Swainson's Hawk (*Buteo swainsoni*) Nesting Ecology in Western Nebraska

INTRODUCTION

Swainson's Hawks (*Buteo swainsoni*) occur primarily in grasslands throughout the western half of the United States (Bechard et al. 1989, Johnsgard 1990, Andersen 1995), but have also been recorded occupying agricultural lands (Olendorff 1973). However, relatively little information exists regarding the nesting ecology of this raptor especially in western Nebraska. As biofuels demands increase and tracts of expiring CRP acres are returned to crop fields in the future, it was important to determine a current estimate of breeding pairs and breeding habitat associations for Swainson's Hawk in western Nebraska. Understanding these facets of Swainson's Hawk ecology on the breeding grounds will help guide future conservation strategies not only for this species, but also for other avian species of conservation concern that might be impacted by conservation strategies for Swainson's Hawk.

Western Nebraska was a focal area for Swainson's Hawks within the state. While Swainson's Hawks occur statewide, they are found in steadily decreasing numbers to the east (Mollhoff 2001). In western Nebraska the Swainson's Hawk breeding distribution overlaps with and therefore have to compete for nesting substrates with Ferruginous Hawk (*Buteo regalis*), Red-tailed Hawk (*Buteo jamaicensis*), Golden Eagle (*Aquila chrysaetos*), and Great Horned Owl (*Bubo virginianus*). Swainson's Hawks are the last of these species to arrive on the breeding grounds in the spring. Great-Horned Owls were usually done nesting before Swainson's arrived, but the other three species were actively nesting and occupying suitable nesting substrates that were then unavailable to

Swainson's Hawks. However, Swainson's Hawk have been documented as the only raptor that regularly nested near cultivated lands (Olendorff 1973, Schmutz 1989). The ability to nest in habitat not selected for by other competing and earlier arriving raptors could allow for Swainson's Hawks to compete and thrive provided other life history requirement are met across the prairie landscape.

Selecting habitat for nesting by most raptors is probably determined by accessibility of food and nesting sites (Schmutz 1984). However, food availability is likely the most important factor determining hawk abundances (Newton 1980). However, Thurow and White (1983) also suggested that Swainson's Hawks purposely nest in proximity to active Ferruginous Hawk nests as part of a mutual defensive behavior for nest protection exhibited by these two species. This evolved behavior could also be another factor in Swainson's Hawk nest placement and occupancy, and a reason why these two species with different nesting chronologies can coexist on the same landscape.

In addition to their extremely long migration, Swainson's Hawks face a number of additional challenges on the breeding grounds. Swainson's Hawks in Nebraska appear to be obligate tree nesters (personal observation). The majority of nests are relatively small and poorly constructed, thus subjecting themselves to common nest failure when blown out of trees during high wind events (personal observation). Climate-caused nest failure and potential nesting substrate limitation could have profound effects on Swainson's Hawk population dynamics, specifically though local extinction and colonization dynamics.

Loss of foraging habitat, increasing habitat fragmentation, and poor landscape complementation (unsuitable habitat surrounding nesting sites) are often the result of

converting remnant prairie to agricultural fields and are factors that breeding Swainson's Hawks must deal with on this landscape. Crop cultivation and human disturbances were suggested to adversely affect the nesting density of Ferruginous Hawks (Schmutz 1984), and the same could be true for Swainson's Hawks. However, it is also possible that habitat conversion and subsequent fragmentation may have minimal impact on Swainson's Hawks, as it was demonstrated that some pairs of Swainson's Hawks have shown noticeable tolerances to agricultural disturbance (Gilmer and Stewart 1984).

Western Nebraska is near the eastern edge of their range in Nebraska, so determining what factors influence nest site selection in this area will help us understand what environmental stressors are restricting their distribution and densities moving eastward across the state. The purpose of our study was to address various habitat associations and other key elements of Swainson's Hawk nesting ecology in western Nebraska. Specifically, we used a modeling approach to explore Swainson's Hawk nest occupancy in relation to nesting substrate characteristics, percents of various land use surrounding nests, and conspecific interactions betweens nests.

