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Great Gray Owl home range and habitat selection during the breeding-season

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Abstract Identifying resource requirements of under-studied species during key stages such as breeding is critical for effective management. We quantified breeding-season home-range attributes and habitat selection of adult Great Gray Owls across multiple spatial (home-range and within-home-range level) and temporal (nesting and post-fledging; day versus night) scales in western Wyoming, USA. In 2018 and 2019 we outfitted adult male owls (n = 18) with GPS remote-download transmitters and collected hourly location data throughout the breeding season (1 May – 15 September). Using 50% and 95% kernel density estimates (KDE), mean core area was 1.2 km^2 and mean home-range size was 6.2 km^2 (n = 16). Resource selection analyses incorporated both remotely-sensed and microsite data. We conducted microsite surveys at used and available points within 95% KDE home ranges using a stratified random sample design (n = 661). Determining home-range and breeding habitat requirements will improve density estimates and facilitate the effective management of Great Gray Owls and their habitat. We found differing patterns between habitat selection at the home-range and within-home-range scales.

Introduction

Habitat change is increasing across landscapes, with largely unknown consequences for under-studied raptor species. Identifying resource requirements of such species during key stages such as breeding is therefore critical for effective management. Older-aged montane and sub-alpine forests are changing rapidly throughout the Intermountain West, in large part due to wildfire, disease and beetle outbreaks, drought, climate change, logging and development. Great Gray Owls (*Strix nebulosa*) are associated with these forested habitats, and studies conducted outside of the Rocky Mountains suggest that they respond negatively to the loss of key habitat elements. However, in general, despite being one of our most iconic birds, the Great Gray Owl is also one of the least-studied raptors in North America, and baseline data on home range and habitat selection are lacking. The Great Gray Owl is listed as a Wyoming Species of Greatest Conservation Need, in large part due to the fact that population trends and habitat associations remain unknown.

Our project objectives include:

1. Quantify the habitat selection of male Great Gray Owls during the breeding season.
2. Determine the sizes and habitat attributes of Great Gray Owl home ranges during the nesting and post-fleding periods.
3. Establish baseline Great Gray Owl territory habitat parameters which can be used for compari-

son after future forest treatments or natural habitat changes.

4. Provide critical information towards managing Great Gray Owl nesting and post-fleding habitat to maintain a long-term viable population in Wyoming.

Methods

Field methods

This research was conducted in Teton County, Wyoming, between Hoback, WY, north through the Snake River riparian corridor and surrounding foothills of the Teton Range, to the Pacific Creek area. Owl territories ranged from riparian forest zones to areas dominated by aspen forest or conifer forest. Territories were located within Bridger-Teton National Forest, Grand Teton National Park, and one territory was on private land within Jackson, Wyoming.

We outfitted 18 adult male Great Gray Owls with remote-downoad GPS transmitters (manufactured by Lotek) in the spring of 2018 and 2019. We targeted adult male owls in particular because we are interested in determining important Great Gray Owl foraging and post-fledging habitat as well as home range areas. Male owls do the majority of the hunting during the breeding season, providing food for nesting females, as well as for the young well into the fall. Capture techniques included the use of balchatri traps, and capture, banding, and tagging methods adhered to standard protocols (including IACUC requirements). GPS transmitter technology provided the opportunity to remotely monitor Great Gray Owl movements and habitat selection. The transmitters collected one location per hour (24 hours per day) throughout the breeding season (April-September).

Microsite habitat selection

We conducted on-the-ground habitat surveys at ∼30 used breeding-season locations and 30 random points within each home range to compare habitat use versus availability. To select used points, we used a stratified random sample of one point per night (between 20:00-06:00) per bird, and plots for these used points had a minimum distance buffer of the survey plot radius (see below) from another used point survey plot. We randomly generated 30 available points per bird within its breeding-season 100% minimum convex polygon (MCP). We had no buffer between available and used point plots. We conducted these on-the-ground habitat surveys from July-September of 2018 and 2019.

Habitat surveys were conducted using fixed radius plots (0.04 hectare plots; 12m radius) which is standard for many forest raptor studies (Moen and Gutiérrez, 1997; Bias and Gutiérrez, 1992; Solis Jr and Gutiérrez, 1990). We recorded general habitat class, dominant understory type, number of tree stories, and any special features (residential area, road, water feature, burned area, etc.). From the plot center, we measured the distance to the nearest edge (if visible) using a range-finder (distance-to-nearest-edge is defined as a change in primary habitat type from the plot habitat type). We also determined the distance to the nearest meadow using a rangefinder (if a meadow was not readily visible, it was recorded as unknown). A meadow was defined as a 5×5m (or larger) opening containing grass, forbs, but no trees (based on field observations of forest openings utilized by Great Gray Owls for foraging).

