

Habitat Modeling for Sprague's Pipit in Montana

Data and Deductive and Inductive Models for Montana

Presentation to USFWS and other Federal and State Agencies
April 10th, 2012 in Helena, Montana





Bryce Maxell - Senior Zoologist

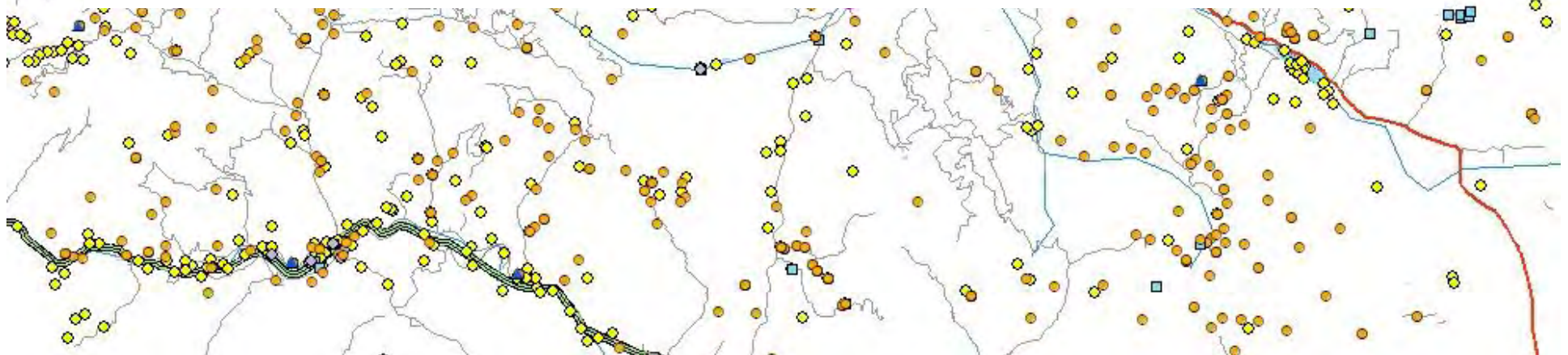




Data Available For Animal Species Modeling in Montana



- 1,218,000+ Animal Observation Records
 - 139,000+ Structured Animal Surveys
 - Positive Data Widely Available
 - Negative Data from Systematic Surveys Rare
 - Wide range of dates, but most data is since 1985
 - Locational Uncertainty Assigned to all Records
 - Records receive 2 to 3 rounds of review for mapping accuracy, precision, and association with appropriate habitats.
 - Limitations on Statewide Environmental Layers
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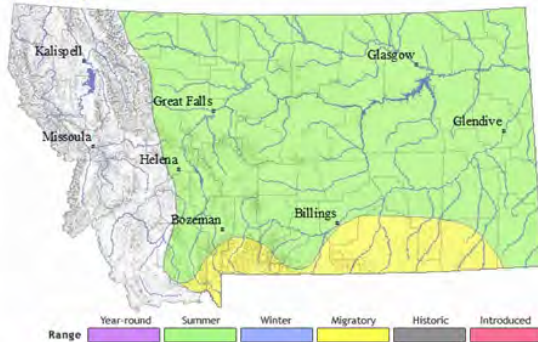
Data and Data Access for Sprague's Pipits

Montana Field Guide - <http://fieldguide.mt.gov>

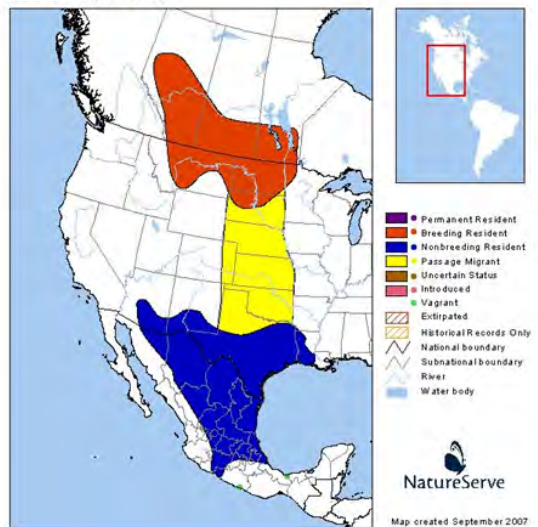


General Distribution

Montana Range



Western Hemisphere Range



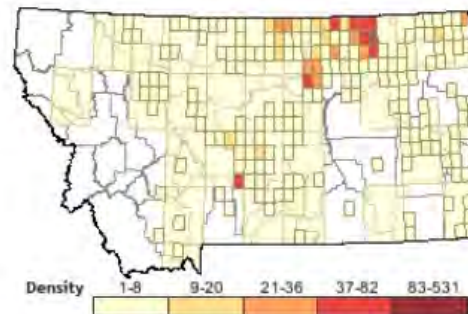
Summary of Observations Submitted for Montana

Number of Observations: 3472

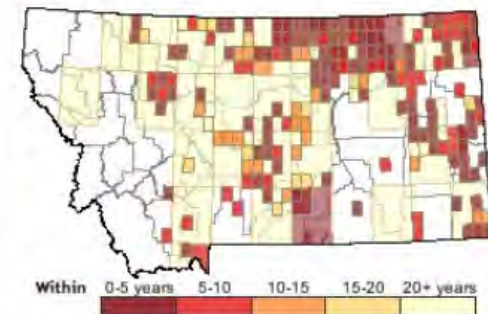
(Click on the following maps and charts to see full sized version)

[Map Help and Descriptions](#)

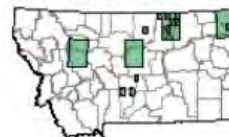
Relative Density



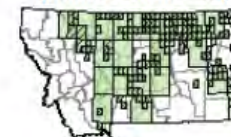
Recency



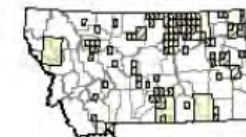
Breeding (direct evidence "B")



Breeding (indirect evidence "b")



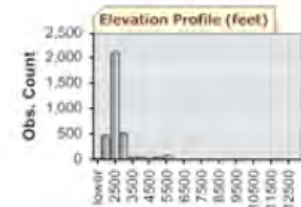
No evidence of Breeding (transient "t")



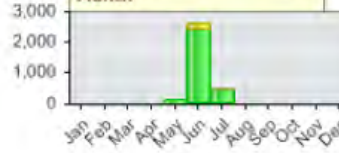
Overwintering (regular observations "W")



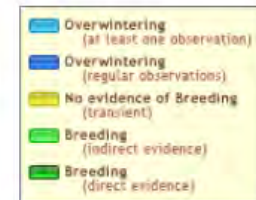
Overwintering (at least one obs. "w")



Submitted Observations by Month




Submitted Observations by Year



(Records associated with a range of dates are excluded from time charts)

Data and Data Access for Sprague's Pipits

NATURAL HERITAGE TRACKER  Field Guide Scale 1:4,071,963 Lat: 49.90793 Long: -110.88812 Maxell, Bryce






Home File Edit View Window Help Sign Out

Display Options

- Point Observations
- Structured Surveys
- Species Occurrences
- Range Maps
 - Year-round Range
 - Summer Range
 - Winter Range
 - Migration Range


display reset

Point Observations - Bird





-  Breeding (direct evidence)
-  Breeding (indirect evidence)
-  No evidence of breeding
-  Overwintering (regular obs)
-  Overwintering (at least one obs)

Outlined symbols are "pending records"




