

Northern Pintail Distribution Modeling



Scientific Name: *Anas acuta*

Distribution Status: Migratory Summer Breeder

State Rank: S5B

Global Rank: G5

Inductive Modeling

Model Created By: Joy Ritter and Bryce Maxell

Model Creation Date: December 11, 2012

Model Evaluators: Joy Ritter and Bryce Maxell

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	2,048
Location Data Selection Rule 1	Spatially unique records associated with breeding activity with $\leq 1,600$ meters of locational uncertainty
No. Locations Meeting Selection Rule 1	109
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	74
Season Modeled	Summer Breeding
No. Model Train Locations	74
No. Model Test Locations	Insufficient data for testing
No. Model Background Locations	60,000
Area of Species Range in State (Percent of Montana)	Statewide range

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:

Range wide = Statewide

```
java -mx2048m -jar c:\MaxEnt\maxent.jar -a -z nowarnings noprefixes -P -J -o  
U:\IndSpecies\Anas_acut\2012_12_11\RangeOut -s  
U:\IndSpecies\Anas_acut\2012_12_11\Anas_acut_train.csv -e !:\modelingSecondRoundInputLayers  
nowriteclampgrid nowritemess maximumbackground=60000 writebackgroundpredictions noextrapolate  
nodoclamp -N CONTVRM -t BIAS -t CATESYS -t CATSDEGEOL -t CATSOILTMP
```

Inductive Model Evaluation

Model Performance:

Where surveys have been completed and/or observations reported, the model appears to generally reflect the relative distribution and quality of Northern Pintail nesting habitat at large spatial scales across Montana. However, there was not enough data to evaluate the model with test data and areas such as the Fort Peck Reservation which have suitable habitat were not highlighted by the models due to lack of data. 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
CONTSLOPE	38.4	64.4
BIAS	19.3	4.2
CATESYS	11.9	0.1
CONTTMIN	10	1
CATSSOILTMP	8.9	3.8
CATSDEGEOL	5.2	5.9

Evaluation metrics:

Metric	Value
Low Logistic Threshold ^a	0.013
Area of predicted low suitability habitat within species' range	12,657 km ²
Medium Logistic Threshold ^b	NA
Area of moderate suitability habitat within species' range	NA
Optimal Logistic Threshold ^c	NA
Area of predicted optimal habitat within species' range	NA
Total area of predicted suitable habitat within species' range	12,657 km ²
Absolute validation index (AVI) ^d	NA
Avg Deviance (X +/- SD) ^e	NA
Training AUC ^f	0.964
Test AUC ^g	NA

