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Authors: McClure, Christopher J. W., Anderson, David L., Buij, Ralph, Dunn, Leah, Henderson, Michael T., et al.

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COMMENTARY: THE PAST, PRESENT, AND FUTURE OF THE GLOBAL RAPTOR IMPACT NETWORK

Christopher J. W. McClure[1], David L. Anderson, Ralph Buij, Leah Dunn, Michael T. Henderson, Jennifer McCabe, Brian W. Rolek, Sarah E. Schulwitz, D. Paul Spurling, F. Hernan Vargas, Munir Z. Virani, and Richard T. Watson
The Peregrine Fund, 5668 West Flying Hawk Lane, Boise, ID 83709 USA

Diego Méndez
Aves Rapaces en Bolivia – Programa de Investigación, Calle El Villar 369, Sucre, Bolivia
and
Museo Nacional de Historia Natural, Calle 26 s/n, Cota Cota, La Paz, Bolivia

Cesar Marquez Reyes
Calle 107A No. 7-82, Apto 501, Bogota, Colombia

Everton B. P. Miranda
Centre for Functional Biodiversity, School of Life Sciences, University of KwaZulu-Natal, P/Bag X01, Pietermaritzburg, 3209, South Africa

Lyle Glowka and Sofi Hinchliffe
Convention on Migratory Species (Abu Dhabi Office), PO Box 45553, Abu Dhabi, United Arab Emirates

Bryce W. Robinson
Cornell University and the Cornell Lab of Ornithology, 159 Sapsucker Woods Road, Ithaca, NY 14850 USA

James R. Belthoff and Julie A. Heath
Department of Biological Sciences and Raptor Research Center, Boise State University, 1910 University Drive, Boise, ID 83725 USA

André Botha
Endangered Wildlife Trust, Glen Austin AH 1685, South Africa

Robert A. G. Davies, Andrew P. Rayner, and Simon R. Trice
Habitat Info Ltd, Rookwood Studios, Llanunwas, Solva, Pembrokeshire, SA62 6UJ, UK

Laurie Goodrich and Jean-François Therrien
Hawk Mountain Sanctuary Association, Acopian Center for Conservation Learning, 410 Summer Valley Road, Orwigsburg, PA 17961 USA

M. David Oleyar and Steven J. Slater
HawkWatch International, 2240 South 900 East, Salt Lake City, UT 84106 USA

Evan R. Buechley
HawkWatch International, 2240 South 900 East, Salt Lake City, UT 84106 USA
and
Migratory Bird Center, Smithsonian Conservation Biology Institute, National Zoological Park, MRC 5503, Washington, DC 20013 USA

Sandesh Gurung and Tulsi R. Subedi
Himalayan Nature, Ganesh Marg, Chabahil, PO Box 10918, Kathmandu, Nepal

Petra Sumasgutner
Konrad Lorenz Research Centre, Department of Behavioral and Cognitive Biology, University of Vienna, Fischerau 11, 4645 Grünau/Almtal, Austria

Luke J. Sutton
School of Biological and Marine Sciences, University of Plymouth, Plymouth, PL4 8AA, UK
and
The Peregrine Fund, 5668 West Flying Hawk Lane, Boise, ID 83709 USA

Franziska Loercher, W. Louis Phipps, and José Tavares
Vulture Conservation Foundation, Wuhrstrasse 12, 8003 Zurich, Switzerland
and
International Bearded Vulture Monitoring (IBM), Wuhrstrasse 12, 8003 Zurich, Switzerland

Abstract.—Most raptor populations are declining and nearly a fifth are threatened with extinction; thus there is a need to increase collaboration to ensure efficient and effective research, management, and conservation. Here, we introduce the Global Raptor *Impact* Network (GRIN; www.globalraptors.org), a tool to enhance collaboration and conservation impact of the raptor research community. We provide an overview of the history and current state of GRIN, including plans for expansion. Predecessors to GRIN include The African Raptor DataBank, which was launched in 2012 to ascertain the conservation status of raptors across Africa; and the Global Raptor *Information* Network, which was launched in the late 1990s as a website to provide information regarding diurnal raptors and facilitate communication among researchers. GRIN expands the data collection and storage capabilities of the African Raptor DataBank to a global scale via mobile application. We have implemented data-sharing rules to ensure the safety of sensitive species, and users of the GRIN mobile app can designate their records as confidential. GRIN staff and partners are developing analyses of species' population trends and geographic distributions to aid in conservation assessments. GRIN is also developing systematic reviews, detailed bibliographies, and online accounts that will summarize the state of knowledge for each raptor species. We hope that GRIN will benefit the entire raptor research community and aid in the collaboration necessary to help raptor populations thrive in the Anthropocene.

