# Boreal Chorus Frog (*Pseudacris maculata*)
# Predicted Suitable Habitat Modeling


**Distribution Status:** Resident Year Round
**State Rank:** S4
**Global Rank:** G5

## Modeling Overview

**Created by:** Bryce Maxell & Braden Burkholder
**Creation Date:** October 3, 2017
**Evaluator:** Bryce Maxell
**Evaluation Date:** October 3, 2017

**Inductive Model Goal:** To predict the distribution and relative suitability of general year-round habitat at large spatial scales across the species' known range in Montana.
**Inductive Model Performance:** The model does a good job of representing the distribution of Boreal Chorus Frog general year-round habitat suitability at larger spatial scales across the species' known range in Montana. Evaluation metrics indicate the model fit is good and the delineation of habitat suitability classes is well-supported by the data.

**Deductive Model Goal:** To represent the ecological systems commonly and occasionally associated with this species year-round, across the species' known range in Montana.
**Deductive Model Performance:** Ecological systems that this species is commonly and occasionally associated with do a good job of representing the amount of suitable habitat for Boreal Chorus Frog across the species' known range in Montana, but should be used in conjunction with the inductive model output to identify areas of higher and lower suitability within those general systems.

**Suggested Citation:** Montana Natural Heritage Program. 2017. Boreal Chorus Frog (*Pseudacris maculata*) predicted suitable habitat models created on October 03, 2017. Montana Natural Heritage Program, Helena, MT. 16 pp.

**Montana Field Guide Species Account:** http://fieldguide.mt.gov/speciesDetail.aspx?elcode=AAABC05130

# Inductive Modeling

**Model Limitations and Suggested Uses**

This model is based on statewide biotic and abiotic layers originally mapped at a variety of spatial scales and standardized to 90×90 meter raster pixels. Furthermore, the spatial accuracy of the training and testing data are varied (typically 20-400 meters) and may result in additional statistical noise in the model. As a result, model outputs may not be appropriate for use on smaller areas or at fine spatial scales. Model outputs should not typically be used for planning efforts on land areas smaller than one quarter of a public land survey system (PLSS) section (<64 hectares) and model outputs for some species may only be appropriate for broader regional level planning efforts. Model outputs should not be used in place of on-the-ground surveys for species, and wildlife and land management agency biologists should be consulted about the value of using model output to guide habitat management decisions for regional planning efforts or local projects. See Suggested Contacts for State and Federal Natural Resource Agencies attached to this document.

## Inductive Model Methods

**Modeling Process**

Presence-only data were obtained from Montana Natural Heritage Program Databases, which serve as a clearinghouse for animal and plant observation data in Montana. These data were then filtered to ensure spatial and temporal accuracy and to reduce spatial auto-correlation (summarized in Table 1). The spatial extent of this model was limited to the known geographic range of the species, by season when applicable, in order to accurately assess potentially available habitat.

We then used these data and 19 statewide biotic and abiotic layers (Table 2) to construct the model using a maximum entropy algorithm employed in the modeling program Maxent (Phillips et al. 2006, Ecological Modeling 190:231-259). Entropy maximization modeling functions by first calculating constraints and then applying the constraints to estimate a predicted distribution. The mean, variance, etc. of the environmental variables at the training data locations are used to estimate the constraint distributions. Maxent requires that the final predicted distribution fulfills these constraints. Maxent avoids overfitting of models to the training data by “regularizing” or relaxing the constraints so that modeled distributions only have to be close to, rather than exactly equal to, the constraint distributions (Elith et al. 2011, Diversity and Distributions 17:43-57).

Maxent fits a model by first assuming the predicted distribution is perfectly uniform in geographic space and moves away from this distribution only to the extent that it is forced to by the constraints. Constrained by training data, Maxent successively modifies the coefficients for each environmental variable via random walk, accepting the modified coefficient if it increases the gain. Gain is a measure of the closeness of the model concentration around the presence samples that is similar to goodness of fit in generalized linear models. The random walk of coefficients continues until either the increase in the gain falls below a set threshold or a set maximum number of iterations are performed. The gain value at the end of a model run indicates the likelihood of suitability of the presence samples relative to the likelihood for random background points. The overall gain associated with individual environmental variables can be used as a measure of the relative importance of each variable (Merow et al. 2013, Ecography 36:1058-1069).

We employed a k-folds cross validation methodology, in this case using ten folds for model training and validation (Elith et al. 2011). Each fold consists of 90% of the data designated for training and 10% of the data reserved for testing. Each record is used for training nine times and testing once. Ten models are estimated and averaged to produce the final model presented here.

**Model Outputs and Evaluation**

The initial model output is a spatial dataset of continuous logistic values that ranges from 0-1 with lower values representing areas predicted to be less suitable habitat and higher values representing areas predicted to be more suitable habitat (Figure 2). The standard deviation in the model output across the averaged models is also calculated (Figure 3). If enough observations were available to train and evaluate the models, the continuous output is reclassified into suitability classes - unsuitable, low suitability, moderate suitability, and high suitability. Thresholds for defining suitability classes are presented and described below (Table 4).

We evaluated the output of the Maxent model with two metrics, an absolute validation index (AVI) (Hirzel et al. 2006, Ecological Modelling 199:142-152) and deviance (Phillips and Dudik 2008, Ecography 31: 161-175). These metrics are described below in the results (Table 5). Area under the curve (AUC) values are also displayed for reference, but are not used for evaluation (Lobo et al. 2008, Global Ecology and Biogeography 17:145-151). Additionally, standard deviation in logistic output of the ten individual models is plotted as a map to examine spatial variance of model output. Finally, a deviance value was calculated for each test data observation as a measure of how well model output matched the location of test observations. In theory, everywhere a test observation was located, the logistic value should have been 1.0. The deviance value for each test observation is calculated as -2 times the natural log of the associated logistic output value.

Table 1: Model Data Selection Criteria and Summary

| | |
|---|---|
| Location Data Source | Montana Natural Heritage Program Databases |
| Total Number of Records | 5,642 |
| Location Data Selection Rule 1 | Records with <= 500 meters of locational uncertainty |
| Number of Locations Meeting Selection Rule 1 | 4,735 |
| Location Data Selection Rule 2 | No overlap in locations within 1600 meters in order to avoid spatial autocorrelation |
| Observation Records used in Model (Locations Meeting Selection Rules 1 & 2) | 2,140 |
| Season Modeled | Year-round |
| Number of Model Background Locations | 47,405 |

