

Agricultural Best Management Practices in Corn-Soybean Systems: Tradeoffs and Synergies between Crop Yield and Ecosystem Services

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Genesis

- Research Papers: often take the form of “knowledge” syntheses – e.g. reviews of the current state of knowledge on some scientific, economic, legal or public policy sustainable issue
- students are encouraged to undertake projects in collaboration with external institutions

Master's of
ENVIRONMENTAL
SUSTAINABILITY



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The Nature
Conservancy 

natural
capital
PROJECT











Agricultural Best Management Practices



Cover Crops



Crop Rotations



Nutrient Management

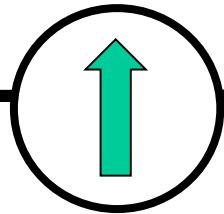
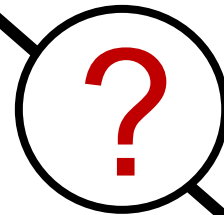


Tillage Practices



Perennial Vegetative Buffers

BMPs on Ecosystem Services



Objective

- BMP implementation: need not exclusively result in tradeoffs; there may be potential synergies



Objective: (a) document the prevalence of agricultural yield and ecosystem service co-benefits (synergies) and tradeoffs; and (b) develop empirical models that predict the likelihood of co-benefits relative to tradeoffs

ES Leakage: does de-intensification of certain plots (via BMPs) reduce yields, prompting further intensification or land clearing elsewhere (which has implications for delivery of ES on a landscape scale)?

Methods

- Literature searches were conducted by *The Nature Conservancy* from 2013-2016
 - Upper Mississippi River Basin-Midwestern United States in corn and soy agroecosystems
- 503 peer-reviewed and 'grey literature' references were screened
- Screening Criteria:



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Tradeoff Summary

- Tradeoff Summary: the relationship between one or more indices/measures of agricultural productivity (yield) and one or more measures/indices of ecosystem service

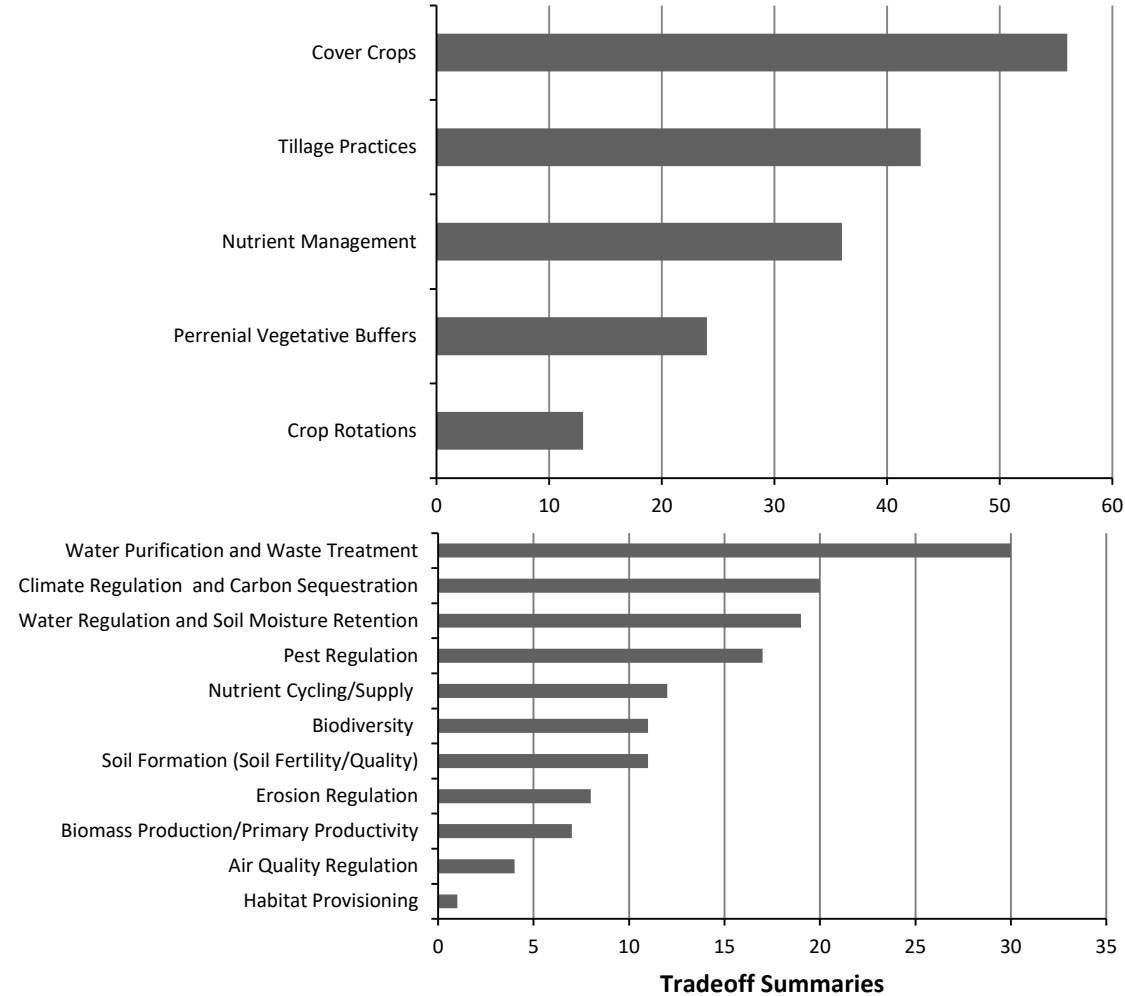
Tradeoff Summary Category	Tradeoff Summary Definition	Combination Characterization
-/-	Yield reduced; ES reduced	Co-costs (negative synergy)
-/+	Yield reduced; ES increased	Agricultural Yield Tradeoff
+/-	Yield increased; ES reduced	Ecosystem Service Tradeoff
+/+	Yield increased; ES increased	Co-benefits (positive synergy)