Key Words: *bird of prey*; *conservation technology*; *literature review*; *monitoring*; *population trend*; *range*; *raptor.*

COMENTARIO: PASADO, PRESENTE Y FUTURO DE LA RED GLOBAL DE IMPACTO DE RAPACES

Resumen.—La mayoría de las poblaciones de aves rapaces está disminuyendo y casi una quinta parte está amenazada de extinción; por lo tanto, es necesario aumentar la colaboración para garantizar una investigación, gestión y conservación eficientes y exitosa. Aquí, presentamos la Red Global de Impacto de Rapaces (GRIN por sus siglas en inglés; www.globalraptors.org), una herramienta para mejorar la colaboración y el impacto de conservación de la comunidad de investigación de aves rapaces. Ofrecemos una descripción general de la historia, el estado actual, y los planes de expansión del GRIN. Los predecesores de GRIN incluyen el Banco de Datos de Rapaces de África, que se lanzó en 2012 para determinar el estado de conservación de las aves rapaces en África, y la Red Global de Información sobre Rapaces, que se lanzó a fines de la década de 1990 como un sitio web para proporcionar información sobre las aves rapaces diurnas y facilitar la comunicación entre investigadores. GRIN amplía las capacidades de recopilación y almacenamiento de datos del Banco de Datos de Rapaces de África a una escala global a través de una aplicación móvil. Hemos implementado reglas de intercambio de datos para garantizar la seguridad de las especies sensibles, y los usuarios de la aplicación móvil GRIN pueden designar sus registros como

[1] Email address: cmcclure@peregrinefund.org

confidenciales. El personal y los socios de GRIN están desarrollando análisis de las tendencias poblacionales y de las distribuciones geográficas de las especies para ayudar en las evaluaciones de conservación. GRIN también está desarrollando revisiones sistemáticas, recopilaciones bibliográficas detalladas y descripciones en línea que resumirán el estado del conocimiento de cada especie de ave rapaz. Esperamos que GRIN beneficie a toda la comunidad de investigadores que estudian aves rapaces y contribuya a generar la colaboración necesaria para ayudar a las poblaciones de rapaces a prosperar en el Antropoceno.

[Traducción del equipo editorial]

Introduction

The group of birds called raptors or birds of prey consists of the orders Acciptriformes, Falconiformes, Cariamiformes, Cathartiformes, and Strigiformes (Jarvis et al. 2014, Iriarte et al. 2019, McClure et al. 2019). Raptors provide ecosystem services (Markandya et al. 2008, Donázar et al. 2016, O'Bryan et al. 2018, Aguilera-Alcalá et al. 2020) and are considered indicators of environmental health (Sergio et al. 2008) and biodiversity (Sergio et al. 2005, 2006). The slow life history of raptors puts them at greater risk of extinction than most other birds (Bennett and Owens 1997) and makes them susceptible to precipitous population declines. Scavenging raptors such as vultures are particularly endangered because of their trophic position and susceptibility to poisoning (Buechley and Şekercioğlu 2016).

Globally, 18% of raptors are threatened with extinction, and 52% have declining populations (McClure et al. 2018). Even among raptors listed as Least Concern by the International Union for the Conservation of Nature (IUCN), 38% are estimated to have declining populations (McClure et al. 2018). Indeed, raptors are more threatened on average than other birds (McClure and Rolek 2020). Of 67 diurnal raptor species in Africa, 26% are currently on the IUCN Red List, but the conservation status of most needs urgent re-evaluation (Amar et al. 2018). Conservation of vultures is of great concern. Vulture crises are occurring in Africa (Ogada et al. 2016) and Asia (Pain et al. 2008), while in the New World both condor species are threatened by poisoning (Finkelstein et al. 2012, Alarcón et al. 2018).

Compounding the population declines faced by raptors, the vast majority of these species are poorly understood and monitored. Buechley et al. (2019) demonstrated that ten species of raptors have received one-third of the research attention, whereas one-fifth remain virtually unstudied. The IUCN lists population monitoring as the greatest research need for raptors, and there is no estimate of population size for 59% of species (McClure et al. 2018). A systematic literature review for the African continent showed that 36% of 66 species have been relatively well-studied (12 or more studies), but 64% had fewer than 10 studies (Amar et al. 2018).

Calls for better monitoring of raptors are common (Goriup and Tucker 2007, Kovács et al. 2014, Andevski et al. 2017), but coordination of monitoring across the global distributions of species is costly and logistically difficult. Such coordination generally requires networks of researchers and infrastructure including online databases, mobile applications, and ideally, standardized protocols (Perrig et al. 2019). For example, the International Bearded Vulture Monitoring network (www.gyp-monitoring.com) coordinates monitoring of Bearded Vultures (*Gypaetus barbatus*) across international boundaries using standard protocols, validated observations, and a shared database. This monitoring program could therefore be a model framework for other species (Perrig et al. 2019).

Researchers and conservationists also need access to the scientific literature to implement and build upon past results while avoiding unintended duplication (Sunderland et al. 2009). Platforms that aggregate, disseminate, and summarize scientific literature aid the science of conservation (Walsh et al. 2015), especially in developing countries where access to scientific literature is limited (Gossa et al. 2015). Pullin and Knight (2009) argue that conservation requires an evidence base on which practitioners can make decisions, and suggest that systematic reviews can fill this need.

Raptor research and conservation benefit from large-scale, multi-species monitoring programs and efforts to synthesize and disseminate scientific literature. An important recent program, the African Raptor Databank (hereafter ARDB; African Raptor Databank 2020) assessed the conservation status of raptors in Africa by collecting and analyzing contemporary and historical data across the continent. Another initiative, the Global Raptor Information Network, synthesized the scientific literature for diurnal raptors and provided a means for raptor researchers to network. To meet current conservation challenges, we argue that these efforts can be broadened, updated, and integrated.