Table 2: Environmental Layer Information

| Layer | Identifier | Original Scale | Description |
|---|---|---|---|
| Land Cover | catesys | 30m | Categorical. Landcover classes (25) from the 2016 Montana Spatial Data Infrastructure Land Cover Framework; Level 2 classes used with a few minor changes including removal of linear and point features: Alpine Grassland and Shrubland, Alpine Sparse and Barren, Conifer-dominated Forest and Woodland (mesic-wet), Conifer-dominated Forest and Woodland (xeric-mesic), Deciduous dominated forest and woodland, Mixed deciduous/coniferous forest and woodland, Lowland/Prairie Grassland, Montane Grassland, Agriculture, Introduced Vegetation/Pasture/Hay, Developed, Mining and Resource Extraction, Wetland or Marsh, Floodplain and Riparian, Open Water, Wet meadow, Harvested Forest, Insect-Killed Forest, Introduced Vegetation, Recently burned, Deciduous Shrubland, Sagebrush Steppe or Desert Scrub, Sagebrush or Saltbush Shrubland, Bluff/Badland/Dune, Cliff/Canyon/Talus http://geoinfo.msl.mt.gov/msdi/land_use_land_cover |
| Geology | catgeol | vector | Categorical. Basic rock classes (5) as defined by USGS (plus water for large water bodies): Sedimentary, Unconsolidated, Metamorphic, Plutonic, and Volcanic. https://mrdata.usgs.gov/geology/state/state.php?state=MT |
| Soil Order | catsoilord | Vector | Categorical. Major soil orders (7) as defined by USDA based on STATSGO2 general statewide soil maps, along with non-soil (Rock, Water) classifications: Entisols, Inceptisols, Aridisols, Mollisols, Alfisols, Andisols, and Vertisols. http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx |
| Soil Regime | catsoiltemp | vector | Categorical. Soil Moisture and Temperature regimes (11) classification pairs as defined by USDA (plus water): Cryic/Udic, Cryic/Udic Ustic, Cryic/Typic Ustic, Cryic/Aridic Ustic, Cryic/Typic Xeric, Frigid/Aquic, Frigid/Udic, Frigid/Typic Ustic, Frigid/Aridic Ustic, Frigid/Typic Xeric, Mesic/Ustic Aridic. http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx |
| Elevation | contelev | ≈10m | Continuous. Elevation in meters above mean sea level. https://www.sciencebase.gov/catalog/item/4f70aa9fe4b058caae3f8de5 |
| Aspect (East-West) | contewasp | ≈10m | Continuous. Aspect of slopes, ranging from 1 (east) to -1 (west). https://www.sciencebase.gov/catalog/item/4f70aa9fe4b058caae3f8de5 |
| Aspect (North-South) | contnsasp | ≈10m | Continuous. Aspect of slopes, ranging from 1 (north) to -1 (south). https://www.sciencebase.gov/catalog/item/4f70aa9fe4b058caae3f8de5 |
| Slope | contslope | ≈10m | Continuous. Percent slope (x100) of landscape. https://www.sciencebase.gov/catalog/item/4f70aa9fe4b058caae3f8de5 |
| Ruggedness | contvrm | ≈10m | Continuous. Vector ruggedness measure (0 to 1). https://www.sciencebase.gov/catalog/item/4f70aa9fe4b058caae3f8de5 |
| Summer Solar Radiation | contsumrad | ≈10m | Continuous. Solar radiation (WH/$m^2$) for the day of the summer solstice. https://www.sciencebase.gov/catalog/item/4f70aa9fe4b058caae3f8de5 |
| Winter Solar Radiation | contwinrad | ≈10m | Continuous. Solar radiation (WH/$m^2$) for the day of the winter solstice. https://www.sciencebase.gov/catalog/item/4f70aa9fe4b058caae3f8de5 |
| Annual NDVI | contndvi | 900m | Continuous. Normalized Difference Vegetation as a measure of yearly mean greenness from the MODIS Terra satellite. ftp://mco.cfc.umt.edu/ndvi/terra/yearly_normals/ |
| Annual Precipitation | contprecip | ≈800m | Continuous. Average annual precipitation (mm) for 1981-2010. http://www.prism.oregonstate.edu/normals/ |
| Percent Winter Precipitation | contwinpcp | ≈800m | Continuous. Average percent (0 to 1) of the total annual precipitation that occurs during winter (Nov-Apr) for 1981-2010. http://www.prism.oregonstate.edu/normals/ |
| Max Summer Temp | conttmax | 800m | Continuous. Average maximum temperature (°C) in July for 1981-2010. ftp://mco.cfc.umt.edu/tmax/monthly_normals/ |
| Min Winter Temp | conttmin | 800m | Continuous. Average minimum temperature (°C) in January for 1981-2010. ftp://mco.cfc.umt.edu/tmin/monthly_normals/ |
| Degree Days | contddays | 800m | Continuous. Average annual total of degree days (°F) above 32°F for 1981-2010. http://services.cfc.umt.edu/arcgis/rest/services/Atlas/Temperature_CropDegreeDays32F/ImageServer |
| Distance to Stream | contstrmed | vector | Continuous. Distance to major streams in meters, based on major streams identified in TIGER files or USGS topographic maps (Stream_Lake_1993 dataset). http://ftp.geoinfo.msl.mt.gov/Data/Spatial/NonMSDI/Shapefiles/ |
| Distance to Forest Cover | contfrsted | 30m | Continuous. Distance to any forest land cover type in meters. http://geoinfo.msl.mt.gov/msdi/land_use_land_cover |

## Inductive Model Results

Table 3: Environmental Layer Contributions to Model Fit

| Layer ID | Percent Contribution[a] | Layer ID | Percent Contribution[a] |
|---|---|---|---|
| catesys | 45.2% | contelev | 1.1% |
| contslope | 11.9% | contnsasp | 0.8% |
| contsumrad | 10.0% | contddays | 0.6% |
| catsoiltemp | 9.4% | contndvi | 0.6% |
| catsoilord | 7.8% | contewasp | 0.4% |
| catgeol | 5.7% | contfrsted | 0.3% |
| conttmin | 1.8% | contwinrad | 0.1% |
| conttmax | 1.5% | contprecip | 0.1% |
| contwinpcp | 1.5% | contvrm | 0.0% |
| contstrmed | 1.2% | | |

[a] Relative contributions of the layers to the model based on changes in fit (gain) during iterations of the training algorithm.

Table 4: Habitat Suitability Thresholds

| Measure | Value |
|---|---|
| Low Logistic Threshold[a] | 0.086 |
| Moderate Logistic Threshold[b] | 0.431 |
| Optimal Logistic Threshold[c] | 0.851 |
| Area of entire modeled range (percent of Montana) | 300,652.1 $km^2$ (79.0%) |
| Total area of predicted suitable habitat within modeled range | 264,099.2 $km^2$ |
| Area of predicted low suitability habitat within modeled range | 179,099.5 $km^2$ |
| Area of moderate suitability habitat within modeled range | 84,020.9 $km^2$ |
| Area of predicted optimal habitat within modeled range | 978.8 $km^2$ |

[a] The logistic threshold between unsuitable and low suitability as determined by Maxent which balances data omission error with minimizing predicted suitable area. This is a conservative threshold that should encompass nearly all potentially suitable habitat for a species.

[b] The logistic threshold value where the percentage of test observations above the threshold is what would be expected if the observations were randomly distributed across logistic value classes (Hirzel et al. 2006). This is equivalent to a null model. When sample sizes are small, it may be undetermined.

[c] The logistic threshold where the percentage of test observations above the threshold is 10 times higher than would be expected if the observations were randomly distributed across logistic value classes. When sample sizes are small, it may be undetermined.

Table 5: Evaluation Metrics

| Metric | Value |
|---|---|
| Low AVI[a] | 99.3% |
| Moderate AVI[a] | 67.8% |
| Optimal AVI[a] | 4.5% |
| Average Testing Deviance ($\bar{x} \pm sd$)[b] | 1.516 ± 0.927 |
| Training AUC[c] | 0.778 |
| Test AUC[d] | 0.772 |

[a] Absolute Validation Index: The proportion of test locations that fall above the low, moderate, or optimal logistic threshold.

[b] A measure of how well model output matched the location of test observations. In theory, everywhere a test location was located, the logistic value should have been 1.0. The deviance value for each test location is calculated as -2 times the natural log of the associated logistic output value. For example, the equivalent deviance values for the low, moderate and optimal logistic thresholds of this model would be 4.909, 1.684 and 0.323, respectively. Deviances for individual test locations are plotted in Figure 6.

[c] The area under a curve obtained by plotting the true positive rate against 1 minus the false positive rate for model training observations (averaged over 10 folds). Values range from 0 to 1 with a random or null model performing at a value of 0.5.

[d] The same metric described in c, but calculated for test observations.