METHODS

Study Area

Our study area was the Nebraska panhandle, where over 95% of the land is privately owned. The majority of our nest locations were found in the southwest portion of the panhandle; within Kimball, Cheyenne, and Banner counties. The landscape of the southern panhandle consists of bluffs, rocky outcrops, native and restored grasslands, and farmland (mostly dryland small grain fields). Stands of Cottonwood and other deciduous trees occur naturally along riparian corridors, but the majority of trees outside these

corridors mainly occur as shelterbelts (personal observation). Grasslands in the southern panhandle are fragmented by a matrix of cultivated agricultural land. A majority of the nests located in the southwest panhandle fell within the Kimball Grasslands Biologically Unique Landscape (Schneider et al. 2005), an area of high conservation concern for the state of Nebraska. The northern portion of the panhandle was mostly irrigated farmland, except for Sioux county on the western side which was primarily native grassland. With the exception of the Pine Ridge, the northern panhandle contained fewer trees and were almost exclusively in shelterbelts (personal observation).

Field Methods

We conducted surveys from the arrival of Swainson's Hawks in mid-April through mid-July during the years 2007 and 2008. We primarily located and surveyed nests from roads, but we located a small number of nests during aerial surveys and interior walking surveys conducted for other avifauna. We assigned occupancy states (0 = unoccupied, 1 = occupied) for individual Swainson's Hawk nests and estimated detection probability of our survey methodology using repeat surveys. We conducted 3 occupancy surveys for each nest for the majority of nests, but numbers of surveys ranged from 1 to 5.

We recorded UTM coordinates (WGS84, Zone 13) for every nest using a Garmin Etrex H GPS unit, which we then plotted onto high resolution aerial photos (citation). We ground truthed and recorded land uses within the section (Township, Range, Section) where individual nests were located, along with all other sections adjacent to the section (n = 8). We digitized various landuses (e.g., rangeland, cropland, Conservation Reserve Program (CRP), and residential lands) for the 9 section (3 mile x 3 mile) grids using ArcView 3.2 (ESRI 2000). We then used the XTools extension to calculate areas for

each landuse surrounding nests. For each nest we also recorded tree type complex (lone tree, group of trees, or shelterbelt), distance from nearest road (m), and distance from nearest apparent active Swainson's Hawk nest (m).

Statistical Methods

We performed all our analyses using the statistical computing language R (R Core Development Team 2008). The overall goal of our study was to understand more about the factors that predicted the probability that an already existing nest was occupied by an adult. However, because adult Swainson's Hawks are a vagile species there was always the possibility that an observed nest was recorded as unoccupied when, in fact, the nest was really occupied (a false-negative error). This could potentially lead to underestimating nest occupancy and associated covariates that could be used to better understand nest-site selection. To account for this possibility we analyzed our occupancy data using a zero-inflated binomial model (ZIB), which allows us to estimate a corrected occupancy probability by estimating the false-negative error rate (Hall 2000; Tyre et al. 2003). The likelihood for this model is

$$L(y \mid \hat{p}, \hat{q}) = \hat{p}\binom{m}{y}\hat{q}^{y}(\mathbf{1}-q)^{m-y} \qquad y > 0$$

$$L(y \mid \hat{p}, \hat{q}) = (\mathbf{1}-\hat{p}) + \hat{p}(\mathbf{1}-\hat{q})^{m} \qquad y = 0$$

where y is the number of observed occupancies, m is the number of visits, p is the probability of occupancy and q is the probability of detecting a female that was on the nest. The top equation is for the situation where the number of observations of occupied nests is 1 or greater. The bottom equation is for the situation where an unoccupied nest was observed.

We considered 8 candidate models that could explain variation in occupancy and detectability. We developed two models that explained variation in occupancy. First, our conspecific model (Conspecific) was composed of a single parameter measuring the distance to the nearest conspecific nest in meters. Second, our landuse model (Landuse) was composed of three parameters describing landuse in the vicinity of the nest on a percentage basis: percent of land in rangeland, the Conservation Reserve Program or residential property. We then composed pairwise combinations of the land use and conspecific models, as well as an intercept-only model (Intercept), resulting in a total of four occupancy models.

We also developed a set of detection models. Our first model, the Distance model, was composed of a parameter measuring the distance between each nest and the nearest road. Our second model considered the nesting substrate in which we found each nest (Nesting). This model was composed of three categorical parameters which described the nest as either being in a single tree, a clump of multiple trees or in a shelterbelt. To keep the total number of models small, we only compared two detection models: the first was composed of the two models described above and the second was an intercept-only model (Intercept). Combining both the detection and the occupancy models, we fit a total of 8 candidate models.