Several raptor research and conservation organizations are collaborating to expand the infrastructure of the ARDB globally while also modernizing the Global Raptor *Information* Network to become the Global Raptor *Impact* Network (hereafter GRIN). The change in name signifies that the change and expansion of GRIN's mission is not simply a data collection and analysis exercise—that raptors will not be "monitored into extinction" (see Lindenmayer et al. 2013). Instead, the data collected by GRIN and the analyses performed are meant to directly inform management, conservation, and policy, and thus to positively impact raptor populations worldwide. Here, we (1) review the predecessors of GRIN: the Global Raptor Information Network and the ARDB, (2) describe the present state of GRIN, and (3) bring forward a vision for the future of GRIN that enhances collaboration across the raptor research and conservation community.

The Precursors to GRIN

The Global Raptor Information Network. Lloyd Kiff launched the Global Raptor Information Network as a website while working for The Peregrine Fund in the late 1990s. The goal was to provide information on diurnal raptors and facilitate communication among researchers interested in raptor conservation. This website provided accounts for all diurnal raptor species, profiles of raptor researchers, recent news, meeting abstracts, and a mechanism for requests for assistance by the research community. Each species account included information regarding taxonomy, breeding biology, migration, population trend, and conservation status, among other aspects of a species' ecology and conservation. Researcher profiles included research interests, downloadable publications, and a list of species studied. The last version of the Global Raptor Information Network website (16 July 2018) includes profiles for 535 researchers and 341 diurnal raptor species, although many of these profiles are now out of date.

The Global Raptor Information Network's bibliography was linked to species accounts, researcher profiles, and The Peregrine Fund's Research Library. Each species and researcher therefore had their own bibliography, which was supplemented by one of the largest ornithology-specific archives in North America. These bibliographies were maintained mostly by staff of The Peregrine Fund who reviewed the ornithological literature and noted studies pertaining to raptors, or were alerted to raptor-related work by the authors.

In 2010, the US Geological Survey (USGS) merged the Raptor Information System into The Global Raptor Information Network. The Raptor Information System evolved from a merger of two collections formerly managed by the US Department of Interior Bureau of Land Management. One of those, The Raptor Management Information System, was developed by the late Richard Olendorff at the Bureau's California State Office. The other, the Snake River Birds of Prey Area Literature System, was developed by Karen Steenhof at the bureau's Boise District Office. The Raptor Information System became part of USGS in 1996, and was used by managers, scientists, and people around the world for information discovery about raptors.

At the time of the merger, the Raptor Information System was a collection of approximately 40,000 articles that were documented in a searchable web service. This collection contained a substantial amount of gray literature and articles about nocturnal raptors, which had not been in the GRIN bibliography. A cooperative agreement governs the relationship between the USGS and The Peregrine Fund in this endeavor.

The Global Raptor Information Network therefore presaged, and was eventually eclipsed by, other platforms including the Cornell Lab of Ornithology's Birds of the World (www.birdsoftheworld.org), ResearchGate (www.researchgate.net), and Academia.edu (www.academia.edu). The Global Raptor Information Network researcher and species profiles are mostly superseded by more recent efforts. However, the bibliography remains thorough and useful, albeit in need of updating and modernization, because it contains a large quantity of literature not available through other sources.

The African Raptor DataBank (ARDB). A large collaboration coordinated by Habitat Info, Ltd., launched the ARDB in 2012 (Davies and Virani 2013). The initiative was funded by Habitat Info and The Peregrine Fund with help for developing mobile apps from Kurt Eckerstrom and The United Nations' Convention on Migratory Species. The purpose of the ARDB was to ascertain the conservation status of, and elucidate the threats to, raptors across Africa. There was also an emphasis on measuring the habitat extent for each species. Such an endeavor required collection of unprecedented amounts of data and sophisticated analyses. Researchers across Africa submitted data to the ARDB via spreadsheet or a mobile app developed for this purpose and made available from the Apple and Google app stores. Regional coordinators oversaw the recruitment and organization of observers who collected data. The ARDB mobile app allowed users to readily organize sightings of raptors across the continent, and it also facilitated the recording of details including fatalities, foraging, and other behavior patterns. Users of the app could record data from multiple survey types including point counts, airplane transects, and migration counts (i.e., hawkwatches). This app was especially well-suited for road surveys, and there were > 214,000 km of road surveys conducted from 2012 to 2017 using the app. In total, approximately 220,000 raptor observations were submitted to the ARDB over the 5-yr data collection period. The ARDB incorporated data from the published literature including the Snow Atlas (Snow 1978), which contains the locations across Africa where specimens were collected for the British Museum of Natural History. ARDB also mobilized thousands of raptor data points from various bird atlas projects; including for West Africa, Tunisia, Tanzania, and Namibia.