We conducted a series of standard forestry measurements that relate to landscape features we hypothesized provide prey availability, foraging opportunity, and cover for Great Gray Owls. Using a convex spherical densitometer, we measured canopy closure in the four cardinal directions at five points within the plot: plot center, as well as half the plot radius (6m) from plot center in each cardinal direction. Each plot had 20 canopy closure measurements, and we calculated the mean canopy closure for the plot. Using a 10-factor wedge prism at plot center and a Diameter-at-Breast-Height (DBH) tape to measure trees 4.5ft from the ground, we measured basal area for live trees (within variable-radius plots for this measurement). We noted the tree species for each DBH measurement. We tallied all coarse woody debris (CWD) within the plot (if partially in the plot, at least half of the downed tree or limb must fall within the plot to be included). CWD are fallen trees or limbs (>1m

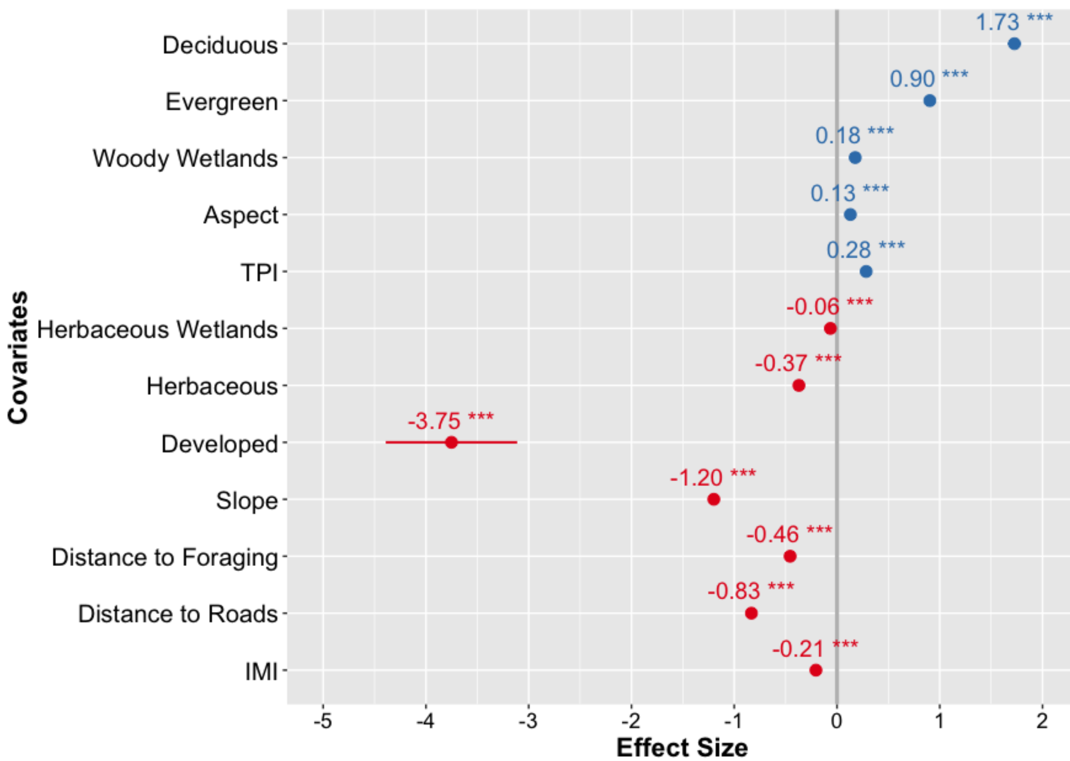

Figure 1. Standardized fixed-effect beta coefficients for the top Generalized Linear Mixed Model output for home-range scale habitat selection for adult male Great Gray Owls during the breeding season of 2018 and 2019 in Teton County, Wyoming (n=16). Covariates are scaled with a mean of 0 and a standard deviation of 1, so beta coefficients can be compared to determine effect size for significant covariates (significance codes: p = 0 (***), p = 0.001 (**), p = 0.01 (*)). Positive values indicate selection and negative values indicate avoidance.

long and >12.5cm in diameter) lying on the ground or leaning over 45 degrees from vertical. We also tallied all snags (dead trees standing or leaning between 0-45 degrees from vertical that are over 3m high and >12.5cm diameter) within the plot. Lastly, we determined presence versus absence of primary prey within each plot by assessing whether Northern Pocket Gopher sign (mounds) was present. If sign was present, we tallied the amount of sign.

