Identifying Sensitive Species

A Noble Application of Big Data

Robert Howe and collaborators
University of Wisconsin-Green Bay

17 April 2018

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Summary

Premises:

- Most bird species are sensitive to habitat degradation.
- Some species are more sensitive than others.
- Sensitive species are absent or rare in degraded habitats.
- Large data sets provide opportunities for quantifying species' sensitivities.

Conclusions/Applications:

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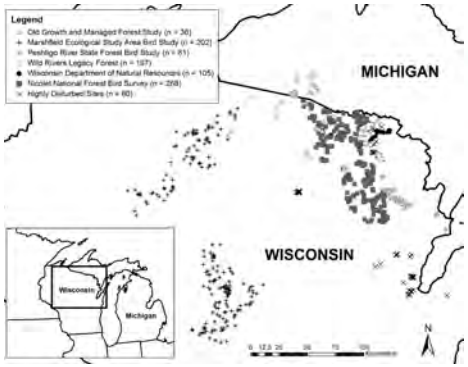
Gnass Giese et al. (2015)



esa ECOSPHERE

Sensitivity of breeding birds to the "human footprint" in western Great Lakes forest landscapes

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[3]*The Nature Conservancy, Madison, Wisconsin 53703 USA*

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Abstract. Breeding birds in forest ecosystems are generally diverse, habitat selective, and easily sampled. Because they must integrate environmental variables over space and time, local populations of forest birds (like other animal and plant taxa) may provide meaningful signals of local forest health or degradation. We evaluated 949 breeding bird surveys in areas ranging from degraded urban/suburban forest remnants to relatively pristine old growth forests in the western Laurentian Great Lakes region of North America. The "human footprint" across this landscape was represented by a one-dimensional numeric gradient derived from land cover variables, forest fragmentation metrics, and publicly available data on housing density and transportation corridors. We used an iterative, maximum likelihood approach to quantify species-specific responses to this human disturbance gradient. Many species showed significant directional responses, consistent with known life history attributes. Other species were most commonly detected at intermediate levels of anthropogenic disturbance, yielding unimodal responses. Relationships between the "human footprint" and occurrences of 38 bird species were illustrated by general Gaussian functions that represented both unidirectional and unimodal patterns. These biotic response (BR) functions were combined into a bird-based index of ecological condition (IEC) ranging from 0 (maximally degraded) to 10 (minimally degraded). We described a successful application of the IEC method at the Wild Rivers Legacy Forest (WRLF), a >260 km^2 conservation landscape in northeastern Wisconsin, USA, managed primarily under a working forest conservation easement established in 2006. In general, areas within the WRLF yielded high IEC values (7.0–9.0), but nearby forest areas not under the conservation easement were characterized by significantly lower IEC values based on breeding bird assemblages.

Key words: bird assemblage; disturbance gradient; ecological indicator; forestry management; northern mesic forest; western Great Lakes (USA).

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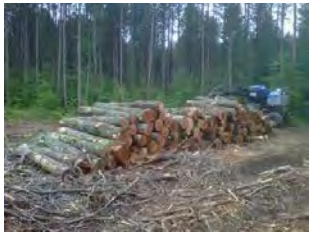
Wild Rivers Legacy Forest



The Nature Conservancy

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Wisconsin

Wild Rivers Legacy Forest

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At more than 64,600 acres, The Wild Rivers Legacy Forest is exceptionally rich in diversity.

About Visit Comments

A project of the Wisconsin Department of Natural Resources, Conservation Forestry LLC, Forest Investment Associates and The Nature Conservancy

WHY YOU SHOULD VISIT

More than 14 miles of two Wild Rivers—the Pine and the Popple—flow through the Wild Rivers Legacy Forest. The property also contains one of the finest remaining wild lakes complexes in Wisconsin, composed of Savage, Dorothy, Mud and Robago lakes. Sugar maple, basswood, hemlock and yellow birch trees preside over a forest understory of maidenhair ferns, club mosses and great white trillium. Wildlife, including bears, flying squirrels and porcupines, is abundant.

