Gyrfalcons and Ptarmigan in a Changing World

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Source: Journal of Raptor Research, 47(1) : 83-86

Published By: Raptor Research Foundation

URL: https://doi.org/10.3356/JRR-Book_REview.1

BOOK REVIEW

J. Raptor Res. 47(1):83–86

Gyrfalcons and Ptarmigan in a Changing World. Edited by Richard T. Watson, Tom J. Cade, Mark Fuller, Grainger Hunt, and Eugene Potapov. 2012. The Peregrine Fund, Boise, Idaho, U.S.A., 2 volumes, 372 pp., 400 pp. ISBN 9781461129073, 97814699 43305. Paperback: maps, photos, figures, tables. Price $37 each volume or free online.—The Peregrine Fund has published proceedings of several conferences over the years and has become expert at the task, and this 2-volume set is no exception. The title of the proceedings sounded especially interesting in this era of almost daily accounts in the media about climate change, its causes and its effects on the planet, including its flora and fauna.

From the Preface, it was noted that climate change modeling predicts large alterations in species' distributions and the potential for extinctions; however, phenological factors involving predator-prey interactions and interspecific competition add levels of complexity that make forecasting difficult. So, this proceedings provides an opportunity to discover, first hand, what is occurring in the Arctic (a region where earliest responses are expected in a relatively simple ecosystem where processes are perhaps easier to understand) with the Gyrfalcon (*Falco rusticolus*), and virtually its only prey (ptarmigan) available during courtship and incubation in most regions. Volume I includes an overview of Gyrfalcons, ptarmigan and the Arctic, plus Gyrfalcons and ptarmigan in North America. Volume II includes Gyrfalcons and ptarmigan in Greenland, Iceland, Scandinavia, and Russia, plus related raptor species (mostly Peregrine Falcons [*F. peregrinus*]) and monitoring and conservation strategies.

The Peregrine Fund, together with Boise State University and U.S. Geological Survey, convened the international conference in February 2011 on the ecology and conservation of the Gyrfalcon with special emphasis on the three species of ptarmigan with which it has a strong predator-prey relationship. The conference was attended by 120 experts in the fields of climate change, the arctic ecosystem, the natural history and ecology of Gyrfalcons, other perhaps competing raptors, ptarmigan, seabirds and mammals, and the conservation, management and monitoring of these species. The proceedings includes 52 peer-reviewed papers, four republished papers, six extended abstracts, eight abstracts and three oral paper transcripts. It is strongly recommended that readers first read the ''conference summary'' by Ian Newton, prior to reading any of the individual papers. Newton has a special way, based on his long career as a researcher and writer, of placing the findings from many sometimes unconnected individual reports into a unified perspective. His assessment also concludes with a section on priorities for future work.

Several general concepts provide the foundation for much of the information presented at the conference. The response of a predator species to climate change will be influenced by the responses of its prey and competitors, and so forth throughout the food web. Furthermore, the complexities of ecological systems warrant sensible approaches for assessing and establishing the role of natural climate variability in order to substitute inferences about the potential effects of global warming (Douglas). Two non-raptor examples from the Arctic provide some excellent perspective. Amstrup reported that because polar bears (*Ursus maritimus*) depend upon sea-ice (and sea-ice dependent seals for food), habitat that literally melts away as temperatures warm, projections of the future are more straightforward for polar bears than for most other species. A long-term dataset on Black Guillemots (*Cepphus grylle mandtii*) provides additional insight into how a species in the Arctic responds to climate change (Divoky). This species did not breed in northern Alaska until the 1960s when warming temperatures allowed access to nest cavities for the 80 d needed for successful reproduction. The species thrived in 1970s and 1980s when ''summer length'' continued to increase and arctic pack ice remained within the 40 km foraging range of breeding colonies. Then, continued temperature increases and reduction in summer pack ice resulted in decreased nesting success by modifying distribution and abundance of prey, competitors, and predators. Lower-quality prey to feed young resulted in brood reduction and lower fledging weights. The decreasing ice also allowed Horned Puffins (*Fratercula corniculata*) to colonize the region and compete with guillemots for nest cavities. Lastly, polar bears abandoned summer ice and swam to guillemot nesting areas where they ate eggs and nestlings, causing almost complete nesting failures during the last three years. Now these guillemots can only nest successfully in bear-proof nest boxes. From many papers at the conference, it should be noted that Gyrfalcons have a broad range of habitats from north-temperate to arctic conditions (though breed only in Arctic) and are capable of taking multiple species of prey when available. Therefore, predicting regional impacts of warming on Gyrfalcons are likely to be much more complicated than for polar bears or guillemots.

