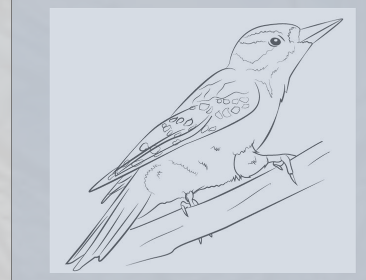

An Exploratory GIS Analysis on Habitat Associations of Black-Backed Woodpeckers in Burned Sierra Nevada Forests

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Background

Introduction to the Black-Backed Woodpecker

The black-backed woodpecker (*Picoides arcticus*) (BBWO) is a disturbance-dependent species strongly associated with early post-wildfire habitat. The BBWO is considered an irruptive species, responding to changes in food supply (i.e. wood-boring beetles that inhabit recently killed/dying trees) (Rota et al. 2015).

The genetically distinct populations in the Sierra Nevada range of California have been targeted for endangered species protection. Conservation efforts are hindered by poor understanding of the dependency on unburned/burned forests by the BBWO. Furthermore, small population and nomadic trends make the BBWO a difficult species to monitor (California Department of Fish & Wildlife, 2013; Beedy & Pandolfino, 2013). We want to improve understanding of wildfire impact on the BBWO. Many factors likely impact ideal habitat for the BBWO including diet, elevation, latitude, fire size and severity, heterogeneity of the burn site, years elapsed since the fire, and snag basal area (Saracco et al. 2011). These factors impact home range size and bird survey method. A full analysis of BBWO distribution is complex and beyond the scope of this project. We intend to model only elevation, latitude, fire severity, vegetation, and temporal impact.