OPEN TO THE PUBLIC

Yes

THINGS TO DO

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GET DIRECTIONS

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Sensitivity of Wisconsin Forest Birds

Which species are sensitive to forest habitat loss/degradation?

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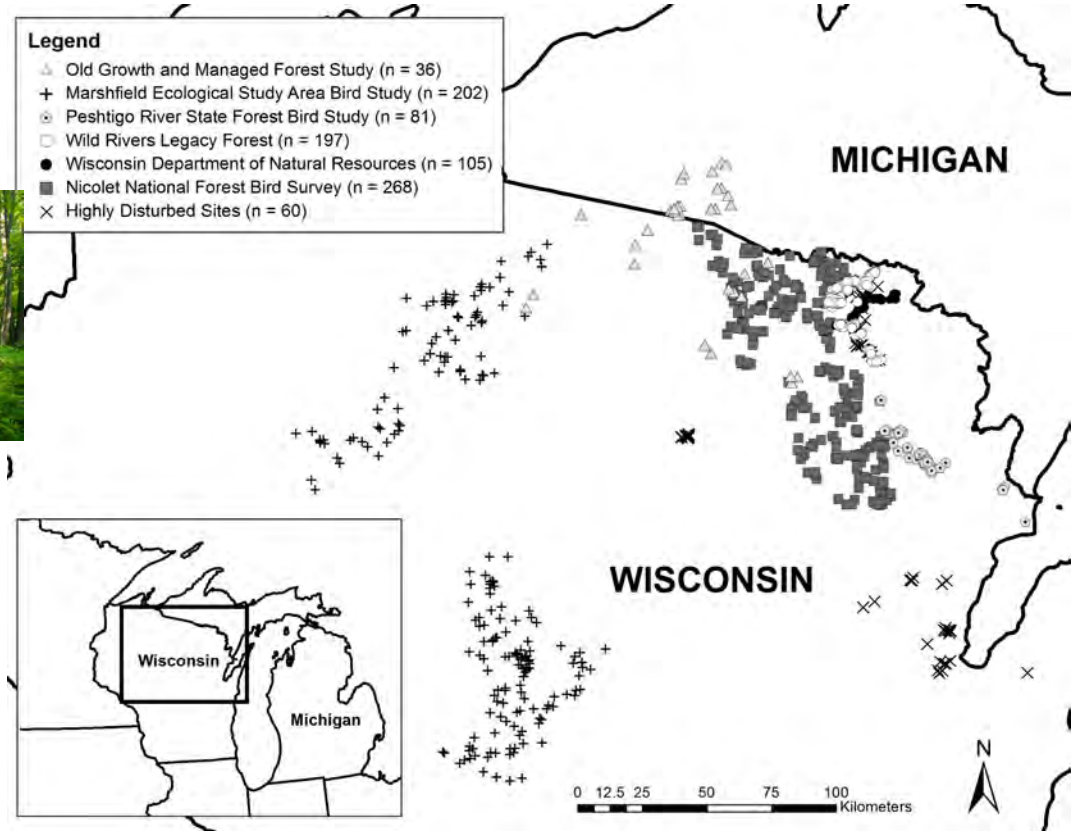
Sensitivity of Wisconsin Forest Birds



949 points sampled with same field method (10 minute point count)

