

Black Tern Distribution Modeling



Scientific Name: *Chlidonias niger*

Distribution Status: Migratory Summer Breeder

State Rank: S3B

Global Rank: G4

Inductive Modeling

Model Created By: Joy Ritter

Model Creation Date: June 22, 2011

Model Evaluators: Bryce Maxell and Joy Ritter

Model Goal: Inductive models will predict the general distribution and relative suitability of breeding habitats at a landscape scale (i.e. not specific water bodies) within the known range of the species 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	611
Location Data Selection Rule 1	Spatially unique records associated with breeding activity with ≤ 10100 meters of locational uncertainty
No. Locations Meeting Selection Rule 1	153
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	100
Season Modeled	Summer Breeding
No. Model Train Locations	60
No. Model Test Locations	30
No. Model Background Locations	60,000
Area of Species Range in State (Percent of Montana)	Statewide Distribution

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 from 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	CONTPRECI	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:Statewide

```
java -mx2048 -jar c:\MaxEnt\maxent.jar -a -z nowarnings noprefixes -P -J -o
U:\IndSpecies\Chli_nige\2011_06_22\StateOut -s
U:\IndSpecies\Chli_nige\2011_06_22\Chli_nige_train.csv -T
U:\IndSpecies\Chli_nige\2011_06_22\Chli_nige_test.csv -e I:\modelingSecondRoundInputLayers
nowriteclampgrid nowritemess maximumbackground=60000 writebackgroundpredictions noextrapolate
nodoclamp -t BIAS -t CATESYS -t CATSDEGEOL -t CATSOILTMP
```

Inductive Model Evaluation

Model Performance:

Despite overpredicting suitability of open water habitats, the model appears to adequately reflect the distribution of Black tern nesting habitat at a landscape-scale across 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
CATESYS	48.9	21.7
CONTSLOPE	19.3	61.1
CONTTMIN	14.3	2.4
CATSDEGEOL	7.1	2.9
BIAS	3.4	1.2
CONTTMAX	1.7	5.3

Evaluation metrics:

Metric	Value
Low Logistic Threshold ^a	0.011
Area of predicted low suitability habitat within species' range	45,648 km ²
Medium Logistic Threshold ^b	0.08
Area of moderate suitability habitat within species' range	14,583 km ²
Optimal Logistic Threshold ^c	0.34
Area of predicted optimal habitat within species' range	4,264 km ²
Total area of predicted suitable habitat within species' range	64,495 km ²
Absolute validation index (AVI) ^d	1
Avg Deviance (X +/- SD) ^e	1.46 +/- 1.55
Training AUC ^f	0.993
Test AUC ^g	0.994

- The logistic threshold between unsuitable and low suitable as determined by Maxent which balances training data omission error rates with predicted area.
- 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.
- 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.
- The proportion of test locations that fall above the low logistic threshold.
- 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.
- 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.
- The same metric described in f, but calculated for test observations.