We will use generalized linear mixed effects models (GLMMs) to compare use versus availability, and microsite selection results will be forth-coming.

Home-range and within-home-range selection

Determining home-range areas was essential for our subsequent resource selection analyses, but these metrics are also important to provide to managers. For comparative purposes, we calculated mean home range size using Minimum Convex Polygons (MCPs), Kernel Density Estimates (KDEs), and Brownian Bridge Movement Models (BBMMs).

We used GLMMs to create Resource Selection Functions (RSFs) at two spatial scales (home-range and within-home-range). At the home-range scale, used points were selected by randomly selecting available points within 95% KDEs (assuming the entire home-range is available to be used), and available points were randomly selected from an MCP drawn around all of the relocations of all of our study birds (delineating the study area). Covariates included land cover, elevation, slope, aspect, topographical position index, distance to foraging (herbaceous, herbaceous wetland, and woody wetland land cover), distance to roads, and an integrated moisture index (a metric of soil moisture index). At the within-home-range

Method (km^2)	50% Contour Mean	95% Contour Mean	50% SD	95% SD
MCP	2.78	9.97	0.81	2.38
KDE	1.25	6.25	0.6	0.82
BB	1.14	5.95	0.19	1.01

Table 1. Breeding-season home range areas of adult male Great Gray Owls between 2018 and 2019 (n=15; in km^2), excluding one adult male who was not observed paired or settled on a home-range and who exhibited a considerably larger home range in 2019. Home ranges were calculated using Minimum Convex Polygon, Kernel Density Estimation, and Brownian Bridge Movement Models, and 50% (core area) and 95% (home range) contours.

Covariates	β	Std. Error
(Intercept)	-0.16382	0.14876
Apect	0.13025	0.01282
Slope	-1.19858	0.01974
TPI	0.28399	0.01534
IMI	-0.20504	0.01373
Woody Wetland	0.17724	0.01575
Deciduous	1.72682	0.03328
Evergreen	0.90338	0.02555
Developed	-3.75152	0.32626
Herb Wetland	-0.06371	0.01152
Herbaceous	-0.37071	0.02595
Dist 2 Foraing	-0.4561	0.01439
Dist 2 Roads	-0.8326	0.02075

Table 2. Standardized fixed-effect beta coefficients and standard errors for the top Generalized Linear Mixed Model output for home-range scale habitat selection for adult male Great Gray Owls during the breeding season of 2018 and 2019 in Teton County, Wyoming (n=16).

Covariates	β	Std. Error
(Intercept)	-0.834775	0.075985
Canopy cover	0.292714	0.012437
Daytime	-0.75296	0.078777
Dist 2 Foraging	-0.235978	0.008046
Herbaceous	-0.659359	0.063323
Herb Wetland	1.505541	0.096192
Woody Wetland	0.663094	0.100057
Canopy:Daytime	0.20342	0.016571
Herbaceous:Daytime	-1.392668	0.104828
Herb_Wetland:Daytime	-1.824971	0.171472
Woody_Wetland:Daytime	0.255814	0.092037

Table 3. Fixed-effect beta coefficients and standard errors for the top Generalized Linear Mixed Model output for within-home-range scale habitat selection for adult male Great Gray Owls during the breeding season of 2018 and 2019 in Teton County, Wyoming (n=16).

scale, actual GPS locations were our used points, and available points were randomly drawn from within 95% KDEs for each owl. Because we were interested in testing our hypotheses regarding whether within-home-range selection varied between day and night, covariates included canopy cover, herbaceous, herbaceous wetland, and woody wetland land cover, and distance to foraging, and we included interactions with time of day (day versus night) for each covariate.

For both RSFs, the ratio of used to available points was 1:1, we included individual by year as a random effect, and we used a backwards step-wise approach to select the most parsimonious model based on AIC value. All covariates were scale-optimized (for each RSF) to determine the optimal neighborhood size for each variable at each spatial scale. Models comparing selection during the nesting versus post-fledging windows are forthcoming.