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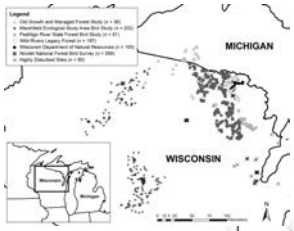
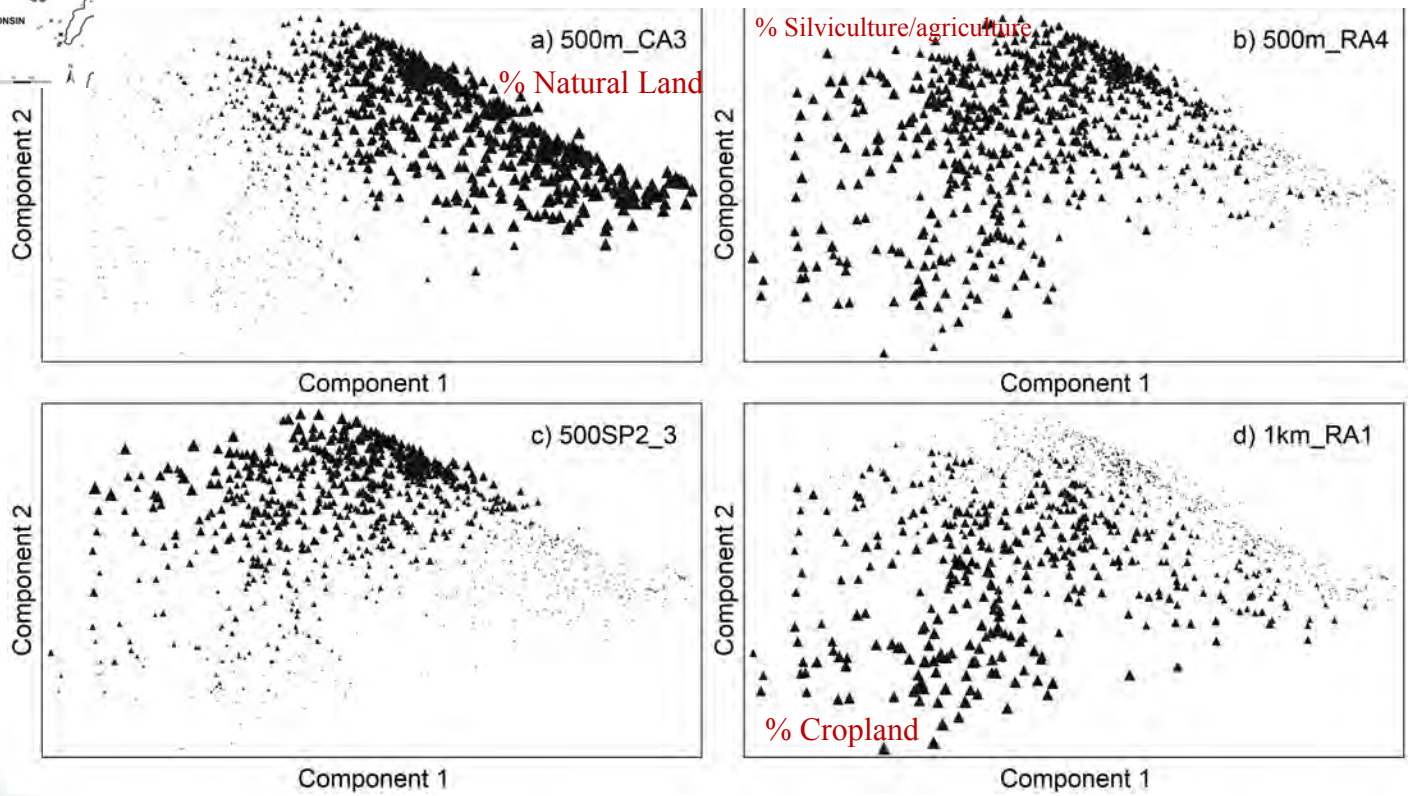
Sensitivity of Wisconsin Forest Birds