- 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

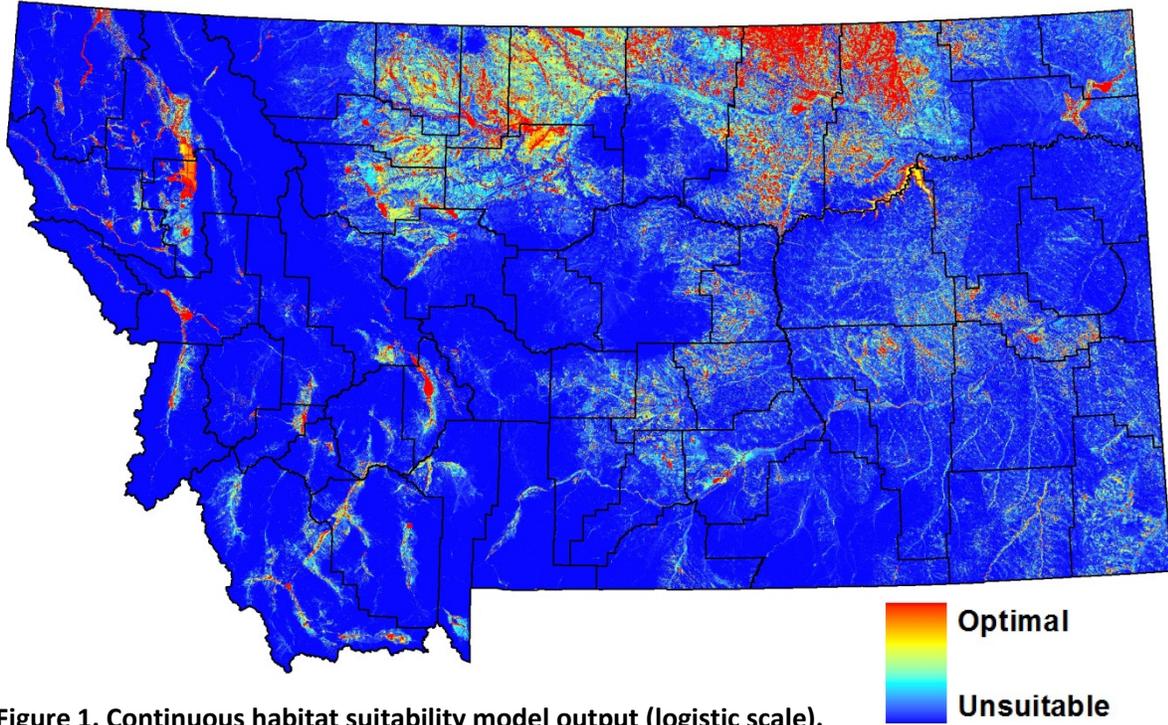


Figure 1. Continuous habitat suitability model output (logistic scale).

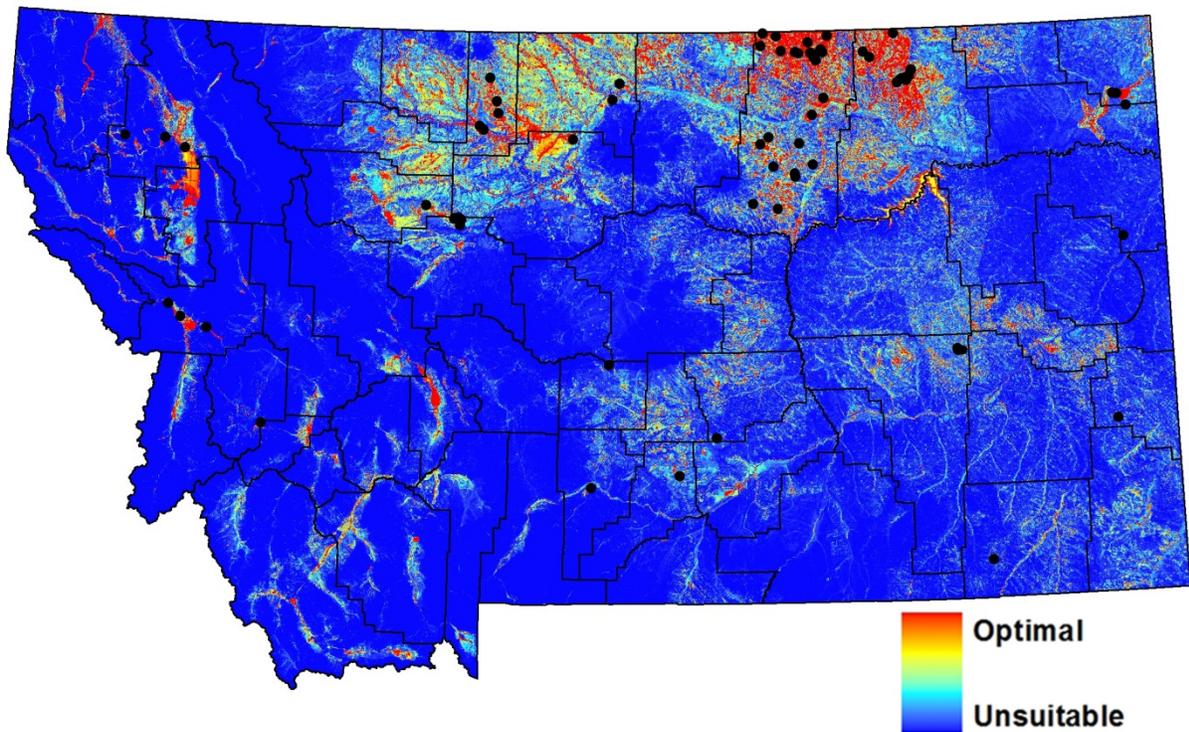


Figure 2. Continuous habitat suitability model output with training and test data.