Analyses using data submitted to the ARDB revealed that six species of vultures lost a substantial extent of their ranges before and after 1977, with contractions of 5% to 63% (www.habitatinfo.com/african_vulture_maps/). BirdLife International is the Red List Authority for all birds on the IUCN Red List—making them the world's authority on the conservation status of birds. BirdLife International considered results from the ARDB when uplisting and revising the range maps for African vultures (Amar et al. 2018). Data from the ARDB also were used by Santangeli et al. (2019a) to map priority areas for conservation of Old World vultures. The ARDB was integral in developing the Multi-species Action Plan to Conserve African-Eurasian Vultures (hereafter Vulture MsAP; Botha et al. 2017), which was spearheaded by the United Nations' Convention on Migratory Species. Indeed, the Vulture MsAP lists incorporation of population surveys as essential for vulture conservation and recognizes the ARDB as an important stakeholder in those surveys. A field guide to African raptors (Clark and Davies 2018) and an online African raptor atlas (African Raptor Databank 2020) also incorporate ARDB data and outputs.

The Next Generation of GRIN

GRIN, i.e., the Global Raptor *Impact* Network, is evolving into a collaborative platform to support the global science of raptor ecology and conservation by collecting, storing, analyzing, and distributing information about nocturnal and diurnal raptors. GRIN combines the globally expanded data collection and analysis capabilities of the ARDB with the library and bibliography of the Global Raptor Information Network. GRIN is therefore not simply a mobile app, website, or database. Among other functions, GRIN will specifically endeavor to quickly and accurately organize information that groups such as BirdLife International need for IUCN Red List assessments.

Data Collection. GRIN is amassing a database of raptor observations from across the globe by mobilizing legacy data, incorporating monitoring programs of GRIN partners, syncing other datasets available online, and encouraging the use of the GRIN mobile app for collection of new data (Fig. 1). GRIN currently holds more than 250,000 raptor observations, contributed by more than 1000 individuals or organizations, and grows daily. Because data within GRIN began with the ARDB, most data to date are from Africa, but coverage is expanding to other continents (Fig. 1). However, clear data gaps exist as some geographic areas such as Russia, Central Asia, Japan, North Africa, China, and New Zealand are underrepresented (Fig. 1). Such data gaps are perhaps partly the result of language barriers, which might be overcome as the app and website become offered in languages other than English.

GRIN has developed specialized infrastructure to collect data regarding raptors around the world. As such, the GRIN mobile app is an expansion of the prior African Raptor Observations app and has inherited its broad functionality. For example, with each observation, app users can record whether the bird is flying or perched and the altitude of the bird. Altitudes are entered into bins to lessen the impact of potential errors in height estimation. The GRIN mobile app also maintains the road survey functionality of the ARDB mobile app. Road surveys are especially useful for monitoring raptors across large areas with open vegetation (Fuller and Mosher 1981, 1987), yet technological infrastructure and analytical tools for such surveys have been, until recently, underdeveloped (McClure et al. 2021a). The GRIN mobile app allows recording of start and end times of surveys, georeferencing routes and observations

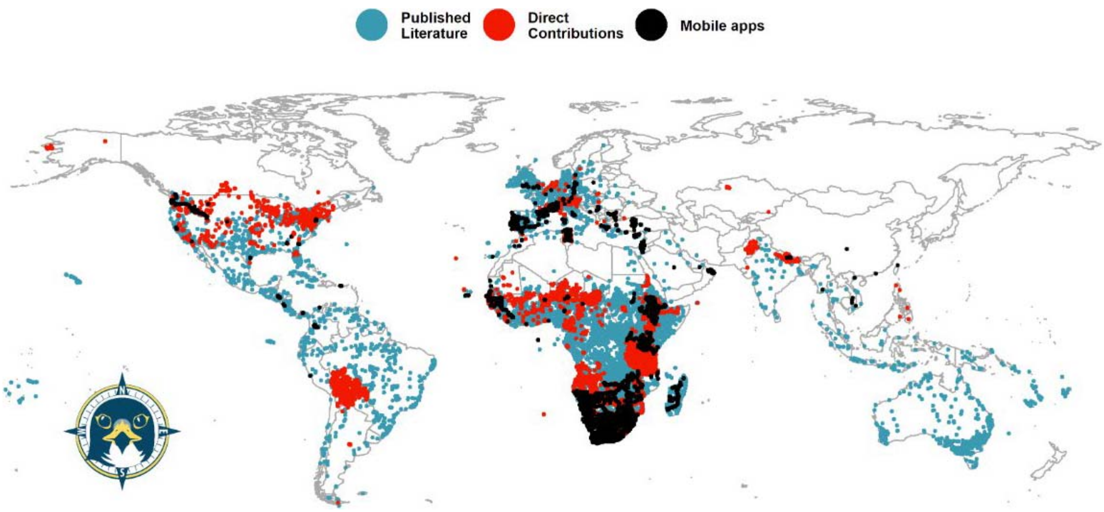

Figure 1. Map of raptor observations within Global Raptor Impact Network (GRIN) as of 1 November 2020. Different colored points indicate data sources. Note that this map does not include data from telemetry or the Global Biodiversity Information Facility.

(Fig. 2), and collecting information on the distance and compass bearing of raptors from observers, all of which are useful for deriving abundance estimates and other aspects of population biology. The GRIN mobile app also inherits from the ARDB app the ability to record multiple types of observations including abundance, nesting, feeding, fatalities, and many other types of activities and behaviors. Users can also record the sex, age, and color morph of individuals, if known. Photos can be uploaded via the mobile app although they will not initially be used to judge the accuracy of identifications.