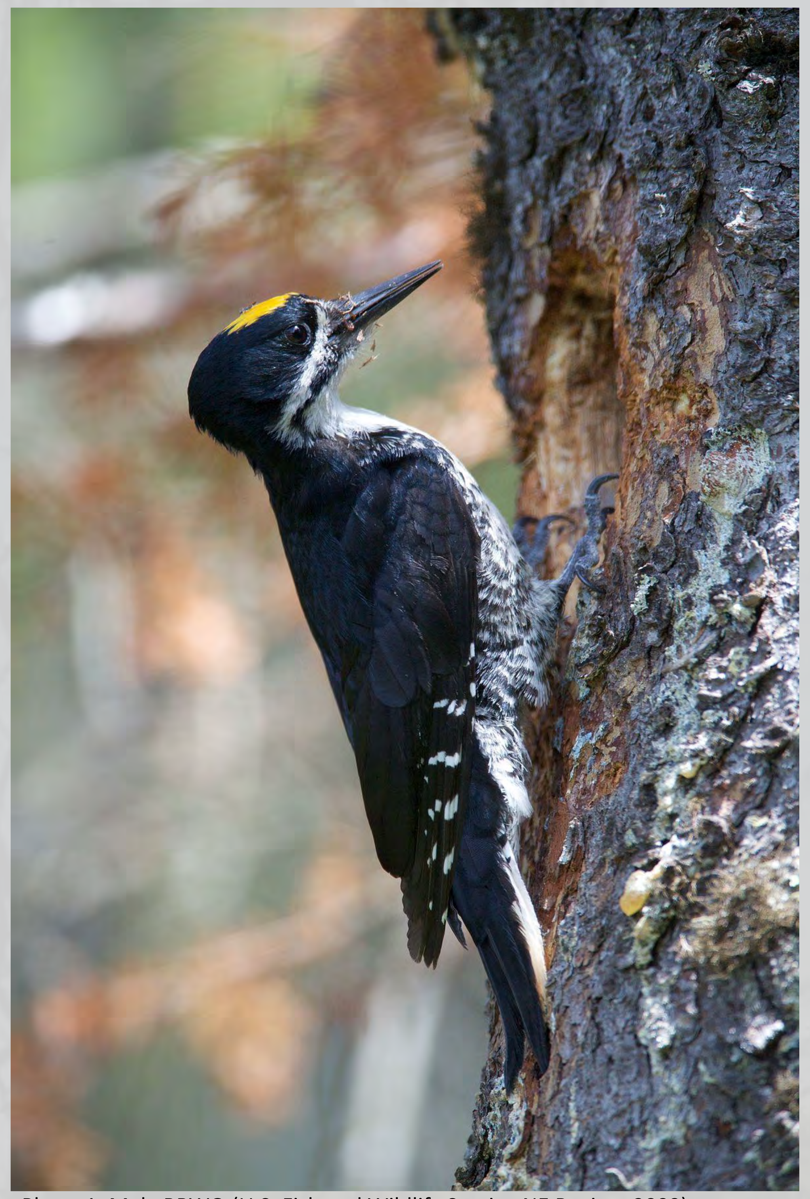

Photo 1: Male BBWO (U.S. Fish and Wildlife Service NE Region, 2009).

Purpose

Results will direct conservation efforts and management of wildfire (e.g. fire suppression). Prescribed burns may result in fires that are not sufficient for the BBWO (e.g. burn sites too homogeneous and/or low severity) and post-wildfire management may disrupt ideal habitat (e.g. salvage logging). Without proper knowledge of the BBWO's dependency on wildfire, their populations may be placed at further risk for endangerment.

Photo 2: Ramsey Fire and salvage logging post-wildfire (Photo courtesy: Martin Frye, 2014).

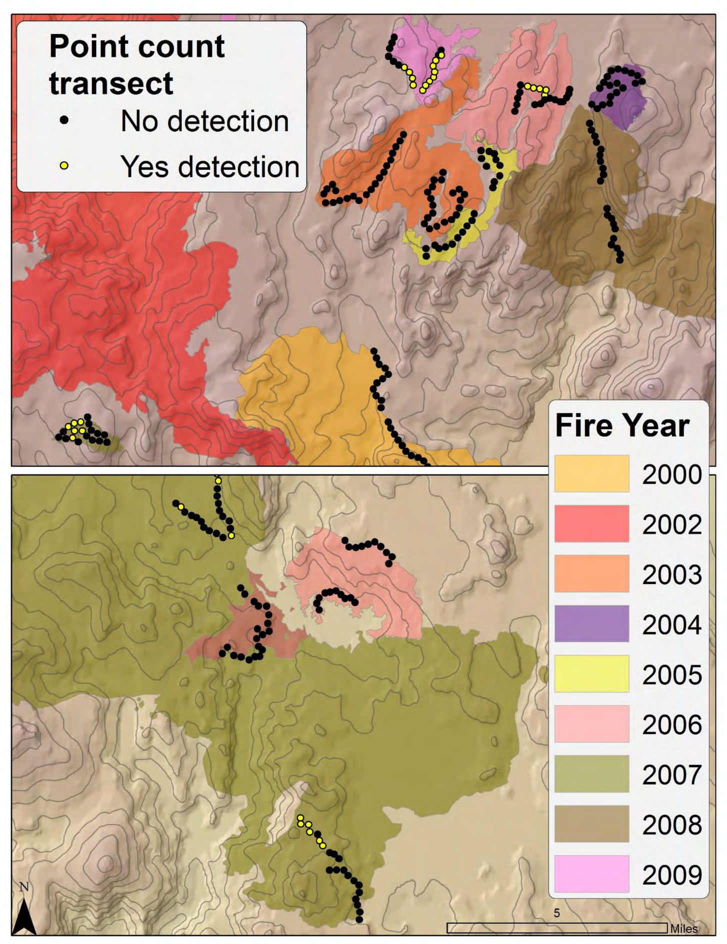

Figure 1: Study site comprising of the Sierra Nevada mountain range of California

Citations

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Methods

Logistic Regression & Frequency Ratio Models

Spatial data was collected and/ or created: vegetation (Landfire), elevation (DEM), latitude, Historic Fire Data (Landfire), BBWO habitat extent (IBP) and BBWO survey data (IBP). Continuous data was reclassified into categorical data as needed. Survey point data (n = 1916) was collected by Institute for Bird Populations (IBP) staff in 2009-2015 via transects through prior wildfire burns, resulting in binary (bird heard vs. bird not heard) results (Detected = 193, undetected = 1723). Chi-square analysis was performed on each individual survey year. A multivariate logistic regression (MLR) and frequency ratio (FR) was used to model habitat suitability (Lee & Pradhan, 2007).

