Sharp-tailed Grouse Distribution Modeling

Scientific Name: *Tympanuchus phasianellus*
Distribution Status: Year-round resident
State Rank: S1 (west of Continental Divide), S4 (east of Continental Divide)
Global Rank: G5

Inductive Modeling

Model Created By: Joy Ritter
Model Creation Date: September 19, 2012
Model Evaluators: Bryce Maxell and Joy Ritter
Model Goal: Inductive models will predict the distribution and relative suitability of breeding habitats at large spatial scales across the species' known breeding range in Montana.

Inductive Modeling Methods

Model Data and Species Range Information:

Location Data Source	Montana Natural Heritage Program Point Observation Database
Total Number of Records	2,477
Location Data Selection Rule 1	Spatially unique records associated with breeding activity with <= 1000 meters of locational uncertainty
No. Locations Meeting Selection Rule 1	321
Location Data Selection Rule 2	No overlap in locations when buffered by the associated locational uncertainty in order to avoid spatial autocorrelation.
No. Locations Meeting Selection Rule 2	303
Season Modeled	Summer Breeding
No. Model Train Locations	227
No. Model Test Locations	76
No. Model Background Locations	47,109
Area of Species Range in State (Percent of Montana)	299,025 km_2 (79%)

Environmental layer information:

Layer	Identifier	Description
Aspect	CONTEWASP CONTNSASP	Continuous measure of east to west aspect Continuous measure of north to south aspect
Bias	BIAS	Categorical layer representing potential underlying biases inherent in the observation database as a result of proximity to roads and public lands
Elevation	CONTELEV	Continuous elevation in meters form the National Elevation Dataset
Geology	CATSDEGEOL	Categorical surficial geology - 931 categories
Land Cover	CATESYS	Categorical Level 2 Montana land cover framework with roads removed – 27 categories
Max Temp	CONTTMAX	Continuous estimated average maximum daily July temperature in degrees Fahrenheit for 1971-2000
Min Temp	CONTTMIN	Continuous estimated average minimum daily January temperature in degrees Fahrenheit for 1971 -2000
Precipitation	CONTPRECIP	Continuous annual precipitation in 1cm intervals
Slope	CONTSLOPE	Continuous degrees of slope
Soil Temp	CATSOILTMP	Categorical soil temperature and moisture regimes – 12 categories
Stream Dist	CONTSTRMED	Continuous Euclidean distance from major streams in 1-meter intervals

Maxent Model Input String:

<u>Range wide</u>

```
java –mx2048 –jar c:\MaxEnt\maxent.jar -a -z nowarnings noprefixes -P -J -o
U:\IndSpecies\Tymp_phas\2012_09_19\RangeOut -s
U:\IndSpecies\Tymp_phas\2012_09_19\Tymp_phas_train.csv -T
U:\IndSpecies\Tymp_phas\2012_09_19\Tymp_phas_test.csv -e I:\modelingSecondRoundInputLayers
nowriteclampgrid nowritemess maximumbackground=47109 writebackgroundpredictions noextrapolate
nodoclamp -N CONTVRM -t BIAS -t CATESYS -t CATSDEGEOL -t CATSOILTMP
```

<u>Statewide</u>

```
java –mx2048 –jar c:\MaxEnt\maxent.jar -a -z nowarnings noprefixes -P -J -o
U:\IndSpecies\Tymp_phas\2011_06_11\StateOut -s
U:\IndSpecies\Tymp_phas\2011_06_11\Tymp_phas_train.csv -T
U:\IndSpecies\Tymp_phas\2011_06_11\Tymp_phas_test.csv -e I:\modelingSecondRoundInputLayers
nowriteclampgrid nowritemess maximumbackground=60000 writebackgroundpredictions noextrapolate
nodoclamp -N CONTVRM  -t BIAS -t CATESYS -t CATSDEGEOL -t CATSOILTMP
```

Inductive Model Evaluation

Model Performance:

Model appears to adequately reflect the distribution of Sharp-tailed grouse nesting habitat at large spatial scales across their known breeding range east of the Continental Divide in Montana. Evaluation metrics suggest a good model fit (see table of evaluation metrics). The presence of Bias as a significant predictor variable suggests that survey efforts may be biased towards roads and public lands.