Variables are combined into a single "human footprint" gradient

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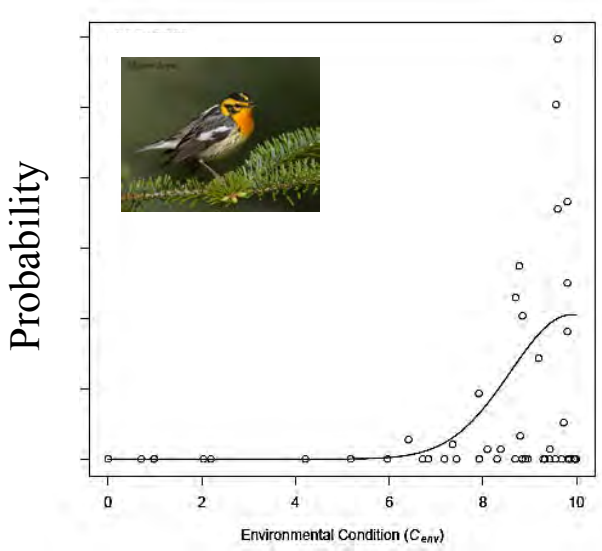
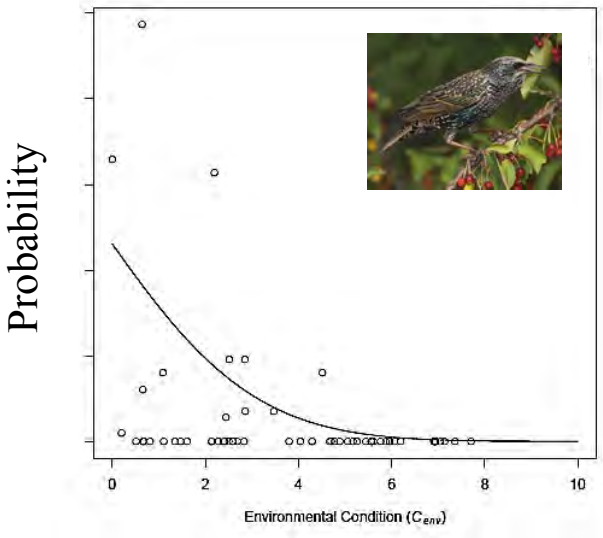
Species (Biotic) Response Functions

Species A



Species B



Frequency (probability) of occurrence is plotted across the “human footprint” gradient

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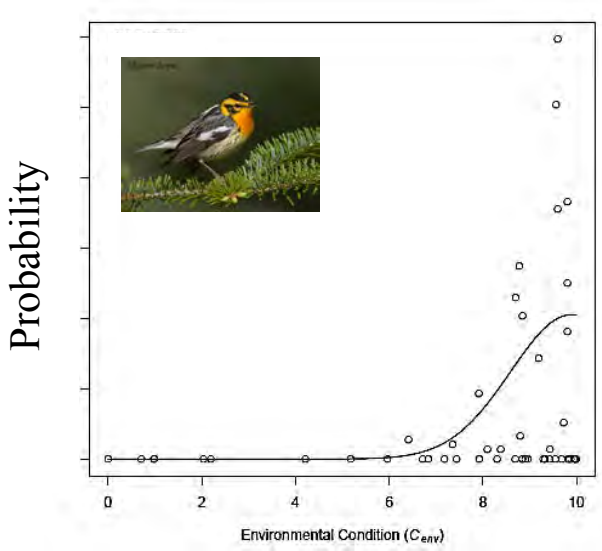
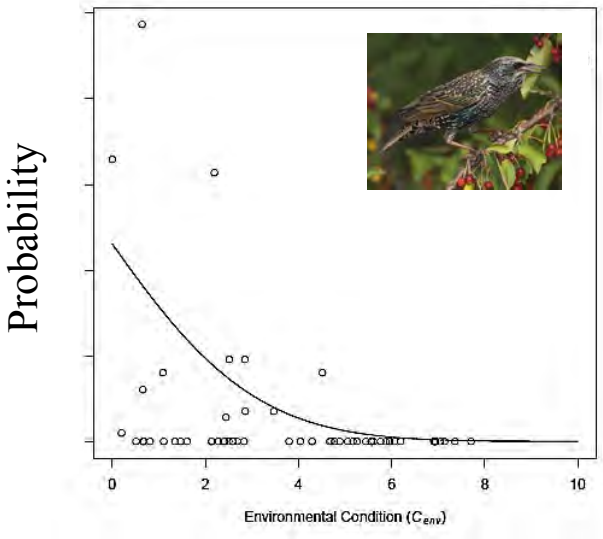
Species (Biotic) Response Functions

Species A



Species B



These responses can be described by a 3 parameter function (μ, σ, h).

