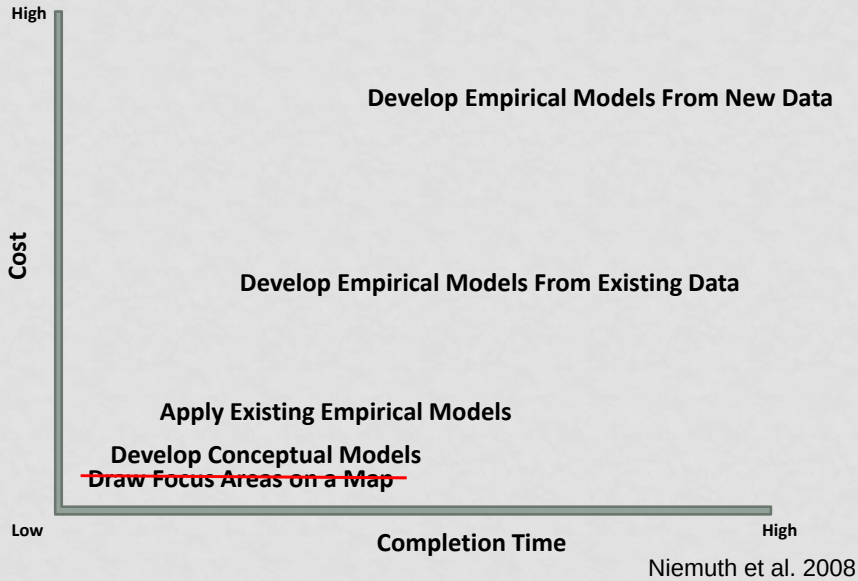
Modeling Approaches for Landscape Conservation in Region 6

ARCGIS MODELBUILDER APPLICATIONS

Model Development

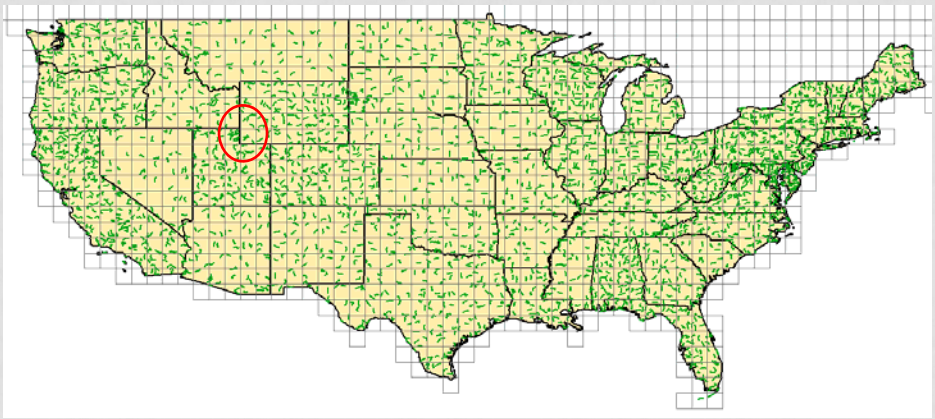


Niemuth et al. 2008

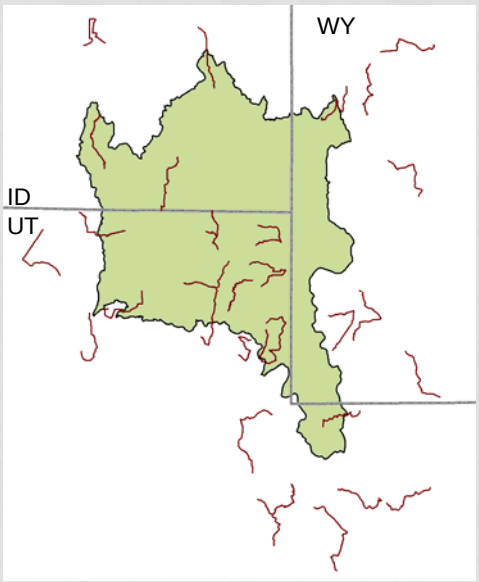
Empirical Models from Existing Data

Regression models for count data using Breeding Bird Survey data.

