Ecosystem Response to a Whole-Reservoir Coarse Woody Habitat Addition

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Reservoir Aging

River inflow

↓

High nutrient and sediment loads

↓

Sedimentation
Eutrophication
Increased turbidity

→

Habitat Degradation

-Reduced substrate heterogeneity
-Increased algal productivity
-Limited littoral vegetation growth

Habitat Degradation

Standing timber removed during reservoir construction → Remaining woody debris decays over time, slow rates of natural replacement

PROBLEM : Lack of physical structure that fish use for refuge, foraging, nursery habitat, and reproduction

Habitat Enhancements

Natural or man-made structures intentionally placed in an aquatic environment

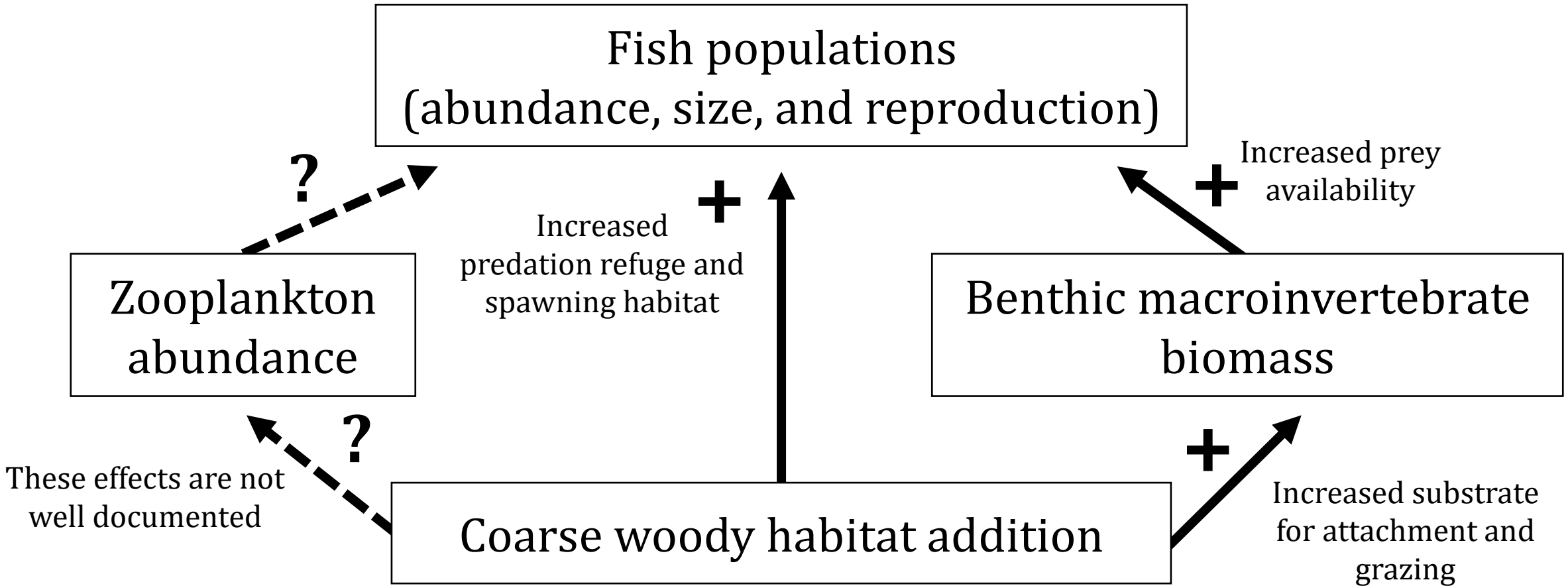
- Maintain ecosystem function by improving degraded habitat
- Reduce physical effects caused by reservoir aging

Management goals

- Aggregate fish to increase angler catch rates
- Provide refuge and nursery habitat for juvenile fish
- Increase fish production?

Objective

To test whether the addition of trees along an entire reservoir's shoreline has a positive, bottom-up effect on zooplankton abundance, macroinvertebrate biomass, and fish abundance, size, and reproduction