Figure 1. Jackknife assessment of contribution by individual environmental layers to training gain.

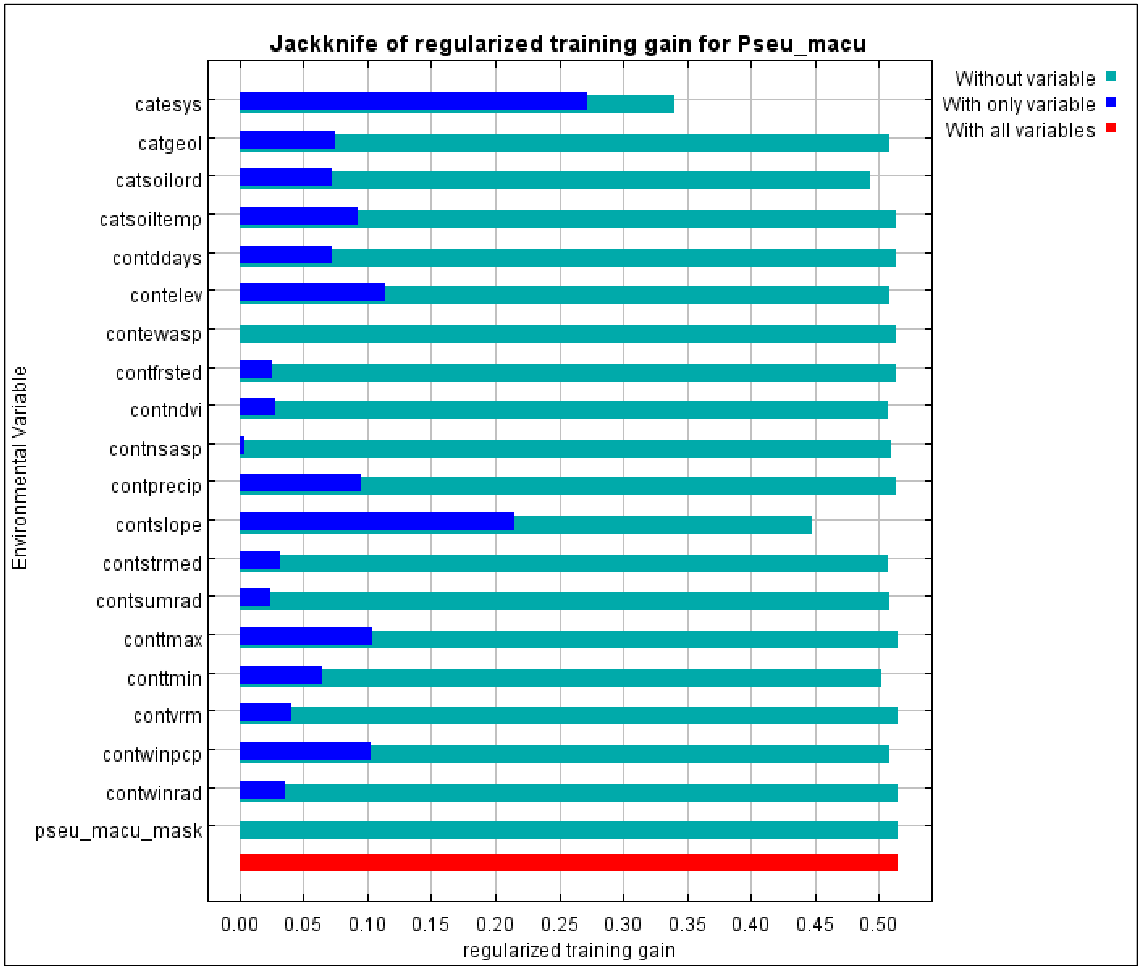
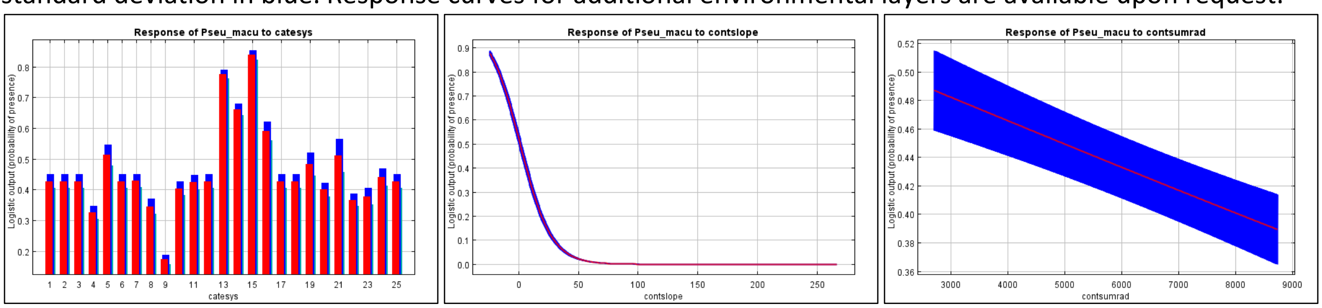



Figure 2. Response curves for the top three contributing environmental layers, mean value in red, +/- one standard deviation in blue. Response curves for additional environmental layers are available upon request.



## Inductive Model Map Outputs

Figure 3. Continuous habitat suitability model output (logistic scale).

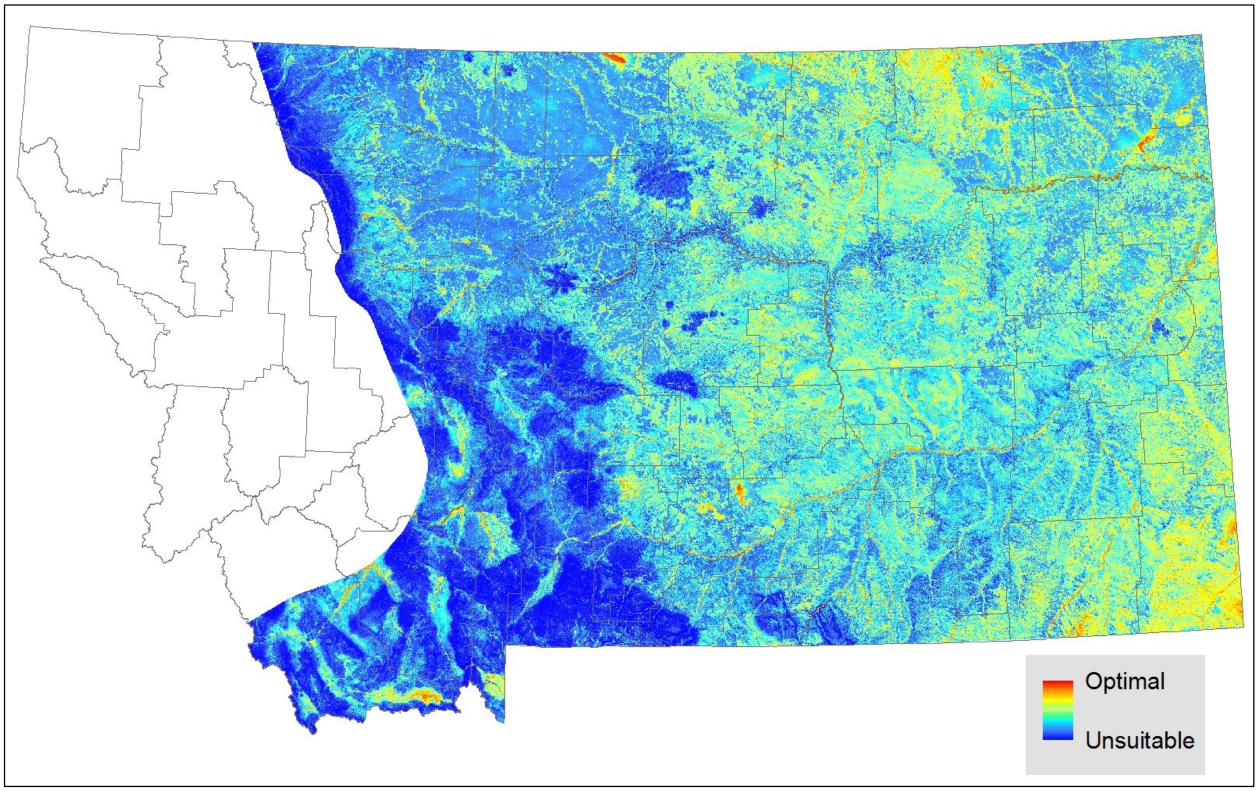



Figure 4. Standard deviation in the model output across the averaged models.