Inductive Modeling Map Outputs

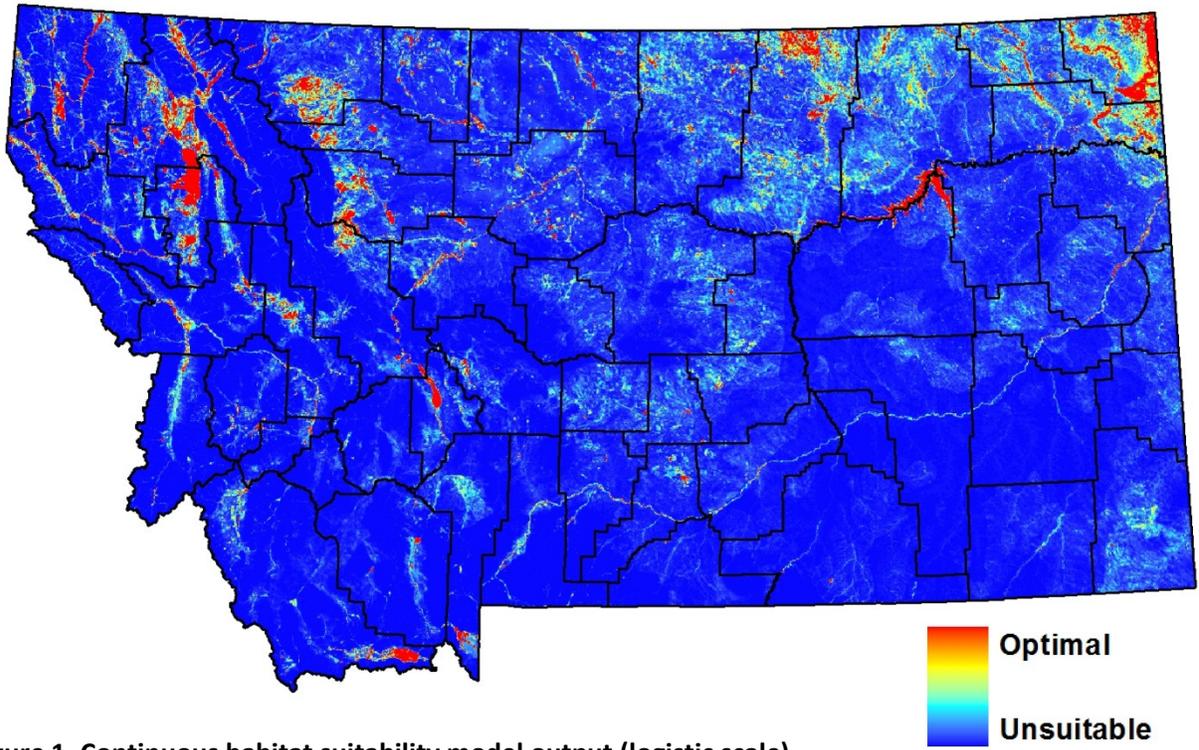


Figure 1. Continuous habitat suitability model output (logistic scale).

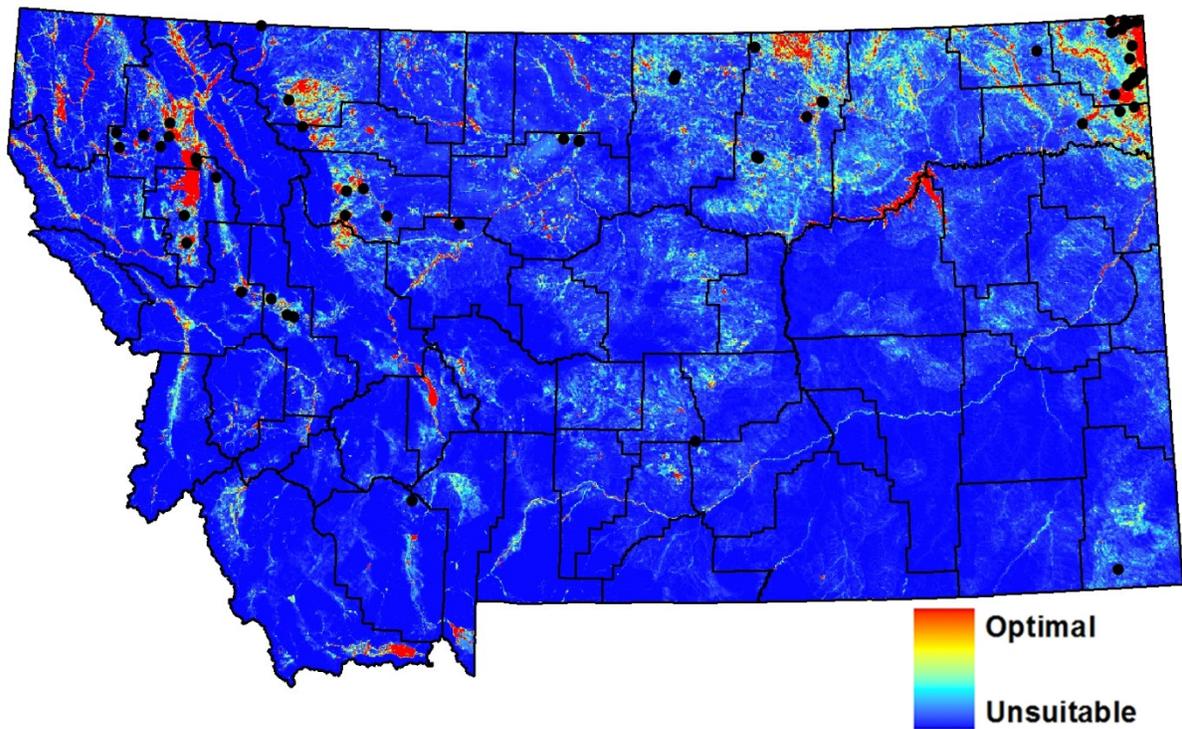


Figure 2. Continuous habitat suitability model output with training and test data.

