Resource Use of Arctic Peregrine Falcons along the Colville River, Alaska[1]

2013 Annual Report

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Abstract: To improve knowledge about the ecology, life history, and behavior of arctic peregrine falcons (*Falco peregrinus tundrius*) on the Colville River Special Area (CRSA), we proposed to (1) summarize and evaluate existing CRSA arctic peregrine nesting data to assess trends in territory occupancy and abundance, (2) assist in summary and evaluation of existing data on nesting habitat use and related productivity, (3) implement additional data collection and analysis efforts to address information needs, and (4) use results of the first three objectives to address management implications in the CRSA. To address the first objective in 2013, we used a long-term dataset developed from breeding arctic peregrine surveys to evaluate how occupancy dynamics of individual nest sites and entire nesting cliffs were related to abiotic and biotic factors. We developed competing dynamic occupancy models with hypotheses for the probabilities of initial occupancy, colonization, local extinction, and detection, and used a stepwise procedure and information-theoretic techniques to select the best-approximating models. Initial occupancy probability was positively correlated with the amount of surrounding prey habitat and height of the nest site above the Colville River. Colonization probability was also positively correlated with nest height, and negatively correlated with the date of snow melt and distance to the

nearest nest site occupied by a conspecific, the latter of which is likely a consequence of variability in resources along the river. Local extinction probability varied with aspect and was negatively correlated with productivity from the previous year (i.e., site quality), amount of prey habitat, and height. Colonization and local extinction probabilities were positively and negatively correlated, respectively, with threshold and logarithmic functions of year. Detection probabilities varied across years and were lower during second surveys. Our results demonstrated relationships between multiple abiotic and biotic factors and arctic peregrine falcon occupancy dynamics, and suggested certain nest sites and cliffs in the CRSA could be protected differently than others. Nest sites and cliffs with historically higher productivity were occupied most frequently and had a lower probability of local extinction between years. This suggests protection measures around higher quality nest sites and cliffs would have the most impact on breeding peregrine population dynamics, and offers the possibility that current regulations in the CRSA Management Plan could be relaxed around infrequently occupied nest sites. Also related to our first objective, we used the long-term dataset to conduct an initial analysis to assess factors related to abundance and population dynamics of arctic peregrines on cliffs. In 2014 and in relation to our third objective, we will complete analyses and develop a model of arctic peregrine resource selection, and use results to produce a map documenting historical and predicted probability of use throughout the CRSA. The results of our analyses will help identify the abiotic and biotic factors having the most influence on arctic peregrines nesting along the Colville River, and evaluate critical information needs.

Introduction

The Colville River provides key nesting habitat for approximately one-fourth of Alaska's migratory arctic peregrine falcon (*Falco peregrinus tundrius*; hereafter arctic peregrine) population, a subspecies that breeds in Greenland, arctic Canada, and in Alaska north of the Brooks Range and on the Seward Peninsula (White 1968, U.S. Department of the Interior [DOI] Bureau of Land Management [BLM] 2008). Arctic peregrines were protected in 1970 under the Endangered Species Conservation Act of 1969 and listed as endangered in 1973 under the Endangered Species Act. In 1977, the Colville River Special Area (CRSA) within the National Petroleum Reserve-Alaska (NPR-A) was established for the purpose of conserving arctic peregrine nesting and foraging habitat while allowing activities including oil and gas development, recreation, subsistence, and research (U.S. DOI BLM 2008). Sufficient recovery of the subspecies led to its delisting in 1994 (Federal Register 1994); however, protective measures are still in place for arctic peregrines under the CRSA Management Plan (CRSAMP; U.S. DOI BLM 2008), which was revised in 2008.

The CRSAMP addressed the following specific issues:

1. The need for additional measures to protect arctic peregrine nesting habitat,
2. Consistency of protection measures for arctic peregrines across the NPR-A,
3. Needed research on arctic peregrines,
4. Impacts of energy exploration and extraction activities on arctic peregrine ecology, behavior, and demography,
5. Planning maps for inventory of arctic peregrine features (nest sites, preferred habitat, etc.),
6. Impacts of recreationists and subsistence users on arctic peregrine ecology, behavior, and demography, and
7. Long-term monitoring of the ecology of arctic peregrines in the CRSA.