BBS routes density varies by state



BRWCA Breeding Bird Survey Routes



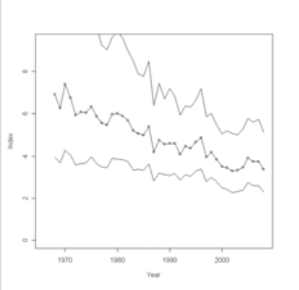
Project Area
- 4.8 million acres

33 total routes.
- Used 32 routes

BBS stops were created by
- Route observers (3)
- BBS web site (1)
- Derived from routes (29)

Sage Thrasher (*Oreoscoptes montanus*)

Southern Rockies
BBS TREND – 1966-2009



Survey-wide Abundance

Survey-wide Trend

Analysis Approach

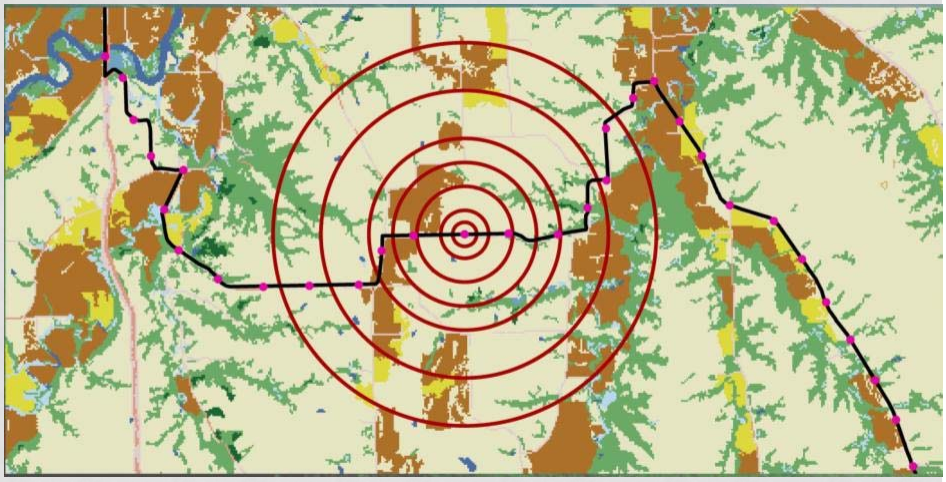
- Competing Model Analysis
  - Compare candidate set of models using AICc
- Validate Best Model
  - Goodness of Fit
  - Predictive ability
  - Spatial Autocorrelation
- Apply best model to landcover data in BRWCA
- Provide BRWCA planning team with priority maps and data layers

(Burnham and Anderson 2002)

Potential Model Covariates

COVARIATE	DESCRIPTION
STOP	proxy for time of day
NORTH	UTM northing meters
EAST	UTM easting meters
ELEVATION	DEM meters
SLOPE	percent
GRASS	proportion in landscape
HAY	proportion in landscape
CROP	proportion in landscape
FOREST	proportion in landscape
SHRUB	proportion in landscape
WATER	proportion in landscape
URBAN	proportion in landscape
PATCHES	number in landscape
PONDS	number in landscape (NHD)
PRECIP	PRISM 30 year monthly May mean (mm)
ROUGHNESS	surface area ratio (1-4)

BBS Stop Level Analyses



Evaluate Landscape Composition at Multiple Scales (meters):
200 400 800 1200 1600 2400 3200

Niemuth et al. (2002)

SATH Model Selection

- Used all BBS routes ran in year 2000
  - Corresponds with landcover imagery dates
- Run competing full models for landscape measurement (400m, 800m, 1200m, 1600m, 2400m, 3200m)
  - 1200m best model (Δ > 3 AICc)
- Poisson vs Negative Binomial Distributions
  - Mean: 0.24 Variance: 0.41
  - Negative Binomial (Δ > 21 AICc)
  - Likelihood Ratio Test: $P < 0.001$
- Tested need for zero-inflated models

Observed	Poisson	Negative Binomial
867	843	865

SATH Competing Models Analysis

BBS Data Year: 2000
Model Type: Negative Binomial Regression
Landscape around each BBS stop : 1200 meter radius