Top contributing layers:

Variable	Percent Contribution	Permutation Importance
CATSDEGEOL	29.3	23.2
CONTELEV	19.9	26
CATESYS	18.1	5.2
CONTSLOPE	10.3	11.3
CONTTMIN	9.9	22.1
BIAS	6.6	4

Evaluation metrics:

Metric	Value
Low Logistic Threshold[a]	0.077
Area of predicted low suitability habitat within species' range	80,082 km^2
Medium Logistic Threshold[b]	0.25
Area of moderate suitability habitat within species' range	55,856 km^2
Optimal Logistic Threshold[c]	0.70
Area of predicted optimal habitat within species' range	4,298 km^2
Total area of predicted suitable habitat within species' range	140,236 km^2
Absolute validation index (AVI)[d]	0.934
Avg Deviance (X +/- SD)[e]	2.06 +/- 1.55
Training AUC[f]	0.918
Test AUC[g]	0.857

a. The logistic threshold between unsuitable and low suitable as determined by Maxent which balances training data omission error rates with predicted area.
b. The logistic threshold value where the percentage of observations above the threshold is what would be expected if the observations were randomly distributed across logistic value classes. This is equivalent to a null model.
c. The logistic threshold where the percentage of observations above the threshold is 10 times higher than would be expected if the observations were randomly distributed across logistic value classes.
d. The proportion of test locations that fall above the low logistic threshold.
e. 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. Deviance values vary from 0, when test observations are associated with a logistic value of 1, to around 13.8, when logistic values approach 0.001. Deviances for individual test locations are plotted in Figure 3.
f. The area under a curve obtained by plotting the true positive rate against 1 minus the false positive rate for model training observations. Values range from 0 to 1 with a random or null model performing at a value of 0.5.
g. The same metric described in f, but calculated for test observations.

Inductive Modeling Map Outputs

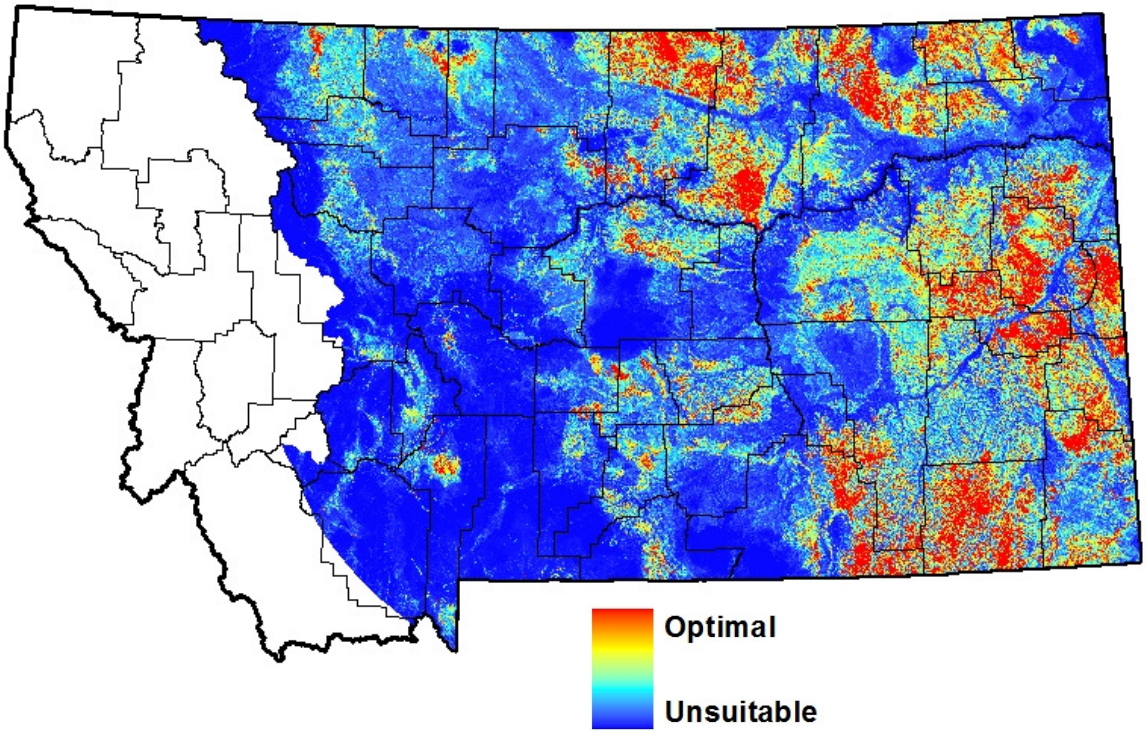

Figure 1. Continuous habitat suitability model output (logistic scale).

