Developing a Habitat Suitability Index Model for Masked Bobwhite Quail

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Background and Introduction

Since the initial discovery of Masked Bobwhite in 1864 and subsequent description in 1884, the species has had a tenuous history. Masked Bobwhite were extirpated in southern Arizona by 1900 and believed extinct in Sonora, Mexico by 1950. Three isolated, wild populations were subsequently re-discovered in Sonora between 1964 and 1992, one or two of which are thought to have since disappeared. During the past 10 years, only two populations were known to exist in the wild, one on the Buenos Aires National Wildlife Refuge (BANWR) and one on several private ranches in north-central Sonora, Mexico. Numbers of birds in these two areas have declined in recent years and no birds were detected in either location during the 2009 standardized survey effort (although BANWR staff reported several incidental detections of birds in 2009).

The last four decades of Masked Bobwhite recovery efforts have seen limited success. The sole population in the U.S. (at BANWR) required annual supplementation of captive-reared individuals. The sole wild population in Mexico is still subject to over-grazing by livestock and limited conservation or habitat management efforts. Successful recovery of the species will require a concerted, international collaborative effort between the United States and Mexico. The 1995 Recovery Plan calls for a habitat suitability analysis to guide habitat management and bobwhite reintroduction efforts in the U.S. and Mexico. Masked Bobwhite recovery is therefore dependent upon synthesizing Masked Bobwhite habitat requirements, identifying areas with remaining habitat, and managing existing habitat to improve its suitability and availability. Unfortunately, traditional methods of developing and testing a habitat suitability index model are not feasible because of the limited number of wild birds. Moreover, results from a habitat suitability investigation on birds occupying sub-prime habitat could lead to incorrectly identifying poor habitat as optimal. In order to overcome these obstacles we will use a novel method which incorporates both published literature and expert opinion to develop a suite of habitat suitability index models.

Project Objectives

Our three primary goals for this project are: 1) Determine important habitat features for masked bobwhite quail; 2) Quantify the relationship between important habitat features and habitat suitability for masked bobwhite quail; and 3) Translate the various bivariate relationships between habitat features and masked bobwhite into a suite of mathematical habitat suitability models.

Progress to Date

*Objective 1*. We identified 12 species experts and contacted them for individual interviews. Two of the experts we contacted did not respond to multiple requests for an interview and the 3rd declined to be interviewed. We used the following questions to aid in collecting information about masked bobwhite habitat from the remaining 9 experts.

* What has prevented masked bobwhite from establishing or recovering?
* What are the most important habitat variables for masked bobwhite?
* How does season affect these variables and their importance?

We identified 22 separate issues affecting masked bobwhite recovery from interviews. We removed 2 of these issues (breeding problems among the released birds and wilderness worthiness of captive birds) because they were unrelated to habitat. The remaining issues are a combination of measurable habitat features and ultimate process that affect habitat selection (e.g. leguminous shrubs and winter food, respectively). We also asked experts to rank each variable they mentioned in order of importance. The variables and their associated ranks are presented in table 1. As might be expected, not all experts ranked each variable. Where no rank was given to a variable we inferred a rank from discussions within the interview. We left the rank blank if the variable was not discussed in enough detail to infer a rank. We summarized the importance of each variable by taking an average of the ranks for each variable. We calculated variable weights by taking the inverse of the average rank (Table 2).

*Objective 2*. We initially selected 5 variables which were also present in the published literature to identify the quantitative relationship between each variable and habitat suitability for masked bobwhites: 1) Woody cover (brush and shrub), 2) Bare ground, 3) Nest substrate height, 4)Herbaceous cover, and 5) Visual obstruction (at ground level). We used given means and ranges from both species experts and the literature to produce a suite of potential relationships for each variable. In cases where we were given a mean but no range we produced three graphs with varying degrees of variance: high, medium, and low. Graphs with high variance would indicate suitability for bobwhites over a broad range of conditions. Conversely, graphs with low variance would indicate only a narrow range of conditions to be suitable for bobwhites. In cases where we were given a range but no mean we created graphs with varying levels of kurtosis (skew) to create various means (low, centered, and high) within a given range. The number of graphs produced for each variable reflects either the degree of uncertainty about the relationship or the diversity of opinion or both. Graphs of the 5 initial variables, along with their probability density functions are presented in appendix A. We will continue this process for the remaining variables until we have quantified the relationship between all of the important habitat features identified by experts and habitat suitability for masked bobwhites.

