**Habitat Suitability Index Model: Roy Tomlinson**

The following habitat suitability index model is the result of information obtained from a single species expert. We developed this model following the U.S. Fish and Wildlife Service guide to the development of habitat suitability index (HSI) models 103-ESM (USFWS 1981). Unlike typical HSI models, this model is intended to be used in conjunction with alternative HSI models developed from additional experts and existing literature. This model represents the best estimates based on the expertise of one individual who is a recognized expert on the Masked Bobwhite.

1.Model Applicability:

1.1 Geographic area. This model was developed based on knowledge of masked bobwhite habitat in Mexico.

1.2 Season. This model was developed to evaluate habitat needs of masked bobwhites over the entire year.

2. Model Description:

2.1 Overview. This model considers the ability of assessed habitat to meet the food, reproductive, and cover requirements of masked bobwhite as an indicator of overall habitat suitability. All components of the model are assessed by vegetative conditions. The relationship between habitat variables and critical life history requirements of masked bobwhite is illustrated in Figure 1.

2.2 Written Documentation.

The following sections provide a written documentation of the logic and assumptions used to interpret the habitat information for masked bobwhite in order to explain the variables and equations that are used in the HSI model. We present each critical habitat requirement and describe the variables which contribute to it.

1. Reproduction. Habitat is assumed to be suitable for reproduction if both food and cover are suitable.
2. Food. Forb diversity is important year round because forbs are a source of food. In the winter and early spring, when food is scarce, forb seeds are critical. Forbs are consumed directly as forage in the summer and fall. Habitat suitability increases with increasing forb diversity. Likewise, grasses are also an important source of food. Leguminous shrubs, such as *Acacia angustissima,* provide a source of food in the winter months when other sources of food are scarce. Abundance of a variety of grass species (high grass diversity) provides an important source of food for masked bobwhite. Insects, e.g. grasshoppers, provide necessary protein for immature masked bobwhite growth during summer and fall. They may also play a small role in the diet of adults.
3. Cover. Masked bobwhites have different habitat requirements in the winter and summer. In the summer, masked bobwhites prefer more open areas with primarily grass and forb cover. In the winter, they prefer more closed areas with a mix of small trees and shrubs. Therefore, the optimal canopy cover of forbs, grass, shrubs, and trees differs between winter and summer. In the summer, optimal habitat includes areas with approximately 50 percent coverage by grass, 30 percent coverage by forbs, 10-20 percent coverage by shrubs and small trees, and 25 percent coverage by bare ground defined as unobstructed ground surface (coverage sums to >100 percent due to overlap of coverage). In the winter, optimal habitat includes areas with approximately 50 percent coverage by grass and forb (combined), 50-75 percent coverage by shrubs and small trees, and 25 percent coverage by bare ground (unobstructed ground surface). Grass cover should include primarily annuals such as Rothrock’s, black, or side-oats grama (see species list in Appendix A). Both forb and grass cover should be measured as a stem density. Masked bobwhites need a balance between adequate overhead cover and adequate openings in the vegetation to move and to detect predators. Buffelgrass (*Pennisetum ciliare*) generally fails to meet this balance because it forms stands which are too dense (lack adequate openings). The explicit relationship between plant density (cover) and habitat suitability of masked bobwhite is not well-established. Shrub cover is an important component in the winter and spring when cover from grass and forbs is minimal. Beneficial shrub species are listed in appendix A. Creosote-dominated areas are considered poor habitat for masked bobwhite during all months of the year. Dense woody areas are only used as escape cover and, therefore, some dense woody vegetation must be available to masked bobwhites but it must only account for a small portion of the landscape. Optimal summer habitat differs from optimal winter habitat and so both must be present in an area (in relatively close proximity) so that habitat requirements are met in all months of the year. Moreover, optimal habitat includes areas where transitions (ecotones) between open areas and tree/brush areas are abrupt.
4. Weather – Masked bobwhites have singularly adapted to a weather pattern where the onset of breeding begins when the annual “monsoon” season begins (ca. July1). A “good” rainy season is characterized by frequent and relatively non-violent rainfall throughout the period (10-14 inches was considered optimal). This pattern allows the optimal growth and maturation of food-bearing plants and insects as well as grass and brush for cover. If the annual precipitation is delayed or significantly diminished, the chances of masked bobwhite breeding success are also diminished accordingly. Because the rainy season is so short (3 months), re-nesting after initial failure can be significantly reduced, whereas other quail (Gambel’s and Elegant) have much longer breeding seasons and therefore greater odds of re-nesting success.
5. Altitudinal Distribution – Masked bobwhites are limited in distribution by altitude; they generally have never been found in areas below 1,500 feet (asl) nor above 4,500 feet. Therefore, they never occupied the low, drier southwestern areas or the higher mountain areas of Sonora. This factor is probably related to habitat requirements not found in the more extreme altitudinal zones.

**Figure 1.** The relationship between measured habitat variables, critical life history requirements, and habitat suitability for masked bobwhites.