One objective of the CRSAMP was to improve knowledge about the ecology, life history, and behavior of arctic peregrines to help decision makers and managers make informed decisions on proposals that could impact falcons. To address that information need, we proposed to (1) summarize and evaluate existing CRSA arctic peregrine nesting data to assess trends in territory occupancy and abundance, (2) assist in summary and evaluation of existing data on nesting habitat use and related productivity, (3) implement additional data collection and analysis efforts to address information needs, and (4) use results of the first three objectives to address management implications in the CRSA. In this report, we describe progress toward these objectives in 2013 and plans for 2014.

Study Area

The study area consists of the Colville River and surrounding land in the CRSA, a 1 million-ha region located on Alaska's North Slope and within the NPR-A (Fig. 1). Recreation and oil and gas exploration are the primary human activities in the CRSA. The Colville River flows 630 km through the CRSA en route to the Beaufort Sea and is the largest river north of the Brooks Range in Alaska. Migratory arctic peregrines begin arriving to the CRSA in late April and nest between May and August on cliffs, escarpments, and bluffs that occurred on one or both sides of the floodplain of the Colville River. Following fledging of young in September, arctic peregrines begin migrating back to wintering areas located from the southern U.S. south to Argentina (Ambrose and Riddle 1988, Britten 1998).

The CRSA contains numerous wetlands and is underlain by continuous permafrost. Vegetation is characterized by tundra plant communities except for those areas associated with the Colville River floodplain, where relatively short (5 m to 10 m) willow (*Salix* spp.) and alder (*Alnus* spp.) communities exist along with perennial herb pioneer communities (Bliss and Cantlon 1957). The CRSA is characterized by short summers and long, cold winters. Maximum and minimum average daily temperatures during the nesting period (May through July) from 1981 through 2002 at the Umiat National Oceanic and Atmospheric Administration (NOAA) station (Fig. 1), and Sagwon and Imnaviat Creek Natural Resources Conservation Service (NRCS) SNOTEL stations ranged from 7.5°C to 18.1°C (mean = 11.9°C; SE = 0.52) and -2.4°C to 4.9°C (mean = 0.29°C; SE = 0.38), respectively (NOAA 2013, NRCS 2013a, NRCS 2013b). The duration of seasonal snow cover was 210 days to 260 days (mean = 236 days; SE = 3; Hall et al. 2013, NOAA 2013).

Methods

Historical Breeding Surveys. Surveys for breeding arctic peregrines were conducted annually along the Colville River between 1981 and 2003 under the auspices of the U.S. Fish and Wildlife Service (USFWS) and BLM. After 2003, surveys were conducted every 3 years resulting in data collected in 2005, 2008 and 2011. Surveys were primarily conducted by Ted Swem from the USFWS except for 2003 and 2008, when surveys were conducted by other raptor biologists. Two surveys were completed each year with the first survey occurring during egg-laying and incubation in June, and the second during the nestling period in late July through early August. The two surveys improved detection of arctic peregrines, especially to account for nesting attempts that failed and birds becoming less detectable later in the season. At each nest site encountered during each year, surveyors documented paired adults, single adults, nest status, and productivity (number of young in the nest). Surveyors mapped each nest location onto a topographical map and recorded the location by GPS when feasible.

Statistical Analysis and Modeling. We used the long-term dataset developed from breeding arctic peregrine surveys to evaluate how occupancy dynamics (MacKenzie et al. 2003) of individual nest sites and entire nesting cliffs were related to abiotic and biotic factors. Specifically, we derived covariates describing habitat, topography, climate, prey availability, competition, productivity, and temporal factors that may have influenced arctic peregrines. Data used to derive these covariates included: (1) GIS layers of elevation and aspect at 10-m resolution (U.S. Geological Survey 2011), land cover at 30-m resolution (Homer et al. 2004), surficial geology (Karlstrom 1964), aerial imagery, and streams; (2) date of snow melt data from the Umiat NOAA station (NOAA 2013) and MODIS/Terra snow cover 8-day L3 global 500-m grid data set (Hall et al. 2013); (3) precipitation data from the Umiat NOAA station (NOAA

2013) and Sagwon SNOTEL station (NRCS 2013b), and (4) productivity and location data of nests obtained during surveys. We developed competing dynamic occupancy models with hypotheses for the probabilities of initial occupancy, colonization, local extinction, and detection (MacKenzie et al. 2003), and used information-theoretic techniques to select the best-approximating models (Burnham and Anderson 2002).