Structured Surveys

-  Survey Location

Range Maps

-  Year-round Range
-  Summer Range
-  Winter Range
-  Migration Range

Structured Surveys

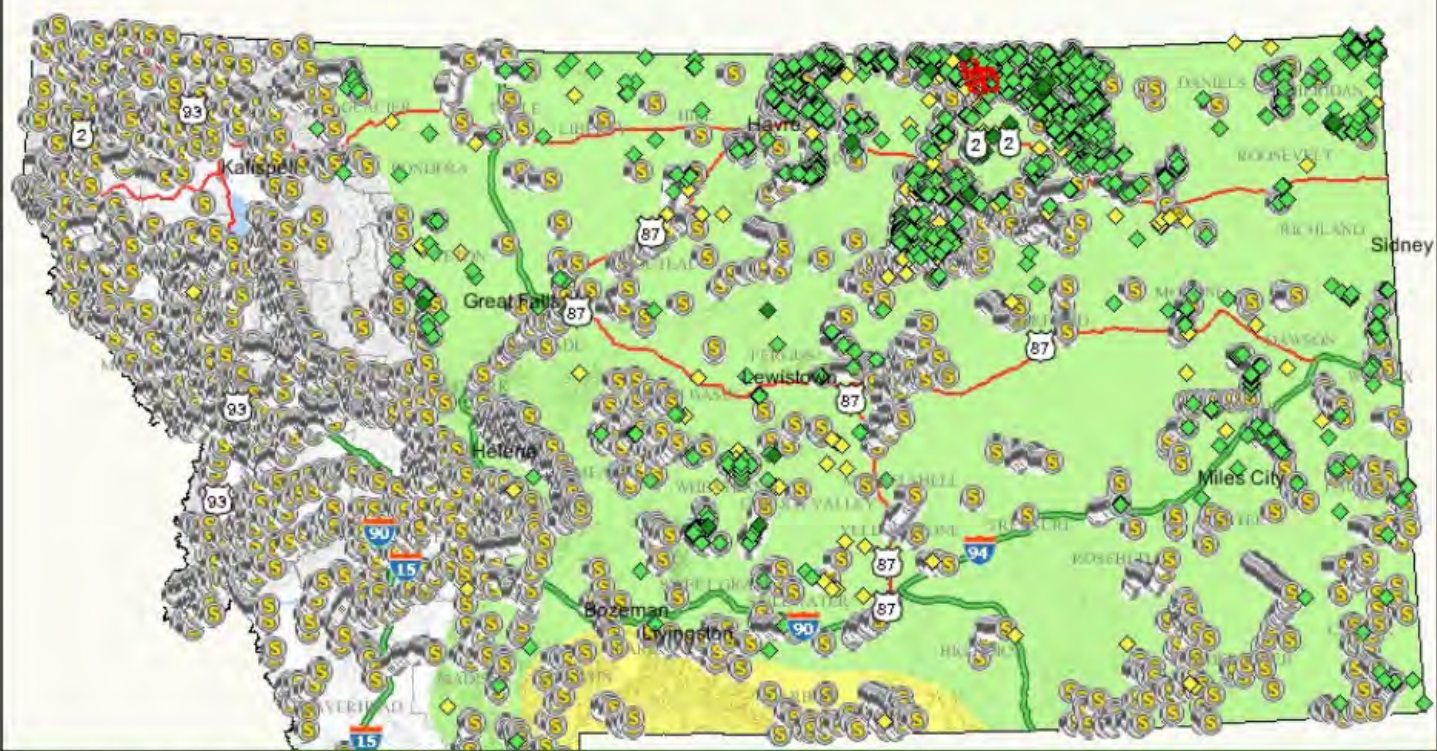
-  Add Animal Observations
-  Photo Viewer
-  Map Layers

Map Layers




- Towns
- County
- LL / QLL / QLLL
- Roads and Highways
- 24K Quads
- Township and Range
- Lakes/Streams
- Conservation Easements

Expand All Collapse All


(Sprague's Pipit) - Overview - Range Map



(Sprague's Pipit) - Overview - Range Map

-  Charts and Graphs
-  Species List
-  Observation Details

[Export to Excel](#) | [Collapse All](#)

 Birds - Sprague's Pipit *Anthus spragueii* Count: 3472 Earliest: Apr 15 Latest: Oct 15 Oldest: 1974 Newest: 2011

TAXA	ID (click to)	SPECIES	OBSERVER'S	MONTH	Notes	LL Q1	COUNTY	Comments	Elevation	Spatial Precision	TYPE	PENDING
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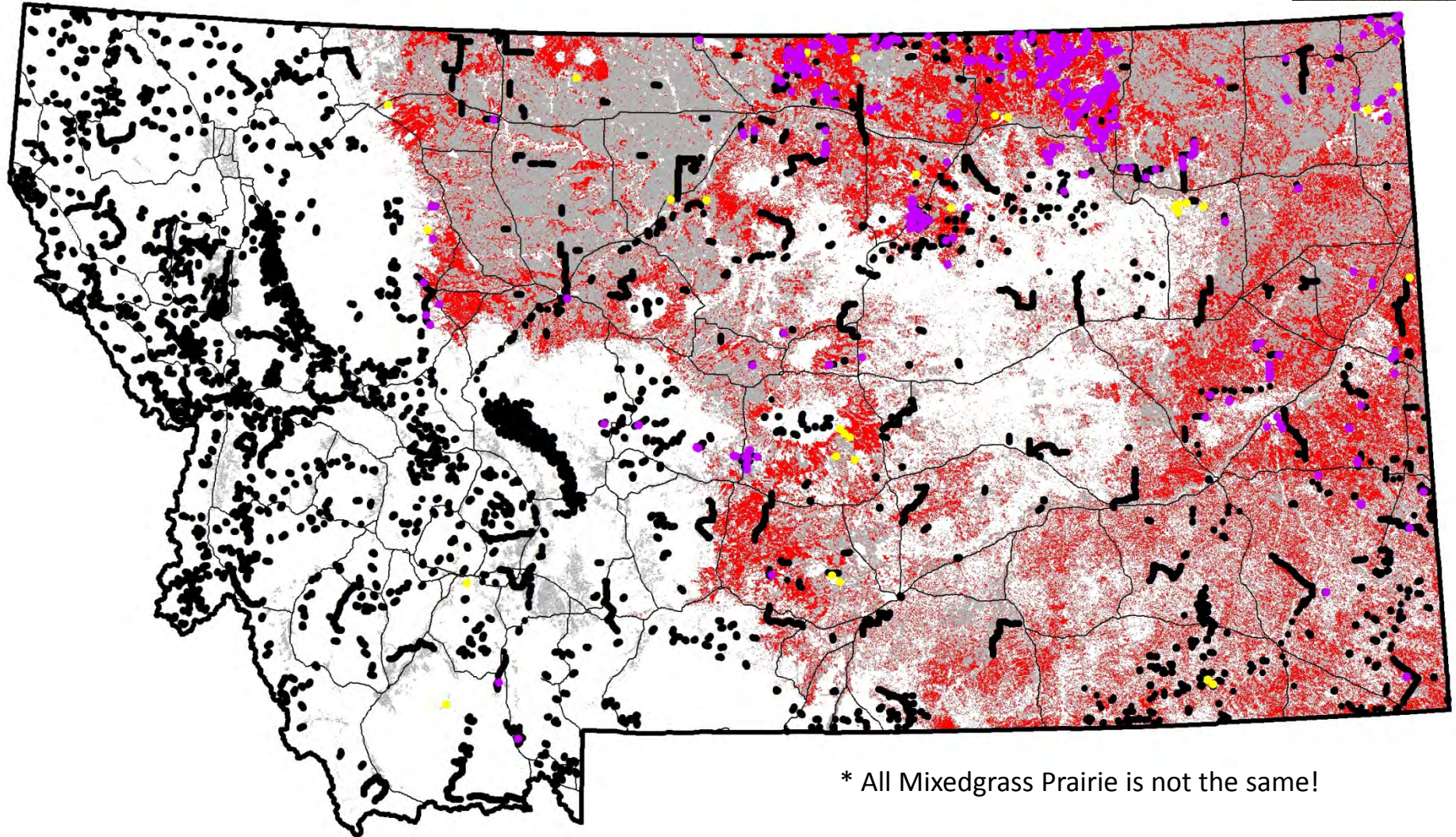
Deductive Model

- Great Plains Mixedgrass Prairie (Red)
- Agriculture (Gray)