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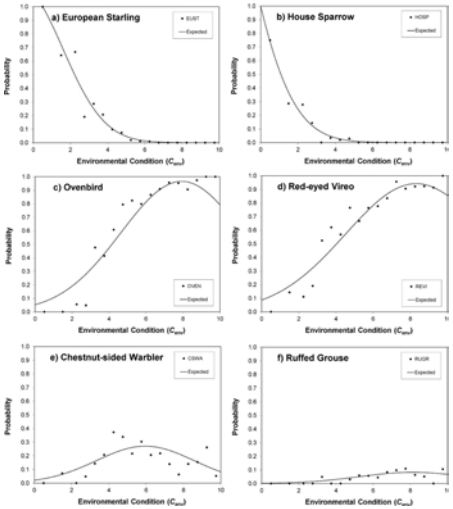
Species (Biotic) Response Functions

Common Name	Scientific Name	μ	σ	h	LOF	P_{diff}†	R^2‡
European Starling	*Sturnus vulgaris*	-0.64	2.23	6.37	0.32	1.00	0.95
House Sparrow	*Passer domesticus*	-3.97	2.67	20.22	0.19	1.00	0.97
Ovenbird	*Seiurus aurocapilla*	7.93	3.29	7.96	1.45	0.91	0.91
Red-eyed Vireo	*Vireo olivaceus*	8.32	3.81	8.99	0.85	0.86	0.92
Common Grackle	*Quiscalus quiscula*	-10.00	5.89	50.36	1.60	0.80	0.78
Mourning Dove	*Zenaida macroura*	-10.00	8.59	30.07	1.63	0.62	0.63
Black-throated Green Warbler	*Setophaga virens*	8.38	2.24	3.38	0.30	0.60	0.96
American Crow	*Corvus brachyrhynchos*	1.86	4.37	7.74	1.36	0.58	0.74
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	8.01	2.90	4.08	0.34	0.55	0.93
Yellow-bellied Sapsucker	*Sphyrapicus varius*	8.40	2.27	2.92	0.24	0.51	0.95
Hermit Thrush	*Catharus guttatus*	7.80	2.58	2.88	0.68	0.44	0.81
Least Flycatcher	*Empidonax minimus*	20.00	6.49	23.76	0.25	0.43	0.94
Blackburnian Warbler	*Setophaga fusca*	9.35	2.30	2.08	0.18	0.36	0.93
Mourning Warbler	*Geothlypis philadelphia*	8.82	2.82	2.44	0.67	0.34	0.74



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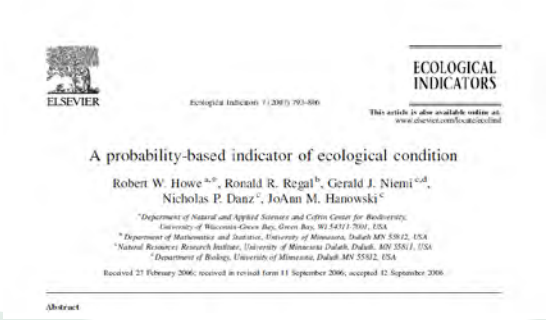
INDEX OF ECOLOGICAL CONDITION (IEC)

A quantitative indicator based on explicit stress-response relationships

1. **Define an environmental reference gradient (stressor)**
   - Scale from 0 (poorest condition) to 10 (best or ideal condition)
2. **Quantify species' responses to the gradient (3 parameter function)**
   - Estimate parameters for each species
3. **Given the species' functions, estimate IEC values for new sites**
   - Use maximum likelihood algorithm based on biotic response functions
   - IEC value ranges from 0 (poorest condition) to 10 (best condition), similar to reference gradient


ELSEVIER

ECOLOGICAL INDICATORS

A probability-based indicator of ecological condition

Robert W. Howe [a,*], Ronald R. Regal [b], Gerald J. Niemi [c,d], Nicholas P. Danz [c], JoAnn M. Hanowski [c]

Received 27 February 2006; received in revised form 11 September 2006; accepted 12 September 2006