MODEL	*LL*	*K*	*AICc*	*deltaAICc*	*weight*
NORTH + EAST + ELEV + URBAN1200 + GRASS1200 + WATER1200 + CROP1200 + FOREST1200 + SHRUB1200 + PATCH1200 + ROUGH1200	-492.52	13	1011.40	0.00	0.905
NORTH + EAST + ELEV + SLOPE + URBAN1200 + GRASS1200 + SHRUB1200 + FOREST1200 + HAY1200 + PATCH1200 + PRECIP1200 + ROUGH1200	-494.05	14	1016.51	5.11	0.070
FULL	-490.98	18	1018.65	7.25	0.024
NORTH + EAST + ELEV + SLOPE + URBAN1200 + GRASS1200 + WATER1200 + SHRUB1200 + FOREST1200 + HAY1200	-502.16	12	1028.62	17.22	0.000
NORTH + EAST + PATCH1200 + PONDS1200 + PRECIP1200 + ROUGH1200	-540.49	8	1097.11	85.71	0.000
NULL	-609.62	2	1223.25	211.85	0.000

BRWCA Sage Thrasher Model

$$SATH = EXP(\beta_0 + \beta_1(NORTH) + \beta_2(EAST) - \beta_3(ELEV) - \beta_4(URBAN) + \beta_5(GRASS) + \beta_6(WATER) + \beta_7(CROP) + \beta_8(FOREST) + \beta_9(SHUB) + \beta_{10}(PATCH) - \beta_{11}(ROUGH))$$

```
Coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept)  4.699e+00  8.312e+00   0.565  0.57182
NORTH        3.197e-06  1.101e-06   2.902  0.00370 **
EAST         1.295e-05  3.176e-06   4.076 4.57e-05 ***
ELEV        -3.411e-03  7.619e-04  -4.477 7.58e-06 ***
URBAN1200   -5.357e+00  3.192e+00  -1.678  0.09332 .
GRASS1200    2.558e+00  1.592e+00   1.607  0.10797
WATER1200    3.133e+00  1.386e+00   2.260  0.02380 *
CROP1200     4.200e+00  1.375e+00   3.054  0.00226 **
FOREST1200   3.897e+00  1.396e+00   2.792  0.00524 **
SHRUB1200    6.306e+00  1.250e+00   5.044 4.56e-07 ***
PATCH1200    3.350e-03  1.388e-03   2.413  0.01584 *
ROUGH1200   -2.521e+01  6.844e+00  -3.684  0.00023 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1
```

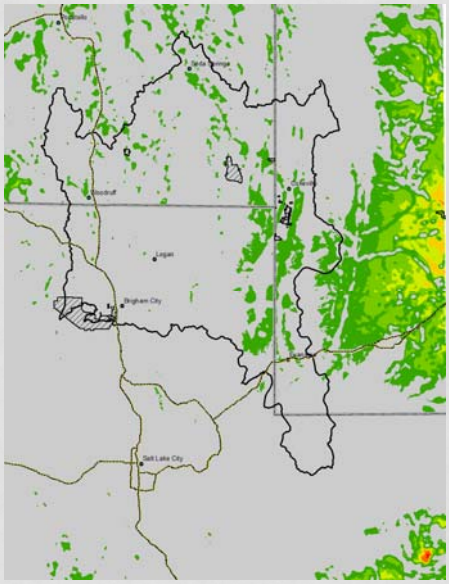
Sage Thrasher Model Validation

- Model Goodness of Fit:
  - Chi-squared test
- How well does the model predict? 2 tests

Year	Method	RMSE	MAE
2001	Observed vs Predicted	0.51	0.19
2000	10-fold cross validation	0.34	

- What does this mean?
  - Large errors in predictions did not occur.
  - Average difference between predicted and observed SATH was 0.19 in 2001
- Spatial Autocorrelation

