Urban Stream Restorations along a chronosequence: floodplain carbon and nutrient retention

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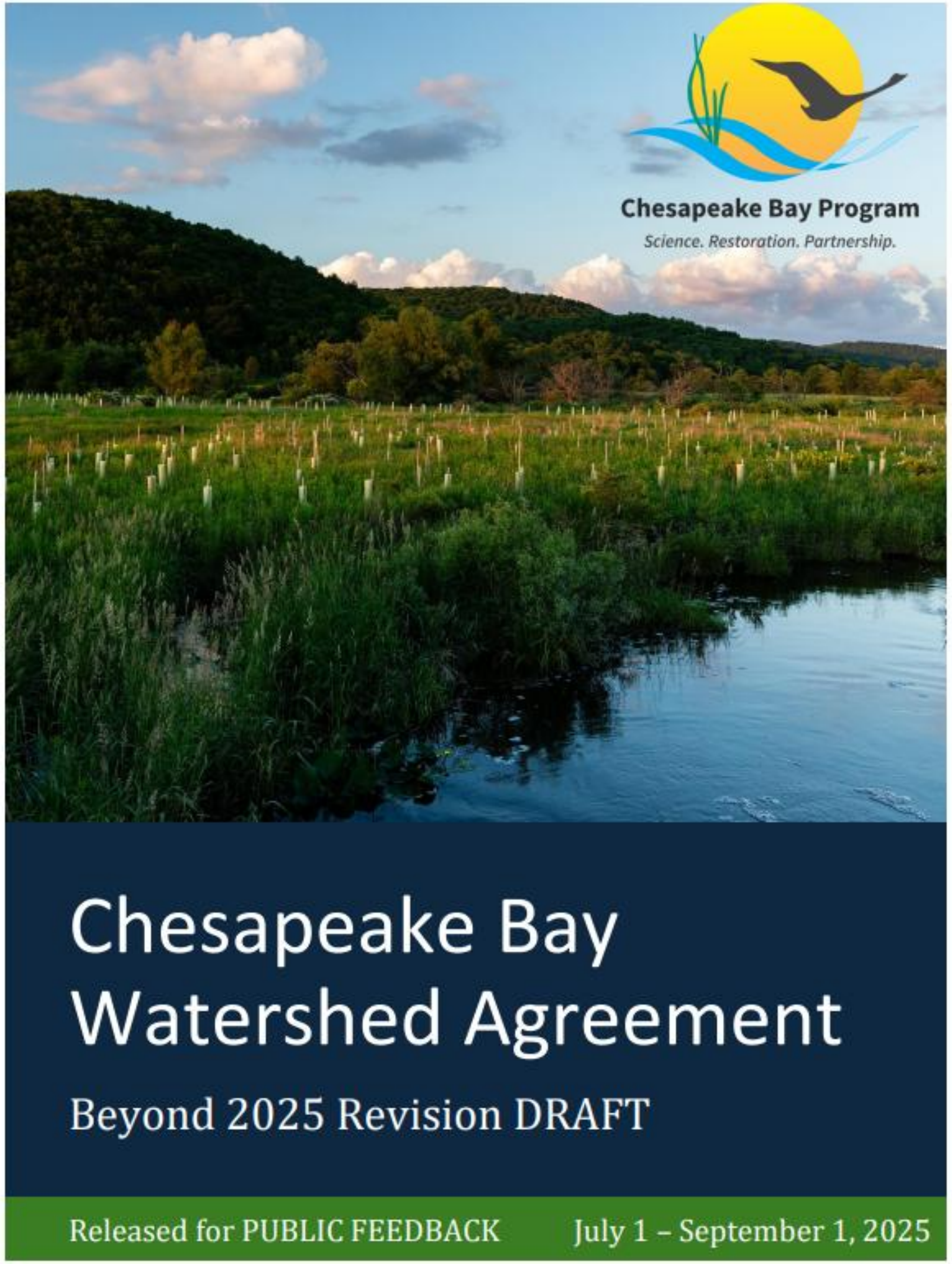
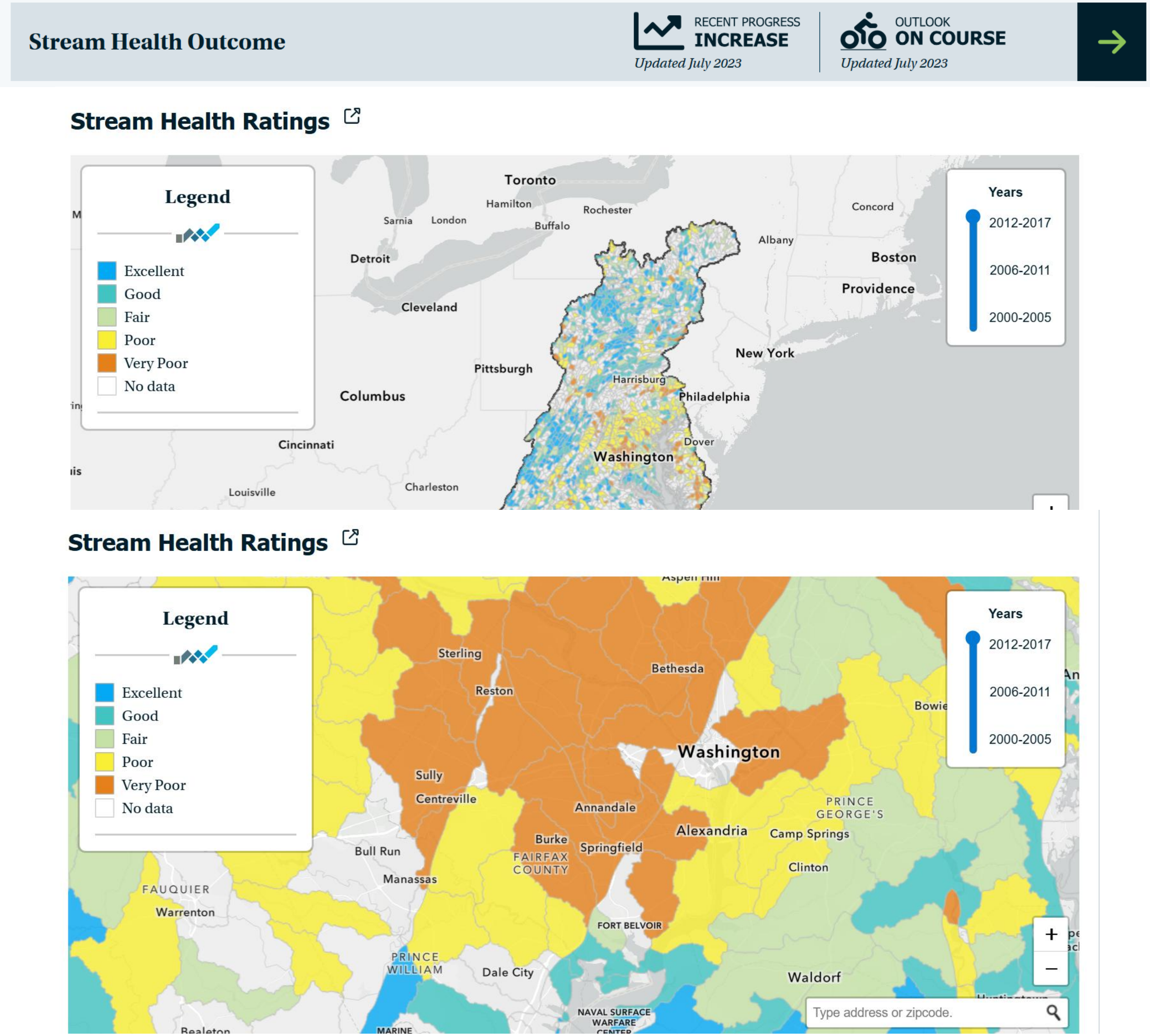




Sources: Chesapeake Bay Program, chesapeakeprogress.com

Insights

MAY 8, 2013

Does Stream Restoration Really

Researchers Ask: “How Effective Are Stream Restoration Projects?”