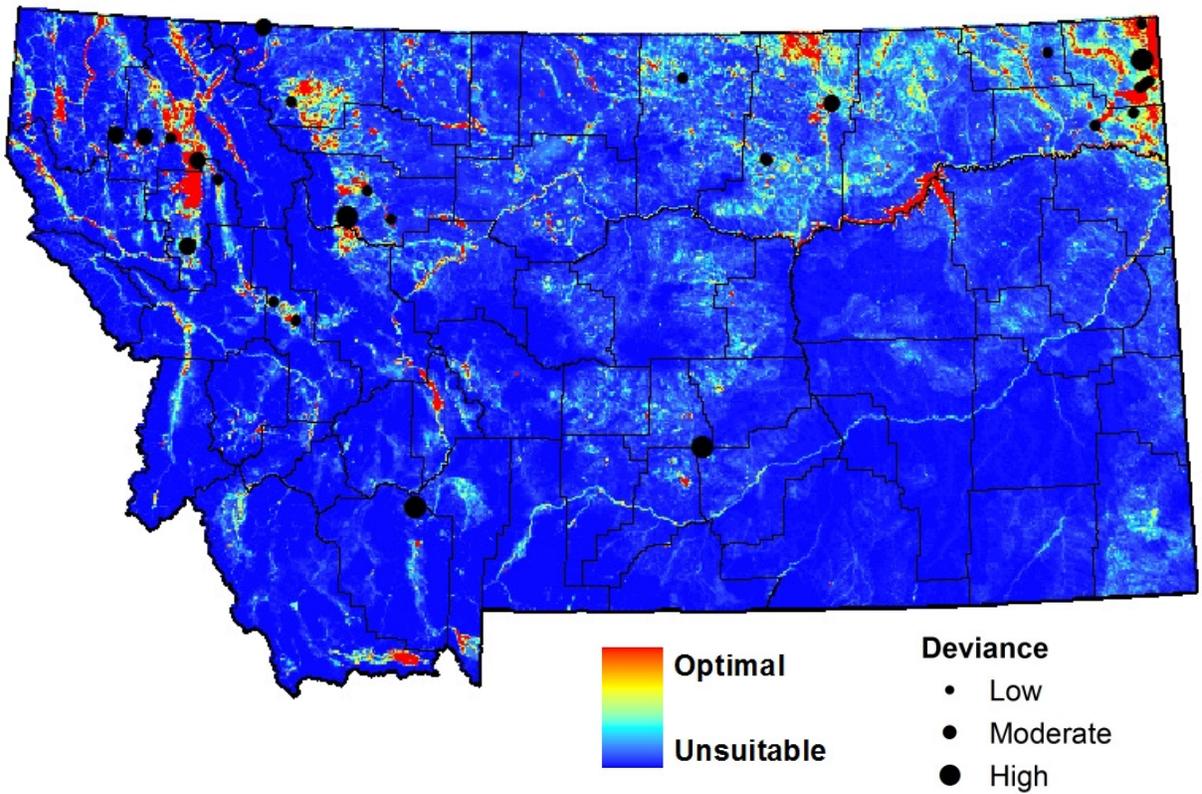


Figure 3. Continuous habitat suitability model output with relative deviance for each test observation