Abstract

$$\sum_{i=1}^{M} \log\left(P_i(C)\right) + \sum_{i=1}^{N} \log\left(1 - P_i(C)\right)$$

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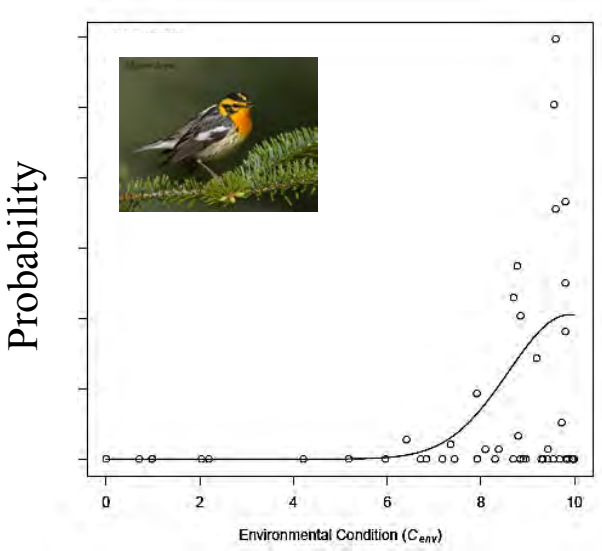
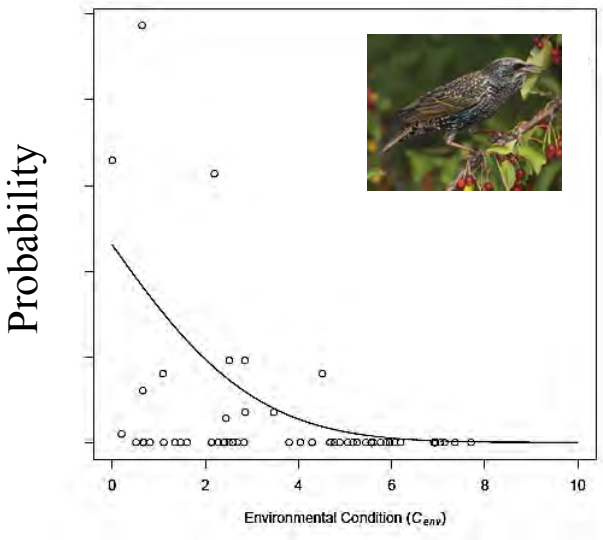
Estimating IEC Values

Species A



Species B



Presence/abundance of Species A will contribute to higher IEC.

Presence/abundance of Species B will contribute to lower IEC.

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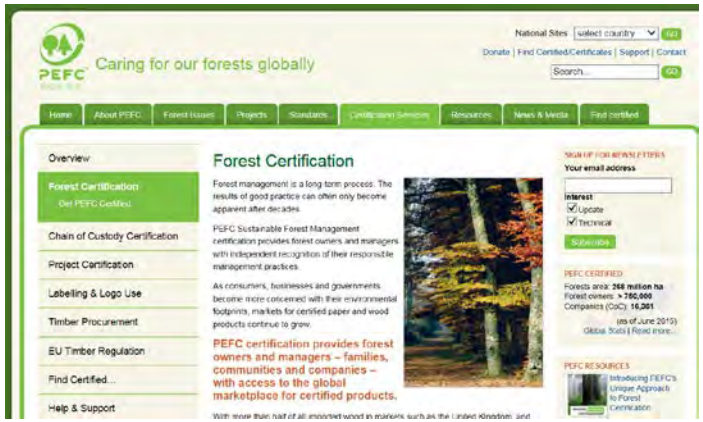
Why Measure Ecosystem Health?