Les Knapp - November 4, 2016 - Environment

NEWS

Conduit Street

Stream Restoration in Alexandria Attracts a Deluge of Controversy

Vernon Miles February 1, 2021 at 1:30pm

ALXnow

Research Purpose

<u>To better understand of how stream restoration changes floodplain soils over time:</u>

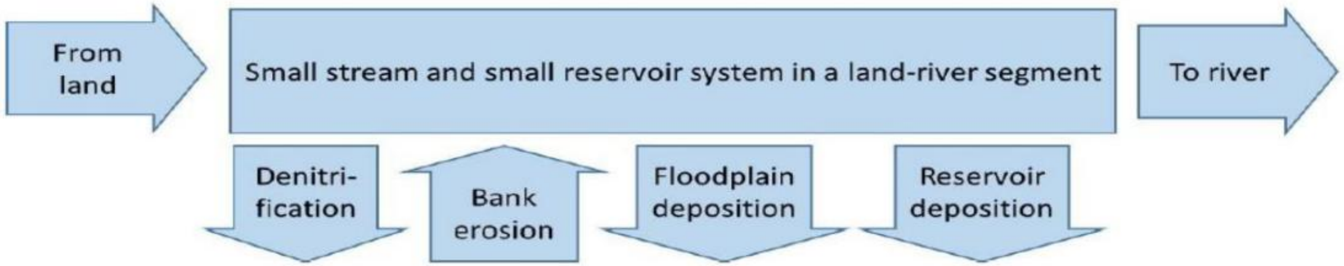
...Are completed stream restoration floodplains significantly different from those unrestored urban sites? How does a 10-year-old site compare to a brand-new restoration?

→ Carbon and nutrient **retention**

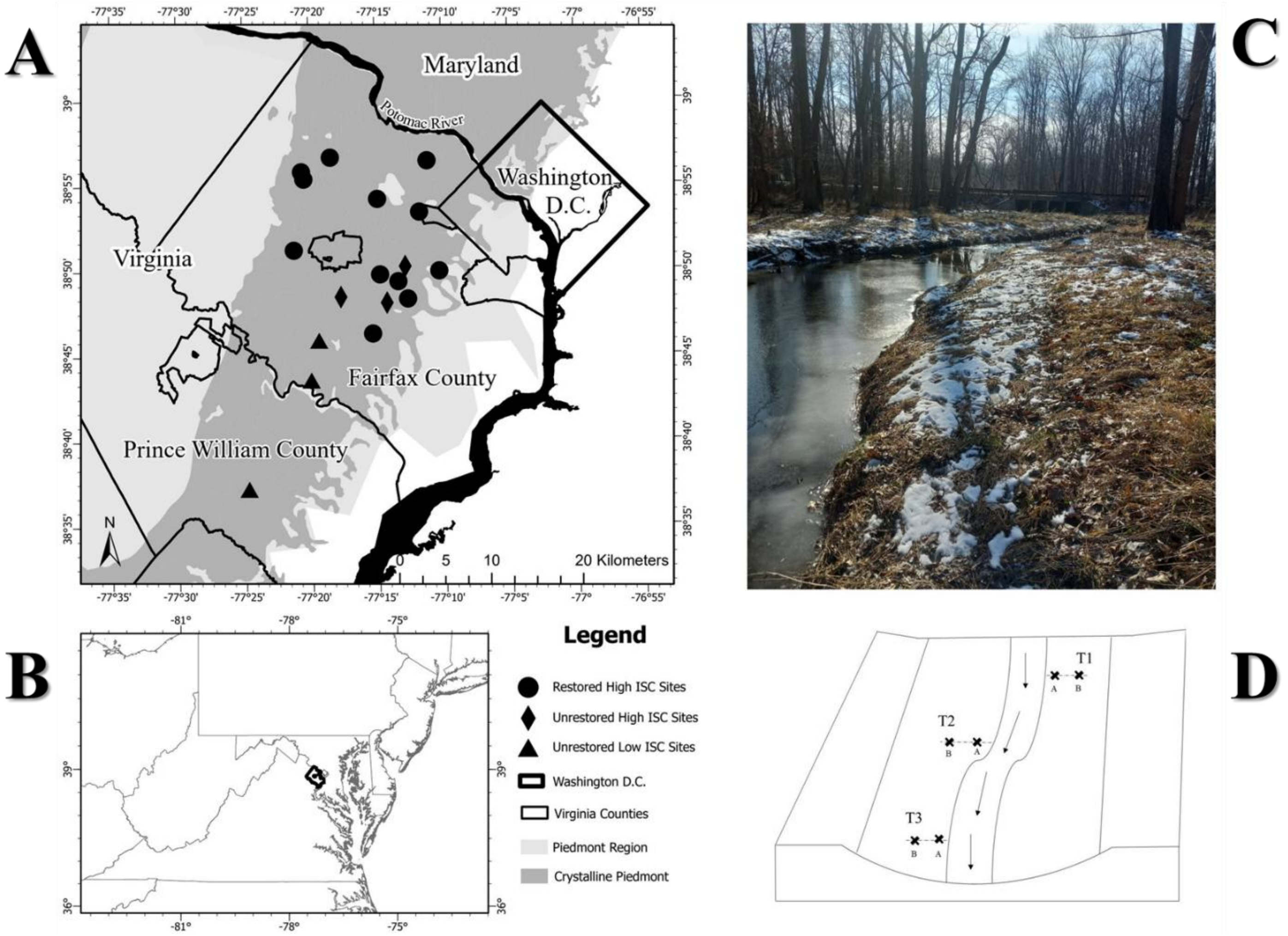
→ Potential avenues of carbon and phosphorus **loss**

→ Local soil characteristics

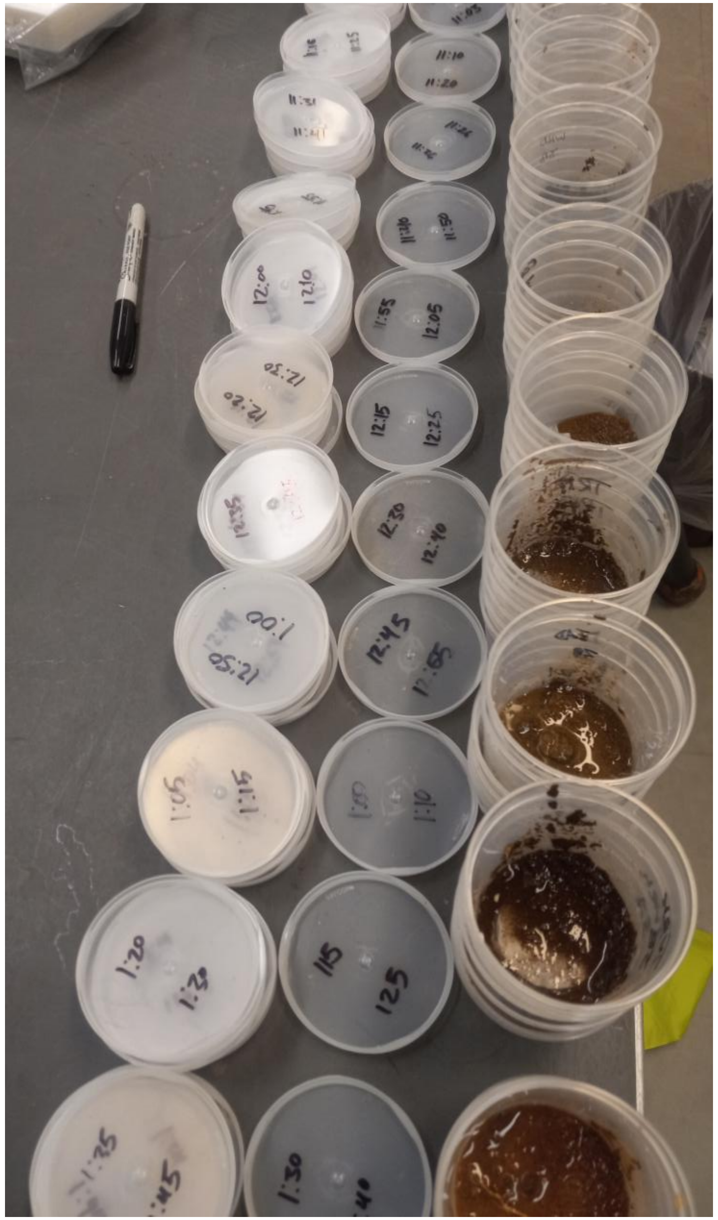
Figure 22. Processes Represented in Phase 6 Model Stream to River Deliver (CBP, 2018)