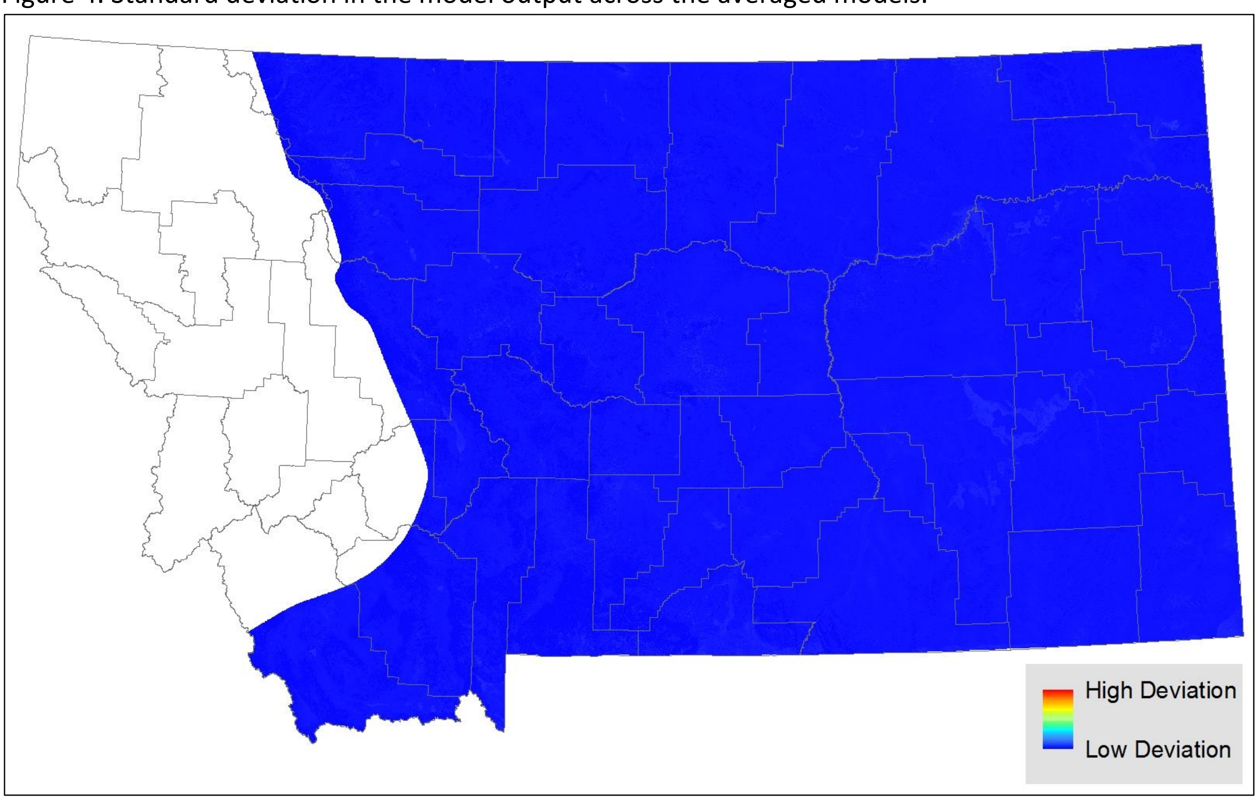


Figure 5. Continuous habitat suitability model output with the 2,140 observations used for modeling.

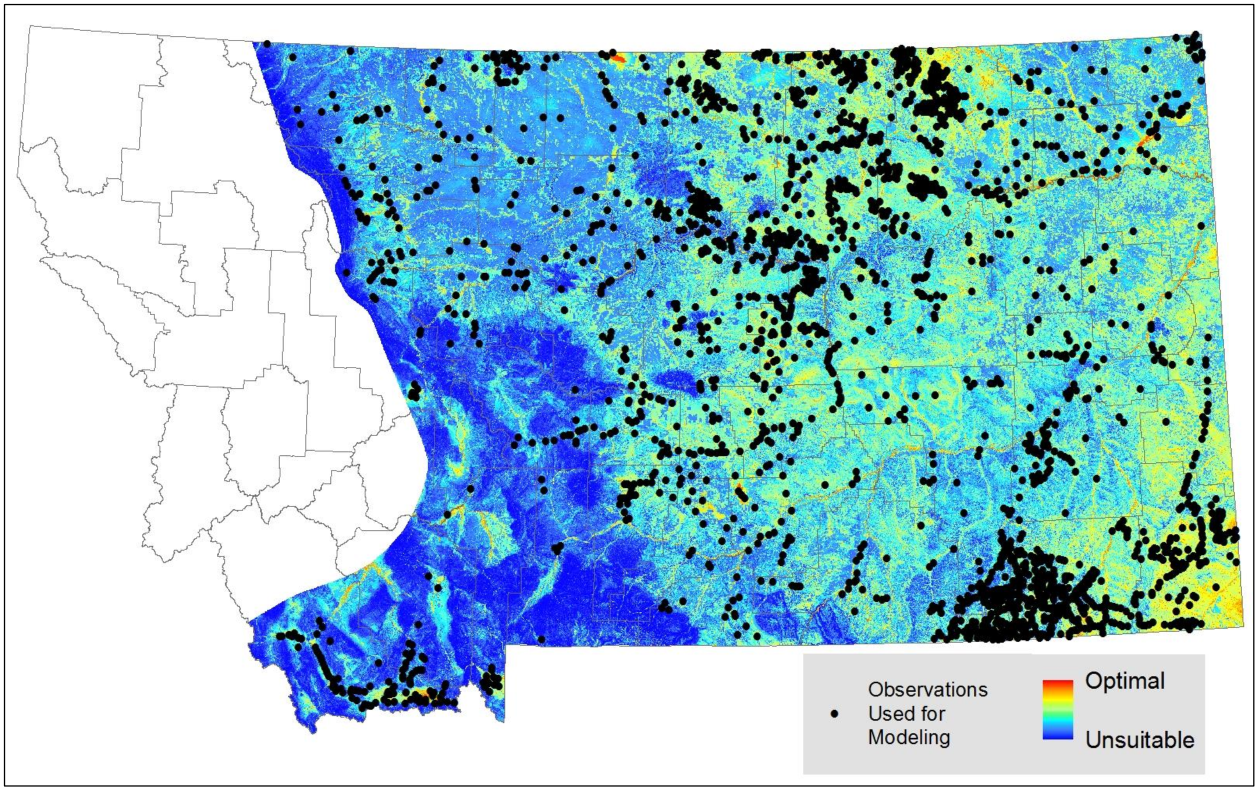



Figure 6. Continuous habitat suitability model output with relative deviance for each observation. Symbol size corresponds to the difference between 1.0 and the optimal, moderate, and low habitat suitability threshold.

