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Viewpoint

Unnatural history: is a paradigm shift of natural history in 21st century ornithology needed?

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Natural history, across disciplines, is essential for the continuation of science, especially as we attempt to identify the myriad of threats that biodiversity faces in this rapidly changing world. Recording the natural history of birds is perhaps the most prominent, widespread and long-standing pursuit of this activity. Yet, there is a distinct decrease in publishing of natural history in the ornithological sciences. Concomitantly, the natural history information being published is often in small and regional journals, less accessible by the global ornithological community. We argue that historical natural history needs a modern reinvigoration, and should focus on placing natural history observations in the context of an anthropogenically altered world – 'unnatural history'. This includes, but is not limited to, behavioural adaptations, novel diet choices, hybridization and novel adaptations to urbanization. Here, we elaborate on natural history's place in modern ornithology, how this relates to citizen science and the potential cost of ignoring it. Ultimately, increased accessibility of natural history observations, encouragement of amateur ornithologists' participation in professional societies (and vice versa) and targeted citizen science projects are potential mechanisms by which to reinvigorate natural history in 21st century ornithology.

Natural history is broadly defined as the observation and description of the natural world (Bartholomew 1986, Herman 2002, Greene 2005, Schmidly 2005) and has contributed enormously to conservation, management, recreation, human health and food security (Tewksbury *et al.* 2014). Documentation of natural history has declined across disciplines (Greene & Losos 1988, Noss 1996, Wilcove & Eisner 2000), which is concerning, as it has underpinned 21st century science (Tewksbury *et al.* 2014, Barrows *et al.* 2016). Furthermore, across disciplines, there is a disconnect between the value and relevance of natural history in 21st century science (Barrows *et al.* 2016). Birds have reaped the benefits of being the most prominent, widespread and long-standing pursuit of this activity. Yet, there has also been a decline in documenting the natural history of birds, while there has been a simultaneous increase in citizen science, presenting a potential opportunity for natural history observations to be documented.

Birds are conspicuous, ecologically diverse, occur worldwide and are better known than other vertebrate groups (Whelan *et al.* 2015), partly because of the long-standing tradition of natural history. More than a century ago, avian natural history focused on 'habits, songs, [and] nesting' (Ridgway 1901), contrasting a scientific or technical ornithology at the time, which encompassed structure and classification of birds. Today, the former is rarely practised by professional ornithologists, whereas the latter is predominantly focused on novel hypothesis-driven research (Bijlsma *et al.* 2014). This is due to both the popularity of birds as model organisms for testing hypotheses and the fact that grants, publishing and tenure favour discrete studies which are more easily associated with the research progression of ornithologists. This change is evidenced by shifts in scientific publications from incidental or qualitative observations to focused question-driven or quantitative studies (e.g. *Emu*: Yarwood *et al.* 2014, *Bird Study*: Bibby 2003). High-impact scientific journals generally seek heavily focused hypothesis-driven research, using increasingly sophisticated modelling (Bijlsma *et al.* 2014). Importantly, we realize the fundamental role that hypothesis-driven research plays in answering questions in biology. This rigorous science provides significant insights into management and conservation of species, including birds. However, we feel it is worth revisiting the complementary role of natural history in ornithology to better understand its role in the conservation and management of avian populations in the 21st century. We feel *all* natural history observations are worth credence, and previous commentaries have highlighted that only a third of all bird species are well known (Xiao *et al.* 2016). However, specifically, we argue that those observations which are placed in the context of a rapidly altering world are of great significance, i.e the 'unnatural' history of a species, regardless of current baseline information. Especially in the Anthropocene era, it is more important than ever that we maximize the contribution of natural history and citizen science to increase our understanding of the world.

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We examine the place of natural history in modern ornithology, delineate what we mean by unnatural history, the decline of natural history and the potential cost of ignoring it, and propose potential mechanisms by which to reinvigorate natural history. We discuss the necessity of systematic scientific investigation to capture the plethora of bird behaviours outside the specific range of scientific inquiry of a study.