We analyzed data collected during two years of sampling (2007-2008). However, due to logistical constraints in the second year of sampling we were only able to visit each nest a single time, making the estimation of occupancy biased and the estimation of detectability impossible. To solve this problem we adopted a Bayesian approach to this analysis, which allows for the inclusion of prior information. Thus, by estimating

parameters from the first year's analysis, we generated priors for the second year's analysis. This makes the estimates for 2008 a weighted average between the prior information (2007 estimates) and the data.

We used Markov Chain Monte Carlo (MCMC) simulation to estimate the parameters for our candidate models. Because of the non-standard likelihood of ZIB model we used a Metropolis-Hastings algorithm. This algorithm works by proposing candidate parameter values and evaluating the relative probability between the candidate value and the current value. Relative probabilities that are greater than a random probability are accepted. After multiple iterations of the algorithm, the values should converge around a stable posterior distribution.

In fitting each parameter we used a logit transformation on the model parameters, thus allowing us to fit covariates in the form of a logistic regression. In the analysis of the 2007 data, we assumed non-informative normal priors (mean zero and variance of 10) on all model parameters. We used the posterior estimates from 2007 as priors on the 2008 analysis. We ran each simulation using 10 chains for 30,000 iterations. We used the first 10,000 iterations as the burn-in period for each chain and we then thinned the chains using every 100th iteration to reduce the amount of serial autocorrelation. We also reduced serial autocorrelation by hierarchically centering any continuous variables by subtracting the mean from each data point and then dividing by the standard deviation.

To determine which model(s) best fit the data we calculated posterior model probabilities using Bayes factors (Link and Barker 2006). Bayes factors (BF) specify the relative odds of a model being "true". In our case, each BF is calculated as the ratio of

the posterior odds of $model_i$ and $model_j$. One can then calculate the posterior model probabilities as:

$$pr(Model_j) = \frac{BF_{\mathbf{1},j}}{\sum_J BF_{\mathbf{1},j}}$$

In the above example, all of the ratios are calculated relative to the first model. It actually doesn't matter which model the ratios are calculated from (Link and Barker 2006). We then used model averaging to make predictions about the effects of model parameters in the best subset of models.

RESULTS

All nests for both years used for analysis in this study were located in trees (1 nest built on a utility pole), and a total of nests were present during both 2007 and 2008 surveys. In 2007 we recorded 107 of the 147 total nests as being occupied with a nesting pair, and in 2008 we recorded 95 of the 171 total nests as being occupied, producing apparent nest occupancy rates of 73% and 56%, respectively.. In 2007 and 2008, shelterbelts contained 53 (50%) and 47 (50%) of our apparent occupied nests, respectively. Small groups of trees and lone trees had similar apparent occupancy rates, where small groups of trees had 27 (25%) and 26 (27%) occupied nests in 2007 and 2008, while lone trees had 26 (24%) and 22 (23%) of occupied nests, respectively.

Swainson's Hawks were first observed in the Nebraska panhandle in mid-April of both years. We recorded our first Swainson's Hawk sitting on a nest on 30 April, during the 2007 field season and 8 May in 2008. We estimated Swainson's Hawk detectability to be high for our study, but was still less than 1 and therefore needed to be accounted for in our analysis of nest occupancy. Our imperfect detection probability of Swainson's

Hawks was not statistically associated with either of the covariates that were thought to possibly hinder our detections. However, (q) was the most important covariate in our detectability model.

There were 4 types of habitats that were recorded associated with the nesting areas. They were rangeland, cropland, which includes wheat, corn, and alfalfa, Conservation Reserve Program (CRP), which are areas that are reseeded with tall grasses and shrubs creating habitat for birds like pheasants, and residential properties, which includes cities and homesteads.

Our model selection results indicated that our Occupancy components were better at explaining Swainson's Hawk nest occupancy than were our Detectability components (Table 1). Of our 8 models explaining Swainson's Hawk nest occupancy, our posterior model probabilities were highest in both years for models that included a null detectability model component and the conspecific variable in the occupancy component. In fact, all 8 models (both years combined) that included the conspecific variable resulted in a better fit of our data than the null model, while every other variable when not coupled with conspecific fell below the null models (Table 1). Our landuse covariate also appeared with conspecific in the best model in 2007 (Table 1), but upon inspection of the parameter estimates for this model it was evident that the conspecific variable was the variable responsible for the models fit to the data (Table 2).

