Where the Wild Things Sleep

an adventure in misusing models

1 Introduction

Habitat models are important tools in wildlife management. In coastal B.C., provincial management of the northern goshawk is assissted by a habitat suitability index (HSI) built around nesting habitat characteristics (Mahon, McClaren, and Doyle 2008). Of course, goshawks need more than just a place to build their nest in order to raise their young–they also need places to hunt and places to sleep.

Nocturnal roosting is small but important part of a goshawk's daily activities. Sheltered nighttime roost sites are crucial for safety and thermoregulation, yet only two studies have investigated roost site selection in northern goshawks (Blakey et al. 2020, Rickman et al. (2005)).

Goshawks might select roost sites similar to nest sites, or they might select sites based on very different criteria. I wanted to know whether the nesting HSI could be extended to predict roost sites as well, and, if not, what habitat characteristics might be better predictors.

2 Methods

2.1 Roost site selection

During 2018-2019 we captured and tagged 7 adult goshawks (4 female and 3 male) at 5 active nest sites located on the south coast of B.C. Goshawk nests were located by provincial survey crews or reported by timber industry professionals. Trapping took place during the mid-breeding season (May-June) using a dho-gaza trap with a live great-horned owl (*Bubo virginianus*) as a lure [bloom_2007]. We fit goshawks with a solar-powered GPS-UHF transmitter with an additional attached VHF transmitter (Harrier model, Ecotone Telemetry, Sopot, Poland). Transmitters weighed approximately 14 g and were attached with a backpack-style Teflon ribbon harness. Transmitters were programmed to record a location every 15 minutes during the breeding season (approximately May-August) and every 4 hours during the nonbreeding season to conserve energy. Location data were retrieved from the tag via either a base station placed near the nest or a hand-held UHF receiver.

Due to insufficient location or habitat data, three individuals were not included in this analysis. An additional female showed strong fidelity to the nest site and rarely roosted off the nest, so was also excluded from the analysis. From the remaining three individuals, 102 nighttime roost locations were obtained between 11 June and 3 September 2019. See Table 1. Roosts were calculated from the location taken closest to midnight within four hours prior to midnight. Locations recorded more than four hours before midnight were discarded.

Table 1: Number of roosts calculated per site in 2019

Site abbr.	N. roosts
MTC	20
RLK	16
SKA	65

2.2 Habitat selection

To determine the area available to goshawks for roosting, I calculated 100% minimum convex polygon home ranges for each site using all telemetry data. Within each home range we used QGIS (Team 2019) to generate a grid of points with 500 m spacing to represent available roosting habitat.

Habitat variables were characterized using forest inventory data ("Vegetation Resources Inventory" 2018) and two variants of the HSI (nesting and foraging) (Mahon, McClaren, and Doyle 2008). From these sources I extracted 5 variables at each "used" ($n = 101$) and "available" ($n = 614$) point: crown closure (percent of ground area covered by tree canopy), basal area (tree area at breast height in m^2/ha), age (basal area-weighted age of dominant tree species), foraging habitat quality (nil-high, 0-3), and nesting habitat quality (nil-high, 0-3). Points located in "impossible" roosting habitat (i.e. water, unforested, etc.) were removed from the analysis.

2.3 Statistical Methods

I developed a set of generalized linear mixed effects models to test whether the nesting HSI or alternative variables could predict goshawk nighttime roost locations. Models included site (equivalent to individual) as a random effect. I used Aikake's Information Criterion (AIC_c) (Burnham 2002) to select the best explanatory model.

3 Results

	Model	K	AIC~c~	Delta AIC	AIC weight	Cum. AIC weights	log-likelihood
6	Nesting HSI + canopy closure	4	563.9689	0.000000	1.0000000	0.6466480	-277.9563
9	Foraging HSI + canopy closure	4	566.6938	2.724839	0.2560405	0.1655681	-279.3187
5	Canopy closure	3	566.9265	2.957553	0.2279164	0.1473817	-280.4464
8	Nesting HSI + basal area	4	571.1555	7.186622	0.0275071	0.0177874	-281.5496
1	Nesting HSI	3	571.8731	7.904162	0.0192147	0.0124251	-282.9197
7	Nesting HSI + age	4	573.8951	9.926215	0.0069912	0.0045208	-282.9194
4	Basal area	3	574.3237	10.354815	0.0056426	0.0036488	-284.1450
2	Foraging HSI	3	575.6482	11.679311	0.0029098	0.0018816	-284.8072
3	Age	3	580.8671	16.898175	0.0002141	0.0001384	-287.4167

The top five candidate models all included the nesting HSI or canopy closure as variables (see table **??**). The top three models all included canopy closure, and this variable accounted for 97% of the cumulative weight of evidence. The most informative model ($R^2 = 0.16$) included both the nesting HSI score and canopy closure. This model was better than the second-best informative model by 2.72 AIC units, and better than the nesting HSI-alone model ($R^2 = 0.09$) by 7.90 AIC units.

4 Discussion

Goshawks roosted throughout their homerange and rarely returned to previously used roost sites. However, they generally selected roost sites in stands with a high degree of canopy closure which also resembled nest sites.

The greater importance of canopy closure over the nesting HSI in predicting roost sites may seem to imply that canopy closure is important for roosting but not for nesting. However, canopy closure is known to be important in nest site selection (citation needed), although it was excluded from the nesting HSI due to data constraints. It is more likely that roost sites are very similar to nest sites and that the nesting HSI would better predict both nest and roost sites if canopy closure could be included.

References

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