We also used the long-term dataset to conduct a second analysis to assess factors related to abundance and population dynamics of arctic peregrines on cliffs. We used recent statistical advances to obtain habitat-specific estimates of abundance, population dynamics parameters, and detection probability (Dail and Madsen 2011). We derived covariates describing habitat, topography, climate, prey availability, productivity, and density dependence using the data sources described above. We developed competing models with hypotheses for initial abundance, apparent survival rate, recruitment rate, and detection probability parameters (Dail and Madsen 2011), and used information-theoretic techniques to select the best-approximating models (Burnham and Anderson 2002).

Results (2013 Accomplishments)

We completed our occupancy dynamics modeling and analyses during summer 2013. Occupancy of nest sites and cliffs increased throughout the 1980s before stabilizing in the mid-1990s (Fig. 2). Our results provided support for many of our hypotheses about the relationships between nest-site quality, amount of surrounding prey habitat, nest height above the river, date of snow melt, and temporal factors on arctic peregrine occupancy dynamics in the CRSA. Nest-site quality influenced arctic peregrine occupancy of individual nest sites and cliffs as the probability of local extinction between years was negatively correlated with the productivity of the nest or average productivity of all nests on the cliff from the previous year. The amount of prey habitat (wetlands; lakes; streams) surrounding the nest site and cliff was related to arctic peregrine occupancy dynamics on the CRSA, with strong support for a negative correlation with local extinction probability and intermediate support for positive correlations with initial occupancy and colonization probabilities. The height of the nest site above the Colville River was positively correlated with the probabilities of initial occupancy and colonization on both nest-site and cliff scales, and all relationships had strong support except that for nest-site initial occupancy, which had intermediate support. Also on the cliff scale, local extinction probability was negatively correlated with the average height of nest sites, which had strong support. Colonization probability was higher for cliffs with surficial geology consisting of steeper slopes and bedrock exposures along the upper slopes of cliffs (Karlstrom 1964), although the relationship had intermediate support. The probability of colonization of cliffs by arctic peregrines was negatively correlated with the date of snow melt, which had strong support. Additionally, the probability of local extinction was lower for cliffs having south aspects and greater for cliffs with northeast and north aspects, although these relationships had intermediate support. The distance to the nearest occupied nest site was negatively correlated with the probability of colonization with intermediate support, suggesting arctic peregrines were more likely to occupy a site if other arctic peregrines had nearby nest sites. Colonization and local extinction probabilities were positively and negatively correlated, respectively, with functions of year. Both logarithmic and threshold functions of year were included separately in the best-approximating models for the nest-site and cliff-scale analyses, and received strong and intermediate support. Detection probabilities varied across years and were lower during second surveys.

Although regulations currently exist to protect nesting and foraging habitats of arctic peregrines in the CRSA (U.S. DOI BLM 2008), the CRSAMP protects all nest sites and nesting cliffs equally regardless of quality, occupancy probability, history of productivity, or physical attributes. Our study provided understanding of the relationships of specific factors with occupancy, and suggested that individual nest sites and cliffs could be managed based on their attributes. First, nest sites and cliffs with historically higher productivity were occupied most frequently and had a lower probability of local extinction between years. In contrast, nest sites and cliffs with historically low, or no, productivity were occupied less frequently. These relationships suggest that from a population perspective, protection of higher quality nest sites and cliffs is likely to have a more substantial effect on breeding arctic peregrines than if the same protection were afforded to lower quality sites, and that current regulations could be relaxed around unproductive nest sites without population-level consequences (e.g., Newton 1991, Sergio and Newton 2003). Second, historically higher occupancy rates existed downriver compared to upriver, suggesting protections around downriver nesting cliffs that also offered higher densities of nesting sites would have the highest population-level effects. However, some upriver nest sites had histories of relatively high occupancy probability and productivity, indicating decisions about what protections to afford nest sites need to be made on finer spatial scales than just simply separating upriver from downriver sites. Finally, consideration of characteristics of nest sites and cliffs associated with high occupancy, and not just productivity, is likely important when making decisions about regulations to protect peregrines. Protecting key nesting locations, especially those on cliffs that are high above the river drainage, surrounded by adequate prey habitat, and with southern aspects that encourage early snow melt and warmer temperatures during spring, will likely provide for continued occupancy by arctic peregrines in the CRSA.

