

Birds as Indicators of Success for Floodplain Restoration in Sierra Meadows

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Problem

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- Functional meadows provide many services, but most Sierra Nevada meadows are degraded
- On the bright side, restoration activities are increasing
- However, conflicting information on effectiveness

Objectives

- 1) Evaluate the effectiveness of pond-and plug restoration using birds as indicators of restoration success
- 2) Improve restoration outcomes for birds



Hypothesis

- 1) If hydrologic restoration creates bird habitat, bird abundance should increase over time



Hypothesis

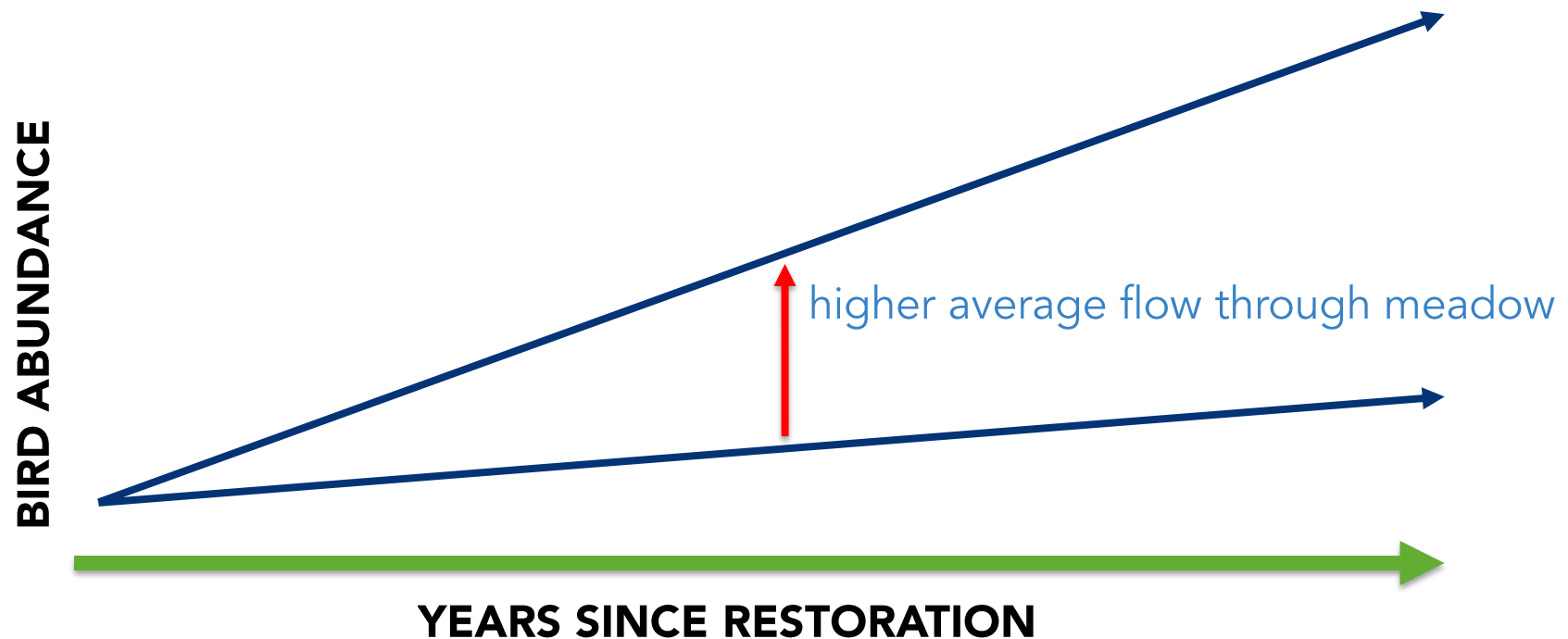
1a) $N \sim \text{Time Since Restoration}$



Hypothesis

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1b) $N \sim \text{Time} \times \text{Flow}$