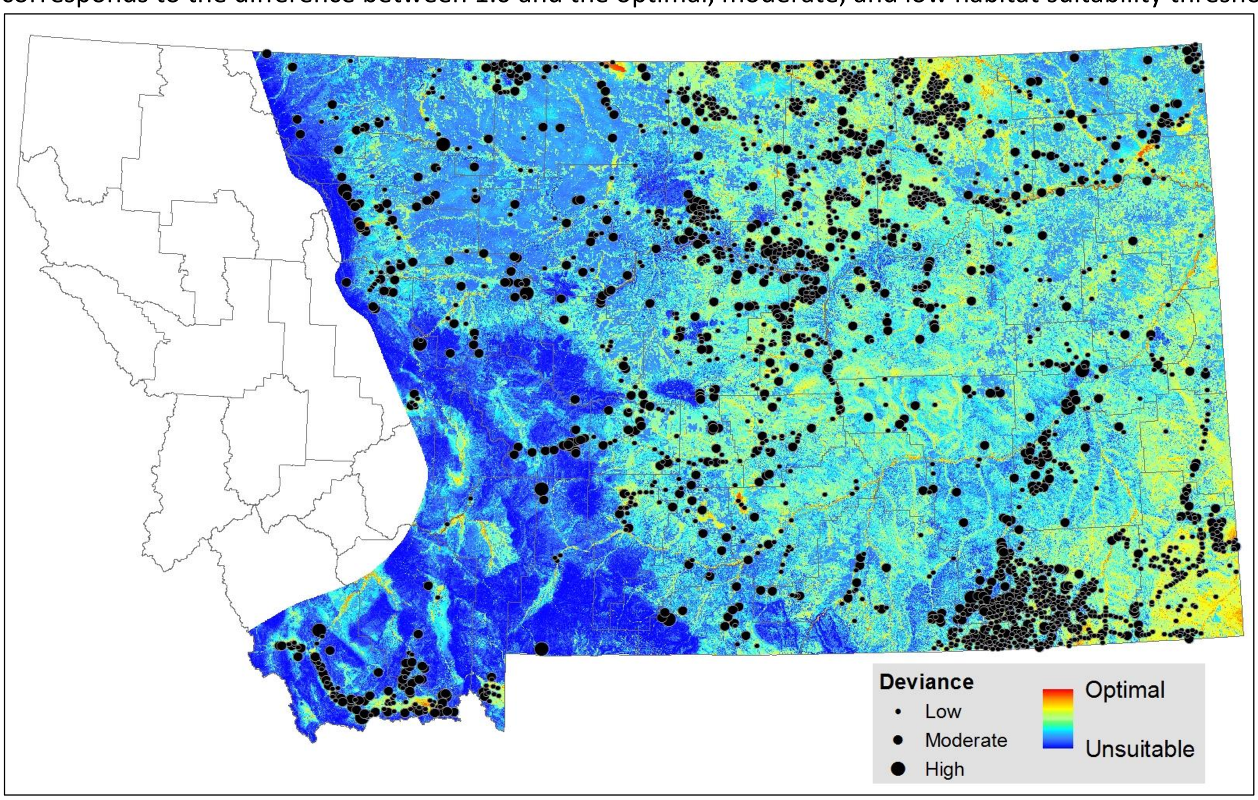


Figure 7. Continuous habitat suitability model output with all 5,642 observations (black) and survey locations that could have detected the species (gray).

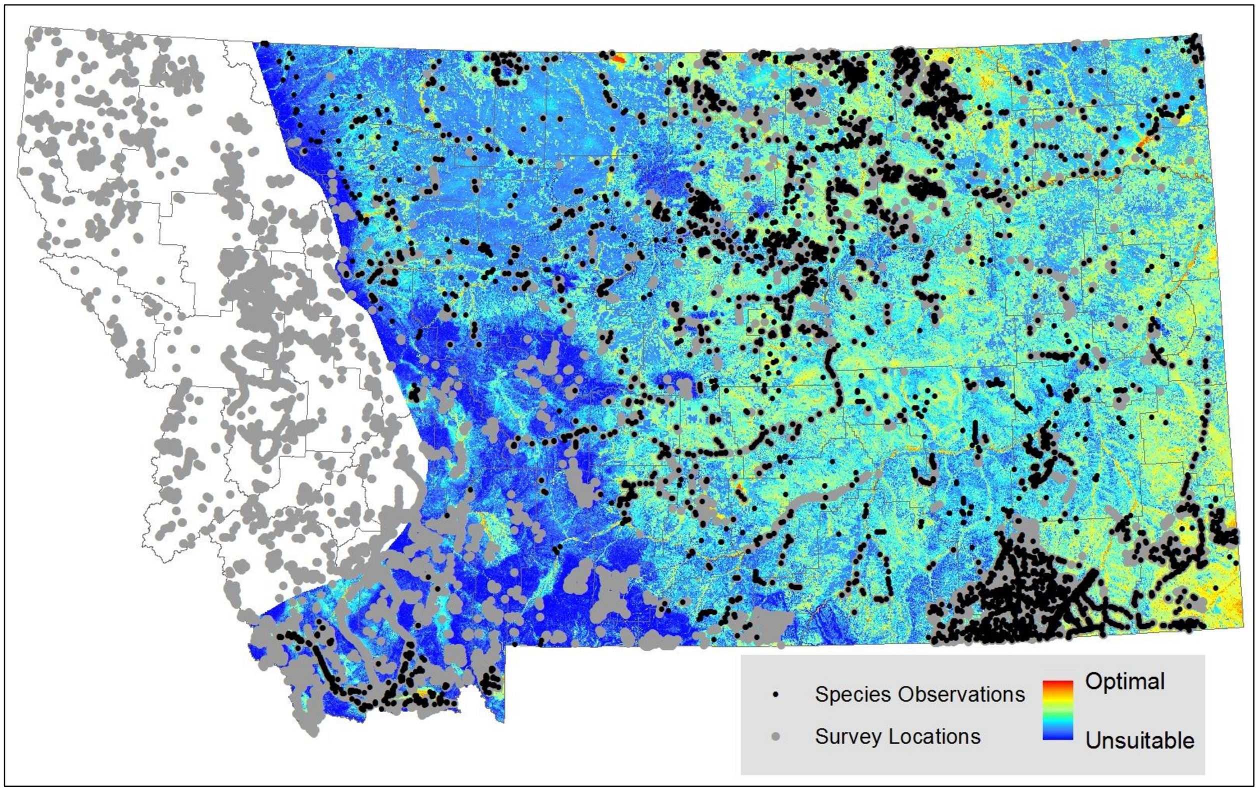



Figure 8. Model output classified into habitat suitability classes.