Black points = point count survey
Purple points = detections

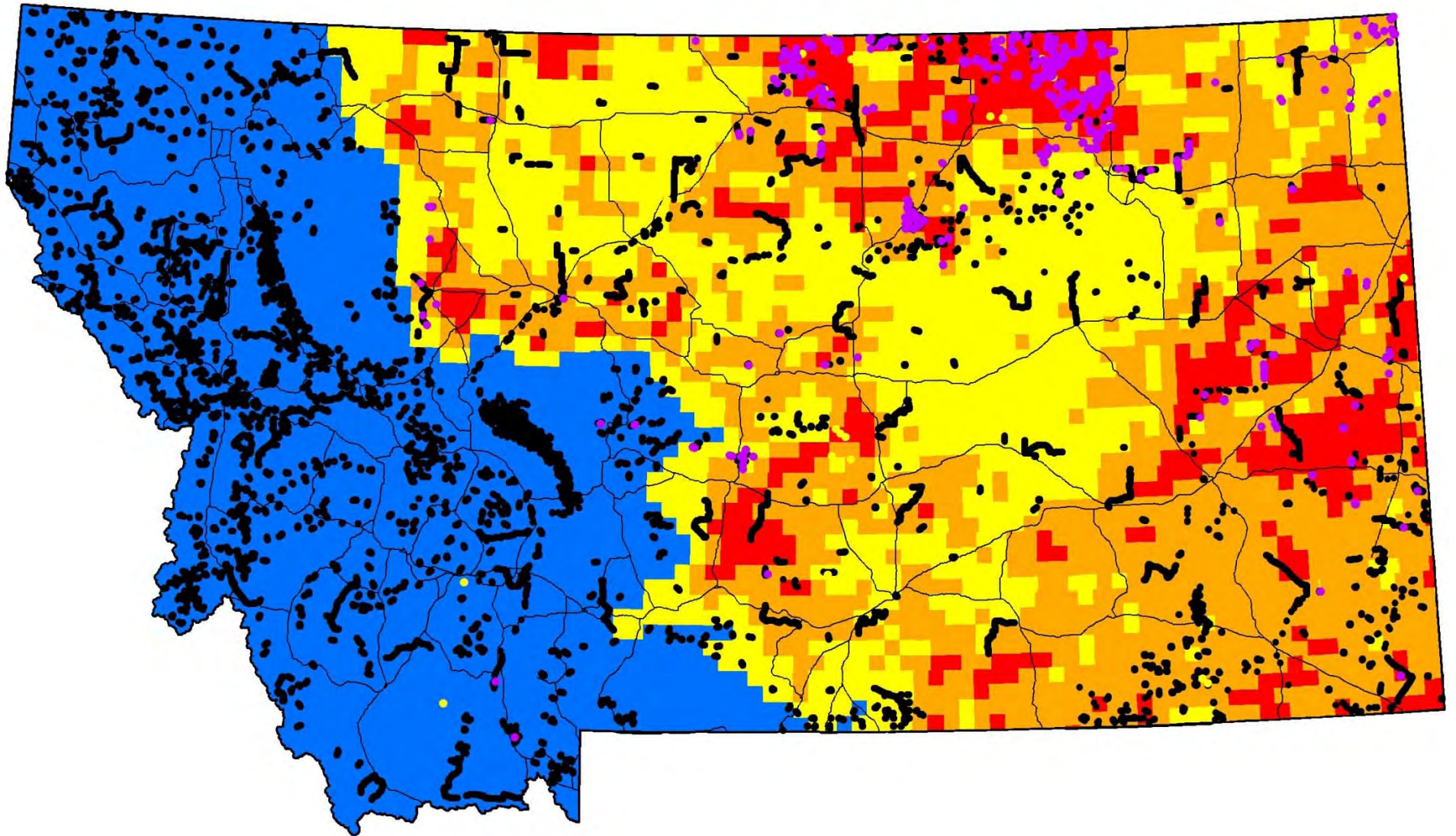


© MTNHP - S. V. Cooper



* All Mixedgrass Prairie is not the same!

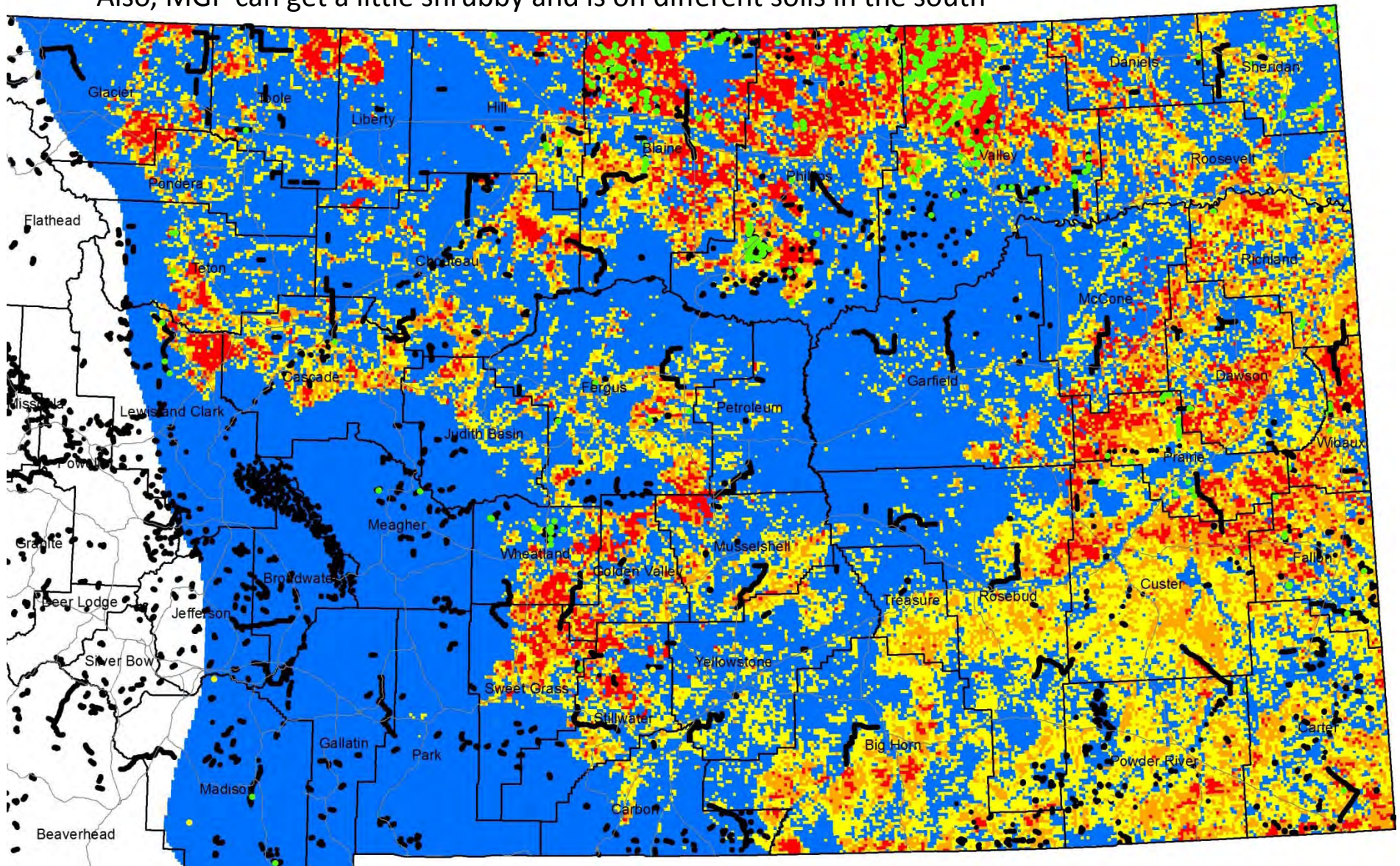
Great Plains Mixedgrass Prairie Density by Township



Percent Mixedgrass Prairie = Blue (0-25%), Yellow (0.25-0.50), Orange (0.5-0.75), Red (0.75-1.0)