Collection of data about raptor fatality incidents in a standardized and centralized way using the GRIN app will facilitate the analysis of mortality patterns and risk assessments. This could overcome one of

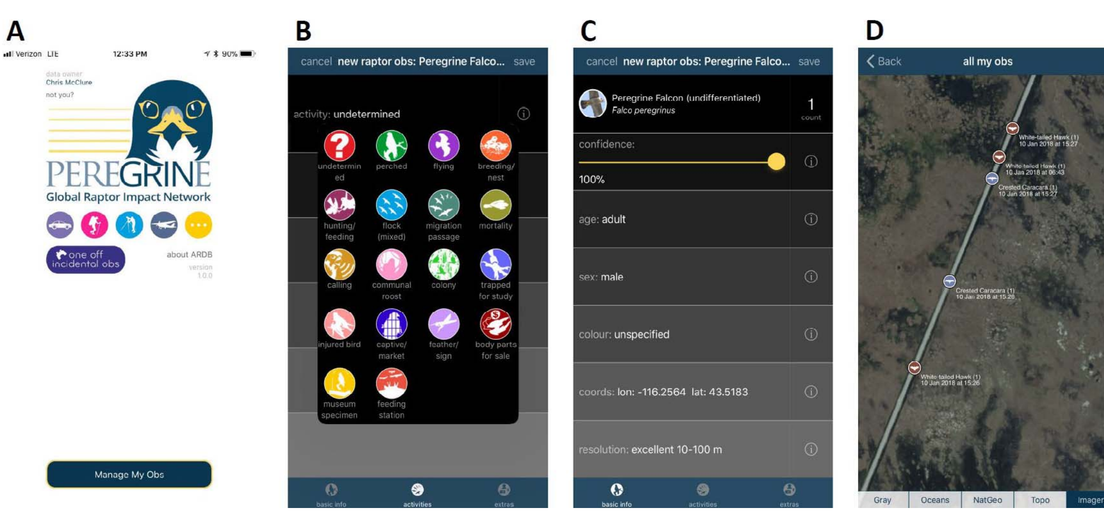

Figure 2. Screenshots of the GRIN mobile app. (A) The home screen, (B) Options for observation type, (C) Data entry screen, (D) Observations during a raptor survey in south Texas. Icons indicate locations of raptor sightings. The white line is the surveyor's path of travel.

the main challenges of attempting to map raptor mortality patterns based upon multiple databases comprised of unstandardized data. For example, the Vulture Conservation Foundation's mortality database consists of roughly 7000 records contributed by more than 35 organizations from 20 countries, all of which used different methods to record and report mortality data. Thus, if the formatting of mortality data can be standardized via the GRIN mobile app, this will facilitate and improve the accuracy of further analysis.

New features of the GRIN mobile app include the ability to log sightings of raptors to subspecies, globally, and new online functionality including a web application for editing one's own data. Users can now record observations on their phone, sync to the GRIN server, and then view, edit, and download their observations online. The GRIN mobile app is designed for use by professional raptor researchers and keen community scientists. Indeed, users must register their level of expertise as amateur or professional. Thus, for especially sensitive analyses, or examination of species that are difficult to identify, analysists can subset the data to those collected by professionals. Such functionality, as well as the ability to record precise locations of raptors during surveys are not implemented by many other important applications such as eBird (Sullivan et al. 2014), thus setting the GRIN mobile app apart.

There are therefore important roles for in-depth applications such as the GRIN mobile app and for community science programs, which have broader appeal with the general public. Many of these open-access databases are available for download and are being incorporated into GRIN. For example, the Global Biodiversity Information Facility (www.gbif.org) incorporates data from eBird, iNaturalist, and many museums and biodiversity programs around the globe into a single, searchable, and downloadable database. Movebank (www.movebank.org) further makes available animal tracking data. These open-access databases will provide GRIN with millions of data points spanning the globe. An increasing amount of data can also be identified (Cornford et al. 2021) and downloaded from the published literature (e.g., Grilo et al. 2018, Miranda et al. 2019, Pereira et al. 2019). GRIN will continue to incorporate outside data and mobilize legacy datasets.

Data regarding population trends are also readily available across the internet. The Living Planet Index (www.livingplanetindex.org) makes its data available for download—mobilizing thousands of time-series of population indices for vertebrates globally. Other sources of freely available standardized time-series include the North American Breeding Bird Survey (Sauer et al. 2017), the Christmas Bird Count (Butcher et al. 1990), the Batumi Raptor Count (www.batumiraptorcount.org), HawkWatch International (www.hawkwatch.org), Hawk Mountain Sanctuary (www.hawkmountain.org), The Hawk Migration Association of North America (www.hmana.org), and the Raptor Population Index (www.rpi-project.org; Farmer and Hussell 2008, Oleyar et al. 2020). All of these aforementioned databases and monitoring programs are important for research and conservation. GRIN does not intend to supersede, replace, or duplicate any of these efforts. Instead, GRIN will use data from all available sources to discern the conservation status of raptors across the globe.