Site Selection and Methods





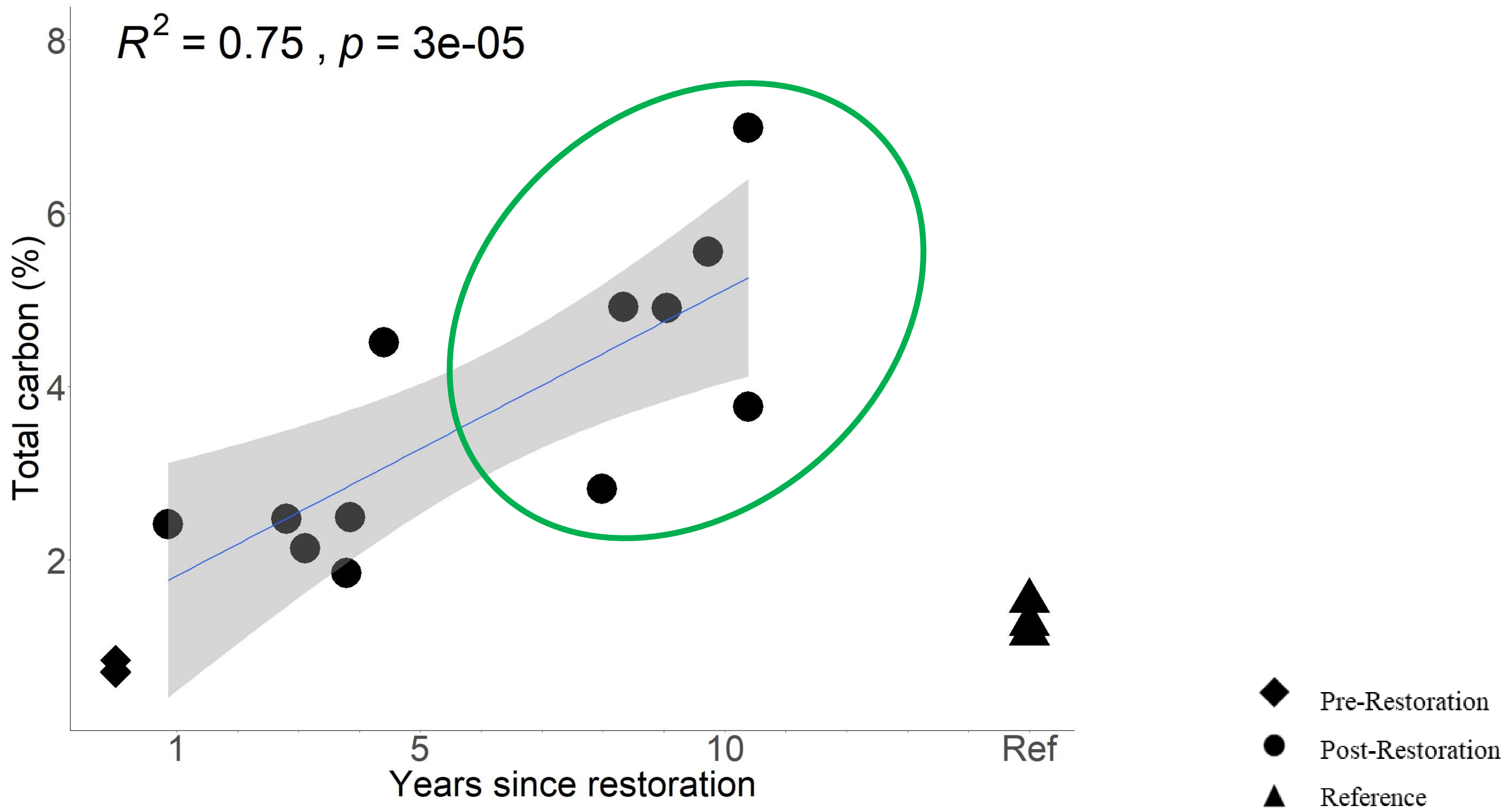




Key Results - Time Since Restoration Does Influence Retention

Linear Model	DF	Adjusted R^2	F-statistic	p-value
TC ~ years since restoration	13	0.730	38.93	<0.001 *
TN ~ years since restoration	13	0.694	32.71	<0.001 *
TP ~ years since restoration	13	0.596	21.61	<0.001 *
C Turnover~ years since restoration	13	0.410	10.72	0.006*
EPC_0 ~ years since restoration	13	-0.075	0.02	0.888

C-N-P Retention Increased With Time Since Restoration



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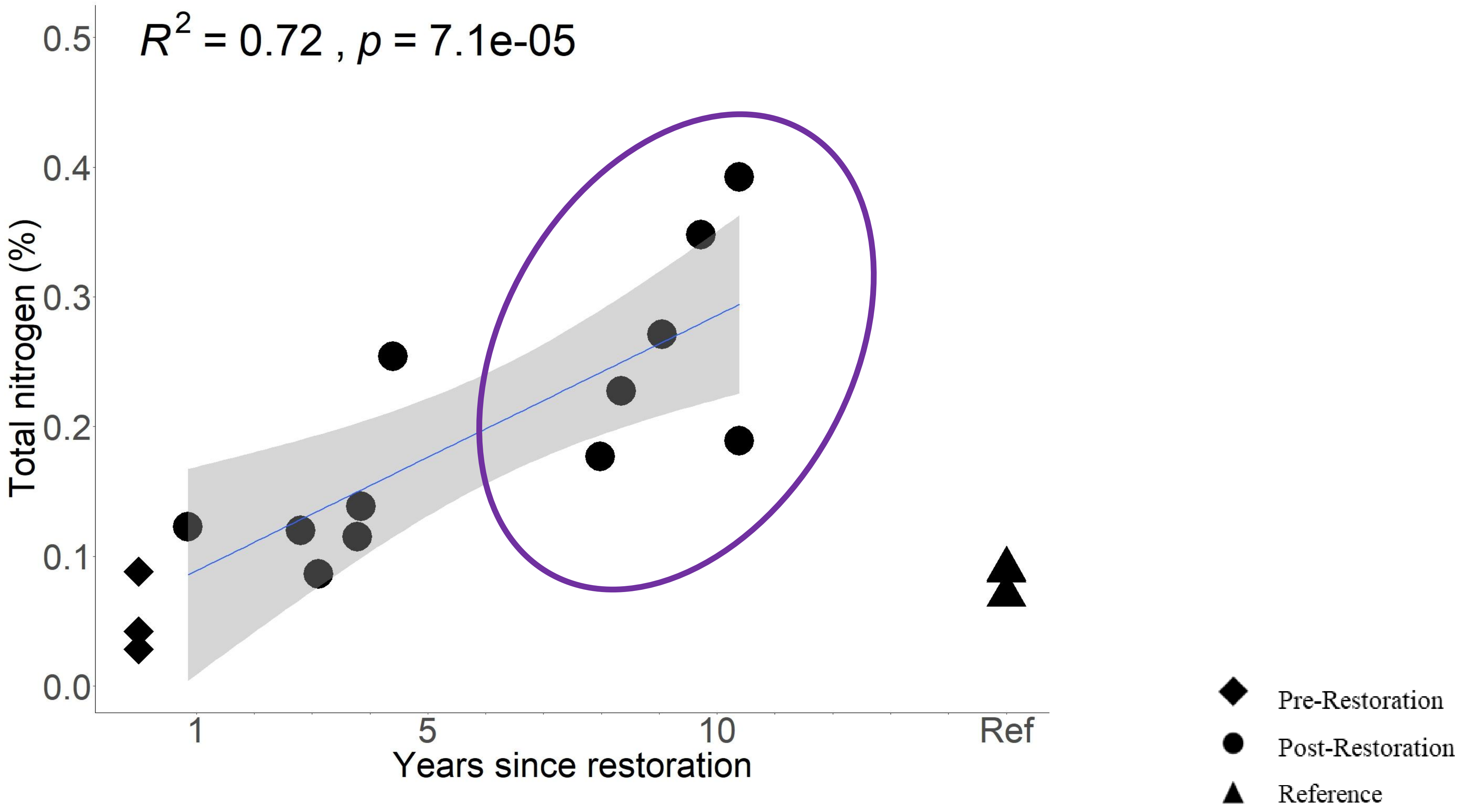