Preliminary results

Mean home-range size varied depending on the method used to calculate it (Table 1). Mean core area (50% contours) during the breeding season were

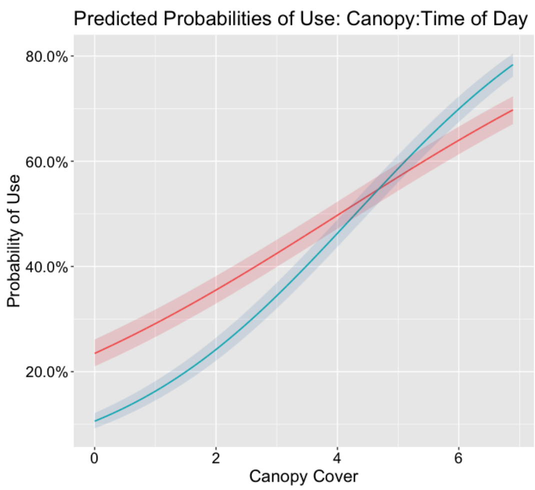

Figure 2. Predicted probability of use for canopy cover for daytime versus nighttime based on Generalized Linear Mixed Model output for within-home-range scale habitat selection for adult male Great Gray Owls during the breeding season of 2018 and 2019 in Teton County, Wyoming (n=16).

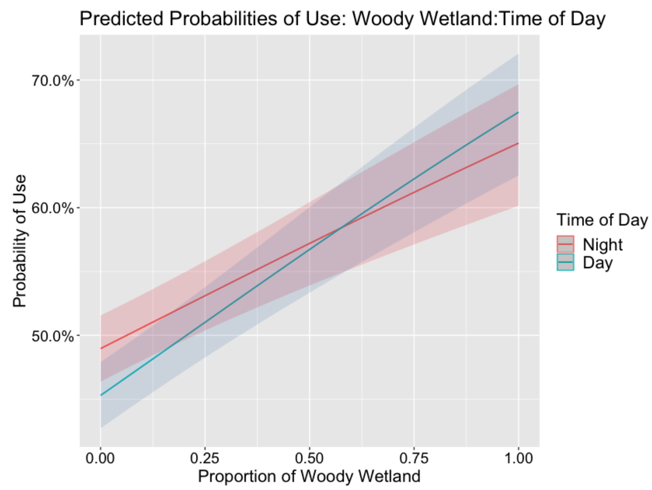

Figure 3. Predicted probability of use for proportion of wooded wetland land cover for daytime versus nighttime based on Generalized Linear Mixed Model output for within-home-range scale habitat selection for adult male Great Gray Owls during the breeding season of 2018 and 2019 in Teton County, Wyoming (n=16).

1.25km^2 (SD = 0.16), 1.14 km^2 (SD = 0.19), and 2.78km^2 (SD = 0.81), and mean home-range area (95% contour) was 6.25km^2 (SD = 0.82), 5.95km^2 (SD = 1.01), and 9.97km^2 (SD=2.38), for the KDE, BB, and MCP methods respectively. We saw clear delineations between adjacent home-ranges with little overlap, indicating that adult male owls are defending their territories from one another during the breeding season.

Broad-scale home-range resource selection results indicate that Great Gray Owls select large tracts of forested habitat, northerly aspects, shallower slopes, convex topography, and areas with lower soil moisture indices (Table 2, Figure 1). They appear to avoid development, open meadows and herbaceous wetlands when selecting home ranges. They also appear to select to be closer to roads, although this may be a product of where we outfitted owls with transmitters (closer to access points).

Finer scale within-home-range selection findings indicate that these owls select to be closer to foraging habitat, and they select areas of increased canopy cover and woody wetlands both day and night (Table 3, Figures 2-3). These findings indicate that these owls are foraging not only at night but also during the day during the breeding season (which has been observed in the field). Additionally, these findings indicate that areas of increased cover not only provide thermoregulation but also foraging opportunities for this species. At the within-home-range scale, Great Gray Owls avoid meadows and herbaceous wetlands during the day, but they also select strongly for herbaceous wetlands during the nighttime (Table 3, Figures 4-5). The fact that Great Gray Owls strongly select for herbaceous wetlands at night indicates that this habitat type is an important foraging area for this species.

Conclusions

Actual core and home range areas can be incorporated into nest-site management, to provide more effective buffers around nesting areas. Additionally, our finding that owls appear to be defending territories during the breeding season can allow us to use our home-range sizes to make more informed predictions regarding how many breeding pairs our study area can support.