Set conservation targets

Identify priorities

Assess outcomes

Protect critical sites



Promote sustainable resource use

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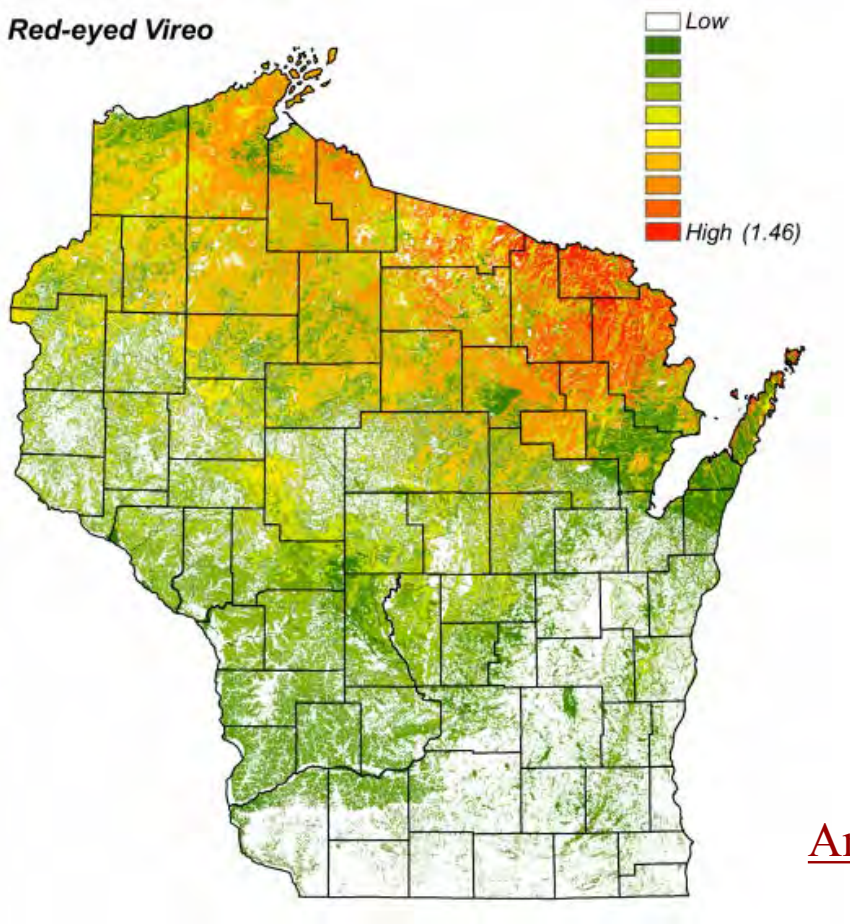
Opportunities from Big Data



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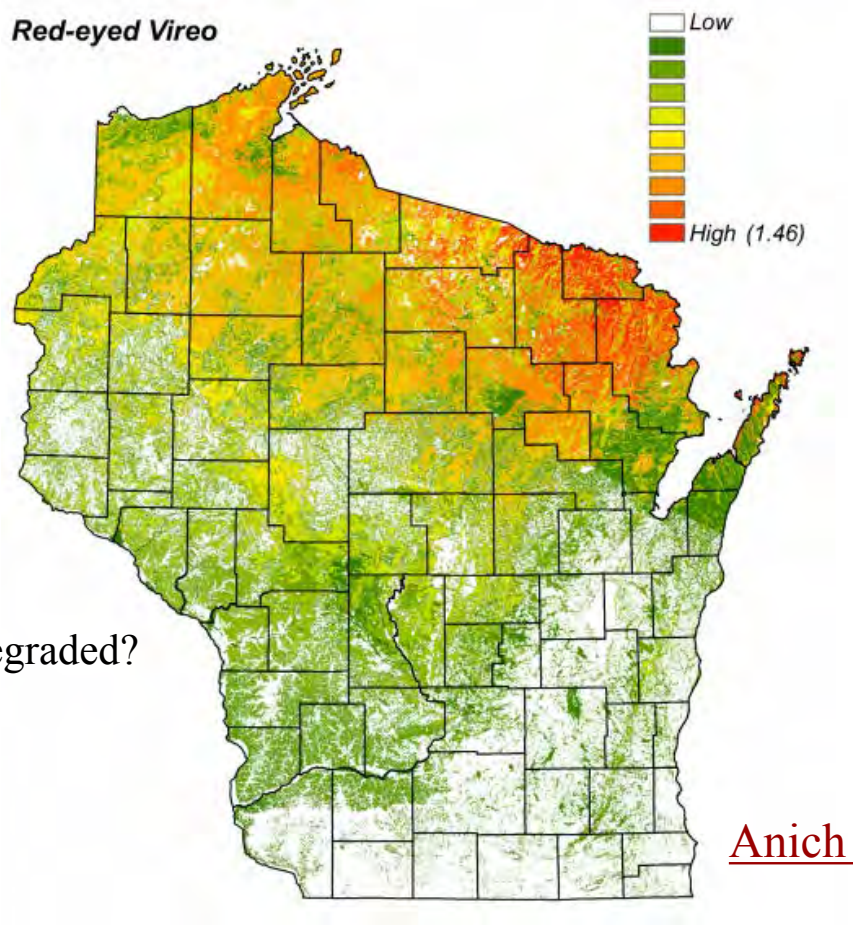