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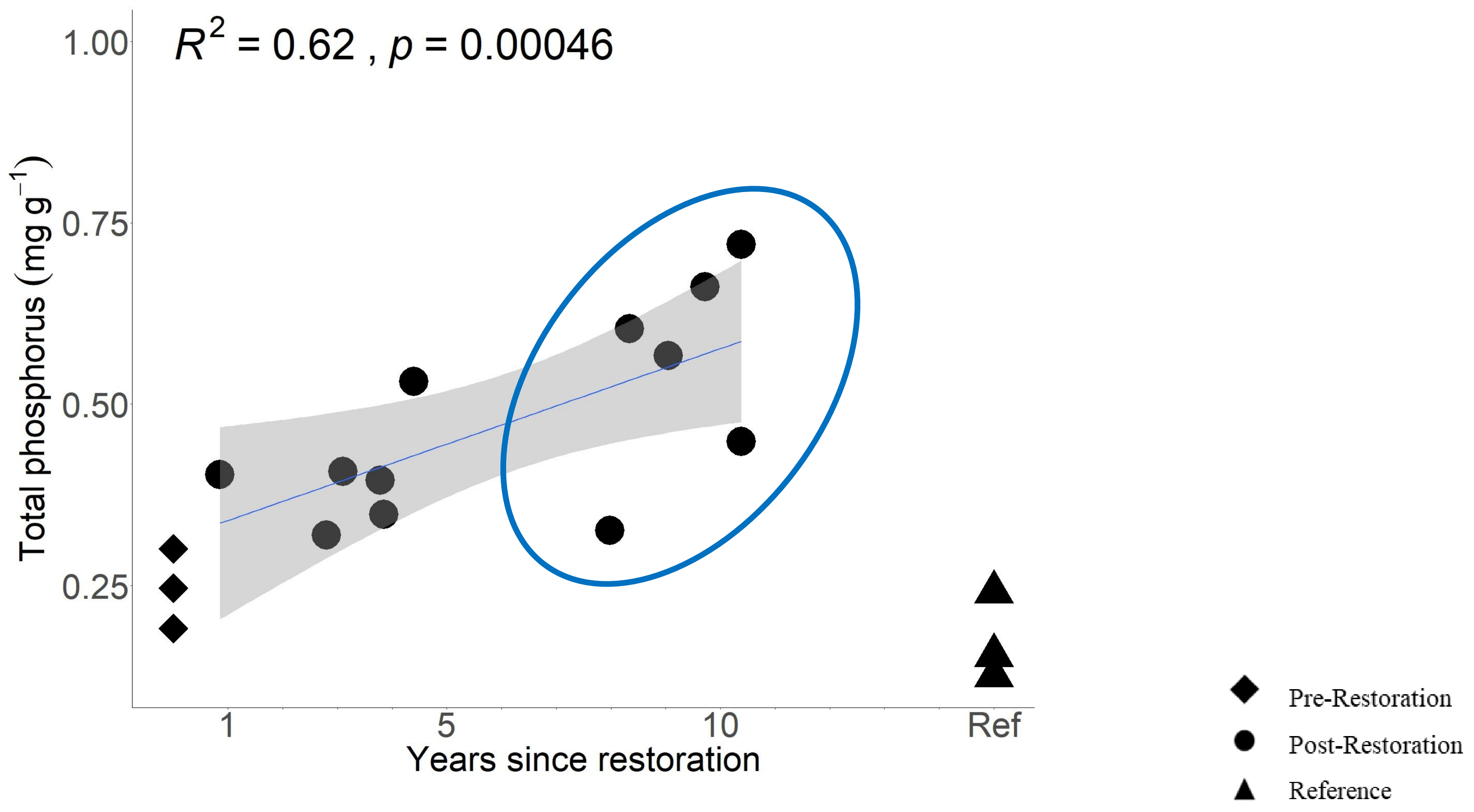
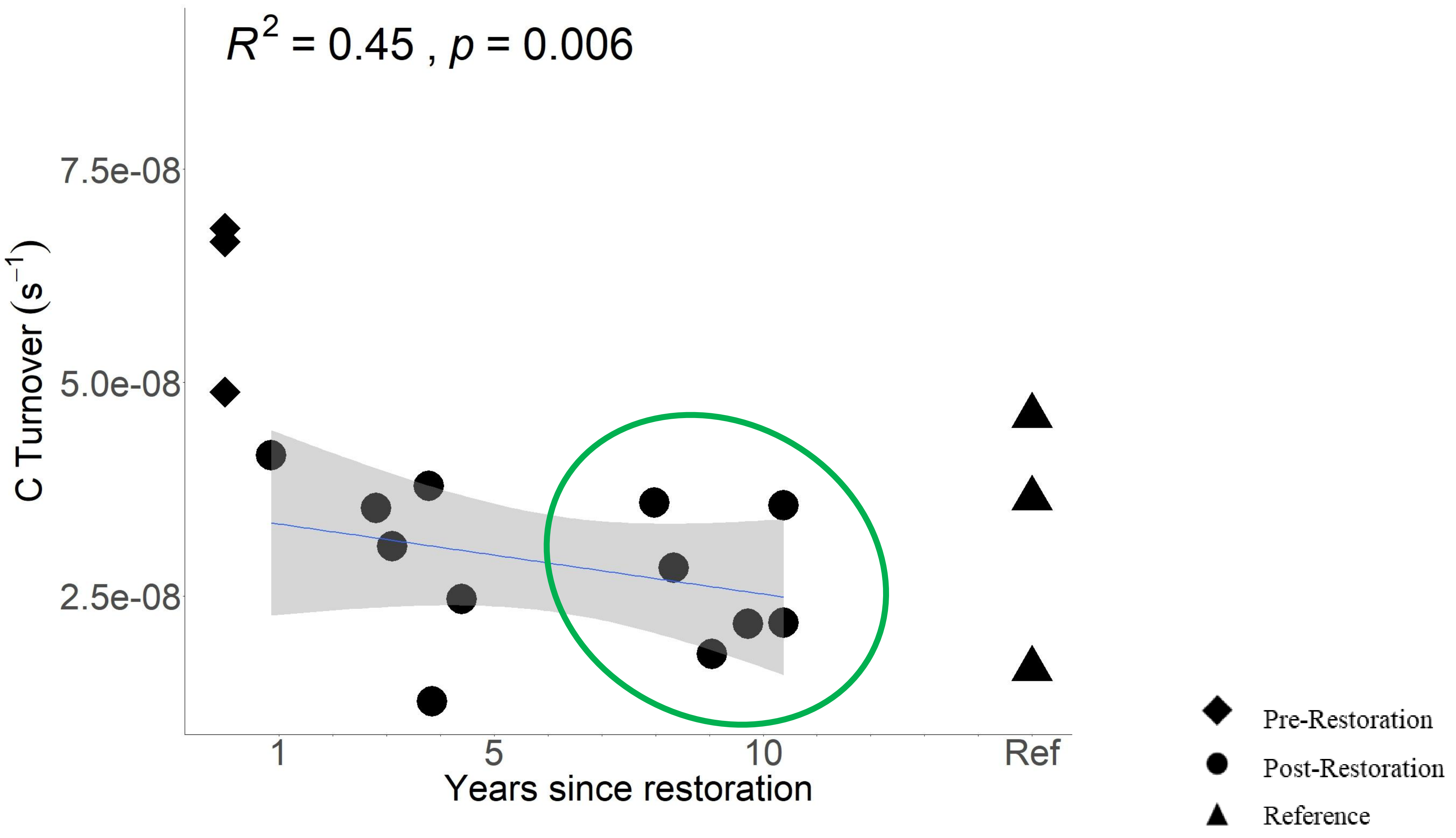
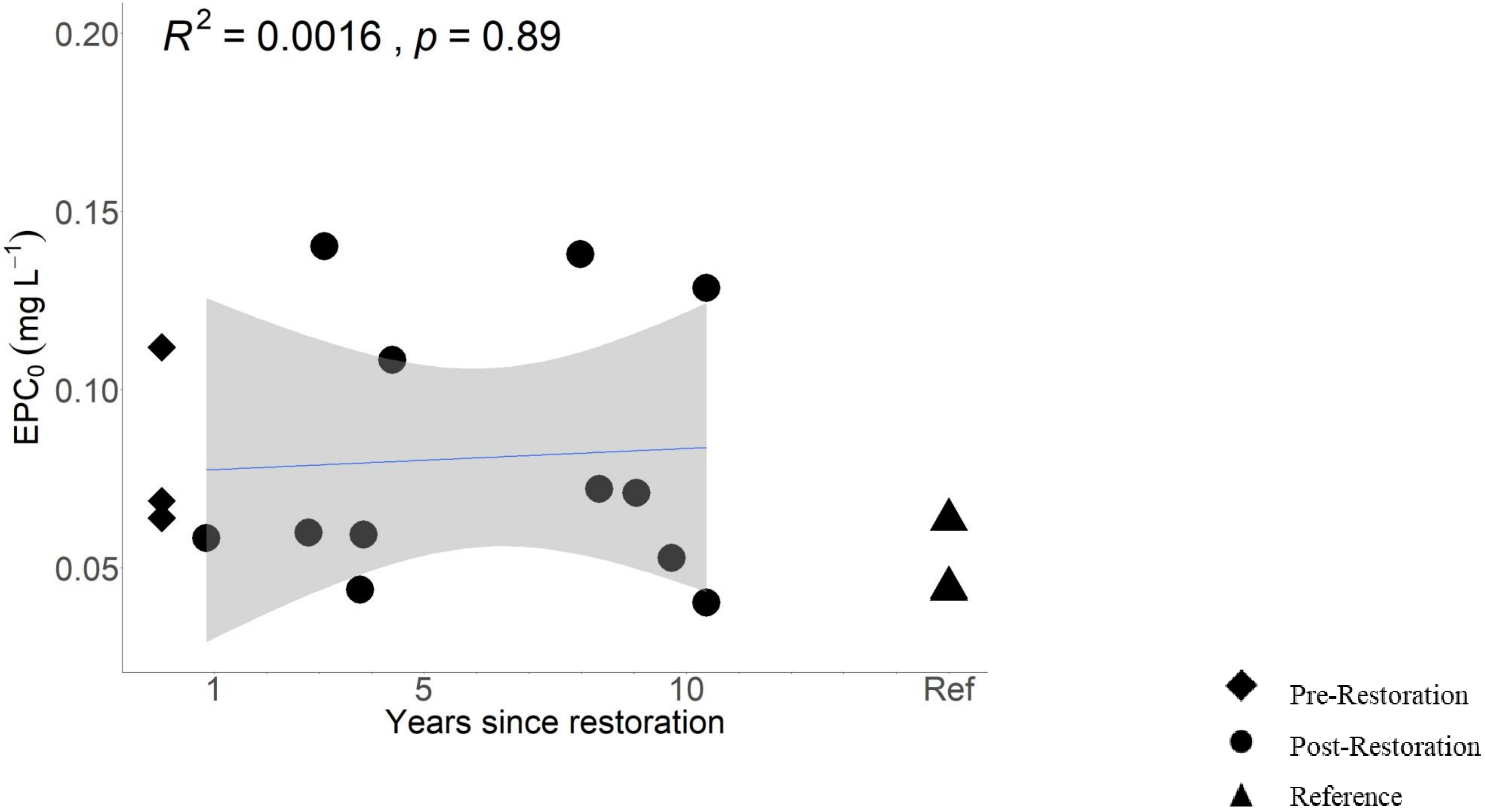