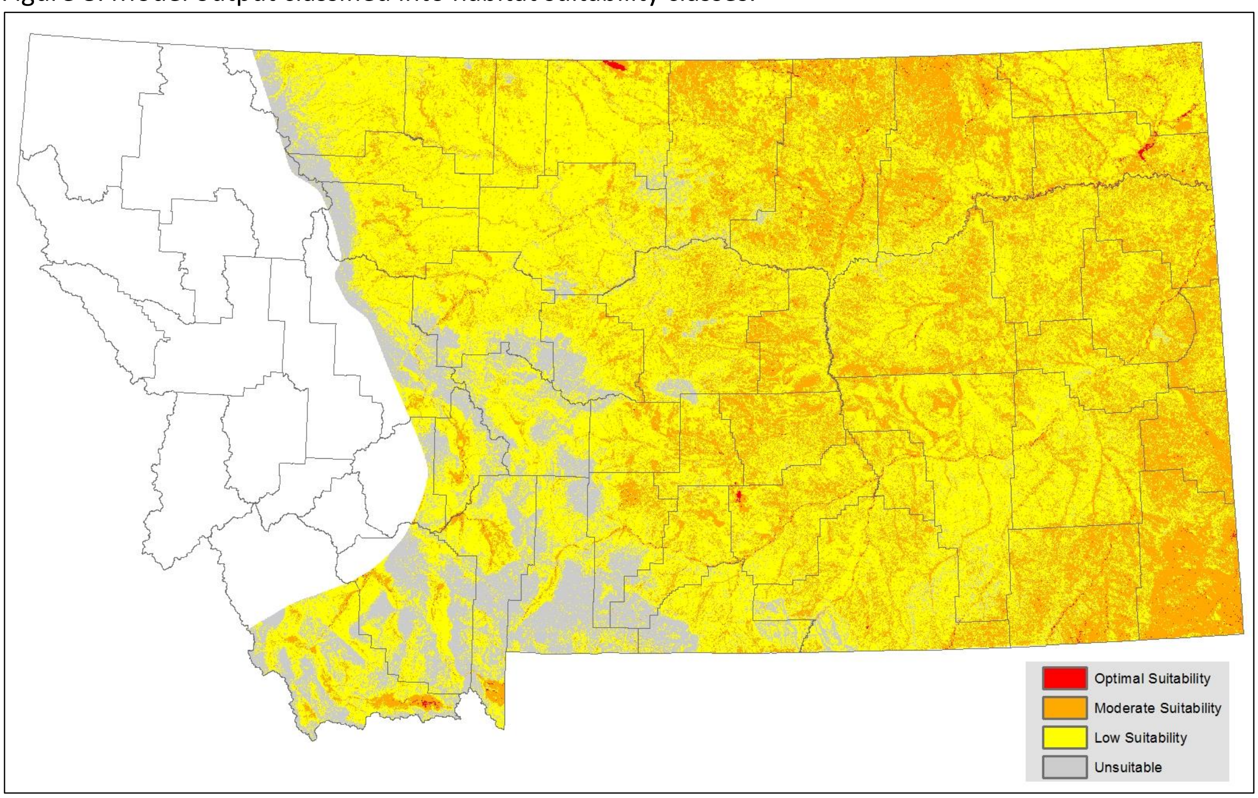
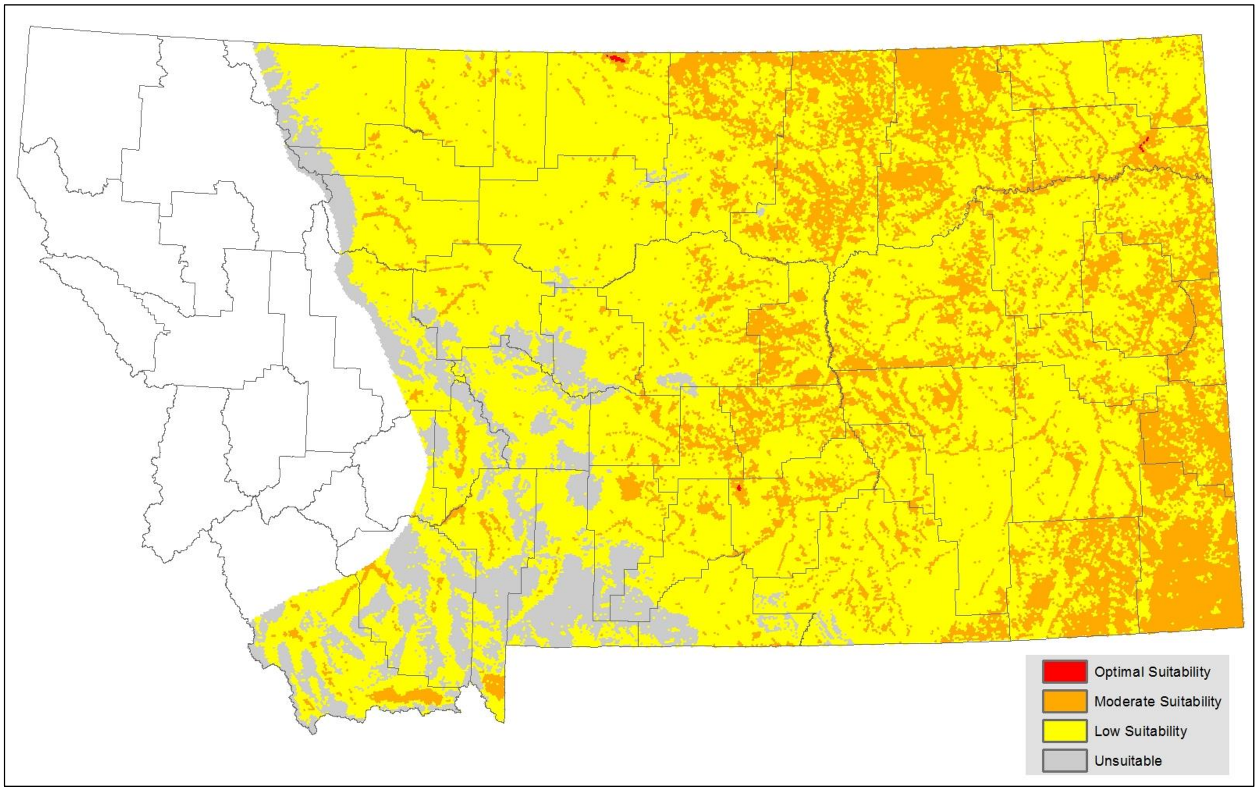


Figure 9. Model output classified into habitat suitability classes and aggregated into hexagons at a scale of 259 hectares per hexagon. This is the finest scale suggested for management decisions and survey planning.



# Deductive Modeling

### Model Limitations and Suggested Uses

Species associations with ecological systems should be used to generate potential lists of species that may occupy broader landscapes for the purposes of landscape-level planning. Users of this information should be aware that the land cover data used to generate species associations was only intended to be used at broader landscape scales. Land cover mapping accuracy is particularly problematic when the systems occur as small patches or where the land cover types have been altered over the past decade. Thus, particular caution should be used when using the associations in assessments of smaller areas (e.g. less than one quarter of a public land survey system (PLSS) section, <64 hectares). Model outputs should not be used in place of on-the-ground surveys for species, and wildlife and land management agency biologists should be consulted about the value of using model output to guide habitat management decisions for regional planning efforts or local projects. See Suggested Contacts for State and Federal Natural Resource Agencies attached to this document. Data used in model evaluation often have locational uncertainties that exceed the 30-meter pixel size of the land cover dataset, potentially intersecting incorrect ecological systems. Additionally, the habitat within a pixel may have been assigned to the wrong ecological system or the habitat may have been modified. As a result, evaluation metrics may be skewed low due to these errors, especially for species occupying ecotones or patchy ecological systems. Finally, users should note that although a species may be associated with a particular ecological system within its known geographic range, portions of that ecological system may occur outside of the species' known geographic range and are not mapped in this model.

## Deductive Model Methods

### Modeling Process

This model is based on the 2016 statewide land cover classifications at 30×30 meter raster pixels (http://geoinfo.msl.mt.gov/msdi/land_use_land_cover). Level 3 ecological systems (90) were used for this model and these data were originally mapped at a scale of 1:100,000. In general, species were associated as using an ecological system if structural characteristics of used habitat documented in the literature were present in the ecological system or large numbers of point observations were associated with the ecological system. However, species were not associated with an ecological system if there was no support in the literature for use of structural characteristics in an ecological system, even if point observations were associated with that system. Species were either commonly associated, occasionally associated, or not associated with each ecological system. This assignment was based on the degree to which the structural characteristics of an ecological system matched the preferred structural habitat characteristics for each species in the literature. The percentage of observations associated with each ecological system relative to the percent of Montana covered by each ecological system was also used to guide assignments of habitat quality. Associations are shown in Table 6.