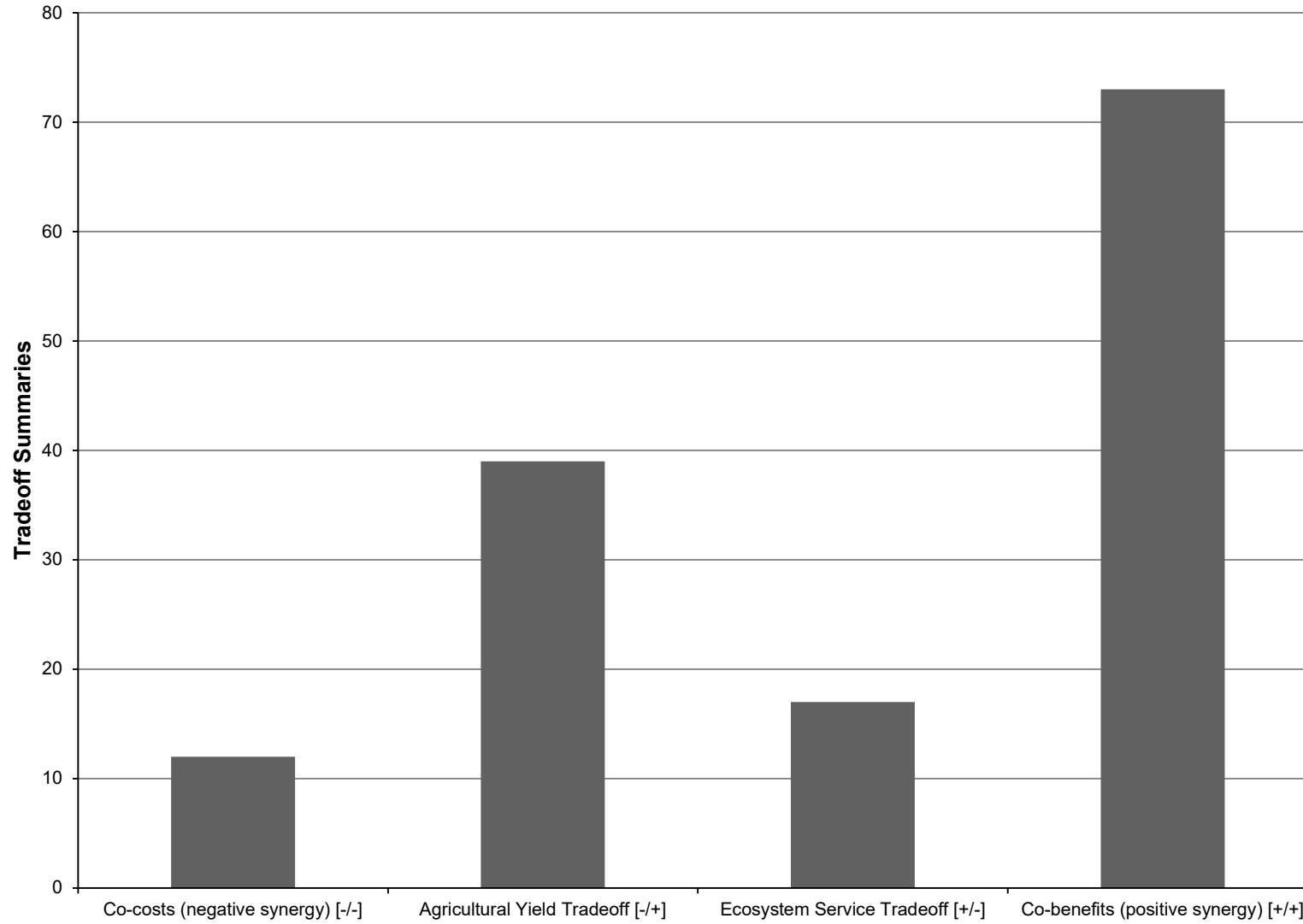
Ecosystem Services; Predictor Variables

Ecosystem Service Category	Ecosystem Service	Predictor variables
Provisioning	Food Production (reference tradeoff outcome)	Temporal Scale (Short; Medium; Long; Very Long)
		Spatial Scale (Local; Regional; National; International)
Regulating	Air Quality Regulation	Precipitation (Average Annual Rainfall (mm))
	Climate Regulation and Carbon Sequestration	Temperature (Average Annual Temperature (°C))
	Erosion Regulation	Study Type (Empirical; Empirical-Modelled)
	Water Purification and Waste Treatment	Study Design (Control-Impact; Correlative Design)
	Water Regulation and Soil Moisture Retention	BMP Category (Edge of Field; In-Field)