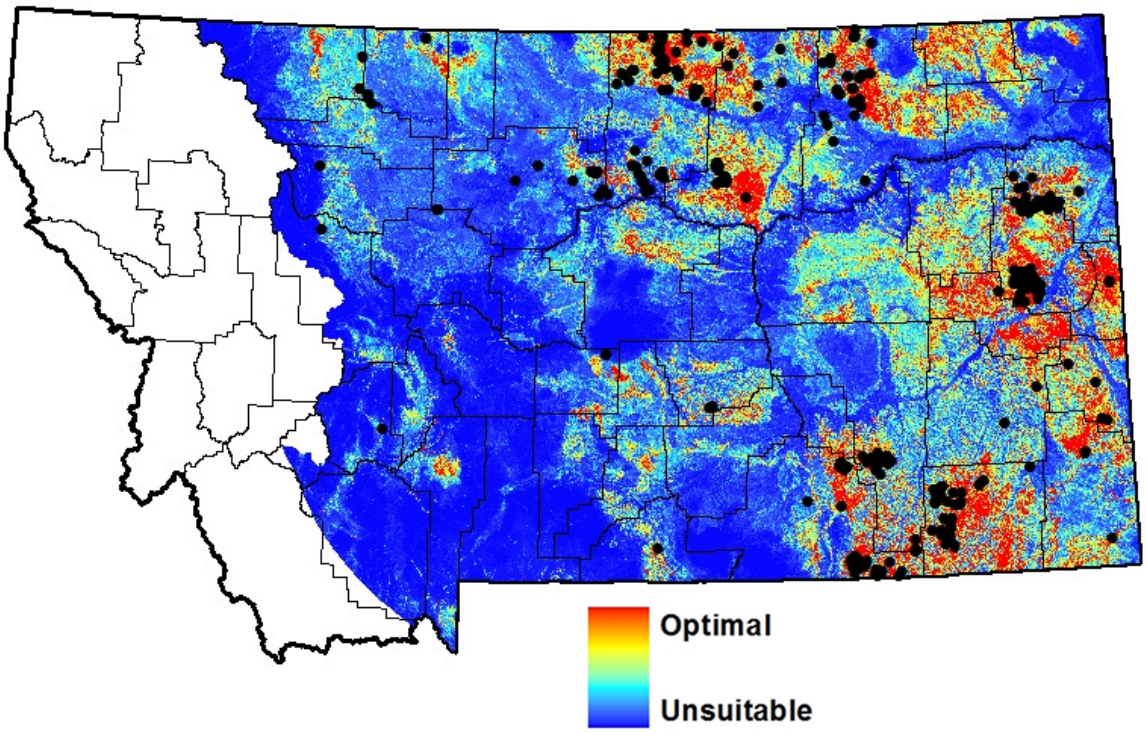

Figure 2. Continuous habitat suitability model output with training and test data.

