# Greater Everglades Amphibians Model Requirements Document

# Version 2

## SPECIES

This version of the Amphibian model will be looking at the following species: Cricket Frog, Oak Toad, Southern Toad, Greenhouse Frog, Eastern Narrowmouth, Green Treefrog, Squirrel Treefrog, Pig Frog, Leopard Frog, Cuban Treefrog, Chorus Frog, Little Grass Frog.

## INPUTS

Two types of input data layers are required to run the model: hydrology and vegetation.

### Hydrology

The hydrology data will be in netCDF format and contain contiguous time steps and measured in units of meters or centimeters.

### Vegetation

This input dataset is a raster with each cell coded to represent a type of vegetation.

This specific vegetation input data that are being used were developed by Drs. Steve Friedman and Leonard Pearlstine of the National Park Service. A Geographic Information System was used to condense 60 vegetation classification schemes into 9 major habitat types: Cypress, Hammock, Mangrove, Pineland, Marsh/Rocky Glades, Slough, Borrow Pit/Canal, Building/Road and Dwarf Cypress Prairie over 500m grids.

## OUTPUTS

Three map type outputs will be produced. Habitat Suitability Index (HSI) values will be generated for each individual species for each hydrological year. Species occurrence will be generated for each species for each year. Finally, a sum across all species will be generated (species richness).

| Output | Inputs | Time Resolution | Type of output |
|---|---|---|---|
| Hydro-period raster for each hydro year. | Hydro-period (water depth) | Time Step | Map |
| Reclassified | Vegetation raster | Static | Map |

| | | | |
|---|---|---|---|
| vegetation raster | | | |
| HSI for each species for each year | Hydro-period, Beta values, Vegetation | Time Step | Map |
| Species Occurrence for each species for each year | HSI | Time Step | Map |
| Species Richness for each year | Species Occurrence | Time Step | Map |

**1. Hydro-period**

The hydro-period is measured as the number of days of inundation (water depth > 5cm) per hydrological year (June 1st of current year to May 31st of following year). This layer will be produced from the water depth netCDF input data. The data will be in raster format and contain contiguous time steps and measured in units of meters or centimeters. The hydro-period must then be transformed using the following equation to input into the linear model found within the Probability of Occurrence section:

$$Hydroperiod = \frac{(Hydroperiod - 195.5048)}{119.5554}$$

**2. Vegetation (Land Cover)**

This version of amphibian model will use the given input vegetation dataset to further classify into the following vegetation classes: Swamp, Prairie, Slough, Pineland, and Hammock. This model will not compute values for cells of type Building or Borrow Pit/Canal. See below for the new vegetation classes:

| | | |
|---|---|---|
| 1 | Mangrove | Swamp |
| 2 | Rocky Glades Marsh | Prairie |
| 3 | Slough | Slough |
| 4 | Cypress | Swamp |
| 5 | Dwarf Cypress Prairie | Prairie |
| 6 | Pineland | Pineland |
| 7 | Hammock | Hammock |
| 8 | Building | Not Used |
| 9 | Borrow Pit/Canal | Not Used |

Each vegetation class is denoted by a beta number as below:

| | |
|---|---|
| Swamp | $b_5$ |
| Slough | $b_4$ |
| Prairie | $b_3$ |
| Pineland | $b_2$ |
| Hammock | $b_1$ |

The beta values for each vegetation class are provided in the tables given at the end of this document.

**3. Probability of Occurrence (HSI)**

Site occupancy modeling was used to estimate the relationship between the probability of occurrence (modeled below as psi (ψ); interpreted for this model as HSI) for each species and the categorical habitat variable and the continuous hydro-period variable. This produces a linear model that can be used to derive the estimate of psi for any cell as long as habitat and hydro-period inputs are available.

The method for doing this is to first obtain the habitat category of the cell and the hydro-period for the year. Those numbers are then inserted into the below equation:

$$\text{logit}(\psi_i) = b_{0i} + b_{1i}Hammock + b_{2i}Pineland + b_{3i}Prairie + b_{4i}Slough + b_{5i}Swamp + b_{6i}Hydroperiod$$

See below tables for $b$ values.

The model should run a separate equation for each species (*i*). The habitat in each cell can take one of the five values, so the other habitats are removed from the equation so that only one of the betas 1-5 are used in any cell.

Finally to convert the logit of the psi value to a number on the real scale we use the following formula:

$$\frac{e^x}{1+e^x}$$

Where *x* is the value from the linear model.

This result will be a value between 0 and 1 that represents the probability of occurrence or the habitat suitability of the cell for the species.