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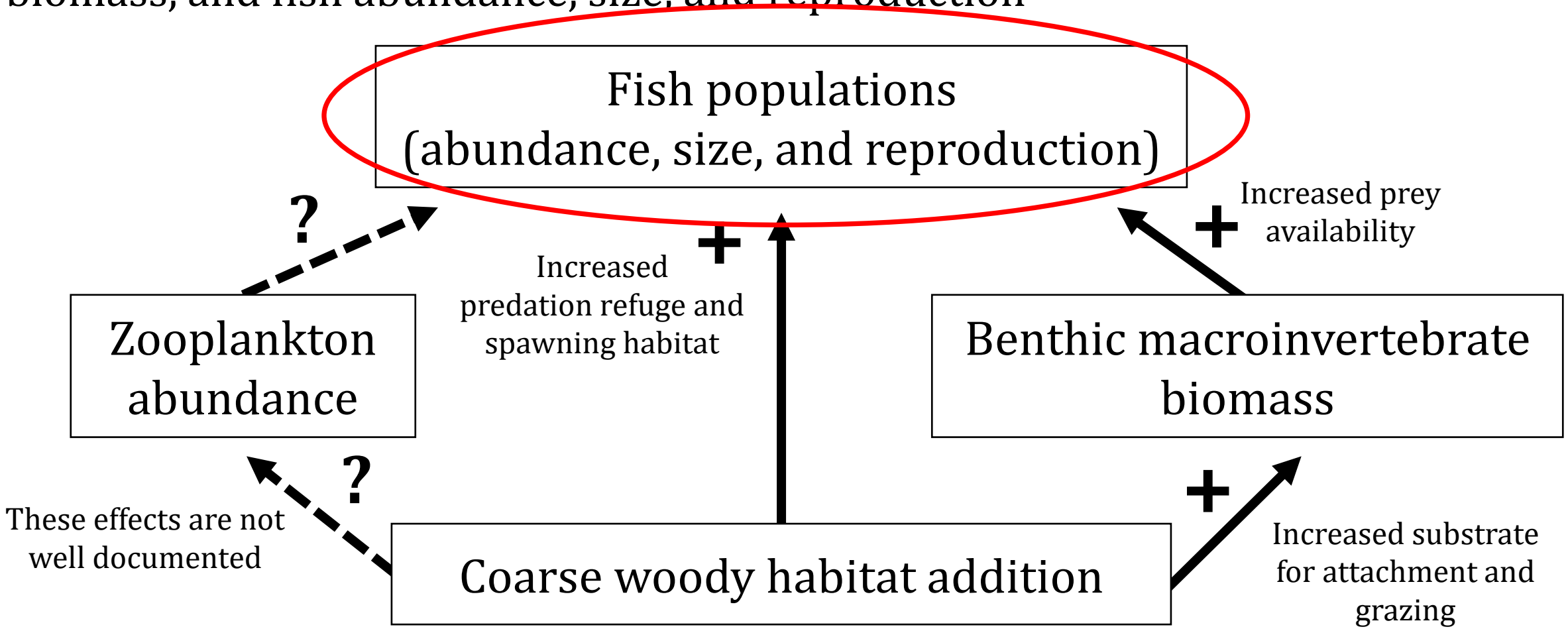
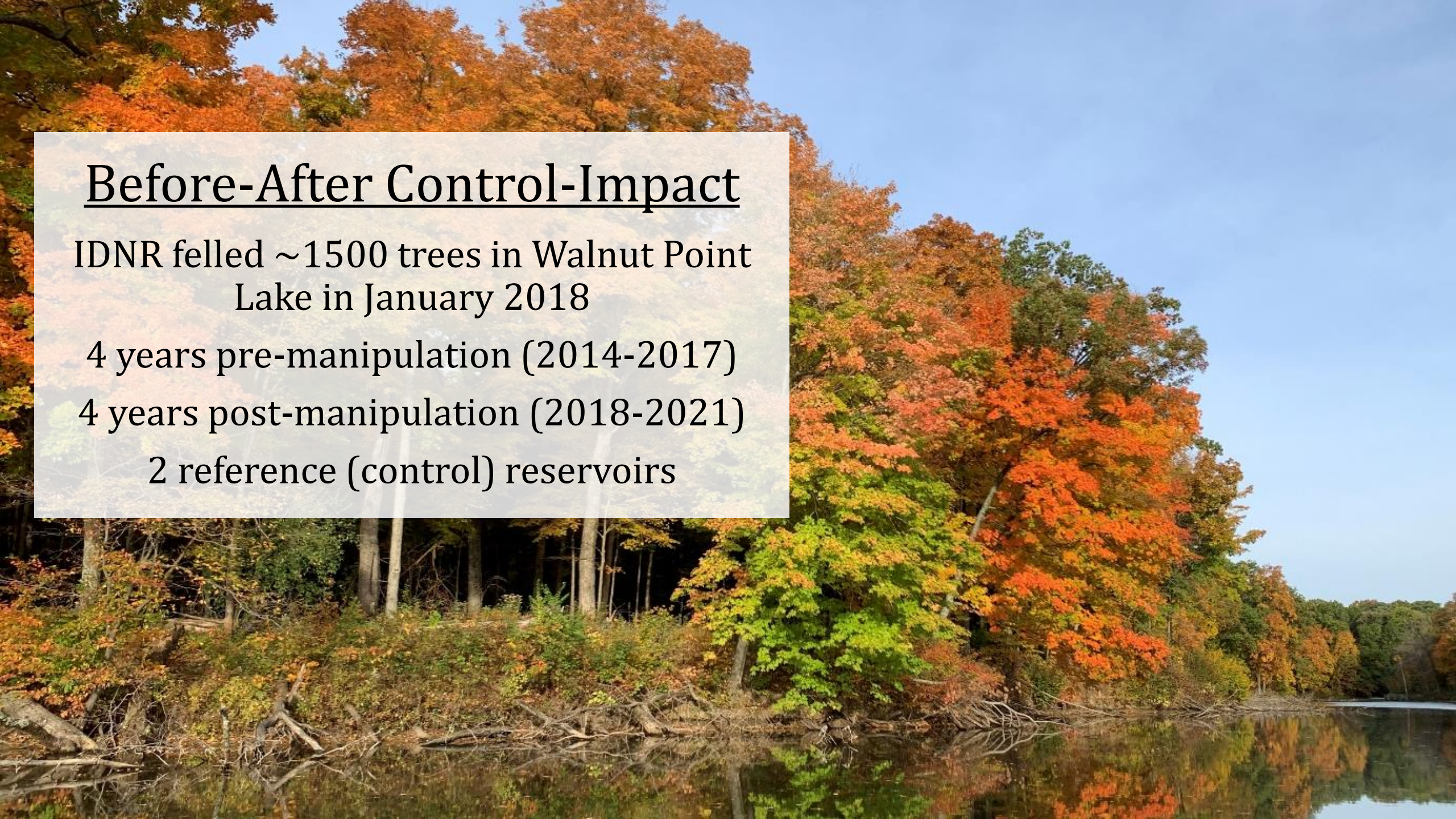




Before-After Control-Impact

IDNR felled ~1500 trees in Walnut Point Lake in January 2018

4 years pre-manipulation (2014-2017)