Sage Thrasher Density in the BRWCA



NB Regression Model using BBS data from 2000

Sage Thrashers per 1.75 mi^2

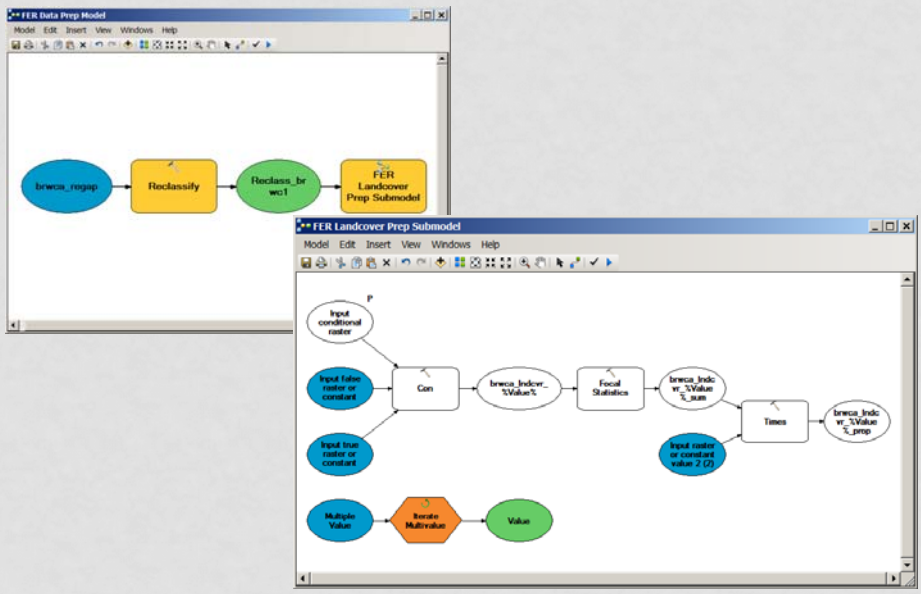
- 0
- 1
- 2
- 3
- 4
- 5
- 6

Citations

Burnham, K. P., & Anderson, D. R. (2002). ***Model selection and multi-model inference: a practical information-theoretic approach***. Springer.

Niemuth, N. D., Estey, M. E., & Loesch, C. R. (2002). Developing spatially explicit habitat models for grassland bird conservation planning in the Prairie Pothole Region of North Dakota. In ***Bird conservation implementation and integration in the Americas: Proceedings of the Third International Partners in Flight conference*** (pp. 469-477).

ModelBuilder Exercise: Data Prep

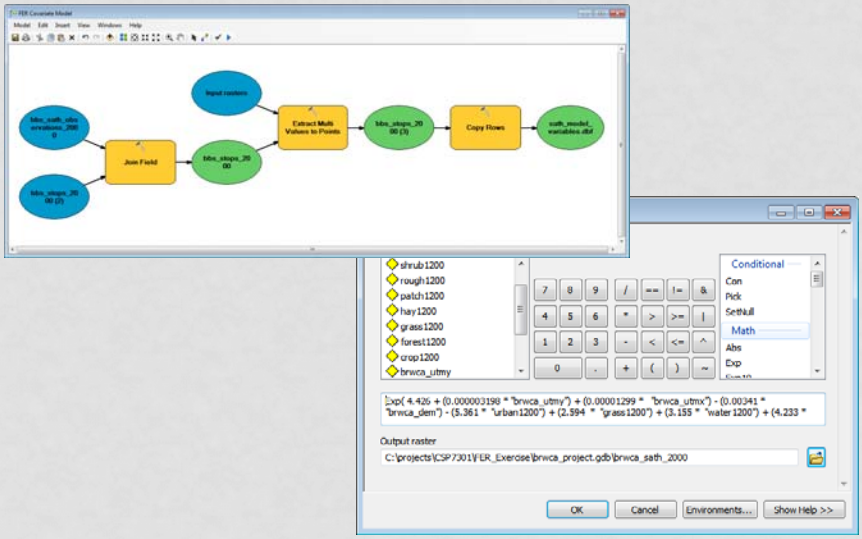


ModelBuilder Exercise: Data Prep

Objectives:

- **Use iterators in ModelBuilder**
- **Use nested/sub models in ModelBuilder**
- **Apply in-line variable substitution in ModelBuilder**

ModelBuilder Exercise: SATH Abundance



ModelBuilder Exercise: SATH Abundance

Objectives:

- **Use ModelBuilder to create resource variables for data analysis in R**
- **Use fixed-effects regression approach in R to estimate relative abundance**
- **Create raster predictive map from estimated generalized linear model coefficients**