### Model Outputs and Evaluation

The model output is a spatial dataset of categorical habitat suitability based on ecological system associations (commonly or occasionally associated) within the species' known range. We evaluated this model output based on known or potential distribution and habitat use in Montana and absolute validation indices (AVI) (Hirzel et al. 2006, Ecological Modelling 199:142-152) using presence-only data (summarized above in Table 1).

## Deductive Model Results

Table 6: Ecological Systems Associated with Boreal Chorus Frog

| Ecological System | Code | Association | Count[a] |
|---|---|---|---|
| Great Plains Mixedgrass Prairie | 7114 | Common | 561 |
| Big Sagebrush Steppe | 5454 | Common | 255 |
| Great Plains Riparian | 9326 | Common | 206 |
| Open Water | 11 | Common | 137 |
| Great Plains Badlands | 3114 | Common | 52 |
| Introduced Upland Vegetation - Annual and Biennial Forbland | 8403 | Common | 46 |
| Rocky Mountain Lower Montane, Foothill, and Valley Grassland | 7112 | Common | 40 |
| Great Plains Floodplain | 9159 | Common | 40 |
| Great Plains Ponderosa Pine Woodland and Savanna | 4280 | Common | 31 |
| Montane Sagebrush Steppe | 5455 | Common | 27 |
| Great Plains Saline Depression Wetland | 9256 | Common | 26 |
| Great Plains Sand Prairie | 7121 | Common | 23 |
| Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland | 9156 | Common | 23 |
| Recently burned grassland | 8502 | Common | 22 |
| Great Plains Prairie Pothole | 9203 | Common | 20 |
| Rocky Mountain Foothill Woodland-Steppe Transition | 5426 | Common | 19 |
| Emergent Marsh | 9222 | Common | 19 |
| Greasewood Flat | 9103 | Common | 18 |
| Pasture/Hay | 81 | Common | 16 |
| Great Plains Wooded Draw and Ravine | 4328 | Common | 15 |
| Recently burned forest | 8501 | Common | 15 |
| Alpine-Montane Wet Meadow | 9217 | Common | 15 |
| Mat Saltbush Shrubland | 5203 | Common | 12 |
| Great Plains Shrubland | 5262 | Common | 11 |
| Rocky Mountain Subalpine-Montane Mesic Meadow | 7118 | Common | 9 |
| Post-Fire Recovery | 8505 | Common | 9 |
| Great Plains Closed Depressional Wetland | 9252 | Common | 9 |
| Developed, Open Space | 21 | Common | 5 |
| Great Plains Open Freshwater Depression Wetland | 9218 | Common | 5 |
| Introduced Upland Vegetation - Perennial Grassland and Forbland | 8405 | Common | 4 |
| Cultivated Crops | 82 | Occasional | 86 |
| Low Intensity Residential | 22 | Occasional | 8 |
| Recently burned shrubland | 8503 | Occasional | 8 |
| Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland | 9155 | Occasional | 4 |
| Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland | 4242 | Occasional | 3 |
| Rocky Mountain Montane-Foothill Deciduous Shrubland | 5312 | Occasional | 2 |
| Rocky Mountain Subalpine Deciduous Shrubland | 5326 | Occasional | 2 |
| High Intensity Residential | 23 | Occasional | 1 |
| Aspen Forest and Woodland | 4104 | Occasional | 1 |
| Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest | 4232 | Occasional | 1 |

Table 6: Ecological Systems Associated with Boreal Chorus Frog

| **Ecological System** | **Code** | **Association** | **Count[a]** |
|---|---|---|---|
| Rocky Mountain Foothill Limber Pine - Juniper Woodland | 4236 | Occasional | 1 |
| Rocky Mountain Lodgepole Pine Forest | 4237 | Occasional | 1 |
| Rocky Mountain Montane Douglas-fir Forest and Woodland | 4266 | Occasional | 1 |
| Rocky Mountain Subalpine-Upper Montane Grassland | 7113 | Occasional | 1 |
| Introduced Upland Vegetation - Annual Grassland | 8404 | Occasional | 1 |
| Rocky Mountain Subalpine-Montane Fen | 9234 | Occasional | 1 |
| Rocky Mountain Ponderosa Pine Woodland and Savanna | 4240 | Occasional | 0 |
| Rocky Mountain Poor Site Lodgepole Pine Forest | 4267 | Occasional | 0 |
| Mountain Mahogany Woodland and Shrubland | 4303 | Occasional | 0 |
| Low Sagebrush Shrubland | 5209 | Occasional | 0 |
| Alpine Turf | 7117 | Occasional | 0 |
| Rocky Mountain Wooded Vernal Pool | 9162 | Occasional | 0 |
| Rocky Mountain Subalpine-Montane Riparian Woodland | 9171 | Occasional | 0 |
| Rocky Mountain Subalpine-Montane Riparian Shrubland | 9187 | Occasional | 0 |

[a] A count of the observation records intersecting each ecological system, based on the 2,140 observation records used in the inductive model (see Table 1). This may be zero if the number of observations is low or if the ecological system is patchy.

Table 7: Area of Range and Ecological System (ES) Classes

| **Measure** | **Value** |
|---|---|
| Area of entire modeled range (percent of Montana) | 300,652.1 $km^2$ (79.0%) |
| Area of Commonly and Occasionally Associated ES | 291,087.0 $km^2$ |
| Area of Commonly Associated ES | 206,563.0 $km^2$ |
| Area of Occasionally Associated ES | 84,524.0 $km^2$ |