A review of the Gyrfalcon's ecological relationships and what is known about its population history by Cade reveals some vulnerability to the potential effects of climate change on Arctic environments, but also some possible mitigating adjustments and (page 35) ''… there is little doubt that the Gyrfalcon has experienced repeated expansions, contractions, and fragmentations of its breeding range during the Pleistocene glaciations, and its past adaptability to survive these changes suggests that it will have considerable ability to adjust to the current climate changes that are upon us, unless they become too rapid and severe owing to anthropogenic influences.'' The Gyrfalcon relies on two ptarmigan species for 50–90% of its diet biomass (especially early in breeding season), so it is likely that an effect of climate change on Gyrfalcons will be mediated through impacts on ptarmigan, thus Cade notes that the main source of food early in the season needs to be better understood for the various populations.

Circumpolar diets of the Gyrfalcon were reviewed in detail by Potopov, but only two studies (in Iceland and Russia) were conducted during this critical early stage of the breeding season. Furthermore, the longer warmer Arctic summer might offer Gyrfalcons some opportunities to adjust their annual cycle to new sources of food during the pre-laying period. Hunt notes that the manifestations of climate change can be regarded as a suite of input adjustments applied to a long-term ecological experiment with Gyrfalcons and ptarmigan, rich with replicates in the form of isolated study areas within the circumpolar region.

So now, with somewhat less complex examples mentioned for the polar bear and Black Guillemot, what do we know now about how the Gyrfalcon has responded or may respond to climate change? And, what types of data are being collected and evaluated to address the climate change issue? Gyrfalcons are being studied by many researchers across the circumpolar region, but what are their approaches, and are the studies unified or fragmented? The fact that this conference occurred with a published proceedings indicates the recognition that a unified approach is required.

Several long-term data sets (the most useful) detailing distribution and abundance of Gyrfalcons are available, with some surveys compromised by survey timing. In the Yukon Territory, Willow Ptarmigan (*Lagopus lagopus*) have been monitored since the late 1950s, and Gyrfalcons since the mid-l970s (Mossop). This impressive long-term study showed stable, regular, and synchronous 10-yr cycles for both species. However, beginning in 2000, the data suggest that the regular cycling of ptarmigan may be faltering, with the Gyrfalcon breeding much later, perhaps producing fewer young and declining in abundance. Mossop notes that Gyrfalcon productivity through the few years of peak ptarmigan productivity may be critical. Similarly, Cade and Bird note that the dependence on species that cycle or fluctuate from low to high numbers could seriously hinder the survivability of Gyrfalcon populations if climate change were to reduce the amplitude or increase the period between peak years of abundance.

Results of a study in the Province of Jämtland, Sweden (1996–2010) showed a strong correlation between Willow Ptarmigan numbers and Gyrfalcon breeding parameters, with a time lag of one year (Falkdalen et al.). Two other long-term study sites in Greenland (1998–2006, and 1994–2006, 2008–2010; Burnham and Burnham) and Iceland (1981–2010; Nielsen) provide additional locations with continued monitoring. Nielsen provides much information on annual Rock Ptarmigan (*Lagopus muta*) populations (cycles), Gyrfalcon occupancy rates, diet, and reproductive success. He also reviewed other studies and noted concerns about length of studies (rule of thumb: should be at least three times cycle period to be useful) and methods for calculation of occupancy rates. Another data set (2000–2010) is available from Fennoscandia (Koskimies). A study (1981–2010) on the Yamal Peninsula, Russia, involves tree-nesting Gyrfalcons (Mechnikova et al.) Until the 1990s, Gyrfalcons occupied almost exclusively large tree nests built by White-tailed Eagles (*Haliaeetus albicilla*), but from the 1990s began more frequently to occupy medium- or even small-sized nests built by corvids and Rough-legged Buzzards (*Buteo lagopus*). However, numbers of large tree nests had not decreased. Average brood size was less in the smaller nests, and the authors suggested that unstable weather conditions (climate change?) of thaws interchanging with frosts produced solidified snow/ice that Gyrfalcons were unable to remove from larger nests.