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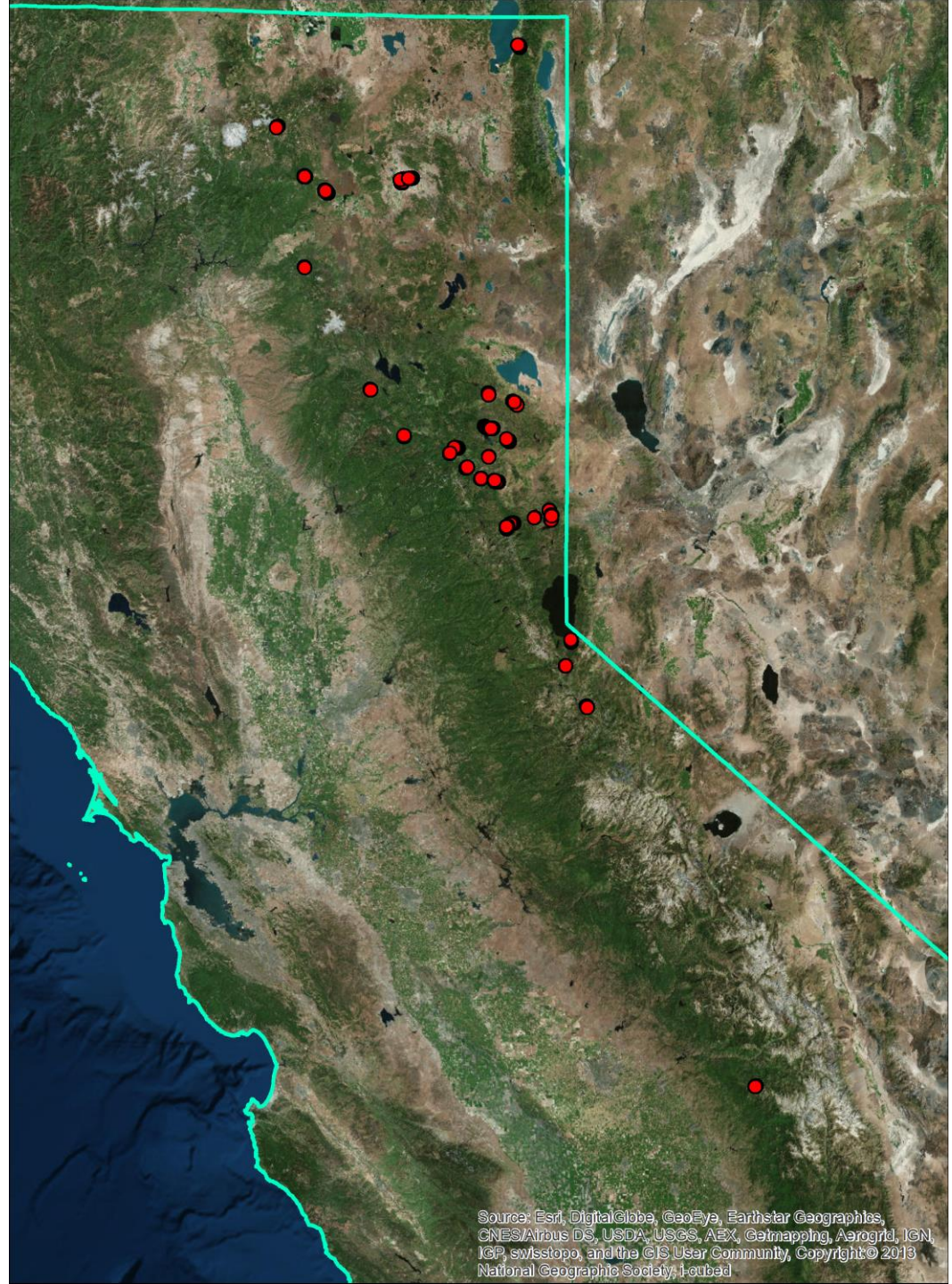
1b) $N \sim \text{Time} \times \text{Flow}$

1c) $N \sim \text{Time} \times \text{Pre-Restoration Condition (NDVI)}$



Sample

- 32 riparian meadow restoration sites
- restored 1999-2015
- 1426 point count visits from 2003 to 2017
- 1-18 years after restoration
- time series data