Our parameter estimates for our best models in both 2007 and 2008 suggest that the conspecific variable was responsible for driving Swainson's Hawk nest occupancy in the Nebraska panhandle (Table 2). Our results suggest a positive relationship between Swainson's Hawk nest occupancy and increasing distance from the nearest occupied

Swainson's Hawk nest (Table 2). Upon inspection of our 2007 and 2008 raw data, the average distance between two occupied Swainson's Hawk nests (when all nests in an area were believed to be accounted for) was 3372m and 3432m, respectively. However, for these same two years the average distance between an unoccupied and the nearest occupied Swainson's Hawk nest was 2166m and 2813m, respectively. Our modeling results suggest that once two Swainson's Hawk nests are seperated by distance, they were almost always occupied (Figure 1).

We explored the effects of several different surrounding landuse variables on Swainson's Hawk nest occupancy, but the only one that had a significant relationship was the percentage of residential land (Table 2). The direction of the association between Swainson's Hawk nest occupancy and percentage of surrounding residential land was as we expected (Table 2), where nests with a larger percentage of surrounding residential area were unoccupied more often than nests with less residential land. However, while percentage of residential land in the surrounding land was important in our models, the effect of this variable on Swainson's Hawk nest occupancy was small compared to the variable exploring conspecific interactions for this species (Table 2). Our parameter estimates also suggest that the percentage of rangeland (and cropland) and CRP had no bearing on the occupancy status of Swainson's Hawks nests in the Nebraska panhandle (Table 2).

DISCUSSION

Our observed nest occupancy rates for both 2007 and 2008 were relatively high and similar to other studies (Schmutz 1984, Bechard et al.1990, Gilmer and Stewart 1984). However, accounting for our imperfect detectability suggested that Swainson's Hawk

nest occupancy in western Nebraska was even higher than our apparent rates of 73% and 56%, respectively. Swainson's Hawks in our study area were obligate tree nesters, but only X number (X%) of nests showed up in both years analysis. In addition to nest occupancy, we also wished to explore the effect that ecological processes and our covariates may have had on local colonization and extinction rates between years, but nests in our study area were too transient between years for these explorations. In contrast to large, sturdy Golden Eagle and Ferruginous Hawk nests in this study area, Swainson's Hawk nest transiency between years was mostly attributable to nests being lost (e.g., blown out of tree) during the non-breeding season. In 2008 we frequently checked areas where nests were present in 2007, but many of these nests were no longer present in 2008. However, new nests had been built in nearby trees at some of these locations. We also recorded some actively occupied nests that were lost to wind during the breeding season, again suggesting that climatic elements (e.g., wind) play a major role in Swainson's Hawk nesting ecology in western Nebraska.

Trees are important in determining Swainson's Hawks nest site selection (Schmutz 1984), as is tree condition (Hansen and Flake 1995). Swainson's Hawk nests in our study area occurred in three different types of tree complexes, but the majority of the active nests (n = ?, x%) were located in shelterbelts. Though the majority of our nests were located in shelterbelts in both years, the apparent occupancy rate of Swainson's Hawk in shelterbelts (65%) was not much different than that observed for lone trees (64%) and small groups of trees (61%). This suggests that the reason why there were so many nests in shelterbelts comparatively was because the largest percentage of trees in our study area was shelterbelts (NRCS data). Historically, the only trees found in the

Kimball County area would have been along the Lodgepole Creek riparian drainage. However, widespread planting of trees on the prairie in recent decades to protect homesteads and agricultural fields from the negative effects of wind (e.g., erosion) has been commonplace (acres of trees planted in Kimball County since 1980??, NRCS). This increase in trees, or nesting substrate, across our study area may have had an unintended result of increasing Swainson's Hawk breeding habitat. Other studies have also found that Swainson's Hawks routinely nest in shelterbelts (Gilmer and Stewart 1984), and even that Swainson's Hawk density was more strongly affected by tree availability when compared to Ferruginous Hawks (Schmutz 1989).