NATURAL HISTORY IN THE 21ST CENTURY

Natural history, in the traditional sense of the term, has had significant impacts in ornithology. For instance, natural history observations of New Caledonian Crows *Corvus moneduloides*, published as a letter to *Nature* (Hunt 1996), fundamentally shifted our understanding of tool use and cognitive function of birds. Yet, there is currently an increasing gap between natural history observations and focused science, risking opportunities for understanding how avian species are adapting or failing to cope with the myriad threats that face them (e.g. urbanization, agricultural intensification, non-native introductions and climate change). Placing current natural history observations in this context is critical for understanding the extent of threats to certain species. For example, innovative behaviours are often used as a measure of behavioural flexibility (Lowry *et al.* 2013) and thus as a predictor of the ability of a species to adapt to current threats. Short, descriptive notes documenting adaptive or maladaptive behaviours in response to a novel and changing environment (i.e. natural history) have made a significant contribution to our understanding. The relationship between plasticity and brain size in avian species benefited enormously from data compiled from 'short notes' of novel feeding behaviours in ornithological journals (Lefebvre *et al.* 1997, 1998). From a conservation perspective, there are seldom sufficient natural history observations of the invasion of non-native species, including negative or positive interactions (e.g. hybridization, direct and indirect competition, and predation) with native flora and fauna, to provide a basis for management action. For instance, the paucity of observations that Baker *et al.* (2015) use to summarize threats from introduced birds to native avifauna highlights our point. Undoubtedly, many more anecdotal observations have been observed by amateurs than the authors were able to find in the literature.

Other natural history observations provide good examples of how this pursuit may contribute to a broad understanding of avian ecology in a changing world (Table 1). Such examples illustrate the importance and need for natural history in ornithology today.

UNNATURAL HISTORY

Here, we recommend an approach to natural history in the 21st century, termed *unnatural history*: the often opportunistic observation and description of avifauna *placed in the context of a rapidly altered and changing world*, and their adaptive or maladaptive behaviours, generally at an individual level. This could include innovative behavioural adaptations, novel diet choices, hybridization, phenological changes in response to a warming climate, non-native interactions with native species and novel adaptations to urbanization (see Table 1 for selected examples). The popularity and commitment to citizen

Table 1. Examples of natural history observations of novel or interesting bird behaviours within a rapidly changing world.

Category	Observation	Citation
Novel foraging	Great-tailed Grackles *Quiscalus mexicanus* feeding on dead bugs from licence plates	Grabrucker and Grabrucker (2010)
	Novel prey items of raptors documented by a professional photographer	Sergo and Shine (2015)
	Sugar packet opening by Noisy Miners *Manorina melanocephala*	Delgado and Correa-H (2015)
Anthropogenic nesting	First nesting record of Florida Scrub Jay *Aphelocoma coerulescens* using an anthropogenic nest-site	Miller (2015)
	Kelp Gull *Larus dominicanus* nests contain high amounts of anthropogenic debris	Witteveen *et al.* (2017)
	Ground-nesting birds using green roofs in Switzerland	Baumann 2006,
	Unusual and noteworthy nesting records for Guatemala	Eisermann and Brooks (2006)
Anthropogenic light use	Shorebirds using anthropogenic light to forage	Dwyer *et al.* (2013)
	Nocturnal feeding by a White-faced Heron *Egretta novaehollandiae*	Higgins and Smith (1999)
Invasive species interactions	Interactions between Common Starlings *Sturnus vulgaris* and Lewis's Woodpeckers *Melanerpes lewis* at nest cavities	Vierling (1998)
	First documented nesting record of Egyptian Goose *Alopochen aegyptiaca* in Florida	Braun (2004)

science (Greenwood 2007) could provide the modern technological mechanism for collecting such basic unpublished and undocumented natural history information. Importantly, this definition of natural history differs from the myriad of basic, life-history data that are collected on the distribution and timing of avian species (e.g. ringing stations, incidental-based broad-scale citizen science projects such as eBird) or on the breeding biology of birds (Xiao *et al.* 2016), which are also critical to our current understanding of avian populations.

THE DECLINE IN NATURAL HISTORY

Natural history in ornithology has probably declined through a lack of funding, an increased disconnect between amateur and professional ornithologists, a reduction in publication opportunities, and professional recognition. There are few philanthropic or government sources willing to fund research which focuses on natural history in ornithology. Funding primarily goes to disciplines of modelling, laboratory and theoretical research, with the aim of publishing in high-impact journals (Barrows *et al.* 2016). Concurrently, there has been a decrease in publishing by private citizens, with a subsequent increase involving universities and multiple institutions (Yarwood *et al.* 2014).