Focal Species

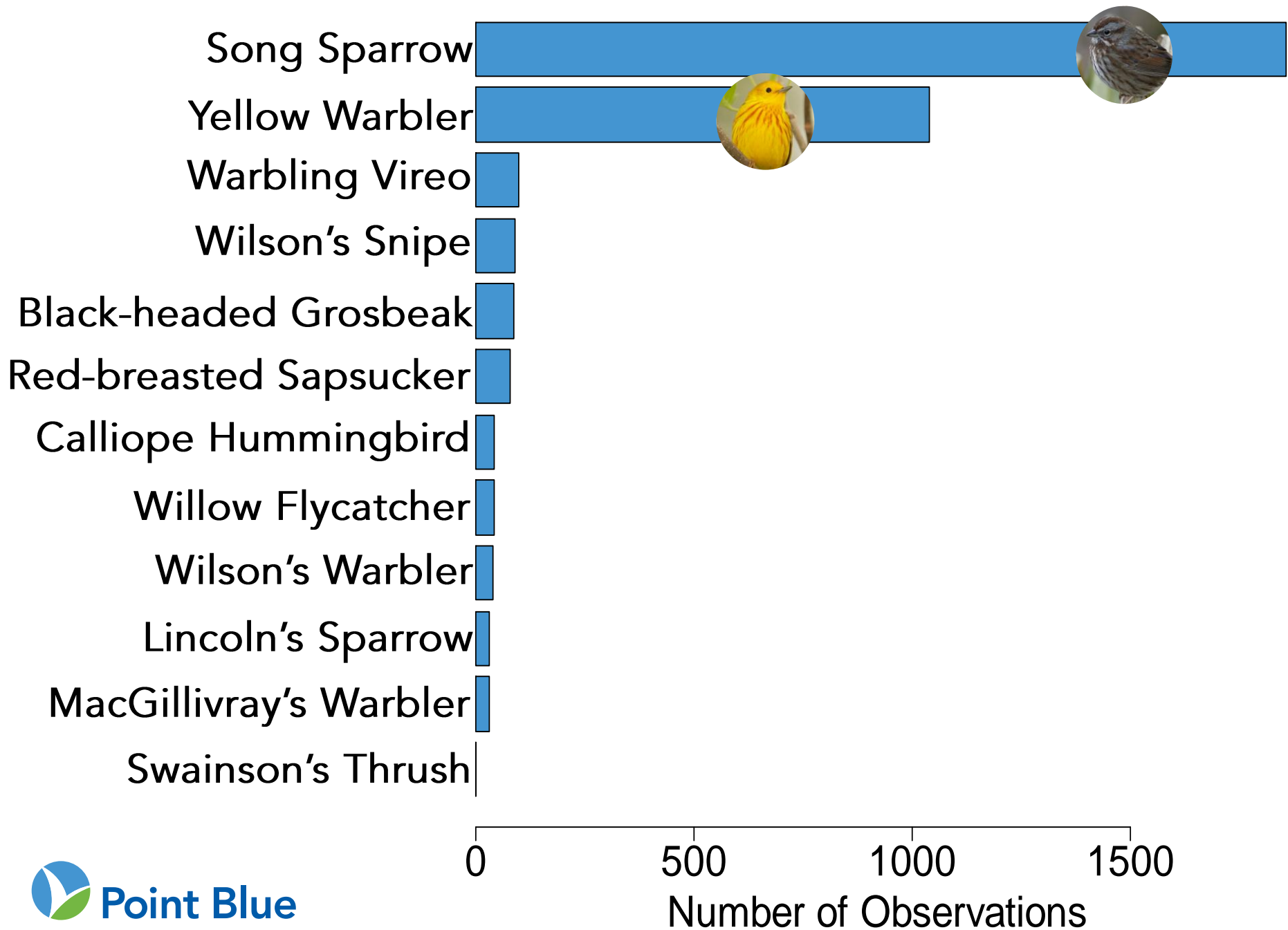


strong association with healthy meadows and riparian habitat at a range of elevations and regions



appropriately surveyed with passive point count methods





Analysis

- Generalized linear mixed models (lme4 package)

count ~ *time* + *flow* + *NDVI* + *hydrology* + *climate*

count ~ *time* × *flow* + *NDVI* + *hydrology* + *climate*

count ~ *time* × *NDVI* + *flow* + *hydrology* + *climate*

- Basin Characterization Model (1981-2010)

- Runoff + Recharge (flow)
- Watershed area
- Average annual precipitation in upstream watershed