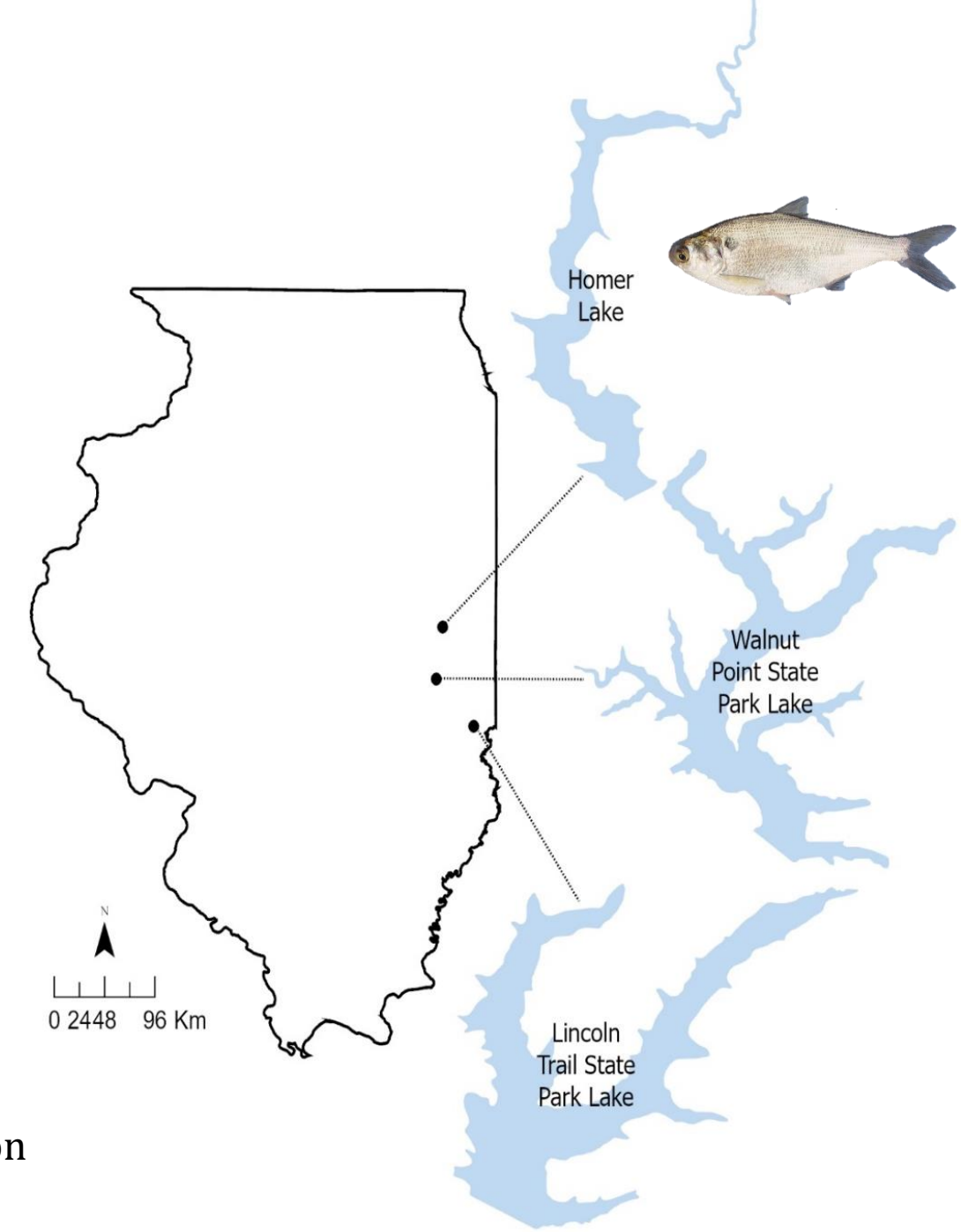
4 years post-manipulation (2018-2021)

2 reference (control) reservoirs

Study Sites

Characteristic	Walnut Point	Lincoln Trail	Homer
	Treatment	Reference	Reference
Area (ha)	21	55	33
Shoreline length (km)	9	8.7	8.5
Mean depth (m)	3.8	4.9	2.5
Maximum depth (m)	9.8	10.7	7.3
Mean Secchi depth (m)	1.5	2.0	0.7
Tree density (log/km)	14.4	14.9	6.6
Post-Tree Density (log/km)	166.7	---	---

*Similar trophic status, sampling history, fish species composition

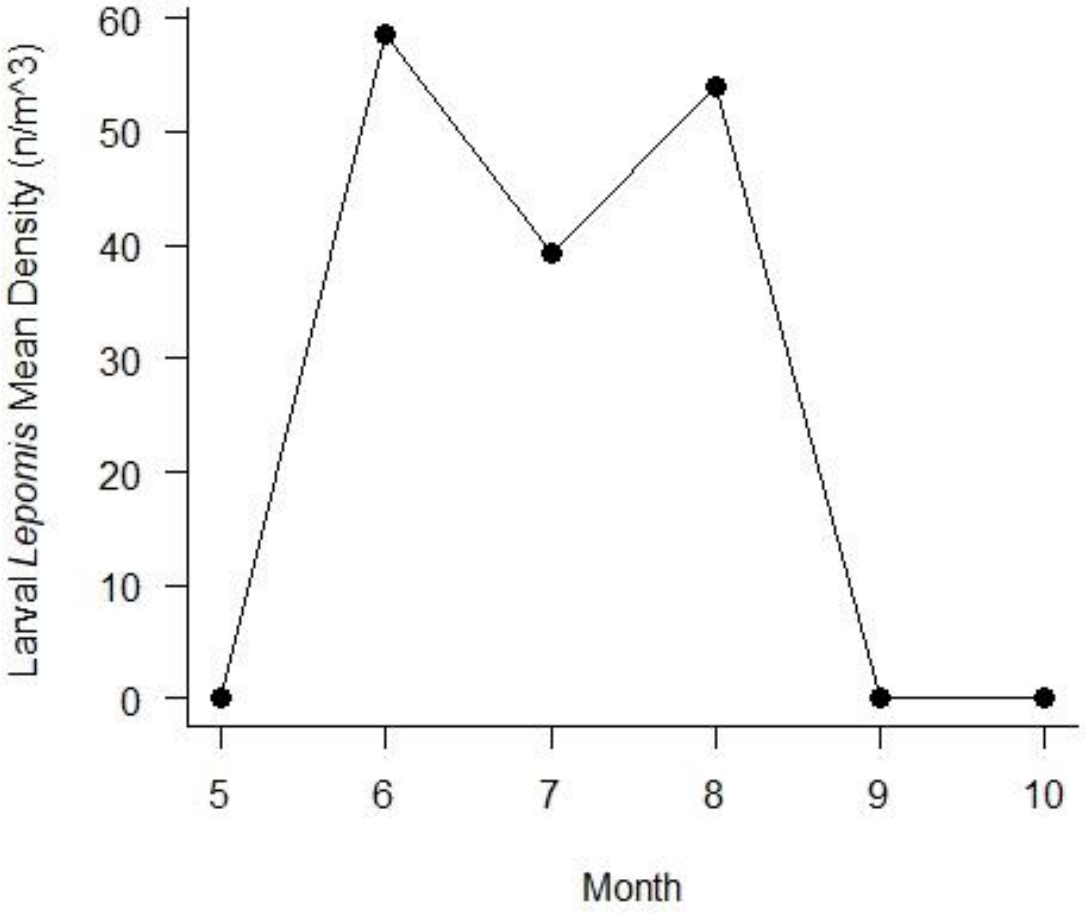


Larval Fish Collection

Response Metric:

Larval *Lepomis* Mean Density (n/m^3)

Area Under the Curve (AUC)