**4. Species Occurrence**

The resulting HSI can then be used to draw from a binomial distribution with probability of success (i.e. probability of value = 1) = HSI. Thus occurrence of the species at the site is stochastic but based on real estimates of occurrence probability derived from our

original sample data. This result will be either a 0 or a 1.

**5. Species Richness**

The species richness indicates the expected number of species present in each individual cell for every time step. This value will be computed by summing the species occurrence value across all species for each cell for each year. This result will be a value between 0 and 12.

## TABLES

| | |
|---|---|
| Cricket Frog | 3.0168 |
| Oak Toad | -3.5193 |
| Southern Toad | -0.7815 |
| Greenhouse Frog | -1.8984 |
| Eastern Narrowmouth | 1.6773 |
| Green Treefrog | 5.2016 |
| Squirrel Treefrog | 0.081 |
| Pig Frog | 3.2213 |
| Leopard Frog | 4.1996 |
| Cuban Treefrog | -0.8507 |
| Chorus Frog | -4.9719 |
| Little Grass Frog | -2.4534 |

Table 1 $b_0$ Intercept Values

| | |
|---|---|
| Cricket Frog | -0.3856 |
| Oak Toad | -3.1593 |
| Southern Toad | 8.4835 |
| Greenhouse Frog | 5.6513 |
| Eastern Narrowmouth | 5.0505 |
| Green Treefrog | 2.432 |
| Squirrel Treefrog | 1.6684 |
| Pig Frog | 5.8635 |
| Leopard Frog | 3.2771 |
| Cuban Treefrog | 1.841 |
| Chorus Frog | 1.3815 |
| Little Grass Frog | -3.0082 |

Table 2 $b_1$ Hammock Values

| | |
|---|---|
| Cricket Frog | 1.6401 |
| Oak Toad | 6.9671 |
| Southern Toad | 2.4239 |
| Greenhouse Frog | 6.3336 |
| Eastern Narrowmouth | 2.7542 |
| Green Treefrog | 4.3316 |
| Squirrel Treefrog | 6.3128 |
| Pig Frog | 0.7017 |
| Leopard Frog | 4.5497 |
| Cuban Treefrog | 2.3202 |
| Chorus Frog | 1.8318 |
| Little Grass Frog | 4.2 |

Table 3 $b_2$ Pineland Values

| | |
|---|---|
| Cricket Frog | 0.6952 |
| Oak Toad | 4.1045 |
| Southern Toad | -1.304 |
| Greenhouse Frog | -2.7673 |
| Eastern Narrowmouth | -4.942 |
| Green Treefrog | 5.7071 |
| Squirrel Treefrog | 2.511 |
| Pig Frog | 2.4821 |
| Leopard Frog | 4.0802 |
| Cuban Treefrog | -8.5608 |
| Chorus Frog | 1.2464 |
| Little Grass Frog | 8.5677 |

Table 4 $b_3$ Prairie Values

| | |
|---|---|
| Cricket Frog | 4.3762 |
| Oak Toad | -4.0175 |
| Southern Toad | 0.2389 |
| Greenhouse Frog | -5.0071 |
| Eastern Narrowmouth | -0.4293 |
| Green Treefrog | 3.0558 |
| Squirrel Treefrog | -4.0568 |
| Pig Frog | 4.263 |
| Leopard Frog | 1.7588 |
| Cuban Treefrog | 0.1605 |
| Chorus Frog | -2.8771 |
| Little Grass Frog | -3.155 |

Table 5 $b_4$ Slough Values

| | |
|---|---|
| Cricket Frog | 3.469 |
| Oak Toad | -1.2063 |
| Southern Toad | -1.0831 |
| Greenhouse Frog | -0.1038 |
| Eastern Narrowmouth | 3.5451 |
| Green Treefrog | 1.6173 |
| Squirrel Treefrog | 1.0418 |
| Pig Frog | 0.9316 |
| Leopard Frog | 1.747 |
| Cuban Treefrog | 3.8709 |
| Chorus Frog | -0.385 |
| Little Grass Frog | 0.2701 |

Table 6 $b_5$ Swamp Values

| | |
|---|---|
| Cricket Frog | 0.7697 |
| Oak Toad | -3.454 |
| Southern Toad | -6.4881 |
| Greenhouse Frog | -1.6686 |
| Eastern Narrowmouth | -7.3085 |
| Green Treefrog | 1.657 |
| Squirrel Treefrog | 0.8339 |
| Pig Frog | 2.9188 |
| Leopard Frog | 0.3063 |
| Cuban Treefrog | -4.1393 |
| Chorus Frog | -5.5992 |
| Little Grass Frog | 2.1152 |

Table 7 $b_6$ Hydro Values