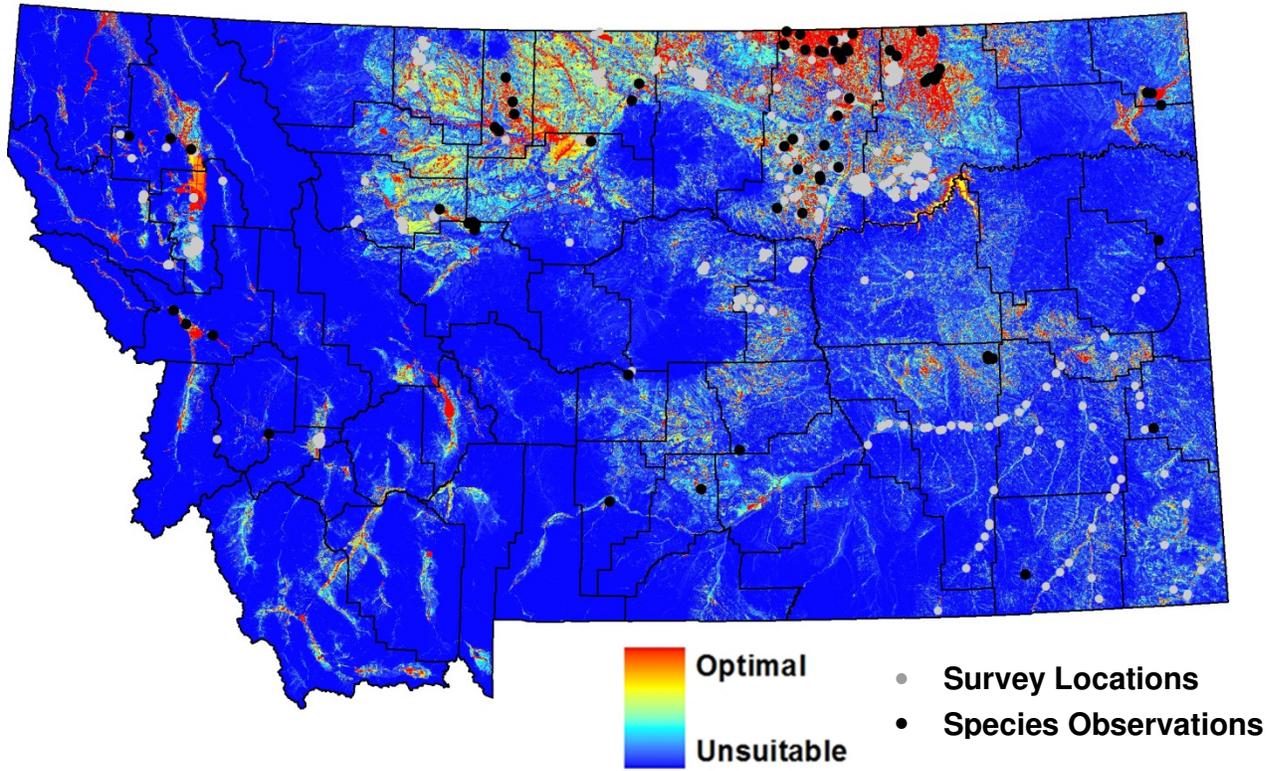


Figure 3. Continuous habitat suitability model output with survey locations that could have detected the species (gray) and detections of species (black).