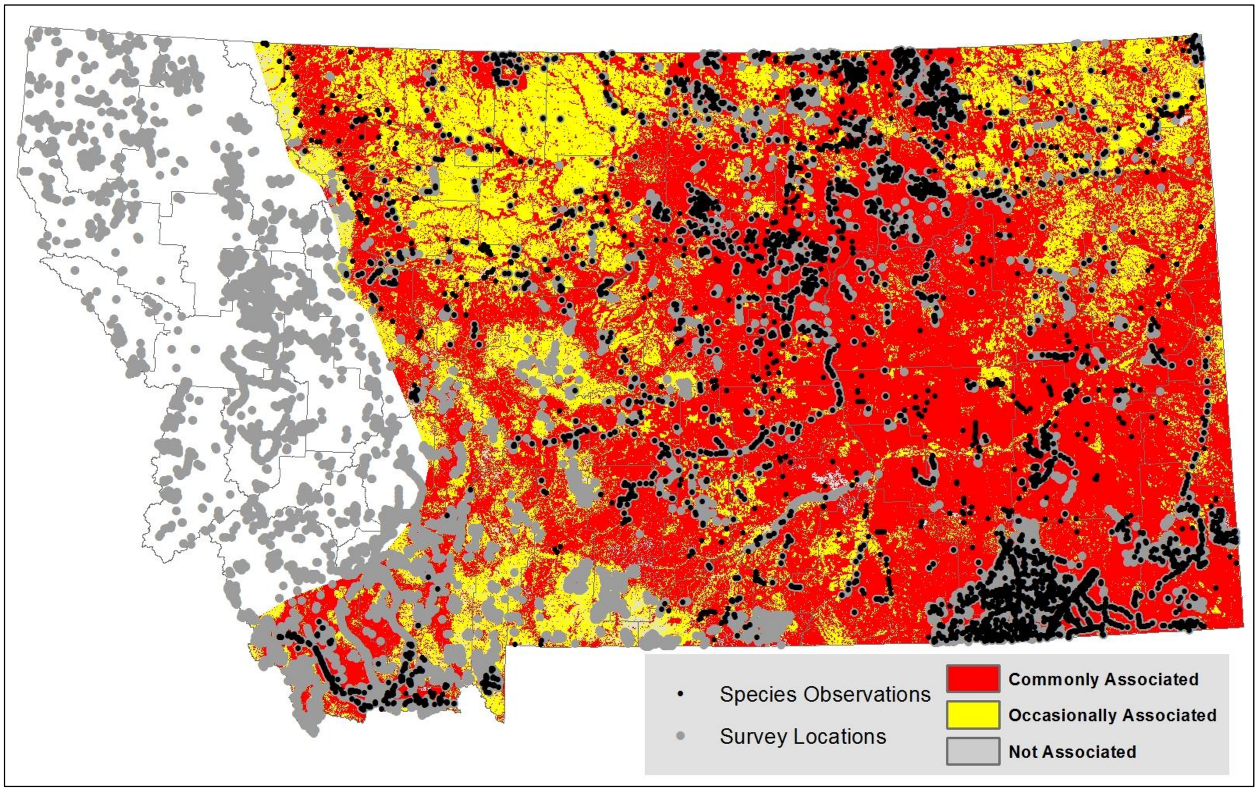
Table 8: Evaluation Metrics

| **Metric** | **Value** |
|---|---|
| Commonly and Occasionally Associated ES AVI[a] | 84.7% |
| Commonly Associated ES AVI[a] | 79.0% |
| Occasionally Associated ES AVI[a] | 5.7% |

[a] Absolute Validation Index: The proportion of test locations that fall within the class(es).

## Deductive Model Map Output

Figure 10. Deductive model output classified into habitat associations.

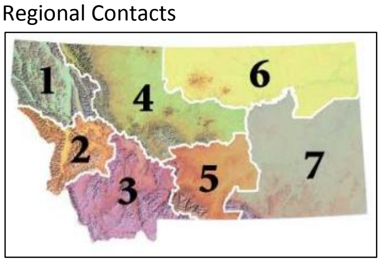


## Suggested Contacts for State and Federal Natural Resource Agencies

As required by Montana statute (MCA 90-15), the Montana Natural Heritage Program works with state, federal, tribal, nongovernmental organizations, and private partners to ensure that the latest animal and plant distribution and status information is incorporated into our databases so that it can be used to inform a variety of planning processes and management decisions. In addition to the information you receive from us, we encourage you to contact state, federal, and tribal resource management agencies in the area where your project is located. They may have additional data or management guidelines relevant to your efforts. In particular, we encourage you to contact the Montana Department of Fish, Wildlife, and Parks for the latest data and management information regarding hunted and high profile management species and to use the U.S. Fish and Wildlife Service's Information Planning and Conservation (IPAC) website http://ecos.fws.gov/ipac/ regarding U.S. Endangered Species Act listed Threatened, Endangered, or Candidate species.

For your convenience, we have compiled a list of relevant agency contacts and links below:

**Montana Fish, Wildlife, and Parks**

| | |
|---|---|
| Fish Species | Zachary Shattuck zshattuck@mt.gov (406) 444-1231<br>or<br>Lee Nelson leenelson@mt.gov (406) 444-2447 |
| American Bison<br>Black-footed Ferret<br>Black-tailed Prairie Dog<br>Bald Eagle<br>Golden Eagle<br>Common Loon<br>Least Tern<br>Piping Plover<br>Whooping Crane | Lauri Hanauska-Brown LHanauska-Brown@mt.gov (406) 444-5209 |
| Grizzly Bear<br>Greater Sage Grouse<br>Trumpeter Swan<br>Big Game<br>Upland Game Birds<br>Furbearers | John Vore jvore@mt.gov (406) 444-5209 |
| Managed Terrestrial Game and Nongame Animal Data | Adam Messer – MFWP Data Analyst<br>(406) 444-0095, amesser@mt.gov |
| Fisheries Data | Bill Daigle – MFWP Fish Data Manager<br>(406) 444-3737, bdaigle@mt.gov |
| Wildlife and Fisheries Scientific Collector's Permits | http://fwp.mt.gov/doingBusiness/licenses/scientificWildlife/default.html<br>Merissa Hayes for Wildlife (406) 444-7321 merhayes@mt.gov<br>Beth Giddings for Fisheries (406) 444-7319 begiddings@mt.gov |
| Fish and Wildlife Recommendations for Subdivision Development | Renee Lemon RLemon@mt.gov (406) 444-3738)<br>See also: http://fwp.mt.gov/fishAndWildlife/livingWithWildlife/buildingWithWildlife/subdivisionRecommendations/ |
| Regional Contacts<br><br> | Region 1 (Kalispell) (406) 752-5501<br>Region 2 (Missoula) (406) 542-5500<br>Region 3 (Bozeman) (406) 994-4042<br>Region 4 (Great Falls) (406) 454-5840<br>Region 5 (Billings) (406) 247-2940<br>Region 6 (Glasgow) (406) 228-3700<br>Region 7 (Miles City) (406) 234-0900 |

**U.S. Fish and Wildlife Service**

Information Planning and Conservation (IPAC) website: http://ecos.fws.gov/ipac/

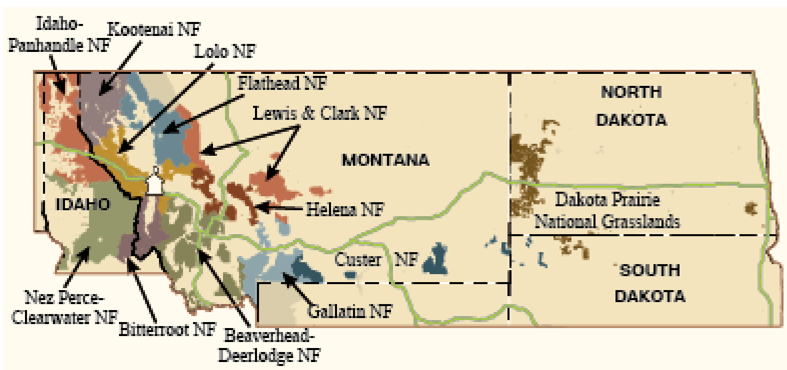
Montana Ecological Services Field Office: http://www.fws.gov/montanafieldoffice/ (406) 449-5225

**Bureau of Land Management**

Montana Field Office Contacts:


| | |
|---|---|
| Billings: | (406) 896-5013 |
| Butte: | (406) 533-7600 |
| Dillon: | (406) 683-8000 |
| Glasgow: | (406) 228-3750 |
| Havre: | (406) 262-2820 |
| Lewistown: | (406) 538-1900 |
| Malta: | (406) 654-5100 |
| Miles City: | (406) 233-2800 |
| Missoula: | (406) 329-3914 |

**United States Forest Service**




**Regional Office – Missoula, Montana Contacts**

| | | | |
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| Wildlife Ecologist: | Cara Staab | cstaab@fs.fed.us | (406) 329-3677 |
| Fish Program Leader: | Scott Spaulding | scottspaulding@fs.fed.us | (406) 329-3287 |
| Fish Ecologist: | Cameron Thomas | cathomas@fs.fed.us | (406) 329-3087 |
| TES Program: | Lydia Allen | lrallen@fs.fed.us | (406) 329-3558 |
| Interagency Grizzly Bear Coordinator: | Scott Jackson | sjackson03@fs.fed.us | (406) 329-3664 |
| Regional Botanist: | Steve Shelly | sshelly@fs.fed.us | (406) 329-3041 |