Many professional ornithologists spend relatively little time in the field because they need to publish peer-reviewed manuscripts, write grant proposals and keep up with the current literature. If today's professional ornithologists no longer receive funding to observe novel interactions of avian species, and amateur (i.e. private) ornithologists are no longer publishing natural history information, many important observations go undocumented in the peer-reviewed literature. Accentuating this problem, some ornithological journals (*Auk*, *Condor*, *Ibis*, *Journal of Avian Biology*, *Emu*) have shifted their focus from natural history to hypothesis-driven research (Bijlsma *et al.* 2014), perhaps further separating amateur from professional ornithologists. However, natural history has not completely disappeared from the ornithological literature, or from broader ecological literature. Some ornithological journals (*Wilson Journal of Ornithology*, *Ardea*) continue to recognize the importance of natural history (Bijlsma *et al.* 2014). Further, some ecology journals *(Frontiers in Ecology* and *Environment & Ecology*) have recently added additional publishing schemes for authors wishing to publish natural history observations (*Natural History Series* and *The Scientific Naturalist*, respectively); both cite the long-standing foundation natural history has in ecology, evolution and conservation. Peer-reviewed ornithological natural history continues to be published in local and regional journals (e.g. *Stilt* – http://awsg.org.au/publications/stilt/, *Corella* – http://www.absa.asn.au/publications/about-corella/, *Florida Field Naturalist* – http://www.fosbirds.org/content/florida-field-naturalist) but these are generally less accessible via high-powered search engines (e.g. Google Scholar, Scopus, Web of Science), making such literature generally inaccessible by the global community of ornithologists.

REINVIGORATING THE ROLE OF NATURAL HISTORY IN THE 21ST CENTURY

We propose the following mechanisms by which we can reinvigorate the decline of natural history reporting in the ornithological literature. First, improve accessibility of natural history observations in local and regional journals. Secondly, encourage amateur ornithologists to publish novel observations. Thirdly, capitalize on the current wave of enthusiasm for citizen science projects, especially among younger age groups.

Improving accessibility of local and regional natural history observations

There is a need to better collate and archive natural history observations, making the information readily accessible. Although not specific to natural history observations, the searchable ornithological research archive (SORA; sora.unm.edu) is an open-access and accessible archive of ornithological publications. From the website: 'It provides access to an extensive library of ornithological literature of international scope, and detailed material documenting the history of ornithology in North America over the last 120 years'. Another example, the corvid database, includes all publications on all extant and extinct crows, ravens and magpies (Droege & Töpfer 2016), archiving 8000 articles (including 1503 journals, books, theses and dissertations), spanning 500 years, from 164 countries.

The creation of a natural history, open-access database of birds would be a monumental undertaking, but it is feasible in the 21st century age of big data. We envision a database that could serve as a central repository of natural history observations for both published and unpublished observations. Notably, many more observations have been documented (i.e. through modern technological advances) or observed by amateur experts than have been published as peer-reviewed notes. The database would critically incorporate both of these instances and serve as a central archive of previously published natural history notes as well as a collection hub of unpublished but relevant natural history observations. It would be vetted by professionals and amateur experts, but the onus of placing the observation in the proper context would be on the observer. Both sections of the database could be tagged with keywords (e.g. behaviour, novel, nesting, hybridization, invasive species). A central collection of natural history observations would increase our understanding of the world of birds, while also

serving to inform hypothesis-driven questions (see Lefebvre *et al.* 1997, 1998). Such a database would fill a fundamental gap in ornithological knowledge, providing a resource for researchers and decision makers with baseline information available for specific species.

Encouraging publications in natural history

Increasing numbers of 'amateur ornithologists' enjoy bird-watching, but their contribution to documentation in the ornithological literature has decreased (Yarwood *et al.* 2014). Birders commonly travel long distances in the pursuit of priority species or locations (Kerlinger & Brett 1995, Sekercioglu 2002), with global avitourism an important industry (Steven *et al.* 2015a,b). Birders now visit places that historically were difficult to access, such as Neotropical countries, with surprising regularity (Steven *et al.* 2015b). These birders may observe (intentionally or unintentionally) novel and important natural history information on poorly understood species (e.g. Neotropical species; Freile *et al.* 2014) that are facing significant anthropogenic threats. This natural history information has the potential to provide valuable baseline information for future conservation and management decisions. Professional ornithologists should encourage amateur ornithologists to write up novel and noteworthy sightings. Thus, greater communication between the professional and amateur ornithological communities is required. Such increased communication may have additional benefits for professional ornithologists, demonstrating relevance of research for non-scientists, through outreach, which bodes well with funders and administrators. For example, how many professional ornithologists are members of recreational birding clubs and regularly attend meetings? Further, ornithological societies should encourage participation by private individuals or 'amateur' ornithologists in conferences and meetings. Although many birdwatchers are list-focused and may not be motivated to contribute to science in this manner, we think that an increase in communication and encouragement by professional ornithologists could help alleviate this.