Great Plains Mixedgrass Prairie Density by Section

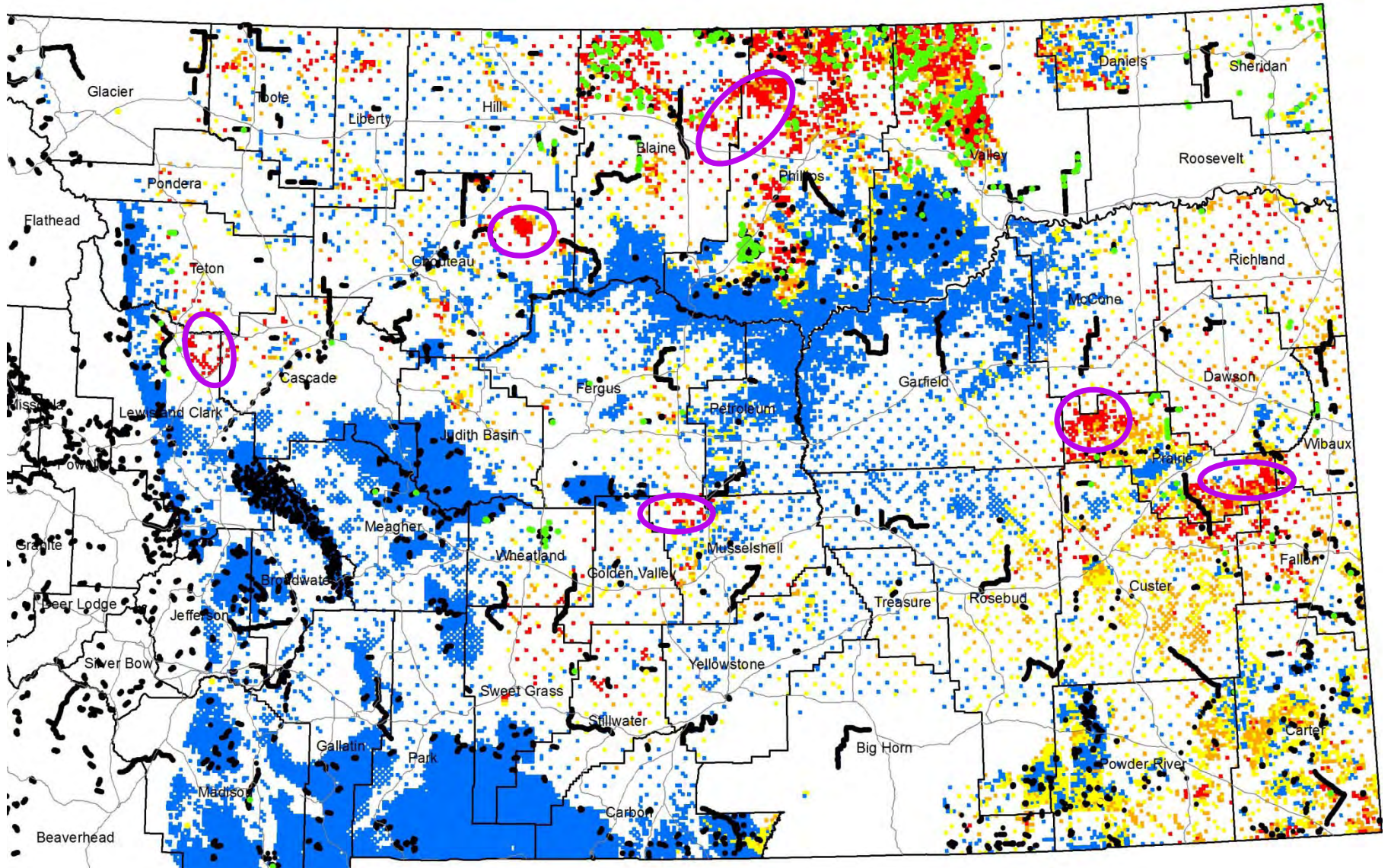
- PLSS sections with SPPI had mean percent MGP per section of ~ 60% (median = 71%)
- Mean is probably biased low because some areas along front and Madison Valley contain no MGP
- Also, MGP can get a little shrubby and is on different soils in the south



Great Plains Mixedgrass Prairie

Surveys Needed!

Public Lands Only



Inductive Modeling with Maxent

- Ideal for positive data only
- Uses random background points as pseudo-absences
- Uses different levels of complexity depending on amount of data available
- Logistic output interpretable as relative habitat suitability
- Output is generally satisfactory in regions with at least a few observation points
- Equivalent or superior to other predictive modeling approaches (*Elith et al. 2006 - Ecography 29: 199-151*)
- Uses empirical distributions to constrain estimated distributions
- Iterative machine learning approach with deterministic outcome

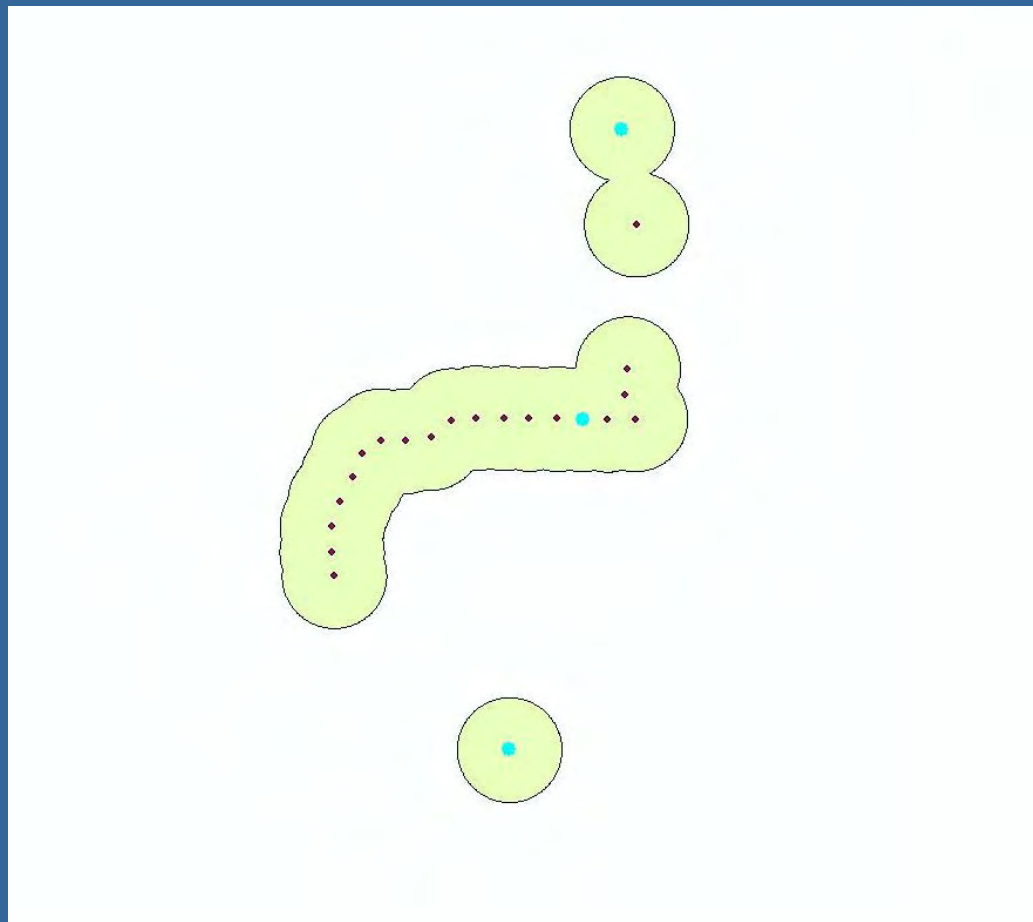
11 Environmental Layers

Layer	Identifier	Description
Aspect	CONTEWASP CONTNSASP	East to West continuous aspect North to South continuous aspect
Bias	BIAS	Categorical layer representing potential underlying biases inherent in the observation database as a result of proximity to roads and public lands (three categories)
Elevation	CONTELEV	Elevation in meters from the National Elevation Dataset
Geology	CATSDEGEOL	931 categories of surficial geology
Land Cover	CATESYS	Montana land cover framework with roads removed – 27 classes
Max Temp	CONTTMAX	Estimated average maximum daily July temperature in degrees Fahrenheit for 1971-2000.
Min Temp	CONTTMIN	Estimated average minimum daily January temperature in degrees Fahrenheit for 1971 -2000.
Precipitation	CONTPRECIP	Relative effective annual precipitation in 1cm intervals as an indicator of available soil moisture.
Slope	CONTSLOPE	Degrees of slope
Soil Temp	CATSOILTMP	Soil temperature and moisture regime – 12 categories
Stream Dist	CONTSTRMED	Euclidean distance from major streams in 1 meter intervals