Measured Habitat Variable Life Requisite Model Output

Grass Diversity

Forb Diversity

Structural Diversity

Forb Cover

Food

Suitability Index

Grass Cover

Cover

Shrub Cover

Woody Cover

Forb Height

Brush Piles

Grass Height

Tree Cover

**3. Suitability Functions and Graphs**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | Description | Suitability Function | Suitability Graph |
| FD | Forb Diversity measured as the total number of forb species on a typical home range (10.9 ha) | (Gamma CDF with α=25.5, β=1) | X:\Masked Bobwhite\Graphs\Suitability Functions\Roy Tomlinson\FD Roy.emf |
| GD | Grass Diversity measured as the total number of both annual and perennial grass species on a typical home range (10.9 ha) | (Gamma CDF with α=24, β=1) | X:\Masked Bobwhite\Graphs\Suitability Functions\Roy Tomlinson\GD Roy.emf |
| FH | Forb Height measured as the average height of forbs on a typical home range (10.9 ha) |  | X:\Masked Bobwhite\Graphs\Suitability Functions\Roy Tomlinson\FH Roy.emf |
| GH | Grass Height measured as the average height of grass on a typical home range (10.9 ha) |  | X:\Masked Bobwhite\Graphs\Suitability Functions\Roy Tomlinson\GH Roy.emf |
| TCS | Tree and shrub cover measured as the percent canopy cover of trees on a typical home range (10.9 ha). Optimal tree and shrub cover differs between summer and winter. Brush piles can be incorporated to improve suitability. | Summer: | X:\Masked Bobwhite\Graphs\Suitability Functions\Roy Tomlinson\Tree-shrub cover Summer -Roy.emf |
| TCW |  | Winter: | X:\Masked Bobwhite\Graphs\Suitability Functions\Roy Tomlinson\TCW Roy.emf |
| GC | Grass Canopy Cover measured from above the grass canopy as the amount of ground covered by grass foliage on a typical home range (10.9 ha) |  | C:\Documents and Settings\cnadeau\My Documents\Work\Masked Bobwhite\Graphs\Suitability Functions\Roy Tomlinson\GC Roy.emf |
| FCS | Forb Cover measured as the average total canopy cover of forbs on a on a typical home range (10.9 ha). Suitability of forb cover differs in winter and summer. | Summer: | X:\Masked Bobwhite\Graphs\Suitability Functions\Roy Tomlinson\FCS Roy.emf |
| FCW |  | Winter: | X:\Masked Bobwhite\Graphs\Suitability Functions\Roy Tomlinson\FCW Roy.emf |
| BG | Bare Ground measured as the proportion of surface area not occupied by stems or other obstructions on a typical home range (10.9 ha). |  | X:\Masked Bobwhite\Graphs\Suitability Functions\Roy Tomlinson\BG Roy.emf |

**Equations.**

The final habitat suitability index score is a result of the combination of suitability scores from component variables. The equations which describe this combination are governed by the assumptions and relationships described in section 2.2. Additive equations imply each variable in the equation can compensate for other variables with low scores unless otherwise noted. Multiplication implies a score of zero for any variable results in a suitability score equal to zero (i.e., both variables must have non-zero scores for the area to be habitat).

Appendix A: List of Beneficial Plant Species

Grasses

* *Trichachne spp* – Arizona Cottontop
* *Bouteloua spp* – Gramma
  + *curtipendula* – side oats
  + *filiformis* – slender
  + *rothrockii* – rothrocks
  + *barbata* – six weeks
* *Cathesticum* spp
* *Chloris* spp
* *Tridews* spp
* *Eragrostis* spp – lovegrass (No Lehman’s)
* *Andropogon*
* *Setaria macrostachya* – Bristle grass
* *Sorghum halepense* – Johnson grass
* *Panicum* – Panic grass
  + *obtusum* – Vine mesquite
  + *virgatum ­*– Switch grass
* *Sporobolus –* Dropseed
  + *airoides –* Alkali sacaton
  + *cryptandrus –* Sand dropseed
* *Echinochloa crus-galli –* Barnyard grass
* *Aristida spp –* Three awns

Forbs and Shrubs

* *Jatropha spp –* Sangre de Drago
* *Kallstroemia spp –* Arizona poppy
* *Gutierrezia spp –* Snake weed
* *Chalochortus kennedyi –* Desert mariposa
* *Rumex hymenosepalus*
* *Anionia spp –* Four-o-clock
* *Abronia spp –* Sand verbena
* *Eschscholzia californica spp –* Mexican gold poppy
* *Argemone spp –* Prickle poppy
* *Oenothera spp –* Evening primrose
* *Calliandra eriophylla –* False mesquite
* *Acacia greggii –* Catclaw acacia
* *Acacia angustissima –* Prairie acacia
* *Cassia spp –* Senna
* *Astragalus spp –* Locoweed
* *Sphaeralcea spp –* Desert mallow
* *Ferrocactus spp –* Barrel cactus
* *Opuntia spp –* Prickly pear
* *Cholla spp-* several species
* *Fouguieria spp-* Ocotillo
* *Phlox spp*
* *Phacelia spp –* Scorpion weed
* *Nama spp*
* *Datura spp*
* *Curcurbita spp –* Gourd

Overstory

* *Prosopis spp –* Mesquite
* *Olneya tesota –* Ironwood
* *Cercidium spp –* Palo verde
* *Carnegiea spp –* Saguaro