Data security and protecting raptors threatened by illegal wildlife trade (Buij et al. 2016, Panter et al. 2019) and poaching (Ogada et al. 2016, McClure et al. 2018, Rodríguez et al. 2019) are paramount. Data security is therefore a priority of GRIN. Anti-hacking and sharing policies to prevent unintended dissemination of sensitive information have been instituted. Data from the GRIN mobile app are firewalled and encrypted in an Enterprise Geodatabase using the ArcGIS Server on Amazon Web Services' cloud where Amazon and ESRI's suite of security measures protect GRIN data. Users of the app have the option of marking their records as confidential to ensure that their data will only be used by GRIN staff and direct collaborators in research and conservation and not shared with outside parties.

Analytical Tools. GRIN will include analytical tools that specifically inform conservation assessments and direct conservation action. For example, flight altitude is an important determinant of collision risk with wind turbines (Khosravifard et al. 2020, Murgatroyd et al. 2021). Data recorded via the GRIN mobile app can therefore be used to inform the potential collision risk with wind turbines. A simple comparison of observed flight altitudes of African Marsh-Harrier (*Circus ranivorus*) and White-backed Vulture (*Gyps africanus*), which were collected via ARDB and/or GRIN, demonstrates the utility of such analysis—with White-backed Vulture observed at the height of modern horizontal-axis turbine rotor-swept zones (50–150 m; Poessel et al. 2018) far more often than the lower-flying African Marsh-Harrier (Fig. 3). Further, analytical tools to account

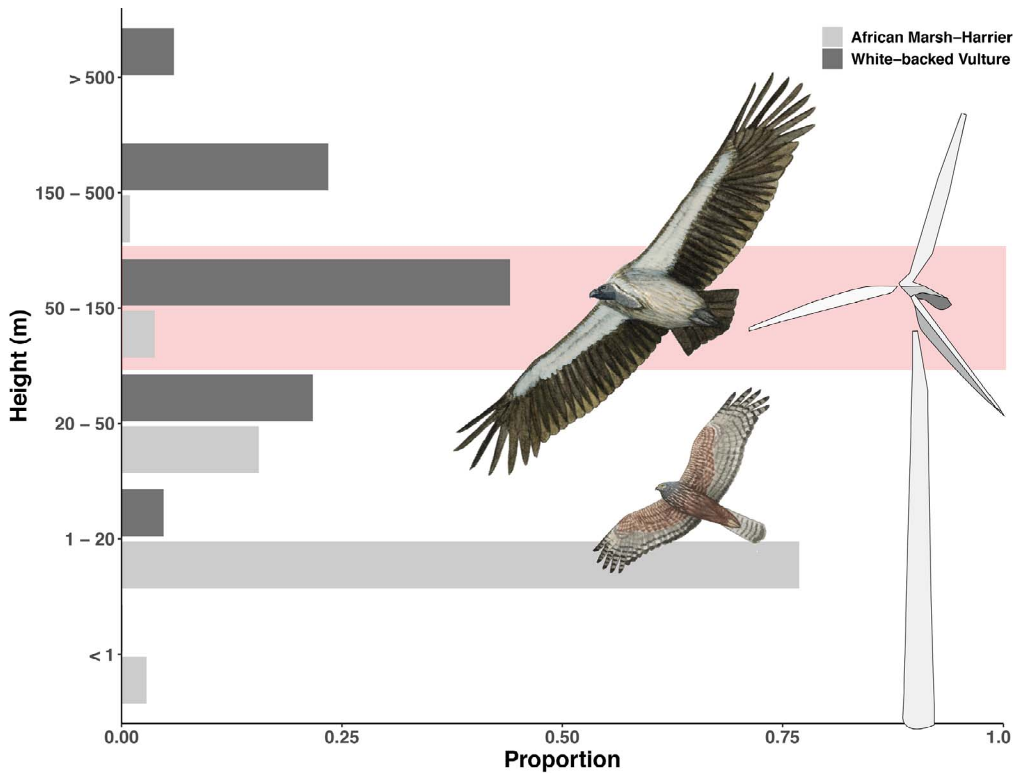

Figure 3. Proportions of flight altitudes of African Marsh-Harriers (*Circus ranivorus*; $n = 212$) and White-backed Vultures (*Gyps africanus*; $n = 2226$) collected using the African Raptor Databank (ARDB) or Global Raptor Impact Network (GRIN) apps. The pink rectangle at 50–150 m represents the height of the rotor-swept zone of a modern horizontal-axis wind turbine (Poessel et al. 2018).

for varying speeds traveled during road counts (McClure et al. 2021b) and other road count analyses that harness the data collection abilities of the GRIN mobile app are currently in development. GRIN's infrastructure will therefore facilitate collaborative analyses of road count data while improving the usefulness of population estimates by correcting for factors such as heterogeneity in effort and detection rates.