Data Summary for Sprague's Pipit Modeling

2012 (2011) modeling efforts

- 3,472 (2,696) total records
- 1753 (1,174) spatially unique breeding records
- 1,057 (722) spatially independent breeding records
- 793 (541) training points
- 264 (181) test points

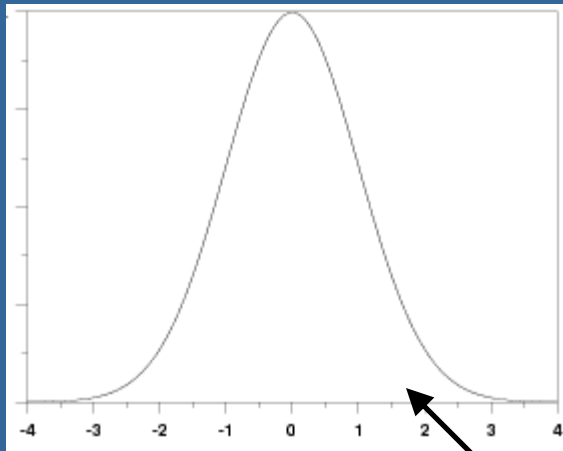


Maxent Algorithm

Phillips et al. 2006 - Ecological Modelling 190:231-259

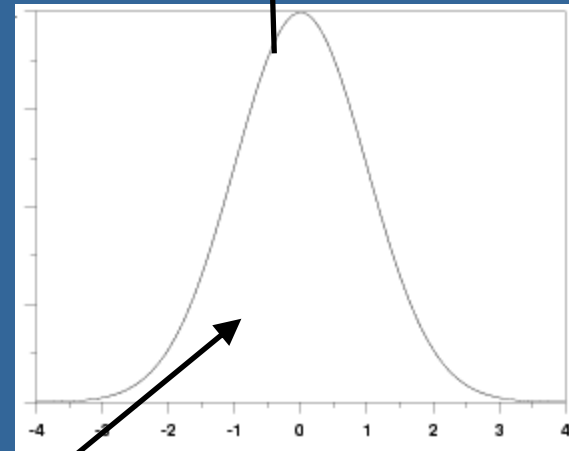
Phillips and Dudik 2008 – Ecography 31:161-175

$$P(x) = \exp(c1 * f1(x) + c2 * f2(x) + c3 * f3(x)...) / Z$$

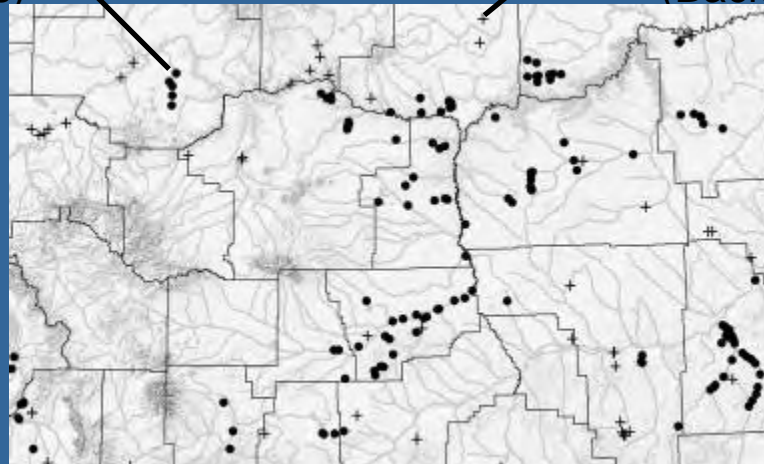


Empirical Distribution
(Positive Observations)

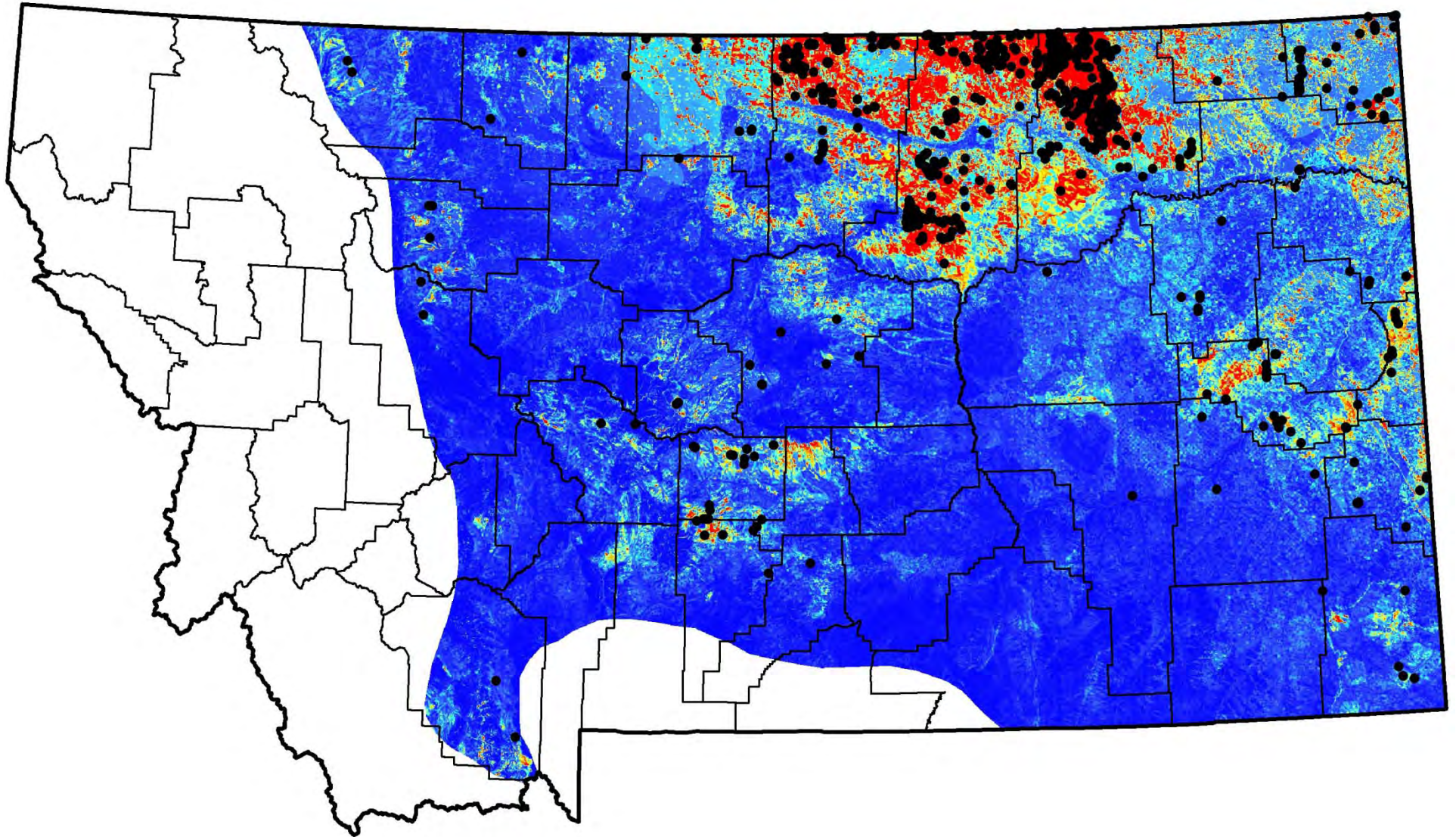
→ Constrains →



Estimated Distribution
(Background Points)