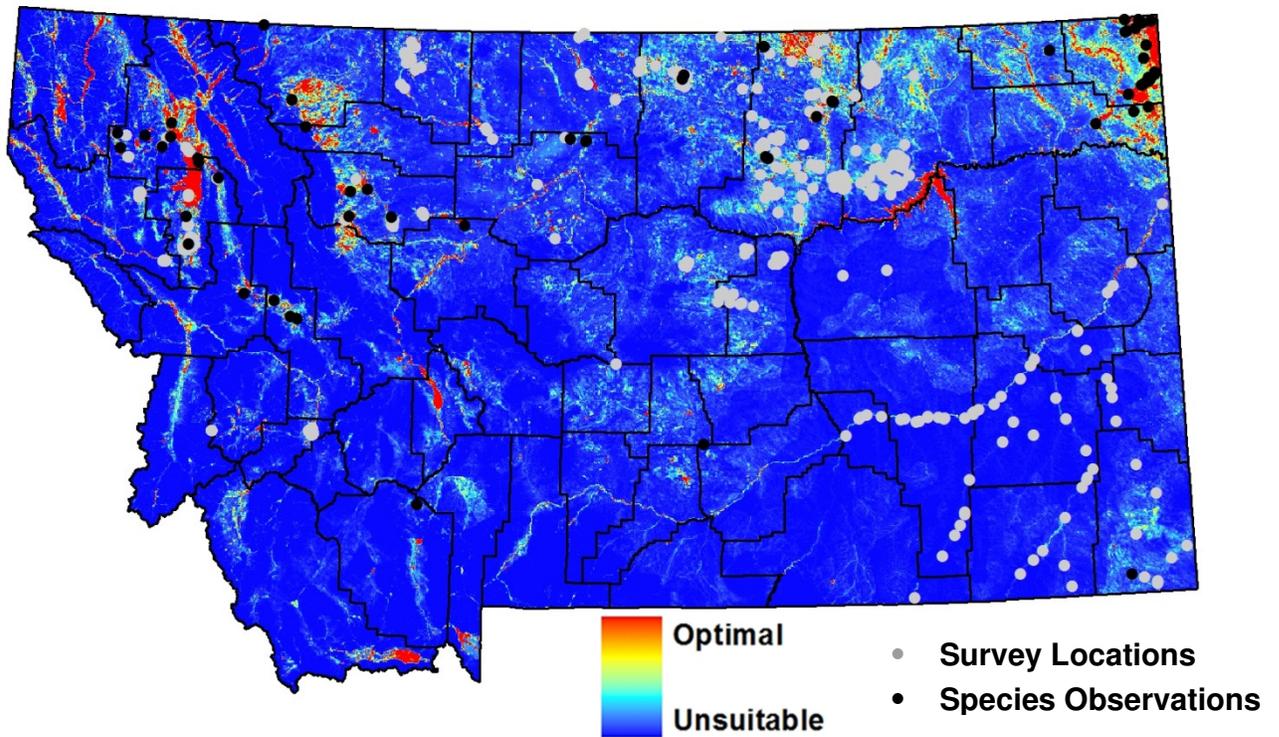


Figure 4. Continuous habitat suitability model output with survey locations that could have detected the species (gray) and detections of species (black)