The natural history of raptors makes them susceptible to precipitous population declines, as seen during the African and Asian vulture crises (Pain et al. 2008, Ogada et al. 2016, Botha et al. 2017). GRIN must therefore keep a "finger on the pulse" (i.e., be updated at relevant time intervals) of raptor populations so that conservation action can be taken while populations are recoverable. Analyses for GRIN to inform BirdLife International's Red List assessments are thus under development. Metrics that are important for such assessments include a species' range, population size, and population trend (Mace et al. 2008, IUCN Standards and Petitions Subcommittee 2017). Global monitoring of these metrics requires acquisition of data from disparate programs and then integration into single estimates and associated precision (i.e., model-based data integration; Isaac et al. 2020). Data integration is a nascent area of research; however GRIN is building upon new data integration techniques to combine road count data with Christmas Bird Count data (Butcher et al. 1990), and eBird data with satellite tracking data to provide improved estimates of species' trends and distributions. Models currently exist to integrate some time series data (Loh et al. 2005, Gregory and Van Strien 2010, Paprocki et al. 2017) and these analyses will be applied to individual raptor species.

GRIN developers have identified models to estimate a species' range using tracking data (J. McCabe et al. unpubl. data) as well as data sourced

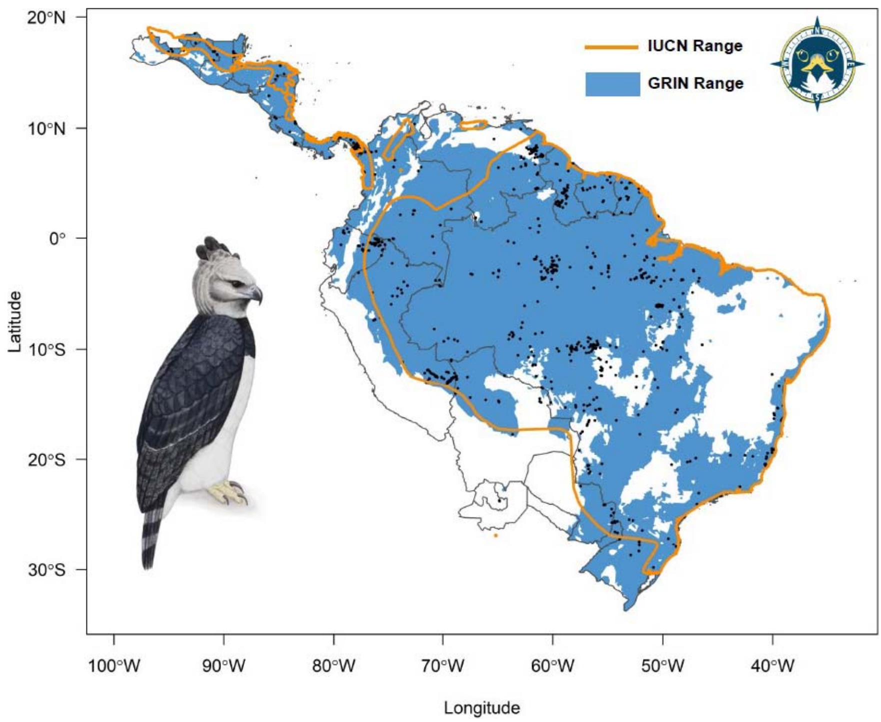

Figure 4. Binary range prediction for the Harpy Eagle from Sutton et al. (2021). Orange polygons define current range for the Harpy Eagle determined by the International Union for the Conservation of Nature (IUCN). Blue area is the suitable environmental space, or range, determined using data from the Global Raptor Impact Network (GRIN). Gray lines depict national borders and state boundaries within Argentina and Mexico. Black points depict Harpy Eagle occurrences within GRIN.

from community scientists, museum specimens, professional researchers, and the scientific literature (Sutton and Puschendorf 2020, Sutton et al. 2020, 2021). For example, Sutton et al. (2021) recently proposed a reduced range size (–11%) for the Harpy Eagle (*Harpia harpyja*) compared to the current IUNC measure (https://www.iucnredlist.org/species/22695998/117357127). This estimate was derived from spatial models built with occurrence data from GRIN (Fig. 4). GRIN is therefore advanced enough to be useful now—with some analytical tools developed and the app available for use by raptor researchers—and will continue to grow in utility.

Sharing Data and Information. To be effective, the bibliography, contents of the library, and outputs of GRIN analytical tools must be readily available to raptor researchers and conservationists. This next generation of GRIN will fulfill the past mandate of the Global Raptor Information Network to synthesize and disseminate scientific literature, while highlighting priorities for research. Indeed, GRIN is now home to the research and conservation priority index for raptors, developed by HawkWatch International and collaborators (Buechley et al. 2019). This index combines information regarding the amount of research conducted on a given species and its IUCN conservation status into one measure of research and conservation priority. Users of the GRIN website will soon be able to sort and search species by the research and conservation priority index values, and this index is planned for update approximately every 5 yr.

GRIN partners are examining methods of synthesizing and presenting information from the scientific literature needed by the raptor research community but not currently implemented by other entities. Systematic reviews (Pullin and Knight 2009), and scoping reviews (also referred to as systematic maps; James et al. 2016) are such tools. Systematic reviews objectively and quantitatively address a specific question, often related to a conservation intervention, whereas scoping reviews collate, describe, and catalog the literature regarding a topic (Pullin and Knight 2009, James et al. 2016, Sargeant and O'Connor 2020). A scoping review can sometimes be an intermediate step of a systematic review (James et al. 2016, Sargeant and O'Connor 2020). GRIN will therefore draw upon the literature of systematic and scoping reviews to implement a rigorous and repeatable approach to bibliography development. This approach uses standardized keyword searches of online databases and institutional libraries to build and synthesize bibliographies. The methodology we have developed for scoping reviews will be applied to each raptor species and to specific research topics. For example, the review conducted by McClure et al. (2021a) of road count methodology in raptor surveys can be updated periodically with tables maintained online.