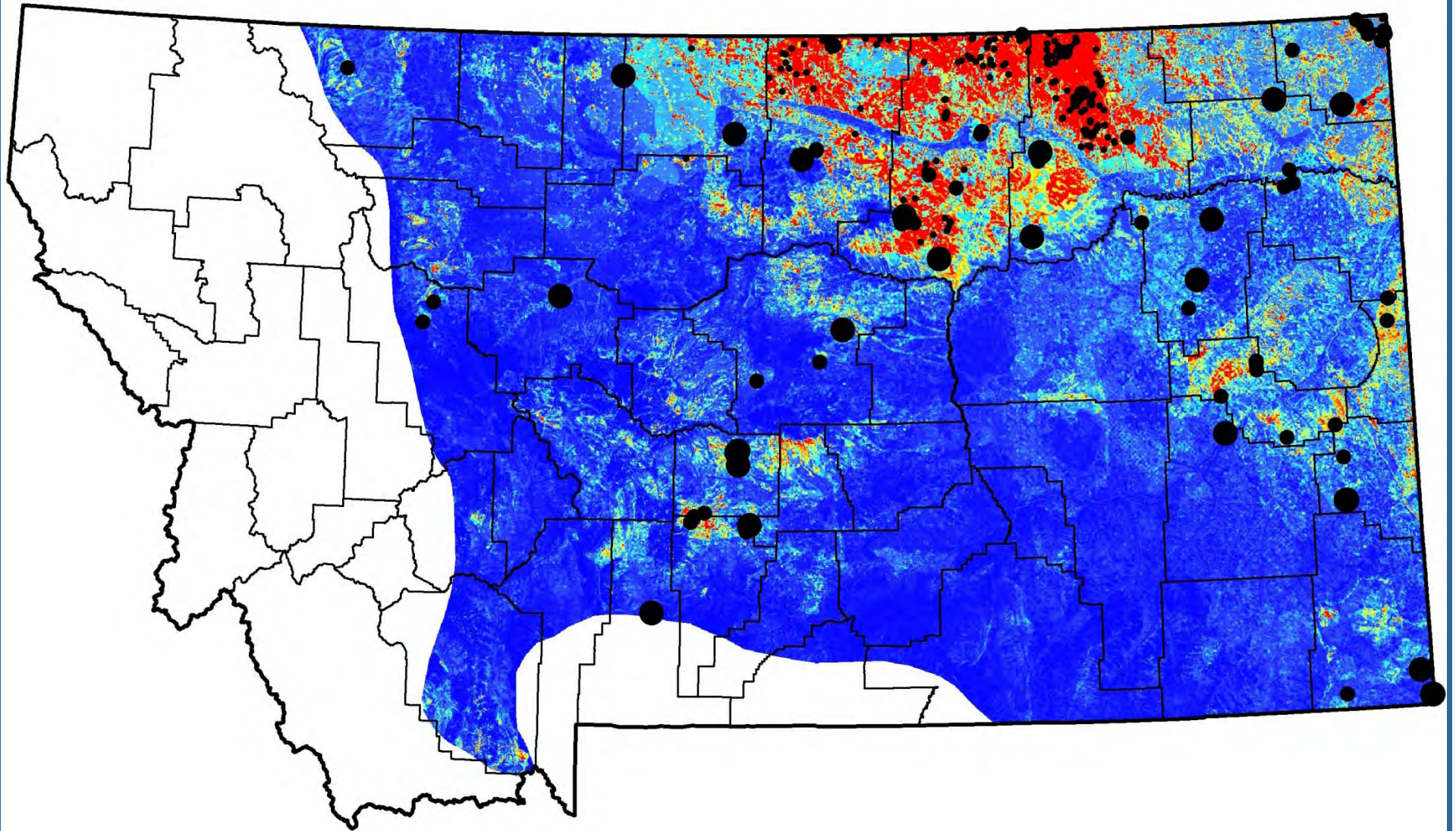
Maximum Entropy Continuous Model with Training Data



Model Evaluation

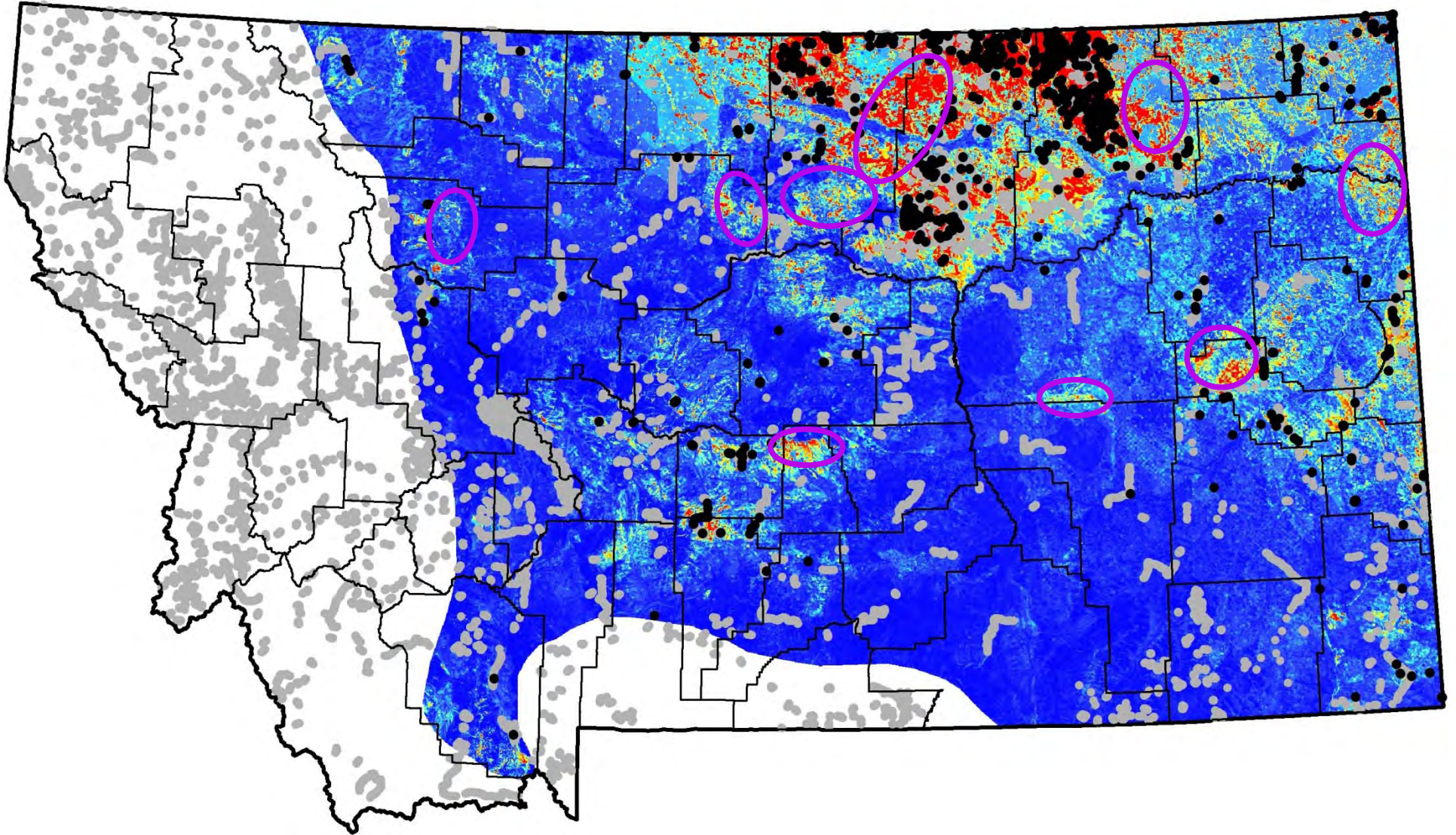
Absolute Validation Index (AVI) for Suitable = 0.96, AVI for Optimal = 0.50

Deviance = $-2 * 1 - \ln(\text{logistic output})$ Values range from 0 to ~14 X (SD) for test data = 2.0 (2.1)