Carbon Turnover Rates Decreased With Time Since Restoration



Equilibrium Phosphorus Concentration Was Not Impacted by Restoration Time



Key Results - Soil Moisture and OM Influence C-N-P retention

Variable	Top-ranked Model	K	AICc	W	p-value	R^2
TC	Soil Moisture	3	54.87	0.58	<0.001 *	0.74
TN	OM	3	-68.60	0.72	<0.001 *	0.91
TP	OM	3	-40.86	0.78	<0.001 *	0.86
C Turnover	D50	3	-604.27	0.92	<0.001 *	0.56
EPC_0	Soil pH	3	-73.52	0.71	0.005 *	0.40

Generalized Linear Models (GLMs)

Key Results Summarized

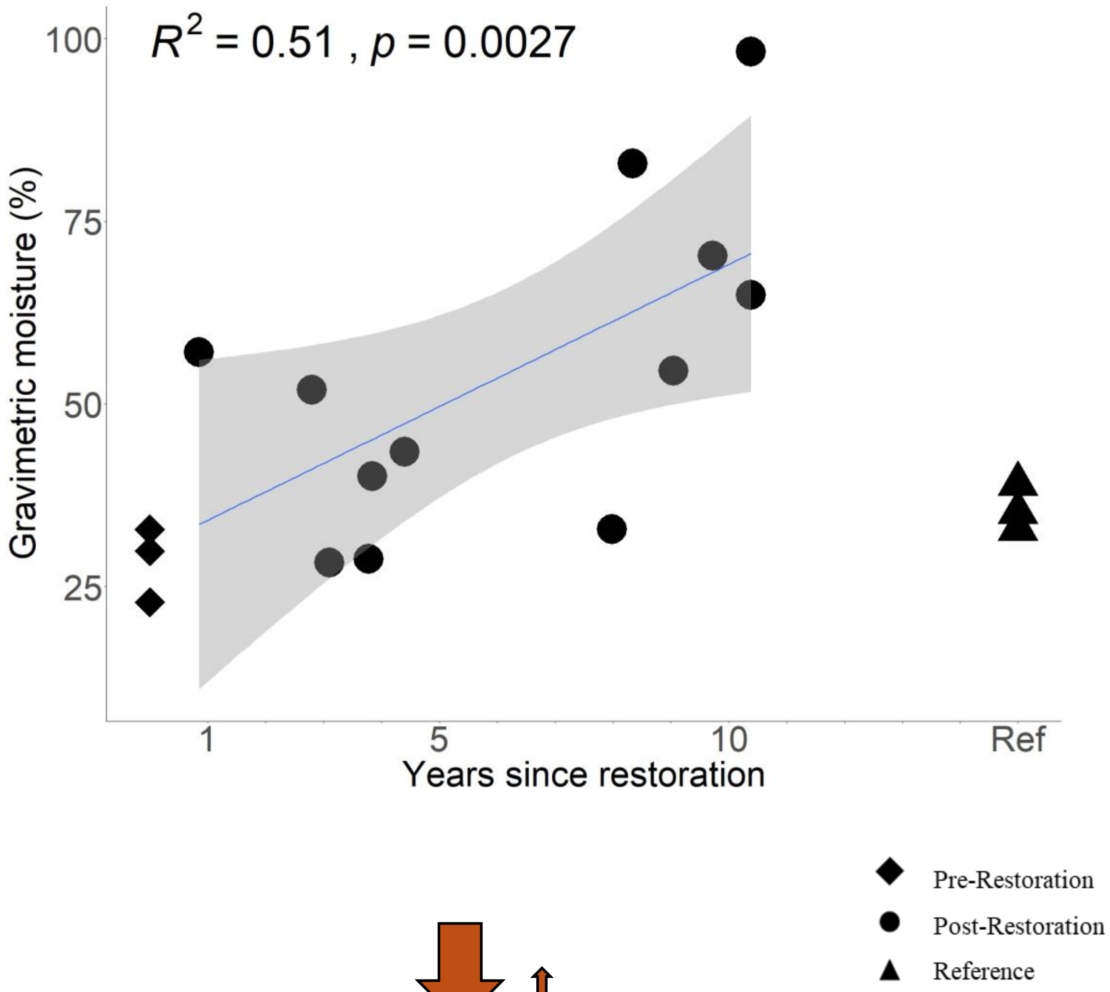
→ TC, TN, and TP all **increased** with time since restoration