The GRIN website (www.globalraptors.org) will be the principal medium through which information is shared. The website is currently exclusively in English, but other languages, including Spanish, French, and Portuguese will be implemented. Future species accounts will minimize repetition of information on other venues such as Birds of the World and will be more technical. Specifically, the GRIN species accounts will present the results of GRIN analyses and scoping bibliographies per raptor species. Visitors to a particular species account will therefore be able to access information regarding range size, population levels and trends, confidence in those values, and the results of scoping reviews for that species. Other websites have eclipsed GRIN in enabling researcher profiles and download of the scientific literature, thus GRIN will no longer serve these functions. However, the gray literature within the Raptor Information System is still available electronically via request from The Peregrine Fund's Research Library.

Most data in GRIN will be available for download on the website. GRIN will implement a tiered sharing system such that users can set their data at levels ranging from unavailable for download, to only available for certain uses, to completely unrestricted. These sharing levels will be similar to the tiers of the Avian Knowledge Network's (www.avianknowledge.net) data sharing scheme. Depending on the tier, data will be available to governments, nongovernmental organizations, universities, industry, the general public, and other users. Data for threatened species and targets of poaching, nests, and those marked as confidential, will automatically be set to the strictest tier to prevent the sharing or posting of sensitive data. The GRIN data sharing scheme will therefore adhere to data sharing standards that ensure the security of sensitive data. We hope such data sharing will allow for enhanced collaboration among raptor researchers and conservationists.

Collaboration

GRIN is designed to foster collaboration. For example, according to GRIN's data sharing agreements and the end user license agreement of the GRIN mobile app, if a dataset constitutes at least 10% of the data used in an analysis, the contributors of the data will be invited to co-author any product resulting from use of those data. Further, GRIN's approach is to be generous with opportunity for coauthorship, never providing gift authorship, but granting the opportunity to earn authorship when possible. Although many databases are freely available (e.g., from www.hawkcount.org), their analysis and publication will ideally be a collaboration. Indeed, collaboration can help avoid the misuse of data by incorporating detailed knowledge and metadata from those who helped assemble the dataset.

Diverse and inclusive scientific communities are known to be more productive, innovative, and impactful (Jimenez et al. 2019). Many of the understudied and threatened species are located in the Global South, where limited funding and other challenges may hinder raptor research and conservation (Santangeli et al. 2019b). GRIN specifically aims to invite early career scientists, especially those from communities that are underrepresented in raptor research. We will aim to include guidance from diversity and inclusion experts as we implement this objective.

National and international entities will also be encouraged to take advantage of GRIN's data collection, storage, and analysis infrastructure to address conservation and research targets under international agreements. For example, the Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia (Raptors MOU) is under the United Nations' Convention on Migratory Species. A priority action for the Raptors MOU is to assess and monitor raptor populations throughout range states. Indeed, Activity 5.1 of the Raptors MOU action plan calls for the establishment of "... flyway-scale monitoring networks comprising a representative range of sites where systematic and coordinated monitoring of breeding populations, reproductive success and migration numbers (spring and autumn) can be undertaken." (Raptors MOU 2008). A recent review of the Raptors MOU Action Plan found that many signatories have difficulty implementing activities in the Action Plan because of a lack of financial resources and capacity (Pritchard 2020). GRIN could provide a large part of the technological infrastructure needed to monitor raptors, thus lowering some barriers to implementation of the Raptors MOU Action Plan and similar efforts.

Such infrastructure will not only allow individual entities to achieve their own goals, but will facilitate the collaboration necessary for monitoring, research, and conservation of the world's raptors at scales unachievable by any single entity. GRIN is part of the newly formed Global Anthropause Raptor Research Network—a network of researchers studying the effects of the COVID-19 "anthropause" on raptor ecology and research (Sumasgutner et al. 2021)—and the One Health initiative to conserve Old World vultures and their ecosystem services (Ottinger et al. 2021). These entities are taking advantage of GRIN's infrastructure to deposit data from multiple research programs into a single platform for collation, storage, dissemination, and analysis.

The philosophy behind GRIN is that enhanced collaboration, data sharing, and networking among raptor researchers and conservationists will ensure the conservation of raptors. In this spirit of collaboration, a survey is available on the GRIN website that solicits input from raptor researchers regarding features of GRIN that need development or improvement. This anonymous survey will remain open in perpetuity. GRIN plans to use this input to continually ensure that it provides cutting-edge tools needed by the raptor research community. Given the staggering challenges faced by raptor conservationists (McClure et al. 2018, Sarasola et al. 2018, Buechley et al. 2019, McClure and Rolek 2020), success will be achievable only through a collaborative global network of governmental entities, individual researchers, community scientists, international consortia, and nonprofit organizations.

Supplemental Material (available online): Contributor Roles Taxonomy (CRediT; credit.niso.org) of author contributions.

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