Supporting	Pest Regulation	BMP Intervention (Single BMP; Multiple BMPs)
	Biodiversity Conservation	Perennial Vegetated Buffers (Buffer and Filter Strips/Hedgerows/Riparian Buffers)
	Biomass Production/Primary Productivity	Cover Crops
	Habitat Provisioning	Crop Rotations
	Nutrient Cycling/Supply	Nutrient Management
	Soil Formation (Soil Fertility/Quality)	Tillage Practices
		Ecosystem Service Category
		Ecosystem Service
		Corn
		Soybean
	Wheat	
	Cereal Grain	

Major Results

- 141 *tradeoff summaries* from 36 individual studies



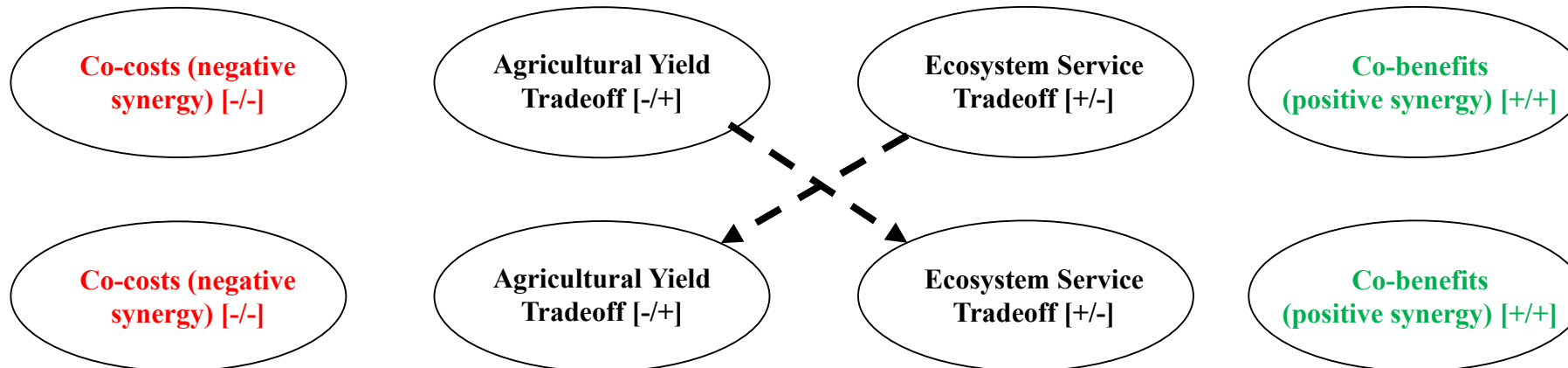


Predictive Modelling

- Multinomial Logistic Regression? (Order not important)