Lone trees in our study area were relatively limited and usually isolated geographically, and it was likely that Swainson's Hawks could lose some potential nesting sites in these areas through interspecific competition with earlier arriving Ferruginous Hawks (personal observation). Thurow and White (1983) suggested that Swainson's Hawks and Ferruginous Hawks exhibited mutualistic nesting behaviors towards one another, but in our study area this is unlikely because of the shear volume of Swainson's Hawk nests compared to Ferruginous Hawk nests in the same area. However, potential nest site competition between Swainson's and the earlier arriving Ferruginous could account for some of the reduced occupancy at these lone tree sites, but was not explored interaction in our study.

Small groups of trees in our study area were primarily encountered near both currently occupied and abandoned farmsteads, putting nests in these trees in close contact with anthropogenic impacts. Our results indicated that Swainson's Hawk nests with a large percentage of residential land in the surrounding area were less likely to be

occupied, which could at least account for some percentage of unoccupied nests in small groups of trees that we observed during our study. A study conducted in southeastern Alberta reported only 1 of 37 (3%) Ferruginous Hawk nests were located within 0.5 km of a farmyard, whereas 15 of 68 (22%) nests of Swainson's Hawks were located within that distance (Schmutz 1984). Competition for these nesting sites with large amounts of neighboring residential area was probably limited, and therefore anthropogenic impacts may play a role in Swainson's Hawk nest site selection in western Nebraska.

Swainson's Hawk detectability was good for our study, but was still imperfect and needed to accounted for in the modeling despite our a priori belief that detecting an incubating adult on a nest would be easily attainable. None of our potential detectability covariates were a factor in detecting an adult on a nest, suggesting that our imperfect detectability was in large part the result of visiting nests when both adults were not present (e.g., foraging).

While trees are important in Swainson's Hawk nesting ecology and imperfect detectability needed to be accounted for in our modeling, none of this information was as important in understanding Swainson's Hawk nesting ecology in western Nebraska as an underlying conspecific interaction. Our data suggested that trees are not a limiting factor for Swainson's Hawk in western Nebraska, but rather that Swainson's Hawks were spacing their nesting sites at specific distances from one another when suitable nesting substrates were available. We have strong model support that Swainson's Hawks were actively selecting nesting sites with respect to an apparent home range or territory size. We are unable to speculate on whether this territory was actively guarded or was based on some aspect of foraging habitat, but when Swainson's Hawk nests were located too

close to one another, only one of them was routinely active. However, once that distance was exceeded both nests were commonly occupied, regardless of the make-up of the surrounding landscape. The conspecific variable alone was the most important factor influencing Swainson's Hawk nesting ecology in western Nebraska.

We also explored effects of surrounding landscape complementation on Swainson's Hawk nest occupancy in our modeling, because prior studies have suggested that native grassland was their preferred nesting area (Gilmer and Stewart 1984), while others suggested they prefer cultivated areas regardless of the extent of cultivation (Schmutz 1989). Bechard (1982) stated that vegetative cover also affects where Swainson's Hawks forage, suggesting that they may need both cropland and native prairie in their nesting area. However, our modeling results show that neither native prairie (and CRP) or cropland in any amount in the area surrounding the nest had any influence on Swainson's Hawk nest occupancy. This result suggests that in western Nebraska neither rangelands or croplands are serving as a more important foraging habitat from which Swainson's Hawks choose their nest sites.

The only landuse that had any association with nest occupancy was the amount of residential area in the surrounding landscape. Specifically, Swainson's Hawk nests with increased amounts of residential area surrounding them where more often unoccupied. However, the habitat model probabilities and parameter estimates accounted for much less variation in our data and had much less support than the conspecific (competition) variable. This suggests that as long as the distance between nests criteria was met, Swainson's Hawks were likely to nest in an available substrate regardless of the surrounding landscape. This may be less true for nests with a large percentage of

residential land in the area surrounding the nest, but our data suggests that Swainson's Hawks were not selecting nest sites for some life history habitat requirement (e.g., foraging habitat).