The authors recently began installing artificial nest-boxes with sheds similar to cliff overhangs on trees as a provisional measure to reduce chick mortality. This Gyrfalcon population declined in recent years (perhaps from nest robbing for falconry and poor production) in spite of a Willow Ptarmigan recovery. Morozov also suggested using artificial nest structures (with or without nests) to increase Gyrfalcon populations in other areas of European Russia and Western Siberia where high numbers of Willow Ptarmigan exist in locations lacking trees or cliffs for nesting. The first systematic study of Gyrfalcon artificial nests occurred in northern Norway (2000–2010; Østlyngen et al.). Cliff ledges were improved or platforms constructed for artificial Raven (*Corvus corax*) nests. The study confirmed that Gyrfalcons make use of artificial nests for breeding, that they accept a variety of nest constructions, and that reproduction is comparable to that in natural nests. Also, the study showed breeding in areas with no history of Gyrfalcon occupation.

Other studies investigated ptarmigan distributions in relation to expansion of woody shrubs associated with warming over the last 50 yr. Ptarmigan may benefit from shrub expansion due to increased food and cover from predators (Christie et al.), but understanding how large- and medium-sized herbivores may react to changes in willow cover and thicket configuration is needed to predict how the arctic ecosystem may change in the future (Ehrich et al.).

An important question in the debate on the ecological effects of climate change is whether Gyrfalcons will be able to adapt fast enough to keep up with their changing environment. The degree of population genetic differentiation or connectivity is discussed (Johnson and Burnham), and recent satellite telemetry data showed movements between Alaska and Russia (McIntyre et al.). Another satellite study from Sweden showed juvenile dispersal (Nygård et al.); however, many authors voiced concerns about transmitter effects on bird survival. Another study evaluated nest-site fidelity and dispersal via noninvasive genetic sampling (Booms et al.). Available sources on the internet for downloading global climate data are listed (Douglas), in addition to the discussion of bioclimatic models for projecting future changes in the distribution of birds in response to climate change (Huntley and Green). Contaminant concentrations in Gyrfalcons are now low, but may increase in some species in the Arctic over time, in association with warming temperatures; however, for Gyrfalcons, the likely increase would be associated with a change in diet from ptarmigan to more aquatic or higher-trophic-level prey (Braune, Matz et al.).

In Russia, information about the Gyrfalcon nesting distribution is fragmentary, with concerns about sharing data because of poaching. Population declines were noted in areas with good transportation connections (Pokrovsky and Lecomte). After the fall of the USSR and the collapse of its fur-trapping industry, the bycatch of Gyrfalcons in animal traps was greatly reduced and some populations may be increasing. The European Russia Gyrfalcon population was under constant trapping pressure for 500 yr (13th to 18th centuries; Shergalin). From 50 to 100 Gyrfalcons were delivered to Moscow annually, with the highest delivered during the reign of Tsar Alexei Mikhailovich Romanov (1645 to 1676). Shergalin noted that the magnitude of this long-term harvest is important for understanding the modern concept of sustainable harvest.

