioğlu, 2016). Cooper's Hawks, Bald Eagles, and Osprey are also experiencing population increases in part owing to a continuing recovery following 20th century declines caused by DDT (Bednarz et al., 1990; Farmer et al., 2008; Bierregaard et al., 2014; Rosenberg et al., 2019). Encouragingly, most raptor species within the USA and Canada are considered by the IUCN to be Least Concern, are listed as Secure or Apparently Secure by NatureServe, were listed by fewer SWAPs in 2015 compared to 2005, had stable or increasing Raptor Population Index values, and have increased in population since 1970 (Fig. 2; Appendix 1).

5. Conclusions

The status of raptors across the USA and Canada is generally secure, but there are some pressing conservation priorities. One of the first such priorities could be updating methodologies to establish reliable population trend and status assessments. Several taxa are insecure or threatened according to NatureServe and IUCN, and some abundant species are declining. Habitat conservation via the protection of IBAs might help maintain populations of many species. We did not perform an assessment of threats. However, lead poisoning is the primary threat to the highest priority species on the continent, the California Condor (Finkelstein et al., 2012), and also has been shown to limit populations of eagles across North America (Slabe et al., 2022). Other anthropogenic threats, including rodenticides, energy infrastructure, and climate change, should be similarly assessed for continental and regional effects on raptor populations.

Finally, the current general security of raptor populations is no guarantee of favorable future conservation status (Santangeli et al., 2022). Indeed, monitoring is essential because raptor populations can decline precipitously (Pain et al., 2008; Ogada et al., 2016). The USA and Canada have perhaps the best bird monitoring infrastructure in the world. Yet, idiosyncrasies among monitoring programs and contrasting trends in population indices highlight the need for holistic inference using a variety of count methods. A database of the various conservation assessments and population indices of raptors within the USA and Canada will be maintained on the Global Raptor Impact Network's website (McClure et al., 2021; www.globalraptors.org) so that policy makers and conservationists can readily assess the conservation status of raptors within these countries. We will work to improve our assessment by incorporating evolutionary distinctiveness (Jetz et al., 2014) and by developing a single composite index of raptors across the USA and Canada. With the proper information, policies, and actions, all raptor taxa across the USA and Canada can be maintained at ecologically relevant levels.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.biocon.2022.109633.

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