Annual sampling 2014-2021

Six, 5-min bow-mounted push net transects

May | **June** | **July**

August | **Sept** | **October**

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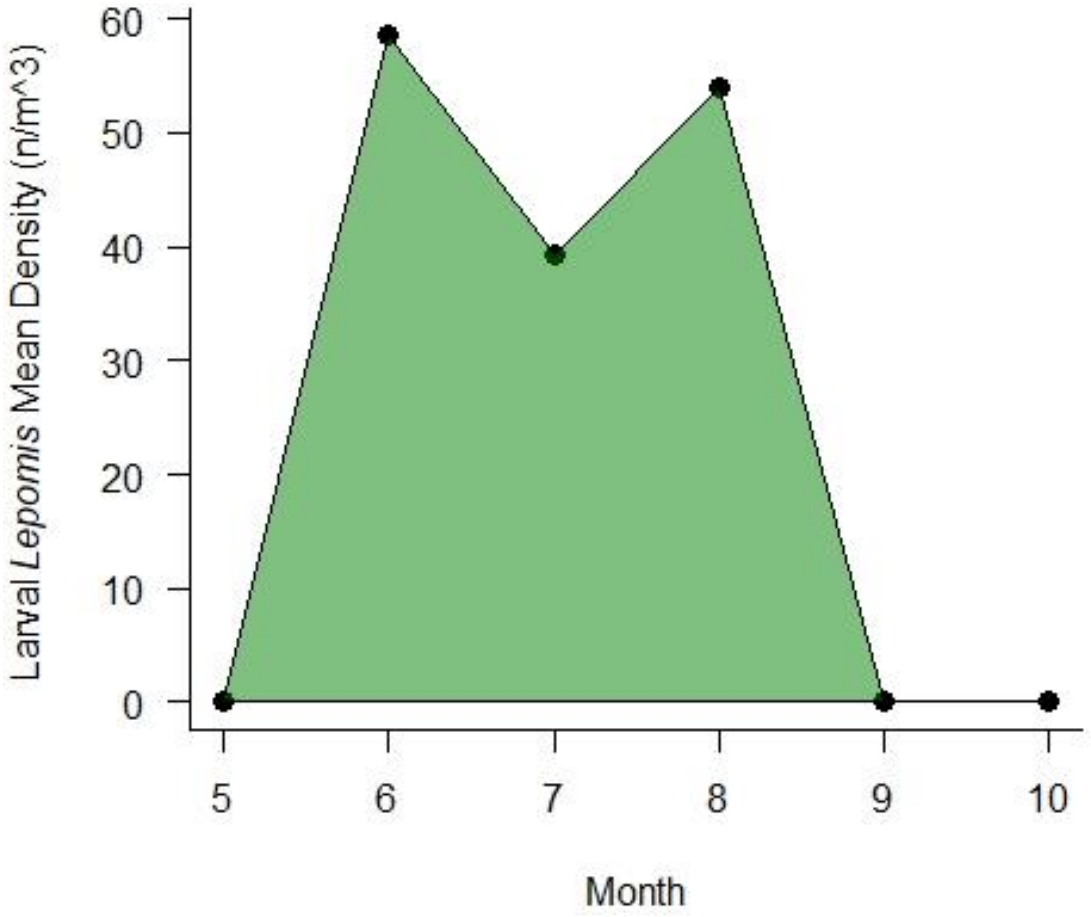

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Fish Population Surveys

Annual sampling 2014-2021

Electrofishing → **September**

Three, 15-minute pulsed-DC boat electrofishing transects

Fyke netting → **October**

10 nets; two consecutive 24-hour soak times

Response Metrics:

Catch Per Unit Effort (CPUE)

and

Proportional Size Distribution (PSD)

Proportional Size Distribution (PSD)

$$PSD = \frac{number \geq \textbf{\textit{quality length}}}{number \geq \textbf{\textit{stock length}}} \times 100$$

Quality length = Minimum size most anglers like to catch
Stock length = approx. length at maturity, minimum length effectively sampled by traditional fisheries gears, minimum length that provides recreational value

- Values range from 0-100

		
Quality Length	150 mm	300 mm
Stock Length	80 mm	200 mm

Gabelhouse (1984)

Analyses

Two-way ANOVA

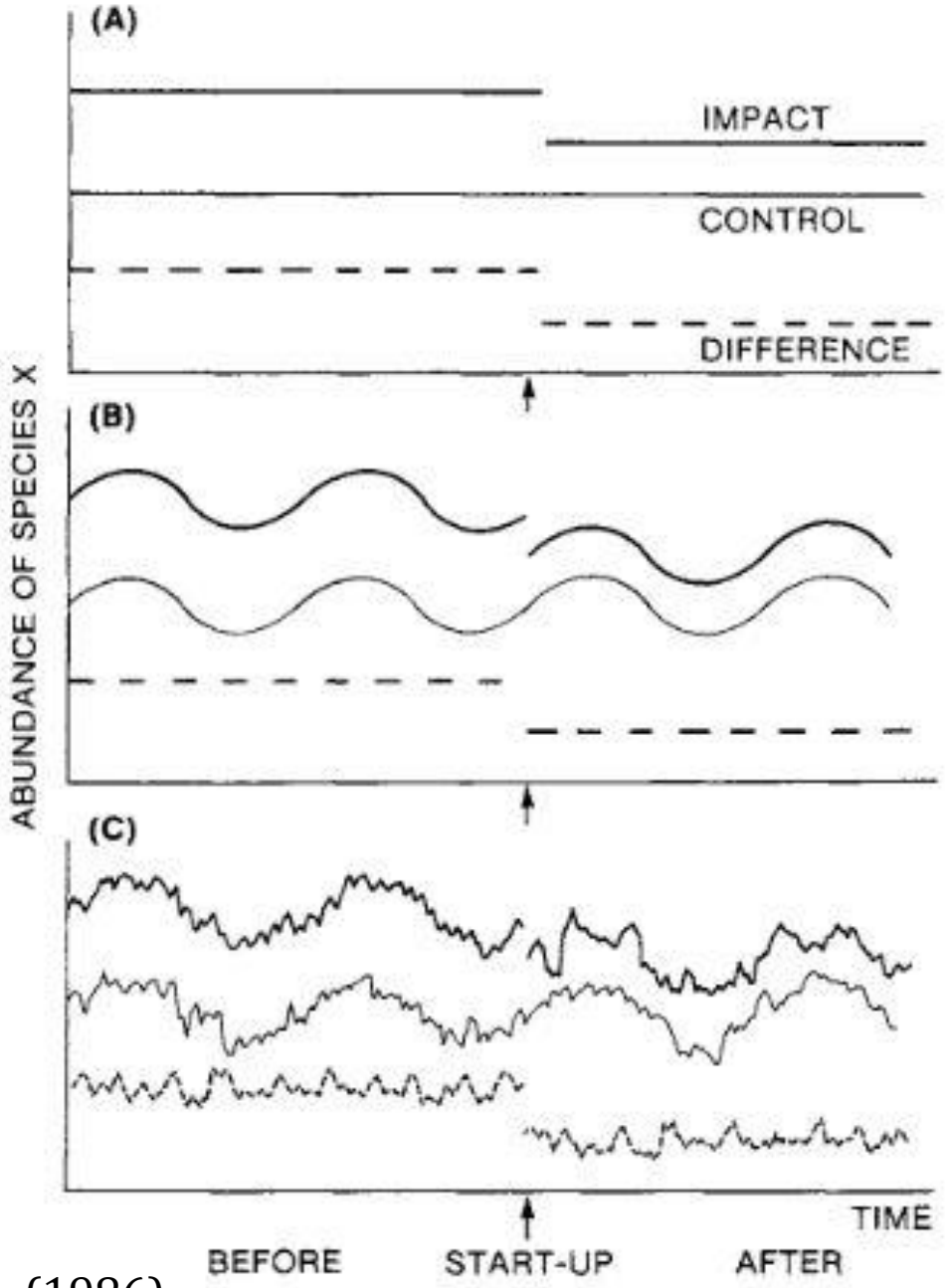
Interaction term:

time (before, after) * treatment (control, impact)

Effect Size (Hedge's g)

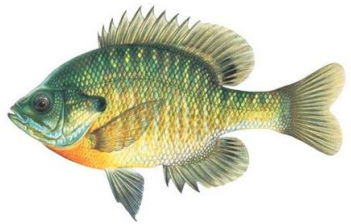
$$d = \frac{\overline{X_1} - \overline{X_2}}{S_{within}}, \quad J = 1 - \frac{3}{4df - 1}, \quad g = d \times J$$

Borenstein et al. (2021)



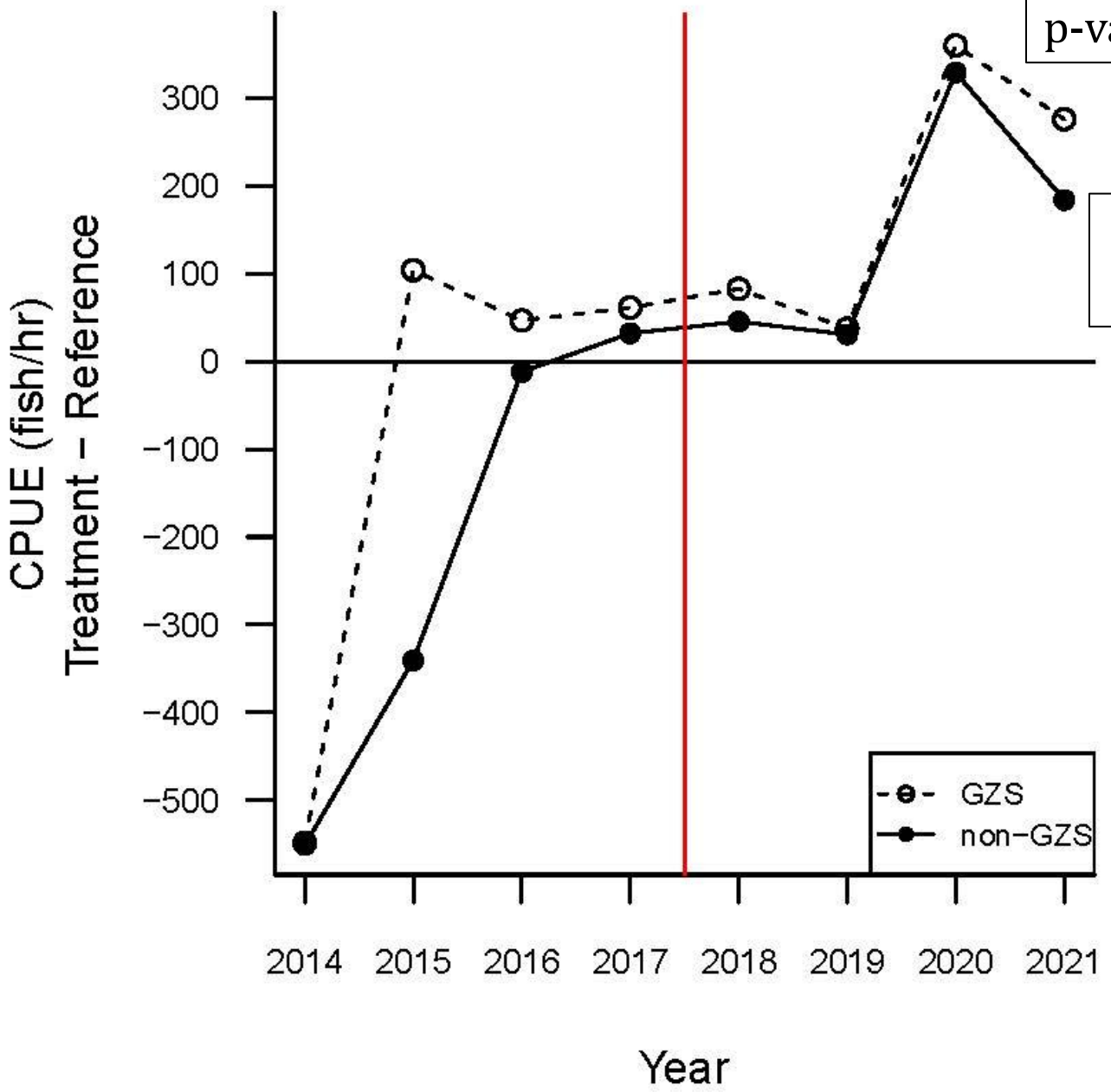
Stewart-Oaten et al. (1986)