Overall, widespread tree planting in southwestern Nebraska in recent decades has provided Swainson's Hawks with an abundance of nesting substrates, and their ability to nest in areas regardless of the surrounding habitat conditions have led to a relatively large population of Swainson's Hawks. However, within this total amount of nesting substrate, Swainson's Hawks are spacing themselves in rough territories and therefore limiting themselves from nesting in some areas even when a suitable nesting substrate is present. Foraging habitat and food itself do not appear limiting to Swainson's Hawks in this area, as we routinely observed them perched and hunting in both grasslands and croplands across our study area. Maintaining current stands of trees would likely help to maintain the current population of breeding Swainson's Hawks in western Nebraska, but focused planting of additional lone trees, or possibly nesting platforms, might help to increase population numbers by providing a key habitat component. However, we would not advocate continued planting of shelterbelts on the prairie despite the increased occupancy rate observed in our study, because shelterbelts are likely migration corridors for predators (e.g., raccoons) that would not otherwise come in contact with or be able to prey on other avian species of conservation concern in this area (e.g., Mountain Plover). Understanding nesting ecology and current population numbers of Swainson's Hawk in western Nebraska is critical to weighing the pros and cons for implementing Swainson's Hawk conservation strategies that might negatively impact other at-risk species..

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Table 1. Model table for Swainson's Hawk nest occupancy study in Kimball Co. Nebraska (2007-2008). Each model is composed of parameters thought to explain variation in occupancy probability (Occuopancy Models) or properly classifying a nest as occupied when an adult was truly present (Detection Models). The effects on occupancy include a single parameter model of the distance (m) between conspecific nests (Conspecific), and three parameter model of landuse near the nest: % rangeland, % CRP and % residental property and a single parameter model that assumed occupancy was constant (Intercept). The effects on detection rate included a single parameter model for the effect of distance (m) from the nearest road (Distance) and a model for the type of nesting substrate (Nesting) composed of three categorical parameters: shelterbelt, single tree and clump of trees. We assessed the amount support for each model by calculating the posterior model probabilities for each model [pr(model)]. Models with higher posterior probabilities indicate a better ability to predict the observed data.

2007		
Occupancy Models	**Detection Models**	**Pr(Model)**
Conspecific + Landuse	Intercept	0.66
Conspecific + Landuse	Distance + Nesting	0.26
Conspecfic	Intercept	0.06
Conspecfic	Distance + Nesting	0.02
Intercept	Intercept	0.00
Landuse	Intercept	0.00
Intercept	Distance + Nesting	0.00
Landuse	Distance + Nesting	0.00
2008		
Occupancy Models	**Detection Models**	**Pr(Model)**
Conspecfic	Intercept	0.71
Conspecfic	Distance + Nesting	0.14
Conspecific + Landuse	Intercept	0.09
Conspecific + Landuse	Distance + Nesting	0.05
Intercept	Intercept	0.00
Landuse	Intercept	0.00
Intercept	Distance + Nesting	0.00
Landuse	Distance + Nesting	0.00

Table 2. Parameter table for Swainson's Hawk nest occupancy study in Kimball Co. Nebraska. The parameters have been model averaged according to the posterior probability for each model. The table below presents estimates for mean occupancy probability (p) as well as multiple effects on that mean: distance between conspecific nests (Conspecific) and the percentage of different types of landuse near the nest (% Rangeland, % CRP and % Residential). The table also shows estimates of mean detection probability (q), as well as effect on the mean: distance to the nearest road (Distance) and type of nesting substrate (Shelterbelt, Single Tree, Clump of Trees). The posterior mean (Mean) for each estimate is presented in the first column, the standard deviation (SD) in the second column and the last columns have the lower and upper 95% central interval esitmates (0.025 and 0.975 quantiles).

	2007			
Parameter	**Mean**	**SD**	**0.025**	**0.975**
P	3.96	0.63	2.84	5.31
Conspecific	3.25	0.59	2.18	4.54
Landuse: % Rangeland	0.07	0.15	-0.21	0.40
Landuse: % CRP	-0.11	0.14	-0.37	0.18
Landuse: % Residential	-0.48	0.14	-0.78	-0.24
Q	0.43	0.06	0.32	0.54
Distance	-0.02	0.03	-0.08	0.05
Nesting: Single Tree	-0.05	0.09	-0.22	0.12
Nesting: Clump of Trees	-0.03	0.08	-0.18	0.12
	2008			
Parameter	**Mean**	**SD**	**0.025**	**0.975**
P	3.51	0.33	2.90	4.20
Conspecific	3.68	0.42	2.84	4.49
Range	0.02	0.02	-0.02	0.05
CRP	-0.02	0.01	-0.05	0.01
Residential	-0.05	0.01	-0.07	-0.02
Q	0.44	0.04	0.35	0.52
Distance	0.00	0.00	-0.01	0.01
Nesting: Single Tree	-0.01	0.01	-0.03	0.02
Nesting: Clump of Trees	-0.01	0.01	-0.03	0.02