→ As did soil moisture, a key secondary driver

→ Rates of carbon turnover **decreased** with time since restoration

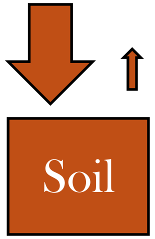
→ EPC_0 **cannot be predicted** using time since restoration

→ Floodplain soils **did not saturate** with PO_4 over time



→ **Increased soil moisture promotes storage…**

…but to what extent?

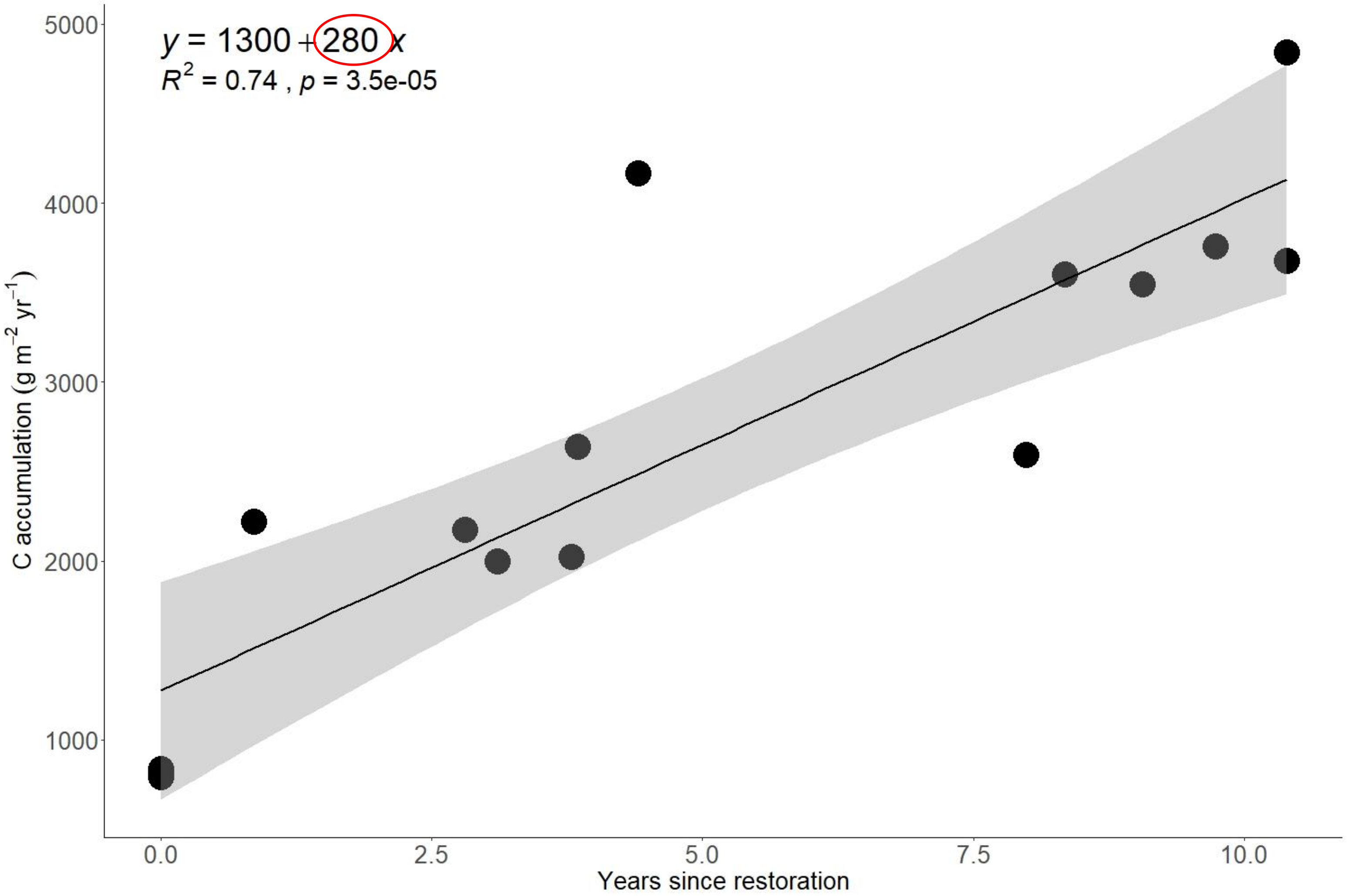


Extrapolating Accumulation Rates

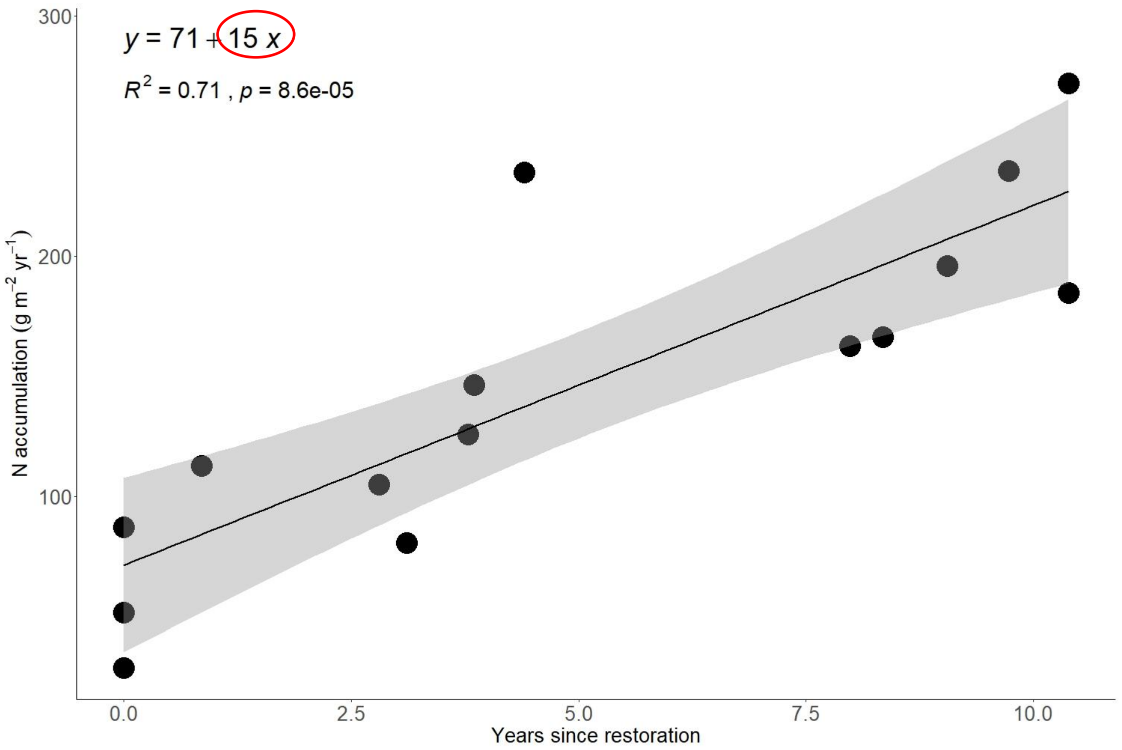
→ Depth x Bulk Density x TC = g C m^{-2}