Bluegill Relative Abundance

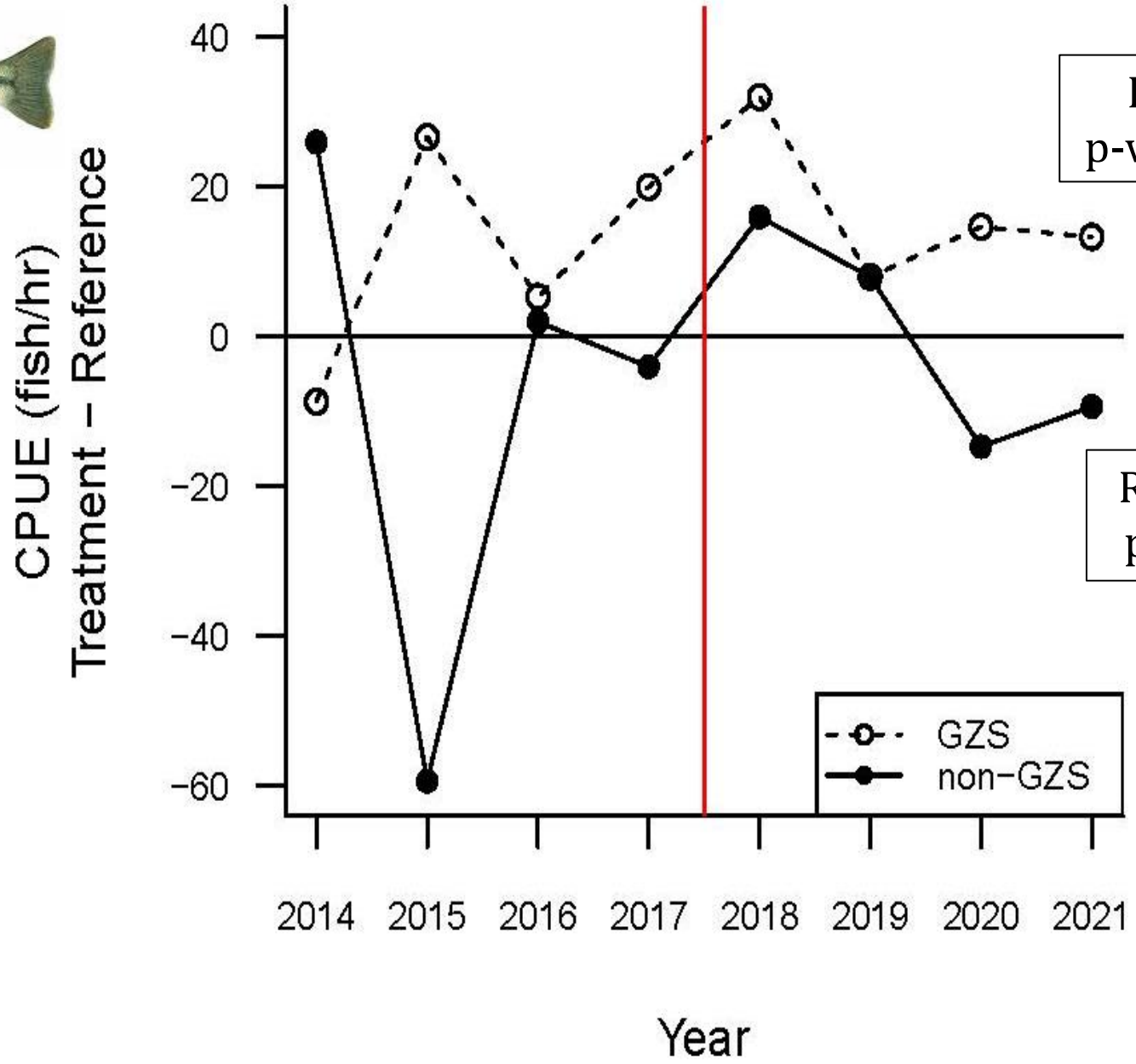


Relative to **GZS** reference
p-value 0.15, +0.97 effect size

Relative to **non-GZS** reference
p-value 0.05, +1.45 effect size



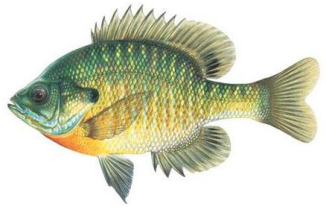
Largemouth Bass Relative Abundance

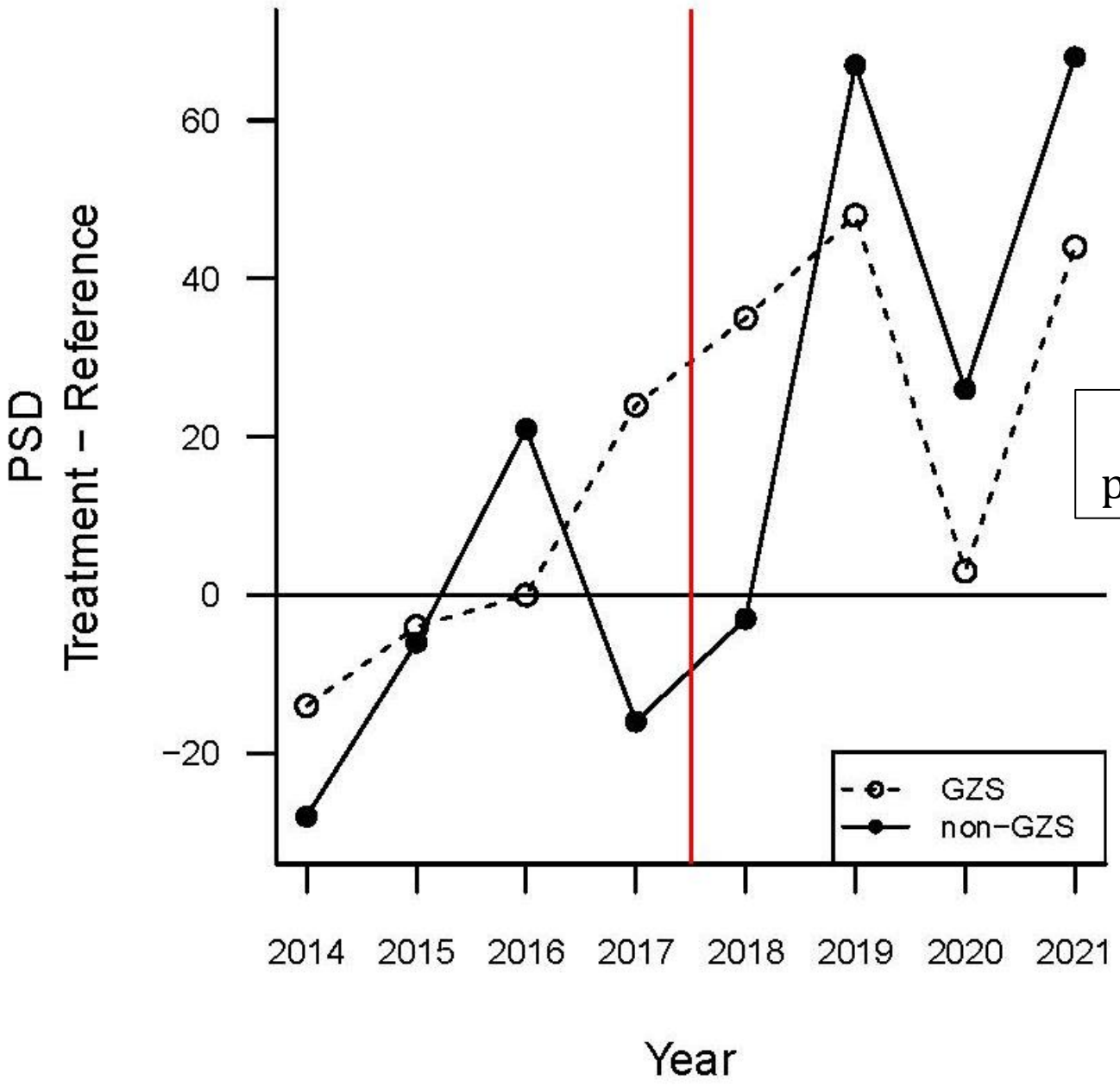


Relative to **GZS** reference
p-value 0.79, +0.40 effect size

Relative to **non-GZS** reference
p-value 0.75, +0.28 effect size

Bluegill Proportional Size Distribution

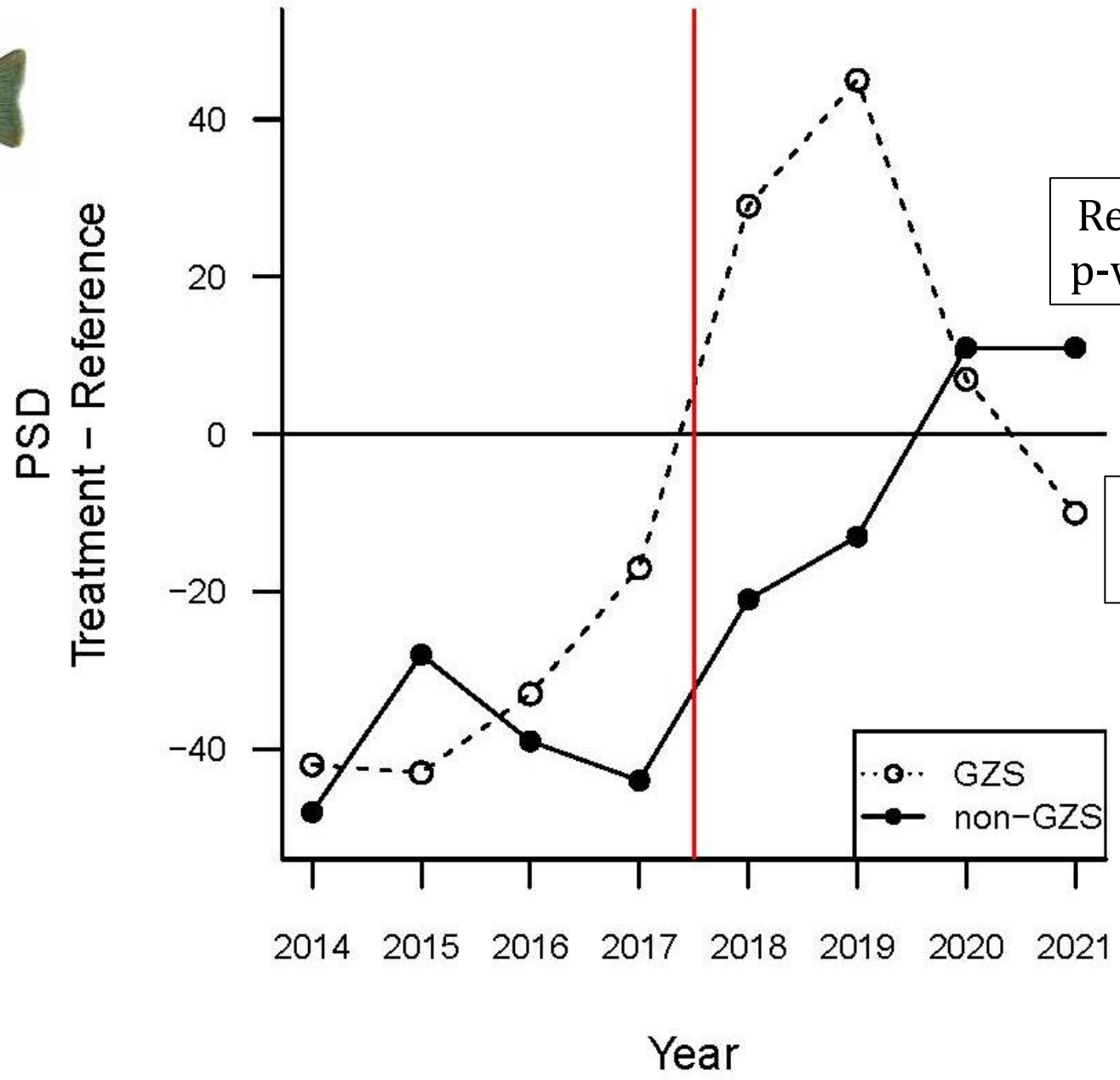