We prepared and submitted a manuscript of our findings to the *Journal of Wildlife Management* in August 2013, and provided the manuscript to Debora Nigro from the BLM and Ted Swem from USFWS, both of whom are co-authors and reviewed the manuscript prior to submission. In response to reviews from the *Journal of Wildlife Management*, we are preparing a revised version of the manuscript for resubmission in January 2014. JEB presented results of our occupancy analyses at The Wildlife Society Annual Meeting in Milwaukee, Wisconsin in October 2013.

In fall 2013, we completed an initial version of our second analysis to assess factors related to abundance and population dynamics of arctic peregrines. Our analysis indicated that initial abundance on cliffs was positively correlated with average height above the Colville River of all nests on the cliff. Recruitment rate was positively correlated with average productivity of nests on the cliff from the previous year and negatively correlated with date of snow melt, indicating lower abundance during years with later snow melt. Our results suggested a density-dependent influence as apparent survival rate was negatively correlated with the number of adult arctic peregrines observed on the cliff the previous year. Total arctic peregrine abundance in the CRSA increased annually throughout the 1980s until becoming stationary in the early 1990s. We prepared a draft manuscript of our findings in fall 2013 and JEB is currently revising analyses and the manuscript.

Plans for 2014

Our first objective for 2014 is to submit our revised occupancy manuscript to the *Journal of Wildlife Management*, which is due by 25 January 2014, and provide the revised manuscript to BLM and USFWS. Our second objective is to finish our manuscript on arctic peregrine cliff abundance and population dynamics. We plan to have this completed and submitted to the *Journal of Applied Ecology*, BLM, and USFWS in spring 2014. Our third objective is to complete analyses and develop a model of arctic peregrine resource selection in the CRSA study area. We will use modeling results to develop a map documenting historical and predicted probability of use throughout the CRSA. We will use this map to help the BLM identify nesting cliffs of high importance and those of lower importance for the purposes of future permitting of oil and gas development and recreational activities, and consideration for protective regulations around nesting cliffs. Our fourth objective will be to assist in analyses of existing data on arctic peregrine productivity and survival using data from marked birds. Our final objective is to examine the use of fine scale satellite imagery for the purposes of improving data sources used for deriving covariates, including those characterizing prey habitat, topography, and snow melt.

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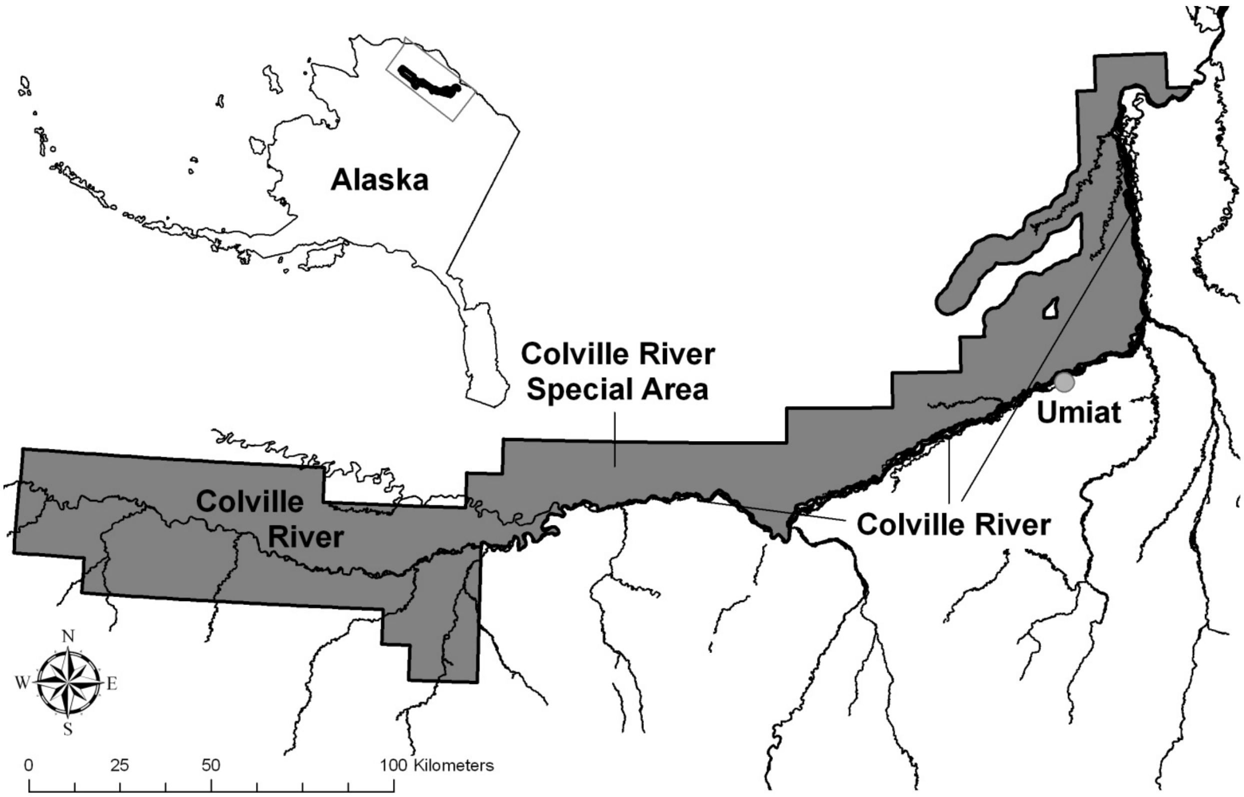