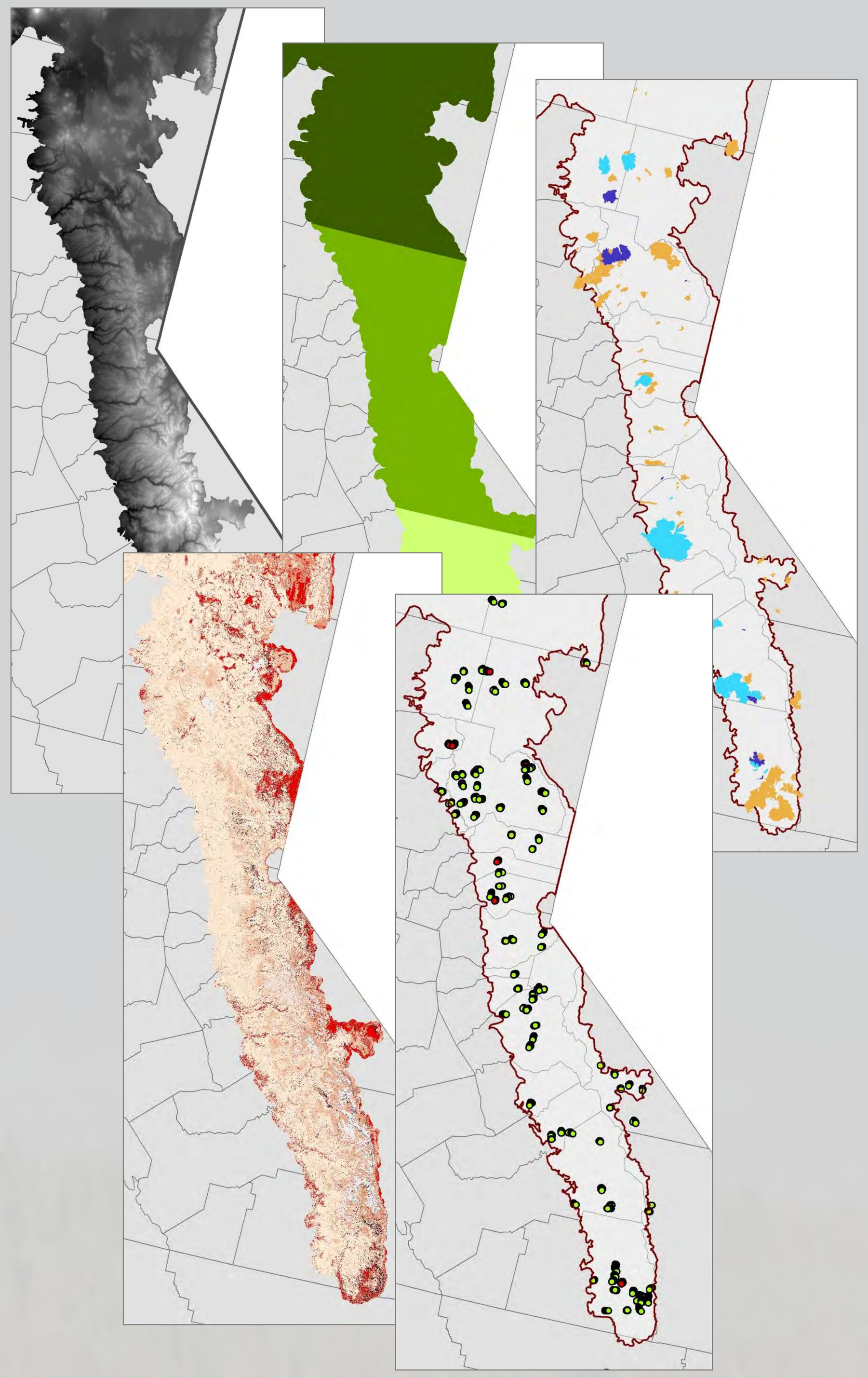

Figure 2: Overlapping DEM, latitudinal, burn age, burn severity and survey point data maps.