- Percent of annual precipitation stored as April 1 snowpack
- Average Jun/Jul/Aug maximum daily temperature in meadow

- NDVI from LANDSAT August images for the 10 years before restoration (Google Earth Engine / Climate Engine)

Focal Species per Acre

Years Since Restoration

average flow

Variable	Estimate	P value
Time	0.135	0.001
Flow	0.272	0.030
NDVI	0.212	0.000
Time x Flow	-0.061	0.053

Focal Species per Acre

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low flow

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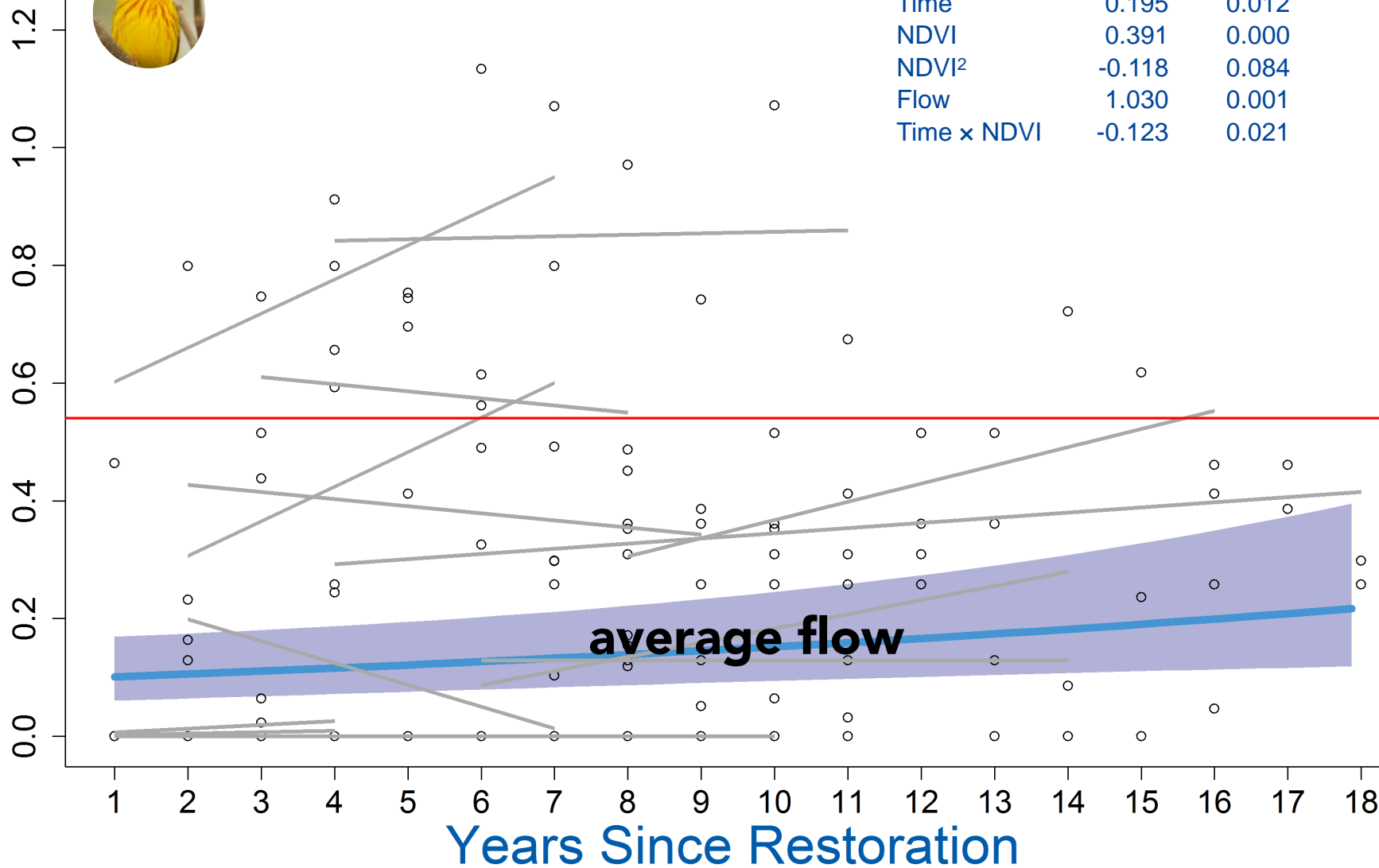
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Yellow Warblers per Acre