*Objective 3.* We will create a habitat suitability model for each expert from their responses to objectives 1 and 2. For each expert we will create a joint probability density model. We will weight each variable in the model according to the variable’s assigned rank. We will use the relationship chosen by the expert for each variable to include in the model. We will also develop a consensus model by combining the responses from all experts into a single model. We will use the average rank assigned to each variable to determine the weight of that variable in the model. We will similarly define the relationship between each variable and habitat suitability, although some cases may require a more complex combination.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Avian Predators | Winter Food | Invasive Plant spp | Climate | Woodland /Grassland Edges | Thermal Refugia | Brush and Shrub Cover | Vegetation Height (herbaceous) | Leguminous Shrubs | Vegetation Structural Diversity | Arthropod Diversity and Abundance | Bare Ground | Grass Cover | Tree Cover | Mammalian Predators | Herbaceous Species Diversity | Forb Cover | Water |
| Expert 1 | 1 |  |  |  |  |  |  |  |  |  |  |  |  | 1 | 2 |  |  | 6 |
| Expert 2 |  | 1 | 2 | 3 |  |  |  |  | 1 |  | 4 |  |  |  |  | 4 |  | 5 |
| Expert 3 |  |  |  | 1 |  | 2 | 3 |  |  | 5 |  | 4 | 5 | 2 |  | 6 | 3 |  |
| Expert 4 | 8 | 3 | 7 | 6 | 2 |  | 3 | 9 | 3 |  |  | 4 | 1 |  | 8 |  | 5 |  |
| Expert 5 | 4 | 1 |  |  | 5 | 3 | 2 |  |  | 5 |  |  | 6 | 6 | 4 |  | 6 |  |
| Expert 6 |  | 6 |  |  | 4 |  | 3 |  |  | 1 | 6 |  | 4 | 5 |  | 2 | 6 |  |
| Expert 7 |  |  | 1 | 1 | 3 |  | 5 |  | 2 | 3 |  | 4 | 3 | 6 |  | 1 | 2 | 16 |
| Expert 8 |  |  | 16 | 1 |  |  | 6 |  | 3 |  |  |  | 5 |  |  | 2 | 4 | 16 |
| Expert 9 |  |  |  | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Very Important and Beneficial | | | | | | | | Very Important and Detrimental | | | | | | | | |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Table 1. Heat map of important variables showing degree of similarity in the rank of each variable by experts. not all experts ranked each variable. Where no rank was given to a variable we inferred a rank from discussions within the interview. We left the rank blank if the variable was not discussed in enough detail to infer a rank. All variable ranks will be confirmed in future interviews.

Table 2. Variables listed in order from most important to least according to expert opinion. These values are subject to change after confirmation of variable ranks from experts.

|  |  |  |
| --- | --- | --- |
| Habitat Variable | Rank | Weight-1 |
| Climate | 1 | 2.166667 |
| Leguminous Shrubs | 2 | 2.25 |
| Thermal Refugia | 3 | 2.5 |
| Winter Food | 4 | 2.75 |
| Herbaceous Species Diversity | 5 | 3 |
| Woodland /Grassland Edges | 6 | 3.5 |
| Vegetation Structural Diversity | 7 | 3.5 |
| Brush and Shrub Cover | 8 | 3.666667 |
| Bare Ground | 9 | 4 |
| Grass Cover | 10 | 4 |
| Tree Cover | 11 | 4 |
| Avian Predators | 12 | 4.25 |
| Forb Cover | 13 | 4.333333 |
| Mammalian Predators | 14 | 4.5 |
| Arthropod Diversity and Abundance | 15 | 5 |
| Invasive Plant spp | 16 | 6.5 |
| Vegetation Height (herbaceous) | 17 | 9 |
| Water | 18 | 10.75 |

**Appendix A:**

For all beta densities listed below the beta function (B(α,β)) is defined as:

Woody Cover (Brush and Shrub)

C:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Woody Veg\Guthery 2001 woody cover-#1.emfC:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Woody Veg\Guthery 2001 woody cover- fatter curve-#2.emfC:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Woody Veg\Guthery 2001 woody cover- biased towards 0 with fat tail-#3.emf

C:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Woody Veg\Guthery 2001 woody cover- linear trend-#4.emfC:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Woody Veg\Goodwin interview woody cover-#5.emfC:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Woody Veg\Goodwin interview woody -cover-fatter distribution-#6.emf

C:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Woody Veg\Kopp 1998 Woody Cover-#7.emfC:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Woody Veg\Lusk 2006 woody cover-#8.emfC:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Woody Veg\Lusk 2006 woody cover- fatter curve-#9.emf

Bare Ground

C:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Bare Ground\Guthery 2001 Bare ground#1.emfC:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Bare Ground\Kopp 1998 Bare Ground#2.emfC:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Bare Ground\Rader-Lusk-Cohan Bare Ground#3.emf

Nest Substrate Height

C:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Nest Substrate Height\Arredondo 2007- Nest Substrate Height#1.emfC:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Nest Substrate Height\Lusk 2006- Nest Substrate Height#2.emfC:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Nest Substrate Height\Rader 2001- Nest Substrate Height#3.emf

Herbaceous Cover

C:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Herbaceous Cover\Arredondo Herb cover High Var#1.emfC:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Herbaceous Cover\Arredondo Herb cover Low Var#2.emfC:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Herbaceous Cover\Arredondo Herb cover Med Var#3.emf

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C:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Herbaceous Cover\Rader-Kuvleski Herb Cover -High Var#7.emfC:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Herbaceous Cover\Rader-Kuvleski Herb Cover -Low Var#8.emfC:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Herbaceous Cover\Rader-Kuvleski Herb Cover -Med Var#9.emf

Visual Obstruction (at ground level)

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