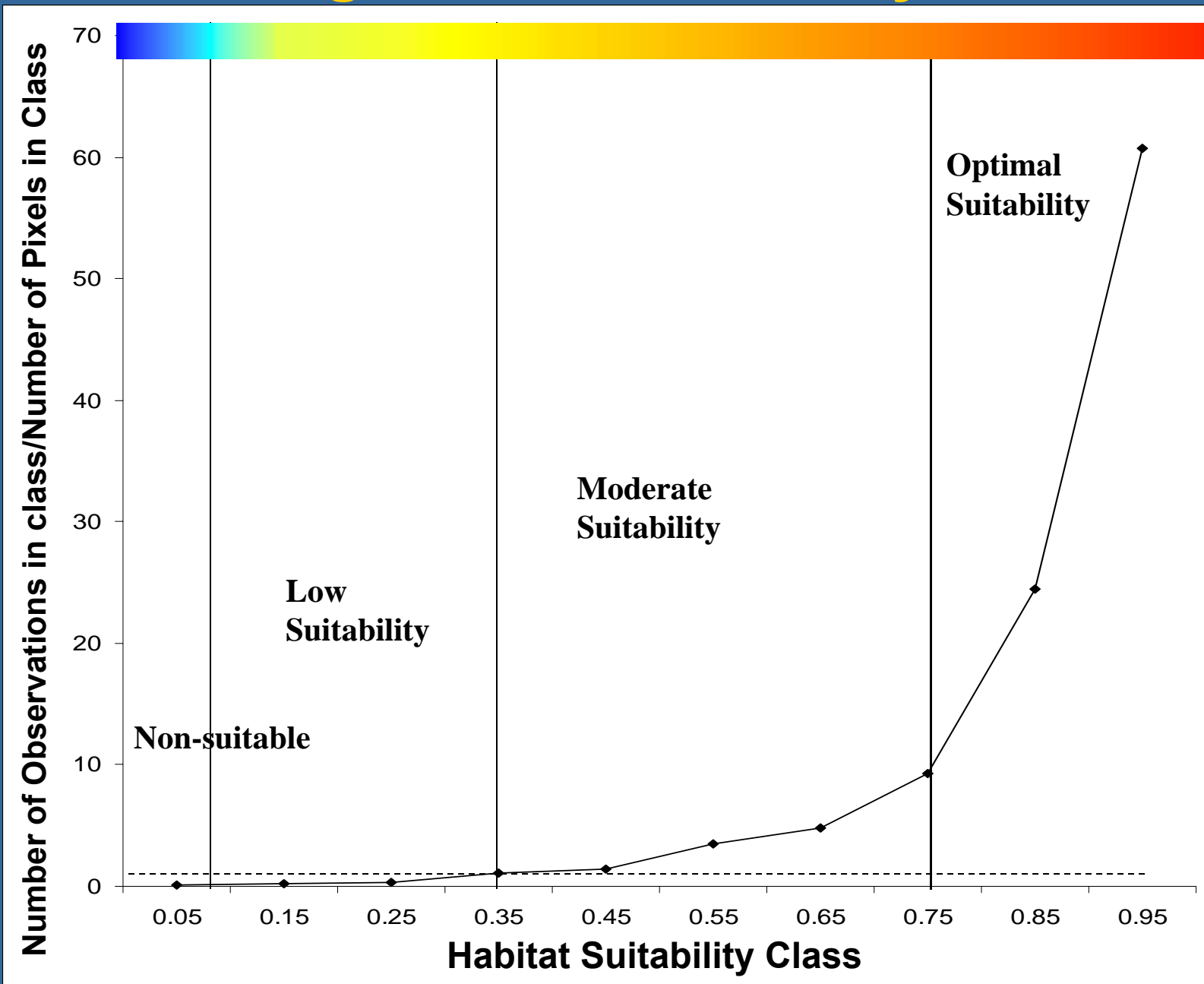


Continuous Model and Data Overview

Surveys Needed!

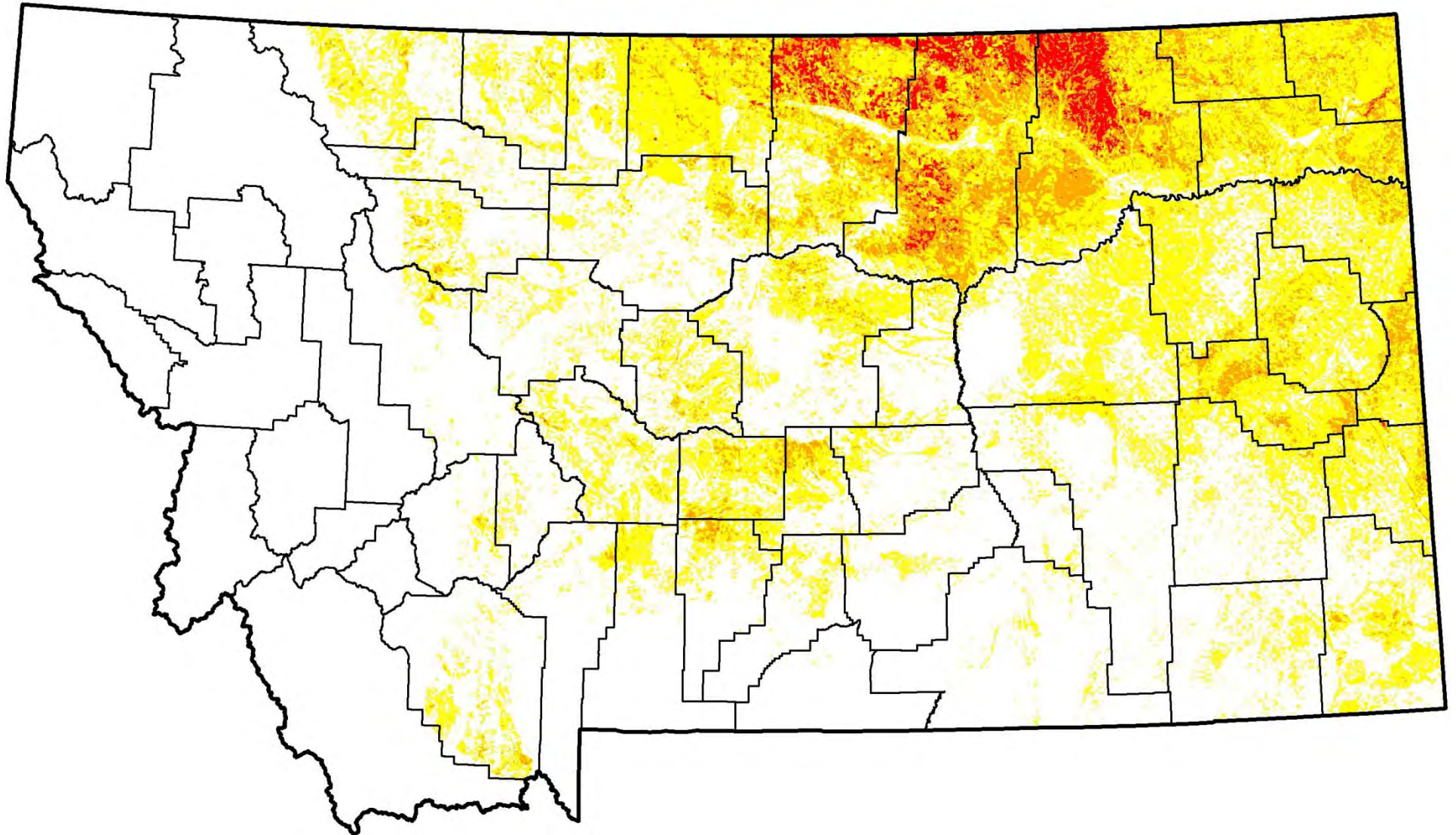


Delineating Habitat Suitability Classes



Suitable & Optimal Habitat

	Logistic Cutoff	Area in Km ²	% of MT
Low	0.032	81,820	21.4
Moderate	0.20	21,493	5.6
Optimal	0.57	5,693	1.5