Our differing results between the home-range and within-home-range scales and between selection

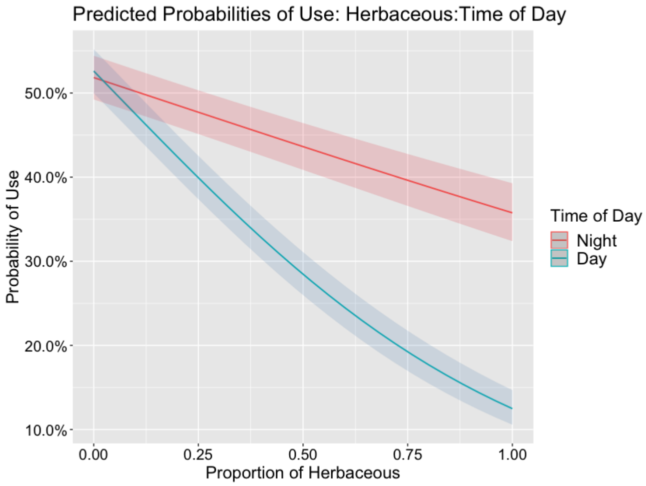

Figure 4. Predicted probability of use for proportion of herbaceous land cover for daytime versus nighttime based on Generalized Linear Mixed Model output for within-home-range scale habitat selection for adult male Great Gray Owls during the breeding season of 2018 and 2019 in Teton County, Wyoming (n=16).

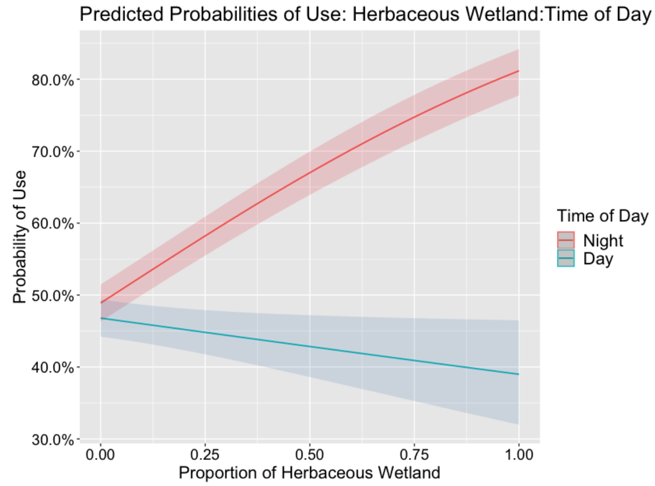

Figure 5. Predicted probability of use for proportion of herbaceous wetland land cover for daytime versus nighttime based on Generalized Linear Mixed Model output for within-home-range scale habitat selection for adult male Great Gray Owls during the breeding season of 2018 and 2019 in Teton County, Wyoming (n=16).

during the day versus at night underline the importance of assessing habitats at multiple spatial and temporal scales, as habitat selection might differ between scales. For example, if we had only assessed habitat selection at the home-range scale (at which they are avoiding foraging habitat), we would fail to determine the importance of herbaceous wetlands, which were highly selected for at the within-home-range scale, specifically at night. In general, our findings indicate that owls select large tracts of forested habitat in which to place their home ranges. However, proximity of herbaceous and woody wetlands is also important and most likely provides key foraging habitat. Selection for higher canopy cover both day and night and selection to be closer to foraging habitat underscores the importance of meadow edges and meadows with perches.

Home-range and within-home-range habitat selection results can be integrated and used to more accurately delineate potential breeding habitat beyond our study area. Additionally, within-home-range habitat selection results can be incorporated into management, thus extending management beyond nest site use and home-range selection. Finally, forthcoming on-the-ground habitat selection findings can further our understanding of important microsites for this species.

Future work

Additional analyses include comparing habitat selection during the nesting versus post-fledging windows of the breeding season, and assessing microsite selection. Following analyses, a written master's thesis will summarize this study. Additionally, findings will be consolidated and submitted for publication in a peer-reviewed journal. Continuing to assess habitat selection across additional years would be valuable to better understand how habitat selection might influence the high variability in Great Gray Owl nest initiation and productivity from year-to-year that has been observed in the Greater Yellowstone Ecosystem. Lastly, understanding winter habitat selection, and how it might impact subsequent breeding-season productivity, is an important future direction for our research on Great Gray Owl habitat selection in Wyoming.

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References

Bias, M. A., and R. Gutiérrez. 1992. Habitat associations of California spotted owls in the central Sierra Nevada. The Journal of Wildlife Management **56**:584–595.

Moen, C. A., and R. Gutiérrez. 1997. California spotted owl habitat selection in the central Sierra Nevada. The Journal of Wildlife Management **61**:1281–1287.

Solis Jr, D. M., and R. J. Gutiérrez. 1990. Summer habitat ecology of northern spotted owls in northwestern California. The Condor **92**:739–748.