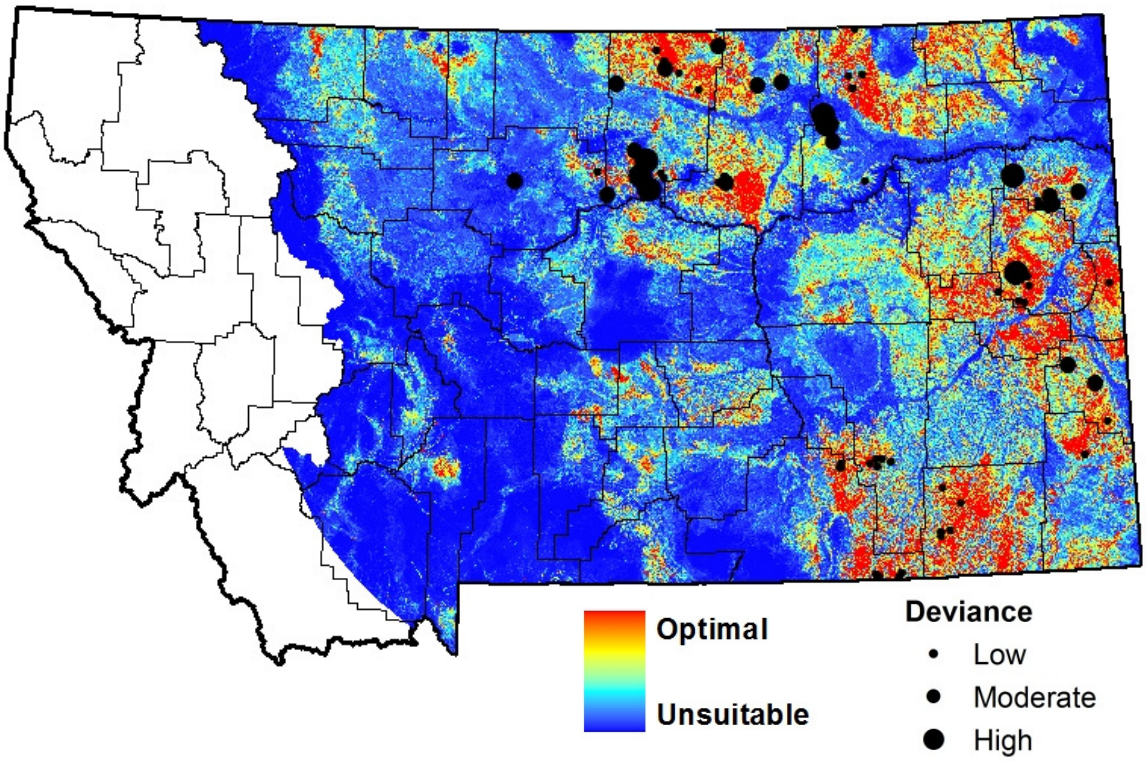

Figure 3. Continuous habitat suitability model output with relative deviance for each test observation

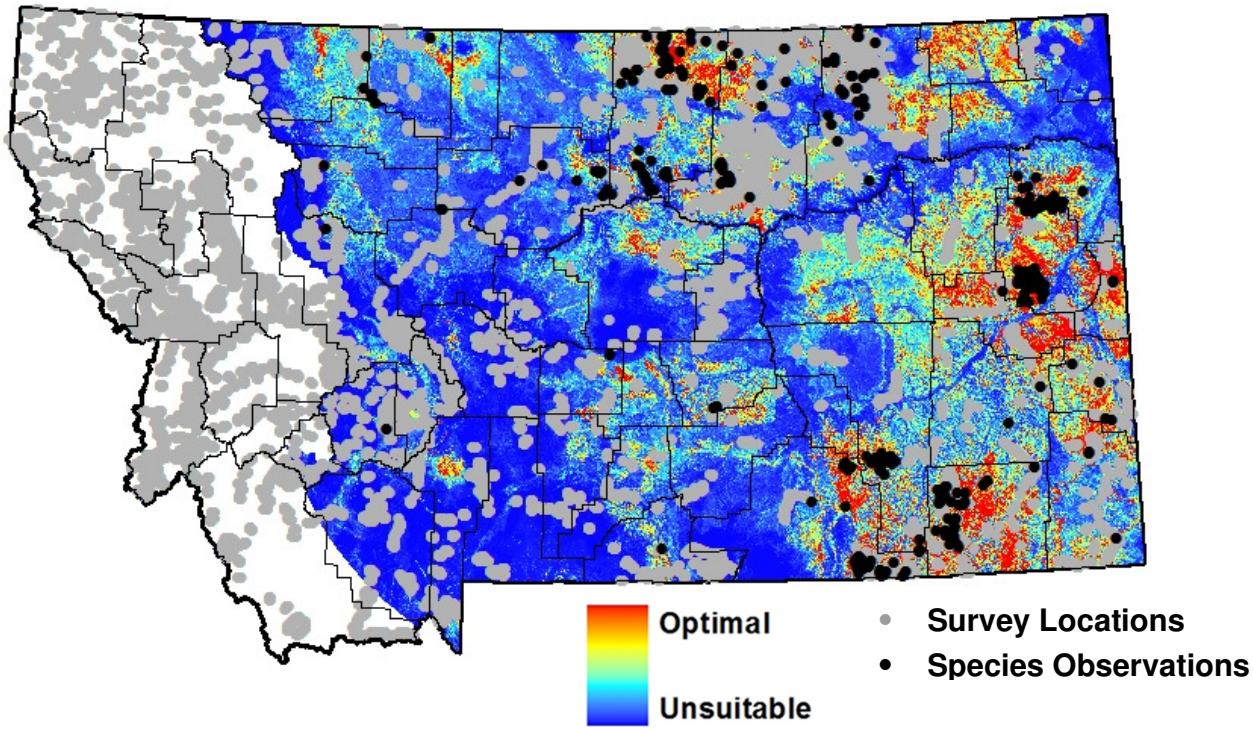

Figure 4. Continuous habitat suitability model output with survey locations that could have detected the species (gray) and detections of species (black)