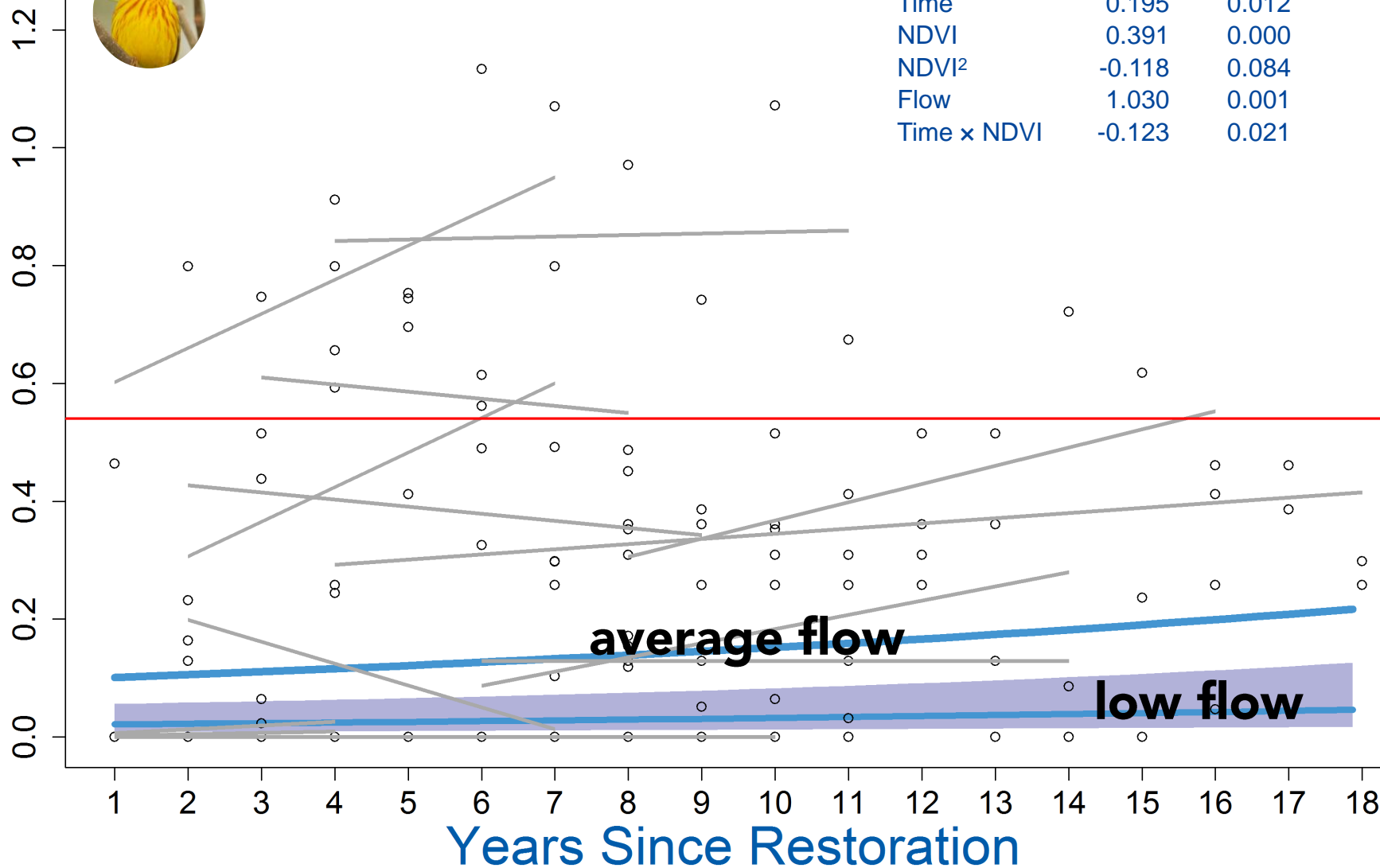
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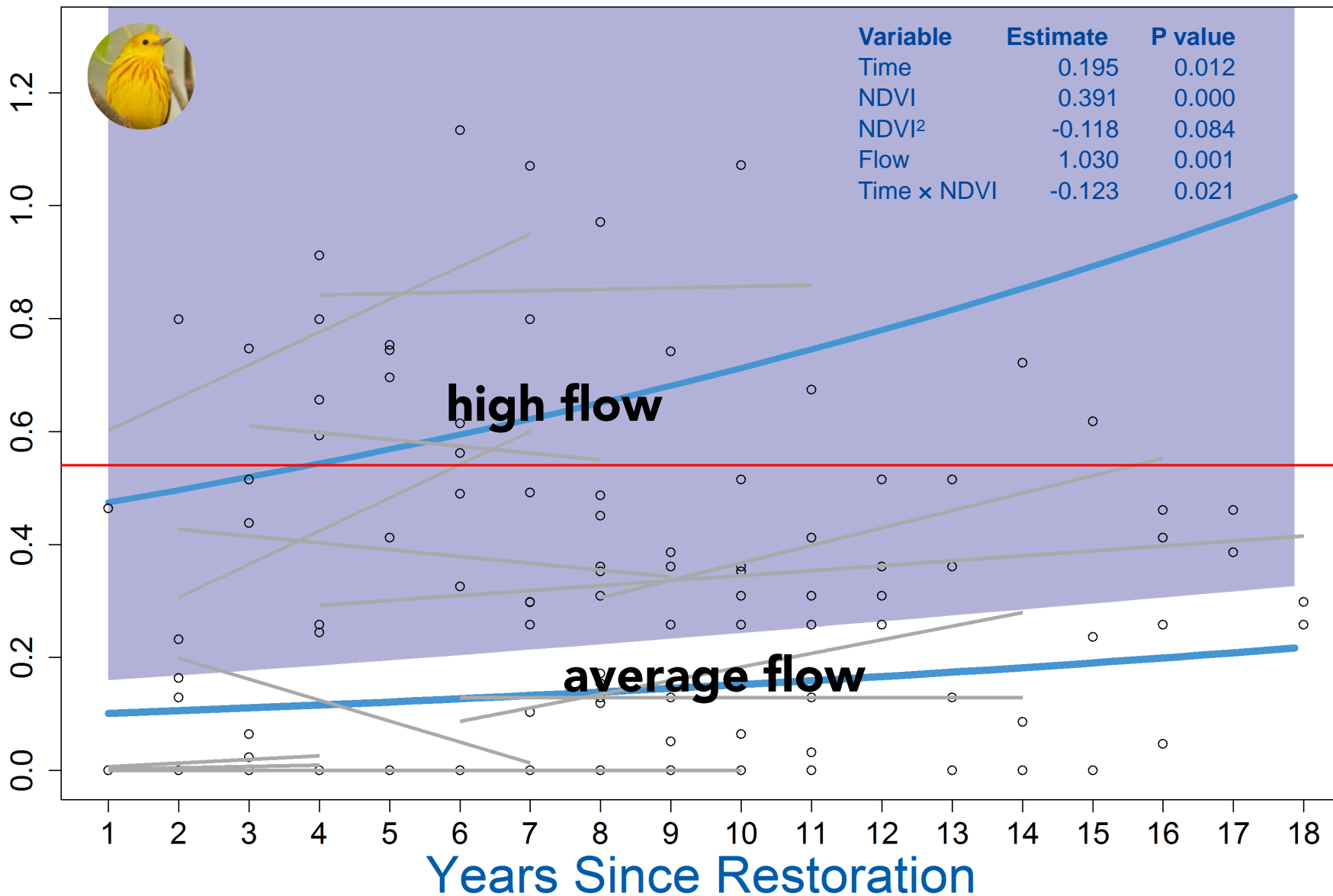
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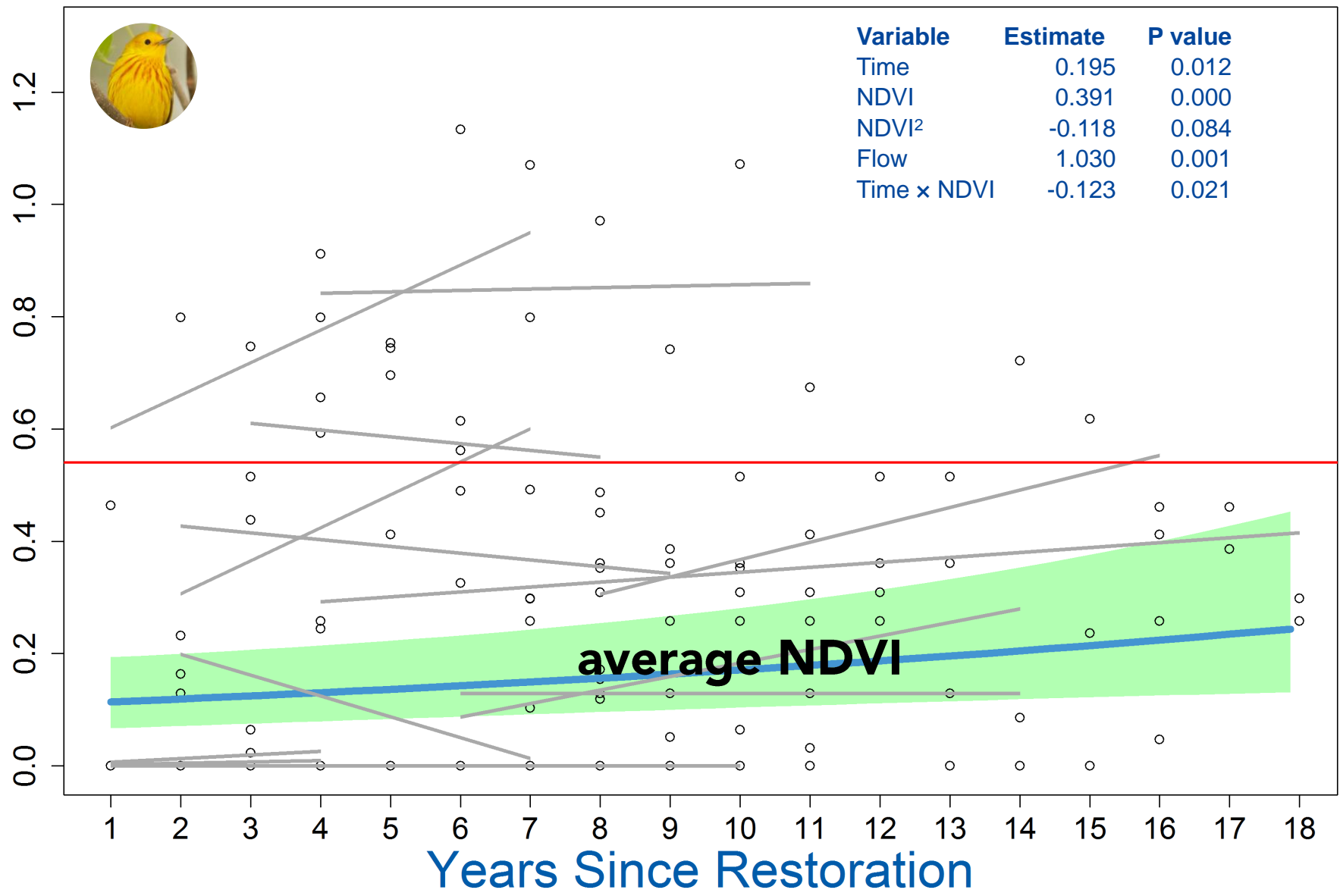
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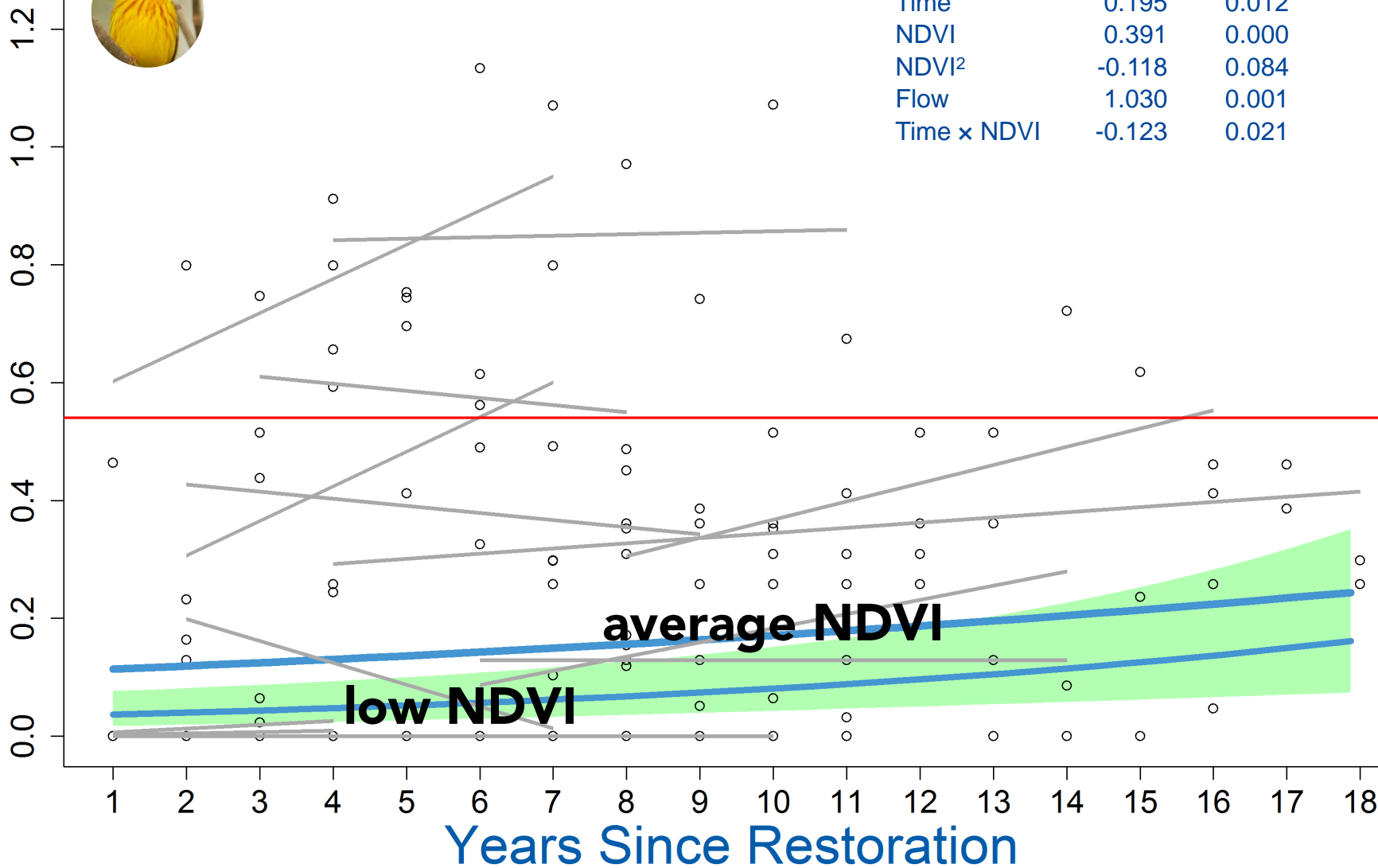