Relative to **non-GZS** reference
p-value 0.05, +1.43 effect size

Relative to **GZS** reference
p-value 0.02, +1.47 effect size

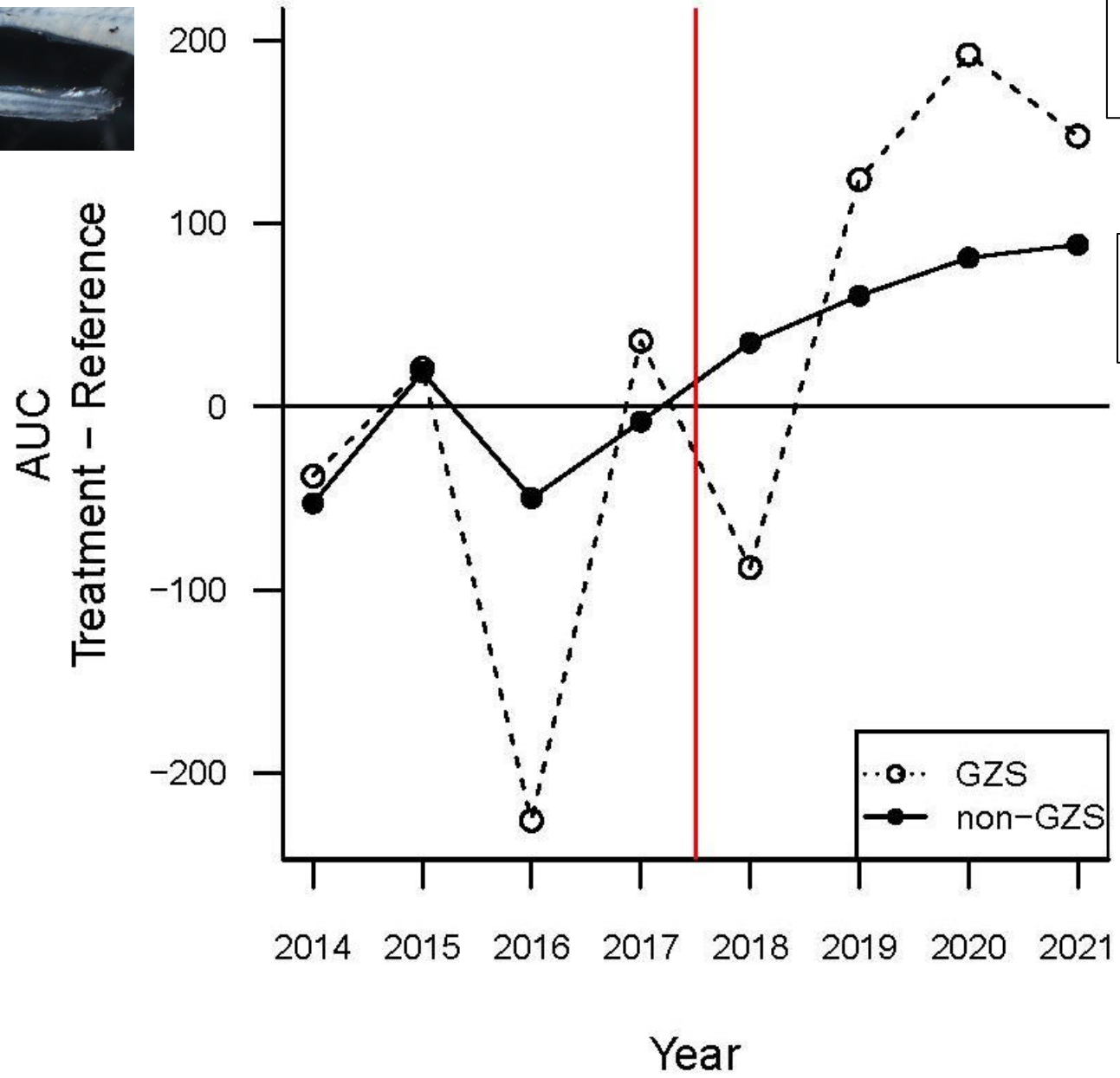
Largemouth Bass Proportional Size Distribution



Relative to **non-GZS** reference
p-value 0.001, +2.43 effect size

Relative to **GZS** reference
p-value 0.009, +2.34 effect size

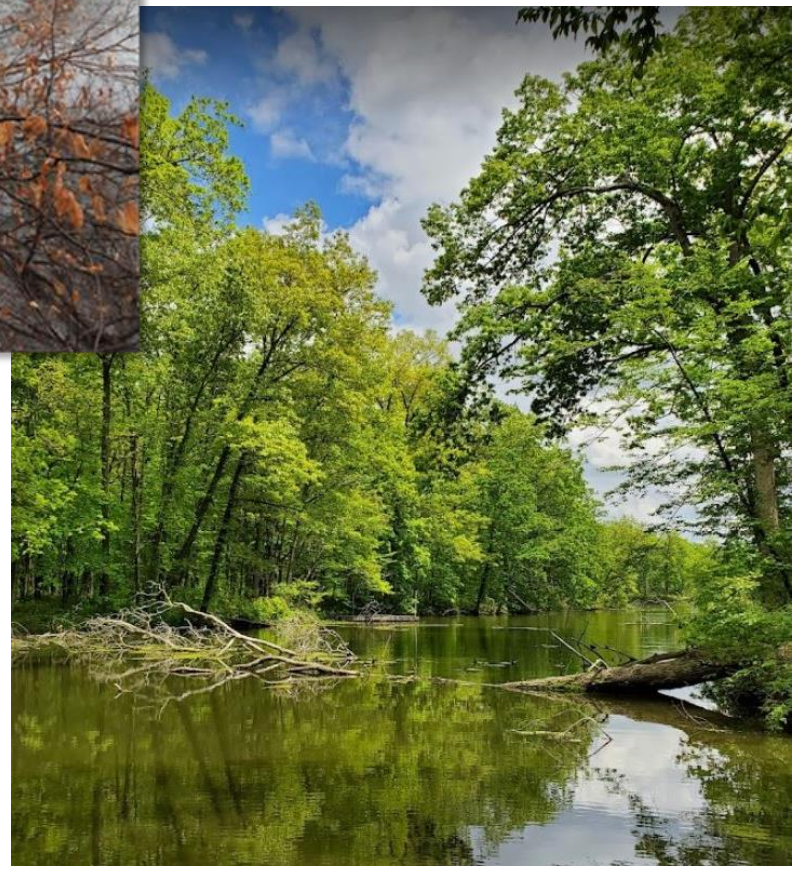
Fish Reproduction: Larval *Lepomis* Mean Density



Relative to **GZS** reference
p-value 0.13, +1.03 effect size

Relative to **non-GZS** reference