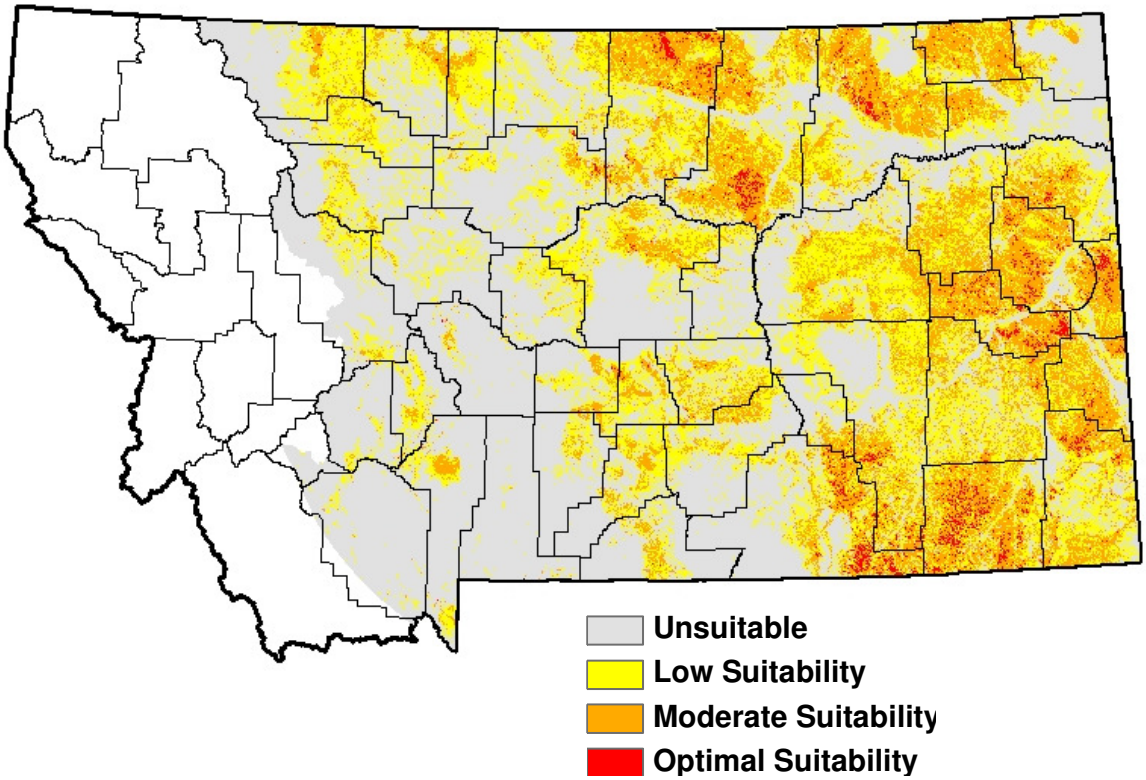

Figure 5. Model output classified into unsuitable (gray), low suitability (yellow), medium suitability (orange), and optimal suitability (red) habitat classes.

Deductive Model

Model Created By: Bryce Maxell
Model Creation Date: November 10, 2010
Model Evaluators: Joy Ritter and Bryce Maxell
Model Approval Date: September 18, 2012
Model Goal: Deductive model is meant to represent species-habitat associations during summer breeding season. Species were classified as commonly or occasionally associated with ecological systems. See details on how ecological systems were associated with species and the suggested uses and limitations of these associations under individual species accounts in the Montana Field Guide at: http://fieldguide.mt.gov