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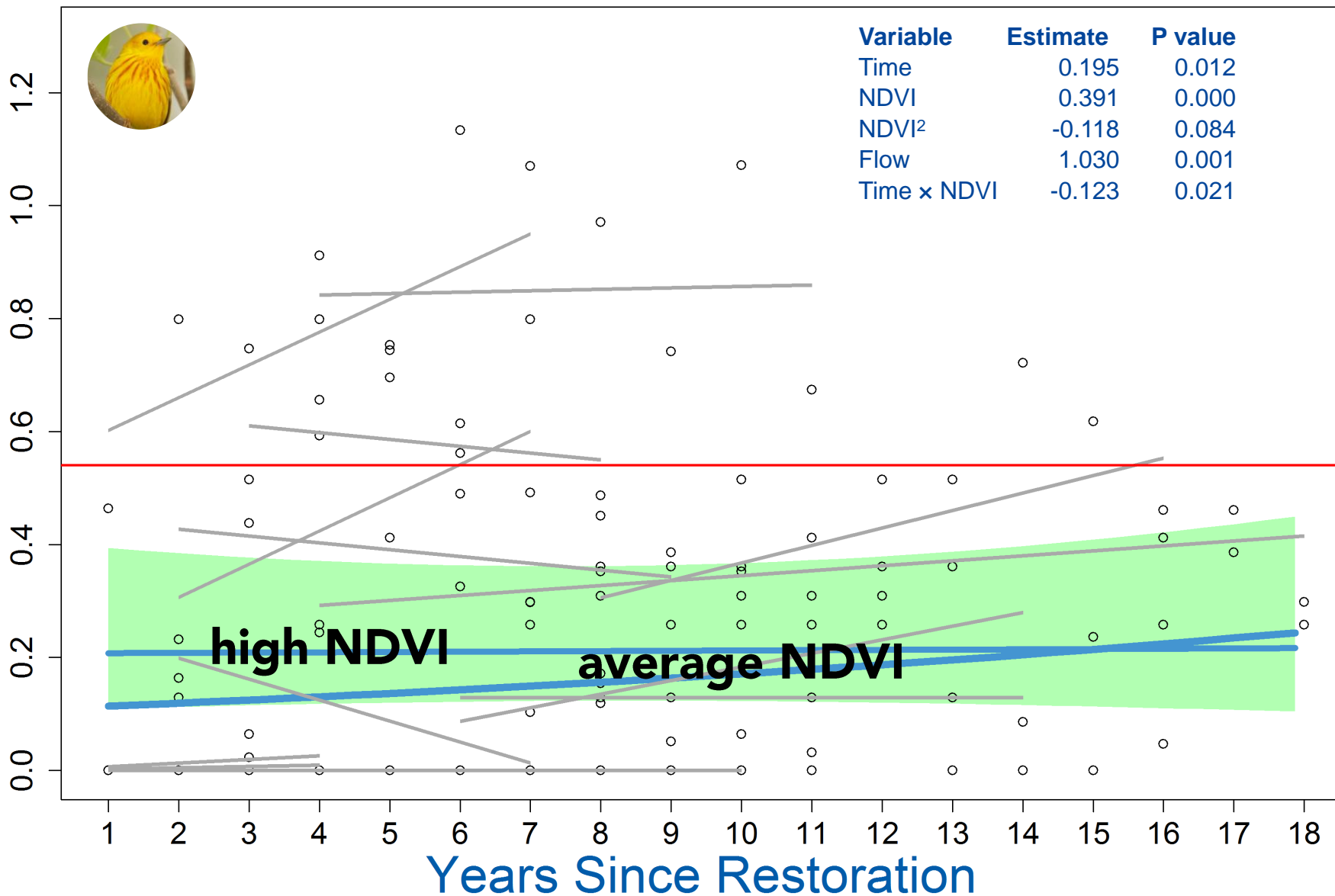
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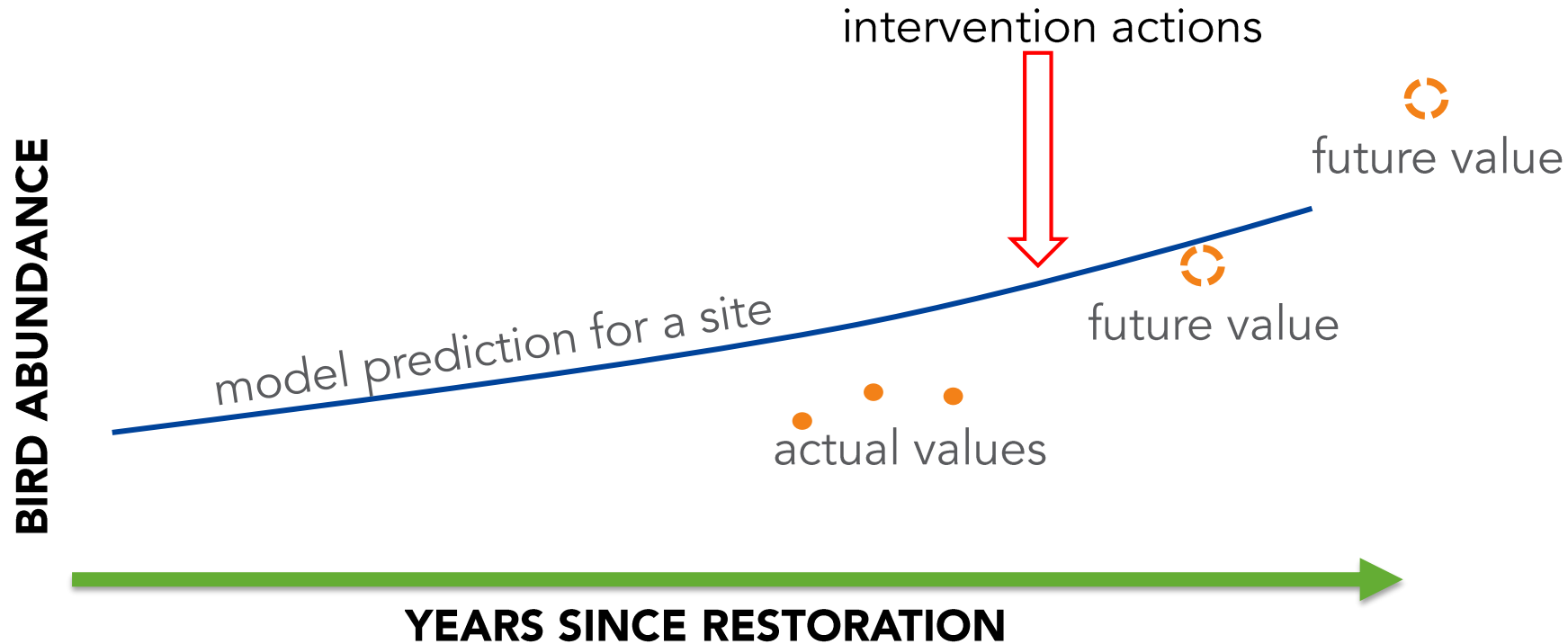
Summary

- Modest increases in bird abundance and species richness over time
- Room for improvement in restoration outcomes
- Meadows with high flows result in higher abundances, but not always a steeper response
- Pre-restoration NDVI may reflect pre-restoration condition as well as future potential for bird habitat
- Yellow Warbler and Song Sparrow are largely driving species richness response

Implications for Meadow Restoration

- Prioritization based on responses of desired bird species
- Plant more riparian shrubs
- Need for long-term stewardship
- Grazing management

Improving Restoration Outcomes



This work would not have been possible
without

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THANK YOU

Photo: Ryan DiGaudio / Point Blue