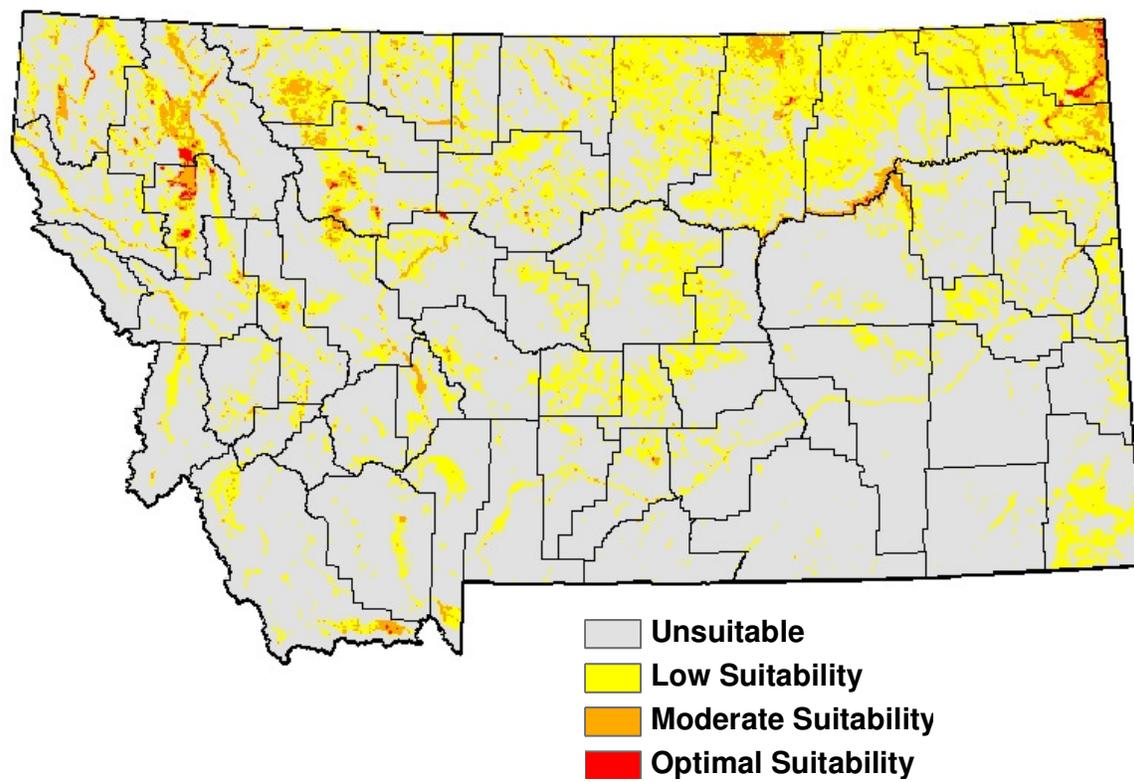


Figure 5. Model output classified into unsuitable (gray), low suitability (yellow), medium suitability (orange), and optimal suitability (red) habitat classes.

Deductive Model

Model Created By: Bryce Maxell

Model Creation Date: 4/23/2010

Model Evaluators: Joy Ritter and Bryce Maxell

Model Evaluation Date: 9/3/2012

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
Great Plains Prairie Pothole	9203	Common
Open Water	11	Common
Emergent Marsh	9222	Common
Great Plains Closed Depressional Wetland	9252	Common
Great Plains Open Freshwater Depression Wetland	9218	Common

Deductive Model Evaluation

Discussion of Model Performance:

Model likely over predicts the amount of suitable habitat for the species; especially on larger water bodies across the state. When completed, statewide wetland and riparian mapping efforts should be able to do a much better job of predicted suitable habitat for the species given their dependence on emergent vegetation.

Evaluation metrics:

Metric	Value
Area of commonly associated habitats (km ²)	4,026
Absolute validation index (AVI) for common habitat associations	0.633

Deductive Model Output (Maps)

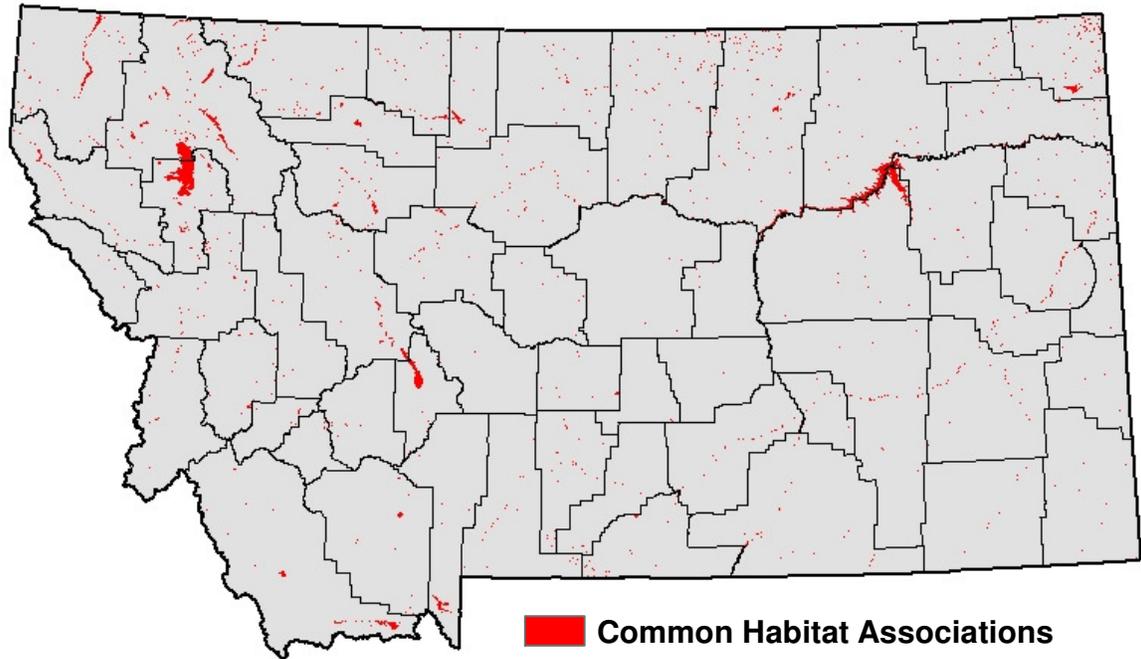


Figure 5. Common habitat association classes as determined by expert opinion (see Montana Field Guide species account).