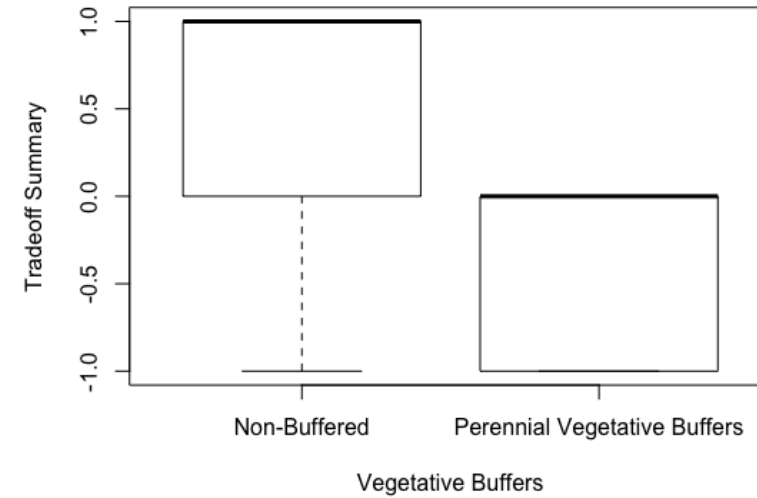
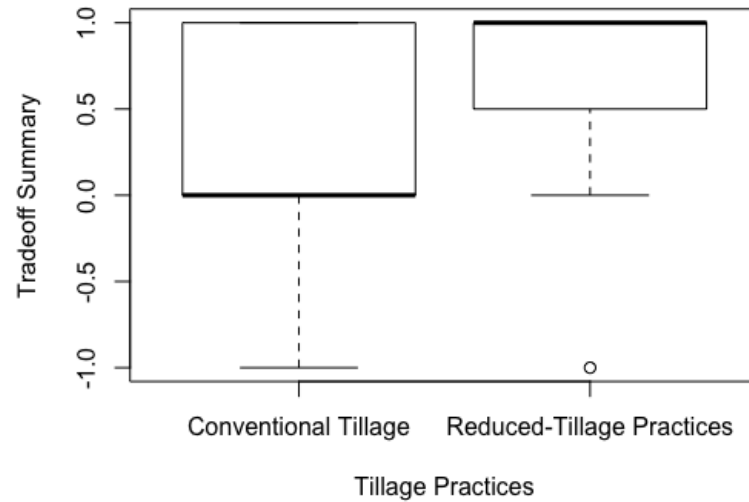
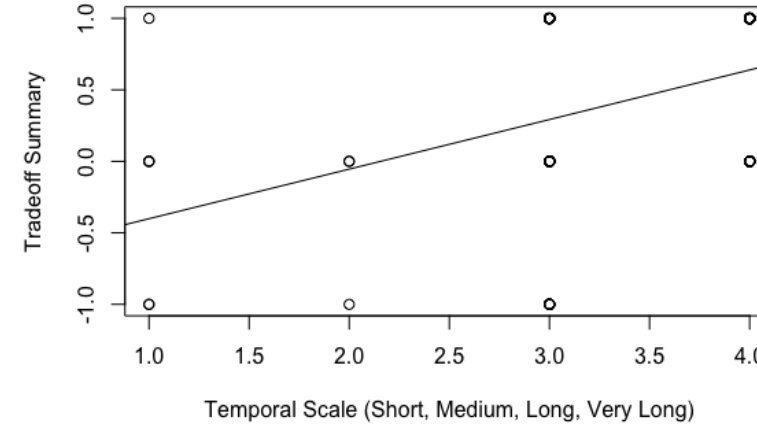
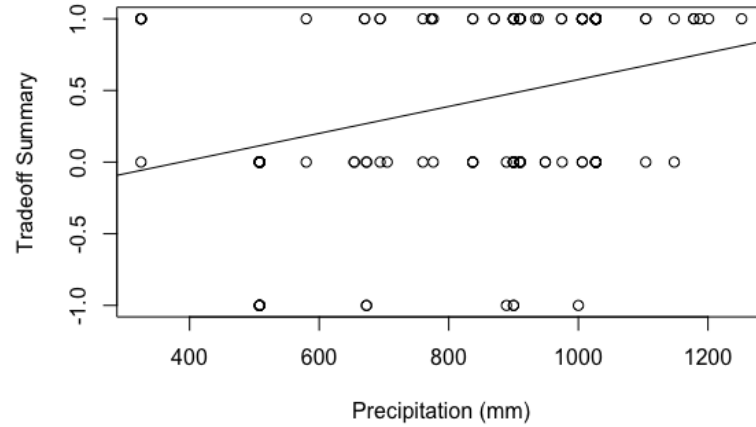


- Ordinal Logistic Regression? (Order important)



- Weighted tradeoffs: 5 different weights to Agricultural Yield
- $P(+/+)$ = 1; $P(-/-)$ = -1; $P(-/+)$ & $P(+/-)$ fall between 1 and -1

Predictive Modelling



Conclusion

- Co-benefits of BMP implementation was more prevalent than tradeoffs
- BMPs are scalable, since they are beneficial (or at least not harmful) – demonstrate low risk of ecosystem services leakage
- A step towards identifying co-benefits and the impact of specific practices on specific ecosystem services

Outreach & Partnership



- "Statistically rigorous quantification of the expected performance of various agricultural BMPs on ecosystem services" → advocate for more implementation of improved agricultural management and more public and private investment in BMPs
 - Farmers, Producer Organizations, Agribusiness Companies, Government Partners

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