→ Regressions along time since restoration to get g C m^{-2} yr^{-1}

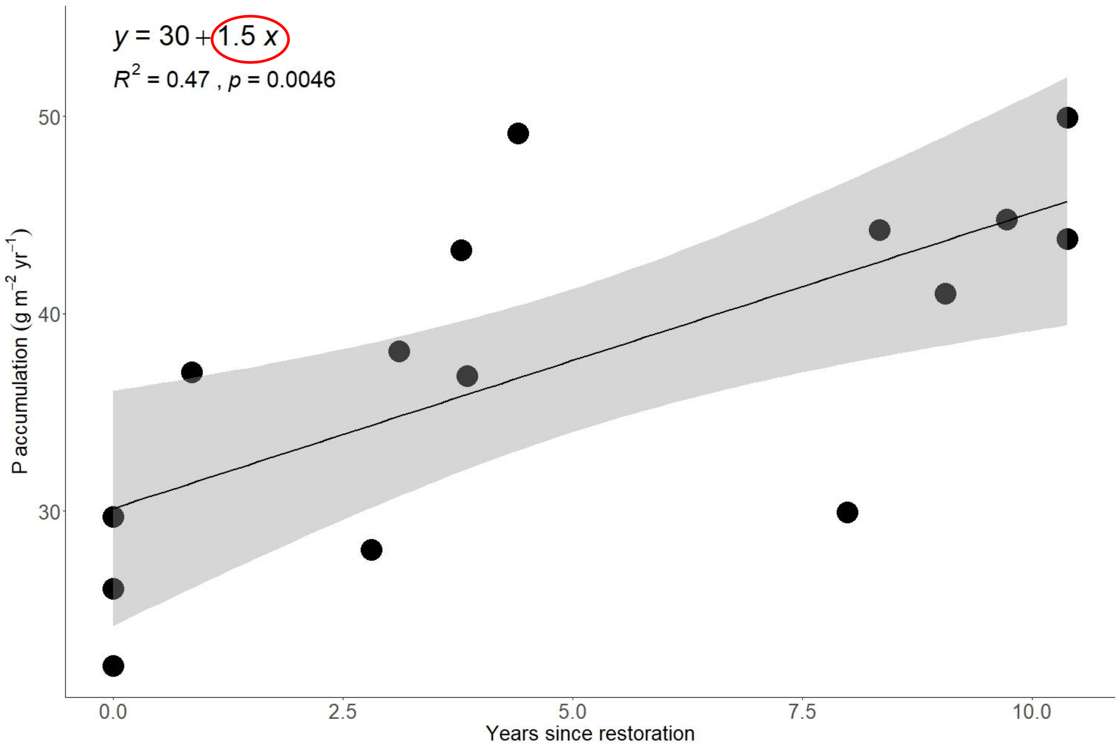
For carbon accumulation, we see rates of 280 g C m^{-2} yr^{-1}



Extrapolating Accumulation Rates



For nitrogen accumulation, we see rates of 15 g N m^{-2} yr^{-1}



For phosphorus accumulation, we see rates of 1.5 g P m^{-2} yr^{-1}

	Wetland Type	TC g m^{-2} yr^{-1}	TN g m^{-2} yr^{-1}	TP g m^{-2} yr^{-1}
This Study	**Alluvial Restored Floodplain**	**280**	**15**	**1.5**
Brinson et al. (1980)	Alluvial Floodplain	278	7.3	0.5
Craft and Casey (2000)	Blackwater Floodplain	18-107	1.4-8.0	0.1-0.8
Gordon et al. (2020)	Average 40 Floodplains		*20*	*2.1*
Johnston et al. (2001)	Alluvial Floodplain		12.8	*2.6*
Johnston (1991)	Mineral Soil Wetlands		14.6	1.5
Kuenzler et al. (1980)	Alluvial Floodplain	37		0.1-0.3
Mitsch et al. (1979)	Alluvial Floodplain			*3.6*
Noe and Hupp (2005)	Connected Floodplains	74-212	4.2-13.4	0.4-4.1
Noe and Hupp (2005)	Disconnected Floodplains	61-74	3.5-4.8	0.2-0.4
Ricker et al. (2012)	Headwater Floodplains	10-260		

Conclusions

- → Stream restoration can be considered **successful** with the lens of improved **water quality** through **increased nutrient retention**, as well as carbon sequestration goals

- → These floodplains are functioning akin to larger, natural floodplains.

- → In **disturbed** landscapes, **restored** floodplains can function **better** than high quality **unrestored** floodplains.

Acknowledgements

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science for a changing world

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Poplar Heights Recreation Association

Society of Wetland Scientists

Society of Wetland Scientists South Atlantic Chapter

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Contextualizing "Reference" Sites in an Urban Stream Network

→ Reference sites with low ISC were more similar to unrestored disturbed sites than sites restored 10+ years ago

→ Less retention of C-N-P, and higher normalized efflux rates

→ Legacy sediment

→ Colonial burial of floodplains

→ Disconnection of banks

No equivalent "undisturbed stream sites"

Stream Restoration and Invasive Species

→ Stream Restoration causes disturbance to the existing landscape

→ Soil Disturbance (compaction, regrading)

→ Increased space availability (denuded surfaces)

→ Increased light availability (loss of canopy cover)

→ Streams act as vector for seeds

forests

MDPI

Article

Drivers of Plant Invasion in Stream Restoration

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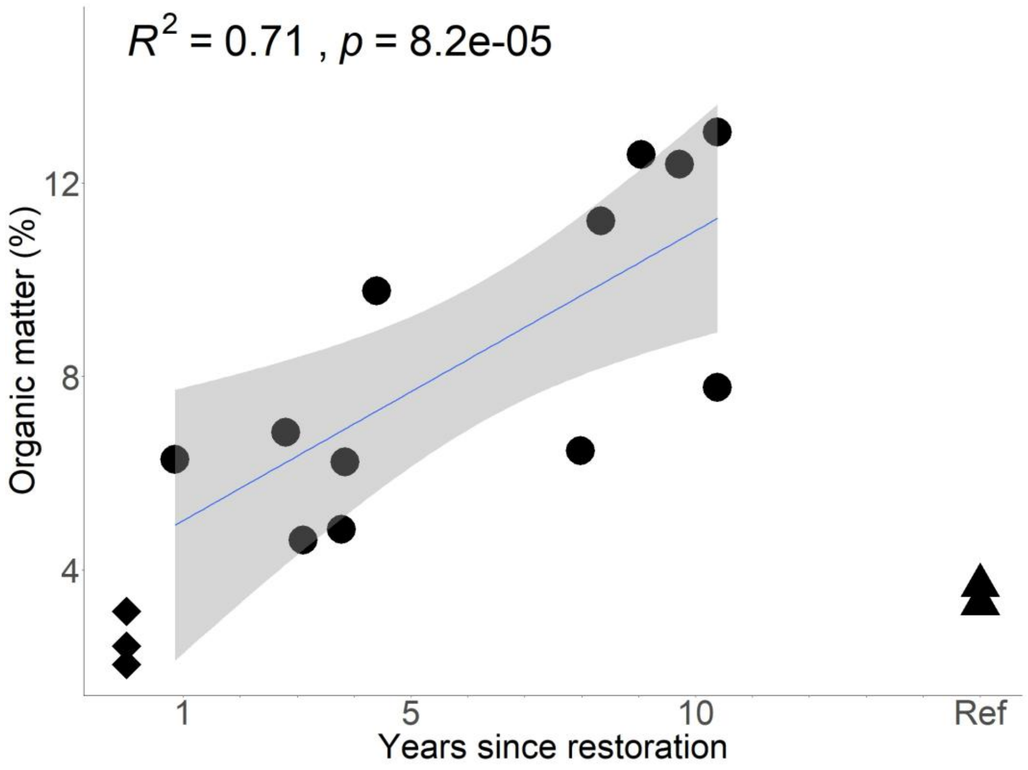
→ However...