The MLR is ideal for predicting binary (presence/absence) outcomes based on a set of predictor variables
The probability of occurrence is expressed as the p-value:

$$z = a + b_1X_1 + b_2X_2 + \cdots + \varepsilon$$
$$e^{-z}: 1/2.71828182845904^{z}$$
$$p = 1/(1 + e^{-z})$$

MLR conducted on each predictor variable results in a sig. value and coefficient (Table 1). Results indicate no association between vegetation and BBWO detection, and was discarded from the study (sig. value = 0.400). Slope coefficients are used to calculate the z-value, which is converted to the p-value as shown above. This input is used to create the MLR model.
The FR model further evaluates spatial relationships between BBWO sighting and each of the predictor variables, and is used to generate the Habitat Suitability Index (HSI).

$$Fr = \frac{\%\,Occurring\ Frequency\ (POF)}{\%\ of\ Area\ (PA)}$$

An FR value of 100 is an average value indicating no association. Values > 100 indicate an association, and values < 100 indicate avoidance. To calculate and map the HSI, each predictor variable's FR is summed:

$$HSI = Fr_1 + Fr_2 + \cdots + Fr_n$$

Photo 3: Sierra Alpine IPB bird survey (Photo courtesy: Liz Bartholomew)

Photo 4: Female BBWO. (Courtesy: Matthew Stratmoen)

Results & Conclusions

The MLR model output indicates poor predictive relationship between independent variables and BBWO sighting. However, chi-square analysis found statistical significance between fire age and BBWO presence (p-values: <0.05). The FR model indicates association with young fire age (1-3 years), southern latitudes, and mid elevations (~5000-9700 feet). Furthermore, the FR indicates that detections rarely occurred in moderately aged and old fires (4-5 and >5 years), mid latitudes, and low elevations (<5000 feet). These associations are mostly consistent with scientific literature. Latitudinal associations are contrary (opposite) to findings found by Sarcocco et al. (2011), suggesting latitudinal relationship may not be as indicative as fire age. Findings reinforce the importance of wildfire management (i.e. suppression/ salvage logging) and the BBWO dependence on wildfire habitat occurrence every 1-3 years.

This type of study is complicated by the irruptive nature of the BBWO inhabiting wildfire sites scattered across the Sierra Nevada. Based on prior studies on the BBWO home range, future work should include examination of fragmented landscape patterns. Creating a buffer around the survey area will allow for a holistic examination of variation the BBWO relationship to home range and vegetation/fire severity. Results of this type of study will help to manage post-wildfire logging and protect BBWO habitat.

Table 1: Sig. values from MLR and frequency ratio data.

Predictor Variable	Area (m²)	% Area (PA)	Detections	% Occur Freq (POF)	Freq Ratio (POF / PA) *100	Sig.	Coefficient
Fire Age							
1-3 years	2,524,707	35%	95	51%	145	.	0.00
4-5 years	1,040,150	14%	9	5%	33	0.50	0.778
> 5 years	3,700,872	51%	84	45%	88	0.00	2.822
Latitude						0.00	-0.465
39.92 - 42.03	48,118,015	50%	102	53%	106	---	---
37.81 - 39.92	26,475,056	28%	13	7%	24	---	---
35.70 - 37.81	21,465,256	22%	78	40%	181	---	---
Elevation (m)						0.00	-0.001
2,695 – 4,387	5,672,271	6%	0	0%	0	---	---
1,544 – 2,965	48,493,048	51%	154	80%	158	---	---
122 – 1,544	41,653,564	43%	39	20%	46	---	---
Fire severity (% severely burned)							
0-20%	63,913,404	70%	149	77%	110	0.016	-2.561
21-40%	8,639,444	9%	26	13%	142	0.044	-2.175
41-60%	8,388,649	9%	12	6%	68	0.011	-2.818
61-80%	608,189	1%	0	0%	0	---	---
91-100%	8,183,022	9%	5	3%	29	0.186	-1.533
Sparse Vegetation	1,573,570	2%	1	1%	30	.	.