Deductive Model

Model Created By: Bryce Maxell

Model Creation Date: August 12, 2009

Model Evaluators: Joy Ritter and Bryce Maxell

Model Evaluation Date: 12/11/2012

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
Open Water	11	Common
Rocky Mountain Lower Montane, Foothill, and Valley Grassland	7112	Common
Great Plains Mixedgrass Prairie	7114	Common
Great Plains Prairie Pothole	9203	Common
Alpine-Montane Wet Meadow	9217	Common
Great Plains Open Freshwater Depression Wetland	9218	Common
Emergent Marsh	9222	Common
Great Plains Closed Depressional Wetland	9252	Common
Great Plains Saline Depression Wetland	9256	Common
Great Plains Riparian	9326	Common

Deductive Model Evaluation

Discussion of Model Performance:

Associated habitats reflect the species habit of nesting in open country with shallow, seasonal, or intermittent wetlands and low vegetation. Relatively low AVI (only 68% of breeding records) is likely a result of the scale of habitat mapping/classification since a fairly large number of breeding records are associated with Big Sagebrush Steppe and Montane Sagebrush Steppe. Presumably, these records are in ecotones of grassland/shrubland habitat, but are classified as shrubland.

Evaluation metrics:

Metric	Value
Area of commonly associated habitats (Km ²)	105,548
Absolute validation index (AVI) for common habitat associations	0.676

Deductive Model Output (Maps)

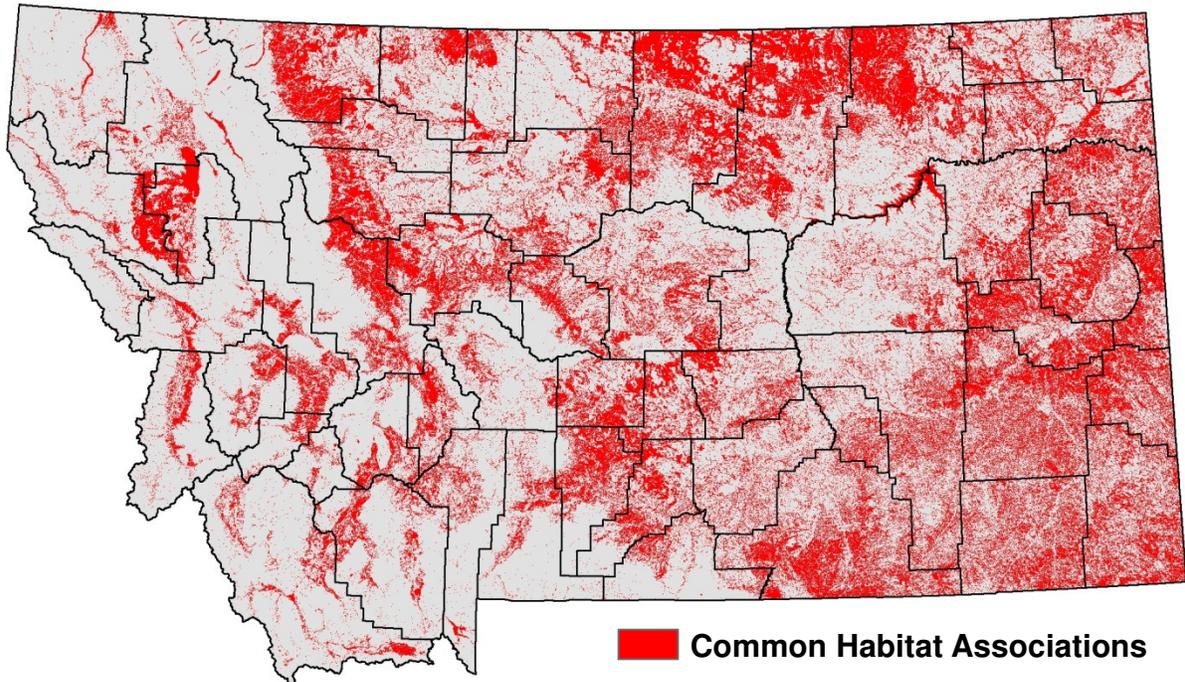


Figure 4. Common habitat association classes as determined by expert opinion (see Montana Field Guide species account).