p-value 0.06, +2.61 effect size

Conclusions



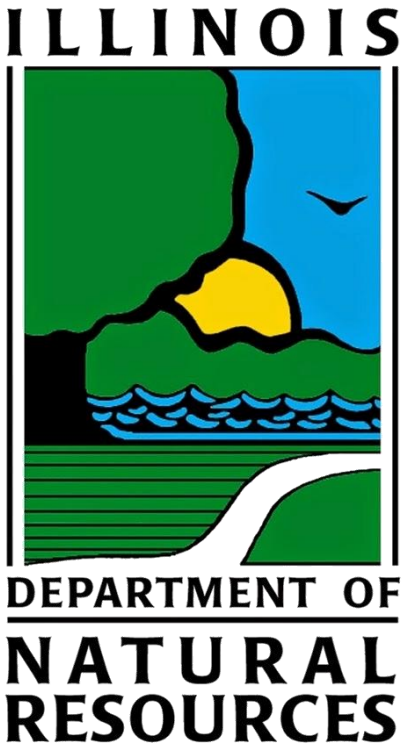
- More Bluegill (when compared to non-GZS reference)
- Larger Bluegill and Largemouth Bass
- Time-lag of *Lepomis* reproductive output?
- Are growth benefits due to increased production of prey resources?

Acknowledgements

Staff of the Kaskaskia Biological Station

- Joe Parkos
- Anthony Porreca
- Kyle Broadway
- Dakota Radford
- Research technicians
- Graduate students

Illinois Department of Natural Resources




Questions?