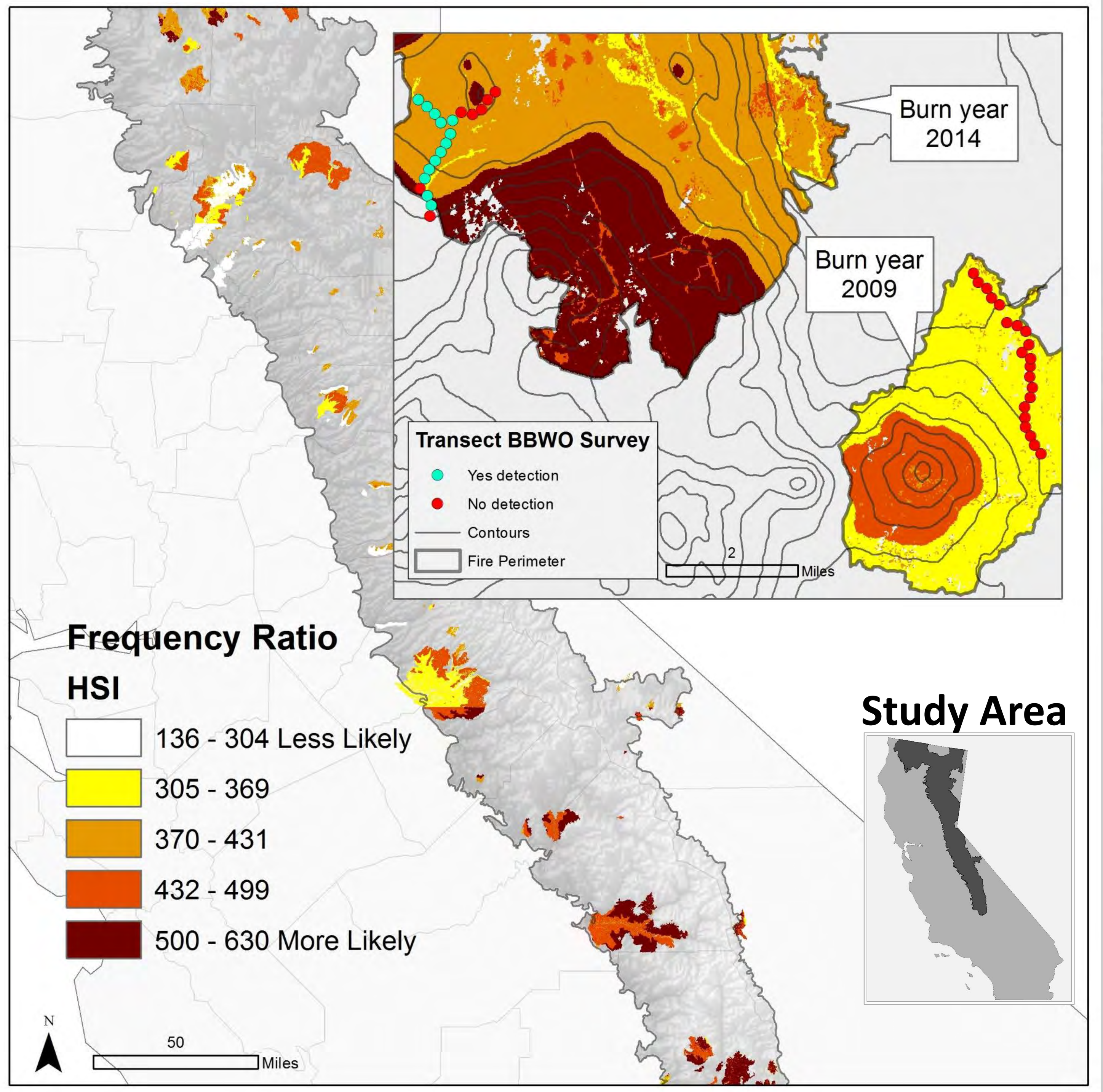

Figure 3: Habitat Suitability Index (HSI) based on frequency ratio (FR).