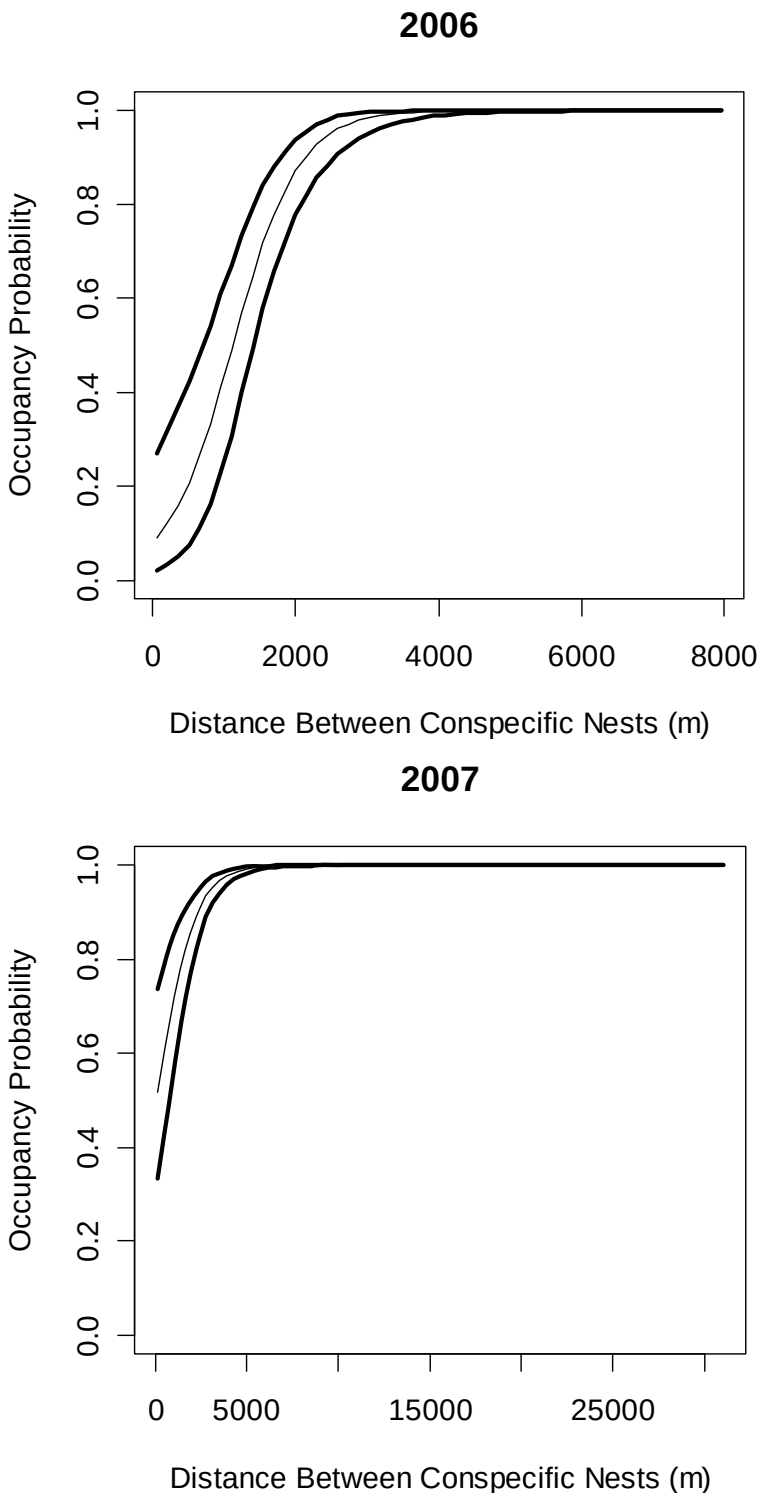

Fig.1. Model averaged prediction of the effect of distance between conspecific nests and the probability of occupancy for Swainson's Hawk nests for 2007 and 2008. The thin line represents the posterior mean prediction and the thin lines represent the 95% central interval (0.025 and 0.975 quantiles).