Deductive Modeling Methods

Ecological System	Code	Habitat Association
Greasewood Flat	9103	Common
Great Plains Riparian	9326	Common
Aspen Forest and Woodland	4104	Common
Great Plains Wooded Draw and Ravine	4328	Common
Great Plains Ponderosa Pine Woodland and Savanna	4280	Common
Mountain Mahogany Woodland and Shrubland	4303	Common
Rocky Mountain Foothill Limber Pine - Juniper Woodland	4236	Common
Rocky Mountain Ponderosa Pine Woodland and Savanna	4240	Common
Rocky Mountain Lower Montane, Foothill and Valley Grassland	7112	Common
Great Plains Mixedgrass Prairie	7114	Common
Great Plains Sand Prairie	7121	Common
Big Sagebrush Shrubland	5257	Common
Great Plains Shrubland	5262	Common
Mixed Salt Desert Scrub	5258	Common
Rocky Mountain Lower Montane-Foothill Shrubland	5263	Common
Big Sagebrush Steppe	5454	Common
Montane Sagebrush Steppe	5455	Common
Rocky Mountain Foothill Woodland-Steppe Transition	5426	Common
Great Plains Floodplain	9159	Common
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland	9156	Common

Deductive Model Evaluation

Discussion of Model Performance:

Model accounts for 85% of the test breeding records and appears to adequately represent the species habitat associations during the breeding season at large spatial scales across the known breeding range in Montana. However, it is probably an over prediction of the amount of suitable habitat available given that grasslands are not always used and shrublands may not have the right density of shrubs and trees.

Evaluation metrics:

Metric	Value
Area of commonly associated habitats (km^2)	165,637
Absolute validation index (AVI) for common habitat associations	0.852

Deductive Model Output (Maps)

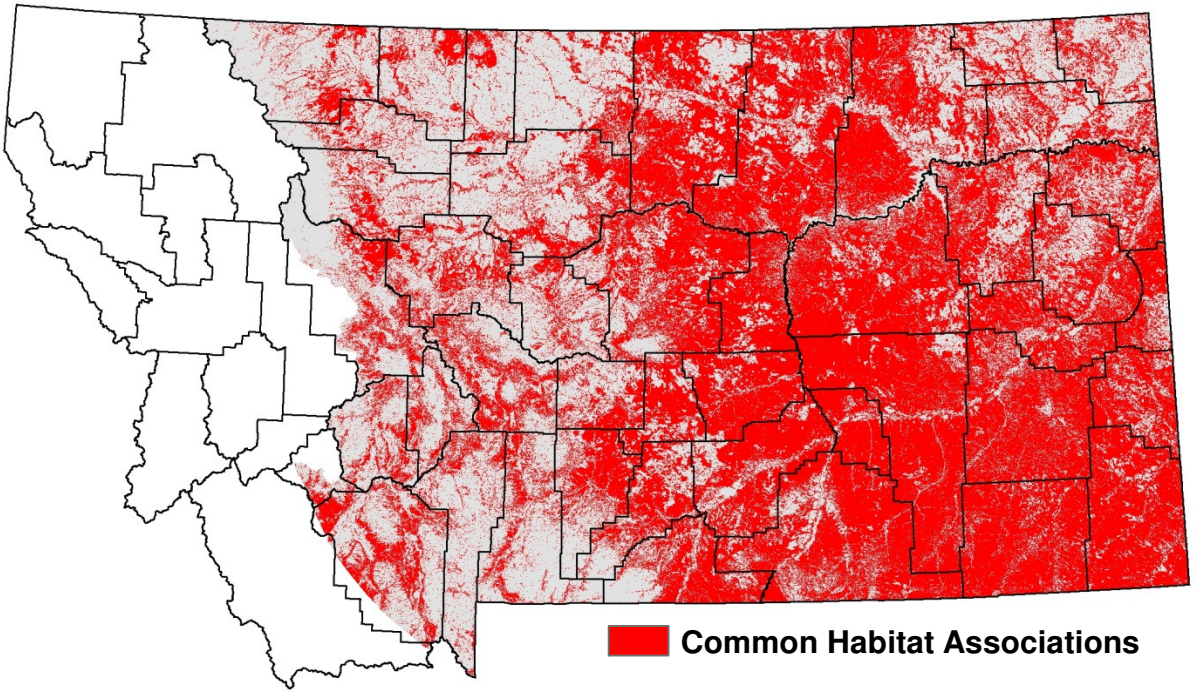

Figure 6. Common habitat association classes as determined by expert opinion (see Montana Field Guide species account).