Another group which could also contribute are graduate students, who may observe novel behaviours or noteworthy natural history information worthy of publication, perhaps as part of their coursework (e.g. written comprehensive examination) or research. Graduate students rarely publish their observations, despite sometimes spending extended periods observing natural history in the field, intentionally or unintentionally. A combination of factors contributes to this circumstance, including a lack of incentives to write low- or no-impact natural history notes, or a lack of support from supervisors. Publishing noteworthy observations should be encouraged by supervisors; succinct notes are excellent practice in scientific writing for graduate students. They also offer an opportunity to become familiar with the publication process, potentially as the sole author of a scientific work – demonstrating independence, and possibly engaging in the peer-review process as a reviewer.

Citizen science – an untapped opportunity

Citizen science, engaging the public in a scientific project, has a long history within the ecological sciences (Kobori *et al.* 2015). Ornithology has historically relied on natural history observations, the precursor to some of today's citizen scientist projects and participants (Greenwood 2007). Global citizen science programmes such as eBird (Sullivan *et al.* 2014) have collected over 300 million bird observations from around the world (Kelling *et al.* 2015). While this highlights the ability to engage citizen science participation in data collection, the drawback is that citizen science programmes generally target presence/absence or abundance data. Few citizen science projects collect data on ecology, reproduction and life

Table 2. Selected examples of targeted citizen science projects which collect data on life history, ecology or reproduction, generally focused on specific species.

Project title	Aim	Citation or website
Texas Invasive Birds Project	Collect and collate life history information on invasive birds in Texas	Brooks (2013b), Callaghan and Brooks (2016), http://www.hmns.org/invasivebirds
Wingtags	Learn about the Sulphur-crested Cockatoo's *Cacatua galerita* roosting and breeding habitat, population size and foraging, and site fidelity.	Davis *et al.* (2017), http://cockatoo.wingtags.com/
NestWatch	Measuring breeding success of common North American bird species	http://nestwatch.org/
Birds and Windows Project	Investigating the effects on bird–window collisions	Kummer and Bayne (2015), http://birdswindows.biology.ualberta.ca/
Condor Watch	Identify individual condors and behaviour, by looking through photos from motion-activated cameras	https://www.condorwatch.org/
Shadow-boxing Birds	Documents the species of birds which are known to fight their reflection in various mirrors or windows	Roerig (2013), https://shadowboxingbirds.wordpress.com/

history, the province of natural history (Table 2). We believe that increasing the number of structured, targeted citizen science projects on particular species (e.g. invasive species or data-deficient native species), or in specific habitats, holds the potential for collecting natural history observations of considerable value (Table 2). The results of these targeted citizen science projects should then be published in peer-reviewed ornithological or ecological journals. Furthermore, citizen scientists should be encouraged by professionals to publish their significant observations in natural history repositories, potentially increasing their sense of fulfilment by contributing to the greater scientific enquiry.

Going beyond observations and the increasing birdwatching community across the world (Cordell *et al.* 1999, Cordell & Herbert 2002, Aula 2011), future natural history observations and journals should incorporate technological advances. Modern digital capabilities have the potential to allow natural history records to go beyond a written account, incorporating images, video (Brooks 2013a) and audio recordings of unique behaviours (Eubanks 2015). In addition, drones (Vas *et al.* 2015) and motion-activated cameras (Cutler & Swann 1999) are increasingly used in scientific studies. However, many operators of these technologies are amateurs, incidentally collecting data that may be highly pertinent (e.g. bird responses to the technology, novel behaviours), but who may not be aware that it is unique. Considerable information recorded by this technology fails to make it into the ornithological literature, or to ornithologists at all. Internet coverage and platforms provide professionals and amateurs with the ability to document and communicate novel observations at an unprecedented rate. Programmes that look to take advantage of this incidental data collection are needed.

CONCLUSION

Natural history is critical to the continuation of science, and is fundamental to progressing the field of ornithology, especially as we attempt to identify and elucidate the significant threats that biodiversity faces in this rapidly changing world. As such, we propose a shift in the focus to *unnatural history*, which encompasses a modern spin on historical natural history. We believe that increased accessibility of such observations, encouragement of amateur participation in professional societies (and vice versa) and targeted citizen science projects are solutions to reinvigorate natural history in ornithology. We urge professional ornithologists to recognize the validity and importance of increased communication with amateur ornithologists, and to reinvigorate the field of natural history in the 21st century.

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