Which points are minimally degraded?

Which points are degraded?

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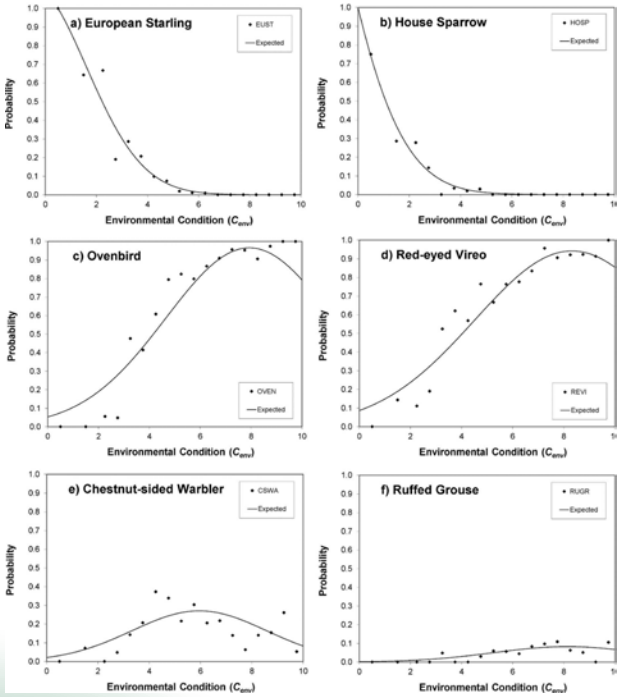
Opportunities from Big Data

Create a “toolbox” of species’ responses to habitat/landscape degradation.



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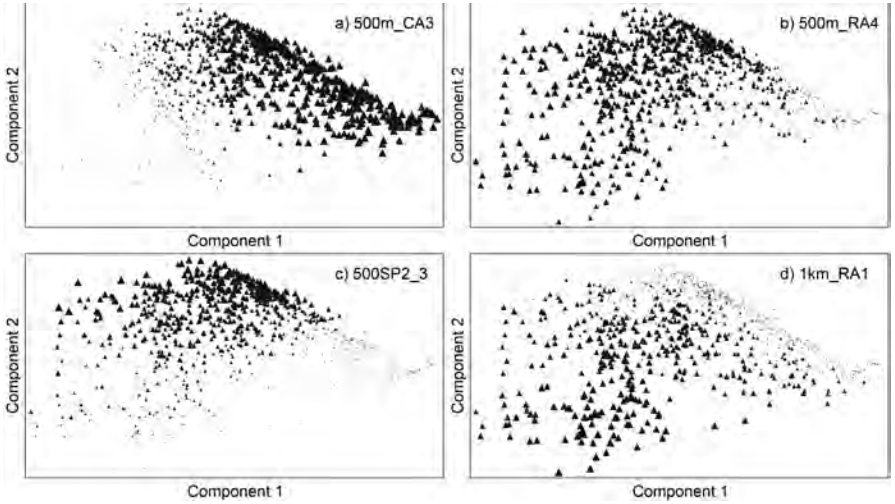
What about the gradient?



Specific stressors or specific regions may be of interest.

Geographic coverage

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