North Valley County Long-term Grassland Bird Monitoring for BLM

Percent of Sites Detected										
CommonName	2001	2002	2003	2004	2005	2006	2007	2008	Change Per Year	Significant
Baird's Sparrow	0.31400	0.32850	0.42857	0.36923	0.39898	0.41545	0.46376	0.34358	0.01	-
Bobolink	0.00483	0.00966	0.05291	0.02051	0.02020	0.02415	0.03381	0.00512	0.004	-
Brewer's Blackbird	0.02415	0.00483	0.02116	0.01538	0.01515	0.00966	0.02898	0.01538	0.0003	-
Brewer's Sparrow	0.04830	0.01449	0.01587	0.02564	0.01515	0.01932	0.05797	0.05128	0.003	-
Brown-headed Cowbird	0.04347	0.04347	0.06349	0.06666	0.05555	0.10144	0.08212	0.07692	0.006	0.02
Chestnut-collared Longspur	0.82125	0.79710	0.84126	0.83076	0.85858	0.85024	0.89855	0.89743	0.01	0.003
Grasshopper Sparrow	0.07729	0.09178	0.20105	0.06666	0.22222	0.21739	0.12560	0.10256	0.007	-
Horned Lark	0.77777	0.74879	0.74074	0.75897	0.75252	0.78743	0.73913	0.81538	0.004	-
Lark Bunting	0.06763	0.33333	0.12169	0.04102	0.15656	0.31400	0.13043	0.01538	-0.008	-
Long-billed Curlew	0.06763	0.04830	0.04232	0.02564	0.08585	0.04347	0.01932	0.05128	-0.002	-
Marbled Godwit	0.04347	0.06763	0.02645	0.09743	0.13636	0.09661	0.06763	0.09743	0.007	-
McCown's Longspur	0.13526	0.15458	0.13756	0.13846	0.22222	0.28502	0.20772	0.24615	0.02	0.02
Northern Harrier	0.00000	0.00000	0.00000	0.00512	0.00000	0.00000	0.00000	0.01538	0.001	-
Savannah Sparrow	0.08695	0.09661	0.12698	0.10769	0.07070	0.06280	0.14492	0.11794	0.003	-
Sprague's Pipit	0.60869	0.64251	0.71957	0.60000	0.64141	0.49758	0.57971	0.54358	-0.02	0.11
Upland Sandpiper	0.00483	0.00000	0.00529	0.01025	0.00505	0.00000	0.00966	0.00512	0.0003	-
Vesper Sparrow	0.21256	0.17874	0.19576	0.11282	0.14646	0.13043	0.13043	0.11794	-0.01	0.01
Western Meadowlark	0.73429	0.72463	0.69841	0.66666	0.72727	0.60869	0.67149	0.56923	-0.02	0.02
Willet	0.00966	0.03381	0.01587	0.01538	0.04545	0.03381	0.01449	0.03589	0.002	-
Wilson's Phalarope	0.00000	0.00483	0.01058	0.01025	0.00505	0.00000	0.00483	0.00000	-0.0004	-

North Valley County Long-term Grassland Bird Monitoring for BLM

Average Number of Birds Detected on Point Count

CommonName	2001	2002	2003	2004	2005	2006	2007	2008	Change Per Year	Significant
Baird's Sparrow	0.46377	0.55072	0.61905	0.63077	0.65152	0.74396	0.70531	0.58462	0.02	0.07
Bobolink	0.00483	0.03382	0.06878	0.07692	0.04040	0.06280	0.05314	0.00513	0.005	-
Brewer's Blackbird	0.02899	0.00483	0.03704	0.02564	0.03030	0.00966	0.04831	0.02051	0.0009	-
Brewer's Sparrow	0.05797	0.01932	0.03704	0.04615	0.01515	0.02415	0.07246	0.08718	0.005	-
Brown-headed Cowbird	0.08696	0.07729	0.11111	0.10769	0.09596	0.16425	0.19324	0.17436	0.016	0.003
Chestnut-collared Longspur	2.96135	2.62319	2.93122	2.95385	3.24747	3.36232	3.39130	3.57436	0.12	0.002
Grasshopper Sparrow	0.14010	0.13527	0.24868	0.10256	0.33333	0.34783	0.16908	0.13333	0.008	-
Horned Lark	1.60386	1.44444	1.51852	1.60000	1.54040	1.66184	1.53140	1.63590	0.01	-
Lark Bunting	0.14010	0.94203	0.34392	0.16923	0.35354	0.69565	0.37198	0.02051	-0.03	-
Long-billed Curlew	0.12560	0.06763	0.06349	0.04615	0.14646	0.05314	0.02415	0.09231	-0.005	-
Marbled Godwit	0.07729	0.12077	0.04762	0.15897	0.20202	0.15459	0.11594	0.13333	0.009	-
McCown's Longspur	0.26087	0.22705	0.22222	0.23077	0.39394	0.49758	0.36715	0.36923	0.03	0.05
Northern Harrier	0.00000	0.00000	0.00000	0.00513	0.00000	0.00000	0.00000	0.02051	0.002	-
Savannah Sparrow	0.09662	0.09662	0.15344	0.14872	0.08081	0.07729	0.17391	0.14359	0.005	-
Sprague's Pipit	0.94686	0.99034	1.06349	0.88718	0.83838	0.59420	0.64251	0.64615	-0.06	0.005
Upland Sandpiper	0.00483	0.00000	0.01058	0.01026	0.01010	0.00000	0.00966	0.01026	0.0006	-
Vesper Sparrow	0.28986	0.21739	0.22222	0.16410	0.16667	0.14493	0.15942	0.13333	-0.02	0.002
Western Meadowlark	1.15459	1.26087	0.95767	1.24103	1.16162	0.90821	0.94203	0.82051	-0.05	0.04
Willet	0.01449	0.05314	0.02646	0.02051	0.05556	0.04348	0.03382	0.05641	0.003	-
Wilson's Phalarope	0.00000	0.00966	0.01587	0.01538	0.00505	0.00000	0.01449	0.00000	-0.0004	-

North Valley County Long-term Grassland Bird Monitoring for BLM

Density per acre*

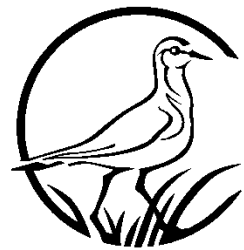
CommonName	2001	2002	2003	2004	2005	2006	2007	2008	Change Per Year	Significant
Baird's Sparrow	0.05976	0.07097	0.07977	0.08128	0.08396	0.09587	0.09089	0.07534	0.00257732	0.07
Bobolink	0.00062	0.00436	0.00886	0.00991	0.00521	0.00809	0.00685	0.00066	0.00064433	-
Brewer's Blackbird	0.00374	0.00062	0.00477	0.00330	0.00391	0.00125	0.00623	0.00264	0.000115979	-
Brewer's Sparrow	0.00747	0.00249	0.00477	0.00595	0.00195	0.00311	0.00934	0.01123	0.00064433	-
Brown-headed Cowbird	0.01121	0.00996	0.01432	0.01388	0.01237	0.02117	0.02490	0.02247	0.002061856	0.003
Chestnut-collared Longspur	0.38162	0.33804	0.37773	0.38065	0.41849	0.43329	0.43702	0.46061	0.015463918	0.002
Grasshopper Sparrow	0.01805	0.01743	0.03205	0.01322	0.04296	0.04482	0.02179	0.01718	0.001030928	-
Horned Lark	0.20668	0.18614	0.19569	0.20619	0.19851	0.21415	0.19735	0.21081	0.00128866	-
Lark Bunting	0.01805	0.12140	0.04432	0.02181	0.04556	0.08965	0.04794	0.00264	-0.003865979	-
Long-billed Curlew	0.01619	0.00872	0.00818	0.00595	0.01887	0.00685	0.00311	0.01190	-0.00064433	-
Marbled Godwit	0.00996	0.01556	0.00614	0.02049	0.02603	0.01992	0.01494	0.01718	0.001159794	-
McCown's Longspur	0.03362	0.02926	0.02864	0.02974	0.05077	0.06412	0.04731	0.04758	0.003865979	0.05
Northern Harrier	0.00000	0.00000	0.00000	0.00066	0.00000	0.00000	0.00000	0.00264	0.000257732	-
Savannah Sparrow	0.01245	0.01245	0.01977	0.01916	0.01041	0.00996	0.02241	0.01850	0.00064433	-
Sprague's Pipit	0.12202	0.12762	0.13705	0.11433	0.10804	0.07657	0.08280	0.08327	-0.007731959	0.005
Upland Sandpiper	0.00062	0.00000	0.00136	0.00132	0.00130	0.00000	0.00125	0.00132	7.73196E-05	-
Vesper Sparrow	0.03735	0.02801	0.02864	0.02115	0.02148	0.01868	0.02054	0.01718	-0.00257732	0.002
Western Meadowlark	0.14879	0.16248	0.12341	0.15993	0.14969	0.11704	0.12140	0.10574	-0.006443299	0.04
Willet	0.00187	0.00685	0.003							
Wilson's Phalarope	0.00000	0.00125	0.002							

Average density equivalent to 26.3 per square kilometer

Questions?

bmaxell@mt.gov

(406) 444-3655



MONTANA
**Natural Heritage
Program**
<http://mtnhp.org>