Figure 1. The study area in the Colville River Special Area (CRSA; gray shaded area), which is located on the North Slope of Alaska (see inset). Annual surveys for nesting arctic peregrines were conducted along the Colville River in the CRSA during 1981 through 2002. The location of the Umiat NOAA climate station is denoted. The Sagwon and Imnaviat Creek SNOTEL stations are located off of the map to the east and southeast of the CRSA, respectively.

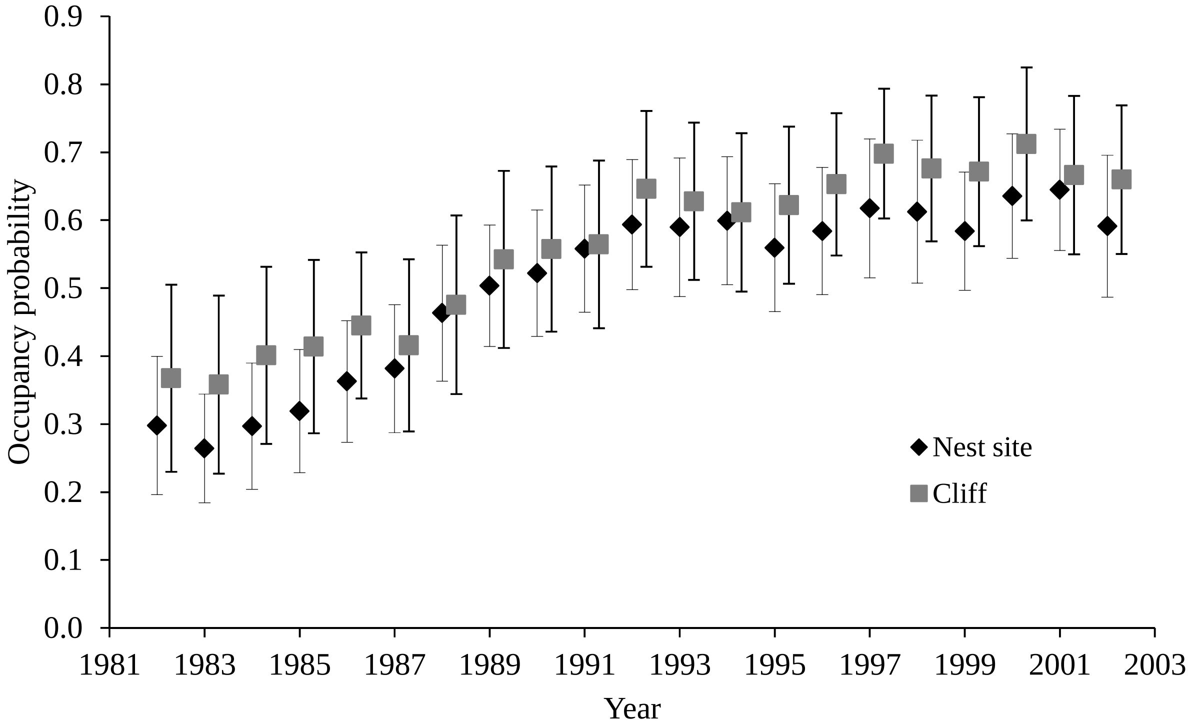

Figure 2. Temporal trends in the probability of arctic peregrine occupancy of individual nest sites and cliffs along the Colville River, Alaska in the Colville River Special Area between 1982 and 2002.