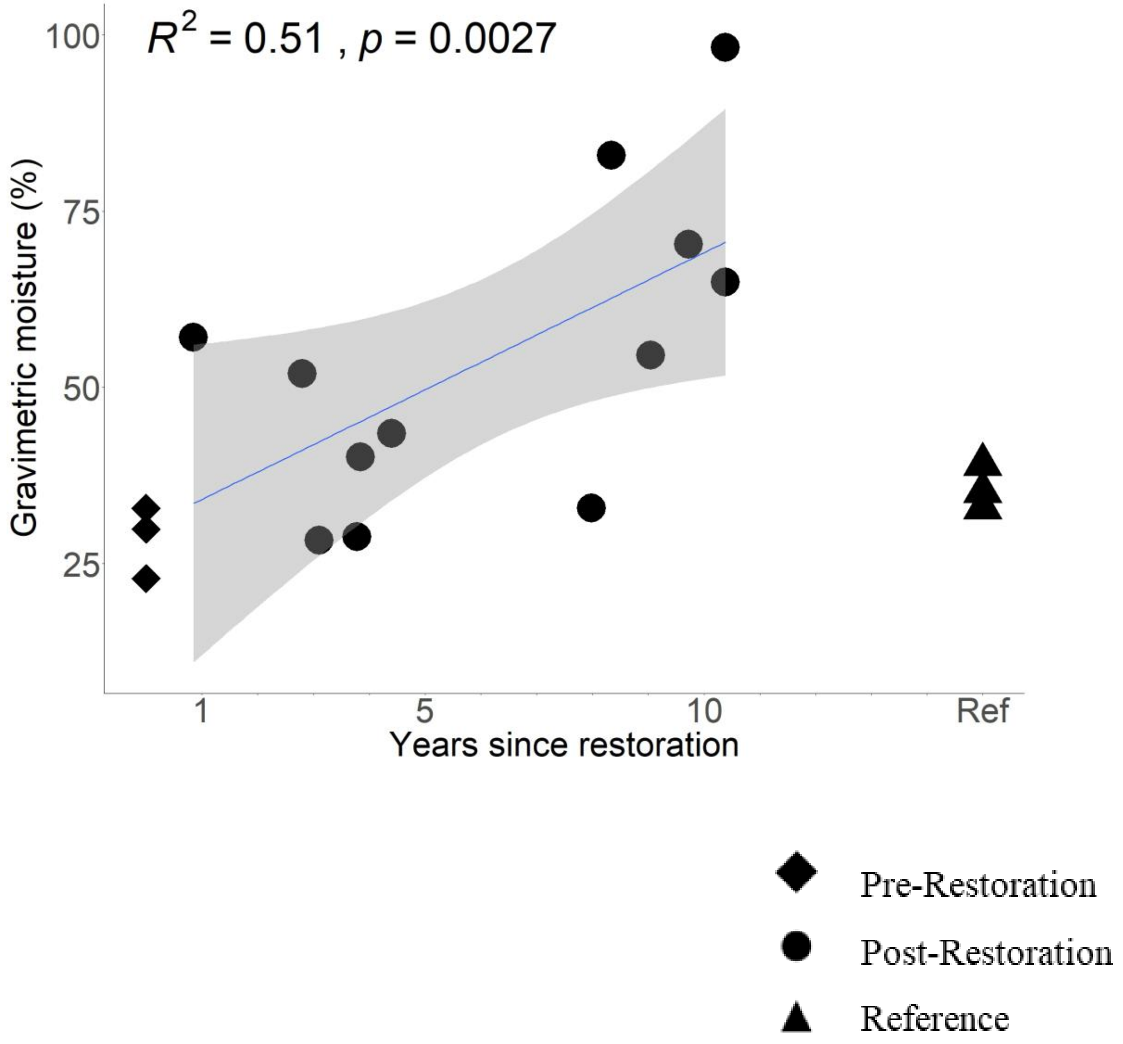
→ Existing habitat may not reflect historic ecosystem (upland species)

→ Urban Stream Syndrome degrades existing habitat continually

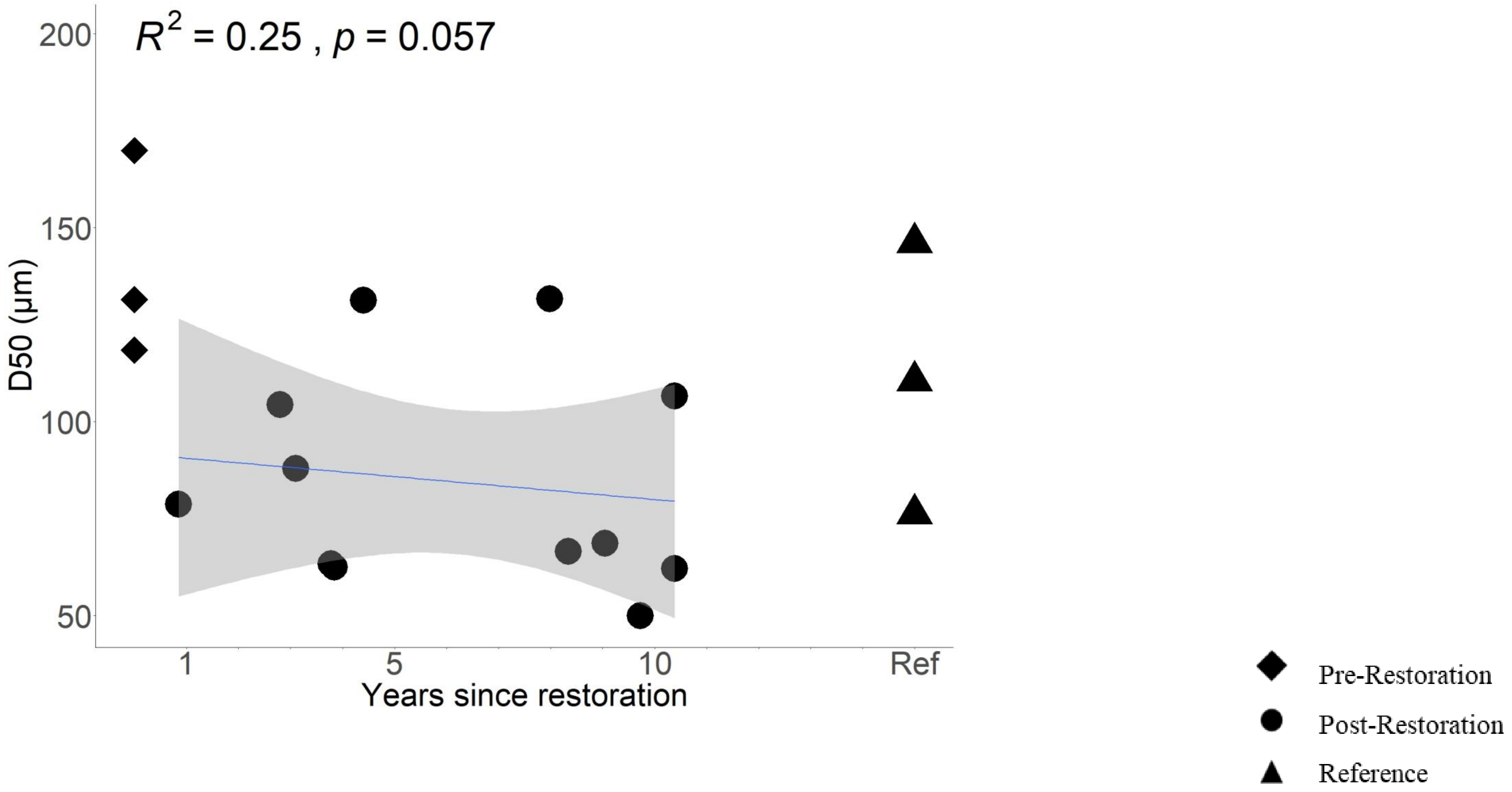
→ Mitigation methods necessary (light management, nutrient management, biodiversity support)

Secondary Drivers- Organic Matter and Soil Moisture





Carbon Turnover Rates Correlated with D50



Equilibrium Phosphorus Concentration Related to Soil pH