A most interesting detailed comparison was made of Gyrfalcon nesting attempts in northern Norway (Finnmark) in 1854–1864, based on egg collections, and nesting attempts in the same area in 2000–2010 (Johansen and Østlyngen). Authors strongly suggest that the number of nesting attempts had not changed during the last 150 yr. Gyrfalcon populations on Kamchatka have declined by a factor to 2–2.5 during the last 20 yr, primarily due to poaching (Lobkov et al.). This loss now involves both take from nests and trapping in the fall and winter (annually at least 10–15% of population removed) with poaching expected to increase in spite of increased penalties.

Papers on other raptor species included ''nomadism in the Saker Falcon'' (*F. cherrug*; Ellis et al.); ''developing a sustainable harvest of Saker Falcons for falconry in Mongolia'' (Dixon et al.); ''long-term (1982–2009) trends in organochlorine (OC) pollutants, occupancy and reproductive success in Peregrine Falcons (*F. p. tundrius*) breeding near Rankin Inlet, Canada'' (Franke et al.). In the last study, OCs declined significantly over time (to no-effect level), but occupancy and number of young per occupied territory declined during the three-decade study. The authors note that mechanism(s) associated with declines are unclear, but the proximate effects of local weather patterns may explain the altered demographic factors.

The fundamental niche of Gyrfalcons, Rock Ptarmigan and Willow Ptarmigan were modeled in relation to temperature and precipitation in space and time across 200 yr in Alaska (1900–2100; Booms et al.). Historical temperature and precipitation information (1900–2006) were used. Because rigorous distribution maps of the ptarmigan and Gyrfalcon in Alaska during the last 100 yr were not available, backwards modeling was used to assess qualitative accuracy. The authors note that machine learning models are sometimes distrusted by the wildlife management discipline (that's me). Models predicted that fundamental niches of Gyrfalcons and ptarmigan will contract and have contracted in the past as Alaska's climate warmed. Likewise, the spatial overlap between Gyrfalcon and ptarmigan fundamental niches also decreased, with the result that the abundance and distribution will likely decrease as temperatures rise. Authors cautioned that the model projects only basic gross trends. Climatic Response Surface models were also fitted to the global breeding distributions during the late 20th century for the Gyrfalcon and three ptarmigan species (Huntley and Green). In discussing conservation strategies from a modeling perspective, Bachelet notes the need to identify the relevant and usable datasets, become aware of gaps in knowledge and information, and translate evolving science results into on-the-ground climate-aware strategies. To work toward common goals, collaboration and effective information sharing are also critical. However, it was noted that species distribution models vary substantially in their ability to predict current species distributions and produce highly variable predictions of species range shifts under changing climate, and mostly ignore non-climatic drivers such as biotic interactions (Bachelet). Consequently, Bachelet notes that existing projections of change in species extent are subject to uncertainty and should be regarded as suggestions rather than predictions.

Perhaps what is needed next from a biological/ecological perspective is a Gyrfalcon synthesis which is defined as "the process of combining different ideas, influences, or objects into a new whole." The synthesis thus takes available information, often disparate or fragmented, and integrates it in a scientifically creative way into a coherent scientific analysis, including emergent hypotheses and priority research questions. It fully utilizes and even preferably extends the data into a meaningful and useful document providing direction. It often requires creative quantitative or quasi-quantitative analysis, especially when prioritization is needed. A good synthesis extends our knowledge. Ian Newton and Dominique Bachelet have certainly provided important thoughts to be used as a starting point for a synthesis document created by those actively involved with the species, especially those involved in long-term studies.

The list of authors includes the Who's Who of Gyrfalcon and ptarmigan investigators, and I was especially excited to see reports from long-term investigations—the need for which most administrators do not seem to understand. This 772-page proceedings is loaded with useful information regarding Gyrfalcons and their prey and should be in the library of all serious raptor researchers and bibliophiles. The sponsors are to be commended for supporting the conference and for publishing the proceedings. Proceedings are available at http://www.peregrinefund.org/gyr-conf.—**Charles J. Henny (emeritus; email address: hennyc@usgs.gov), Forest and Rangeland Ecosystem Science Center, U.S. Geological Survey, 3200 SW Jefferson Way, Corvallis, OR 97331 U.S.A.**