# Incorporating Ecosystem Services into Monarch Habitat Restoration Planning using Riparian Buffer Strips



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# Project Description and Goals

- Monarch butterfly population is under consideration for Threatened and Endangered status under the Endangered Species Act

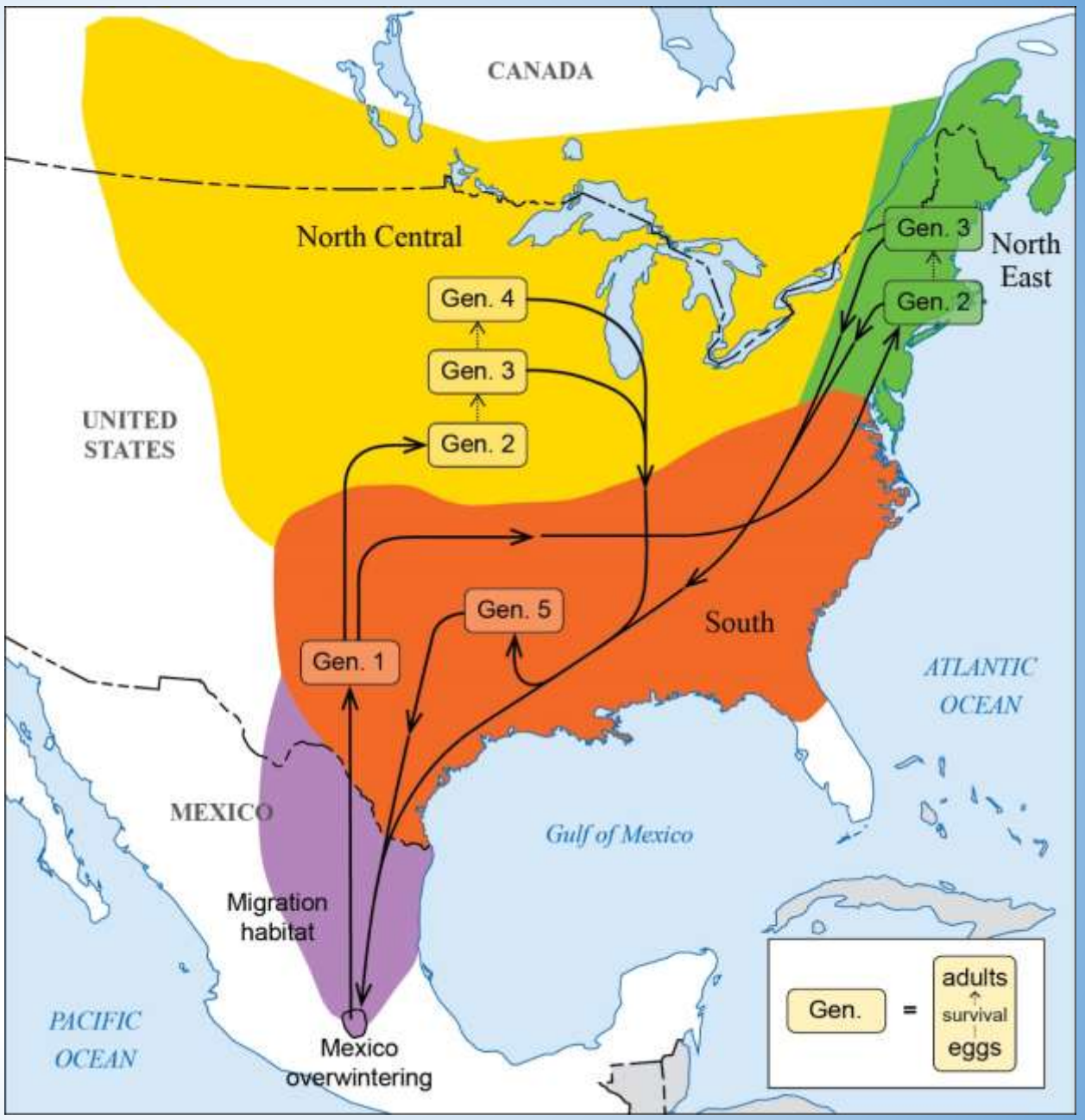
- “Presidential Memorandum” 2014
  - By 2020, the primary objective is to increase eastern monarch population numbers to 6 hectares of area occupied in Mexico, or approximately 225 million individual butterflies. As a primary means of reaching this goal, the central flyway of the U.S. has been identified as a high priority for habitat restoration efforts, including the addition of at least 1 to 1.5 billion milkweed stems and abundant nectar resources to support monarch reproduction and migration.

- Examine the viability of targeting riparian buffer strips in agricultural areas to provide milkweed and other native vegetation habitat for monarch butterflies
  - Thogmartin and Semmens et al. (in press) “All Hands on Deck”

- Consider the co-benefits that riparian buffer strips have on improving ecosystem services like sediment and nutrient retention on croplands throughout the Upper Midwest Region

**Piedra Herrada Monarch Butterfly Sanctuary, Mexico**

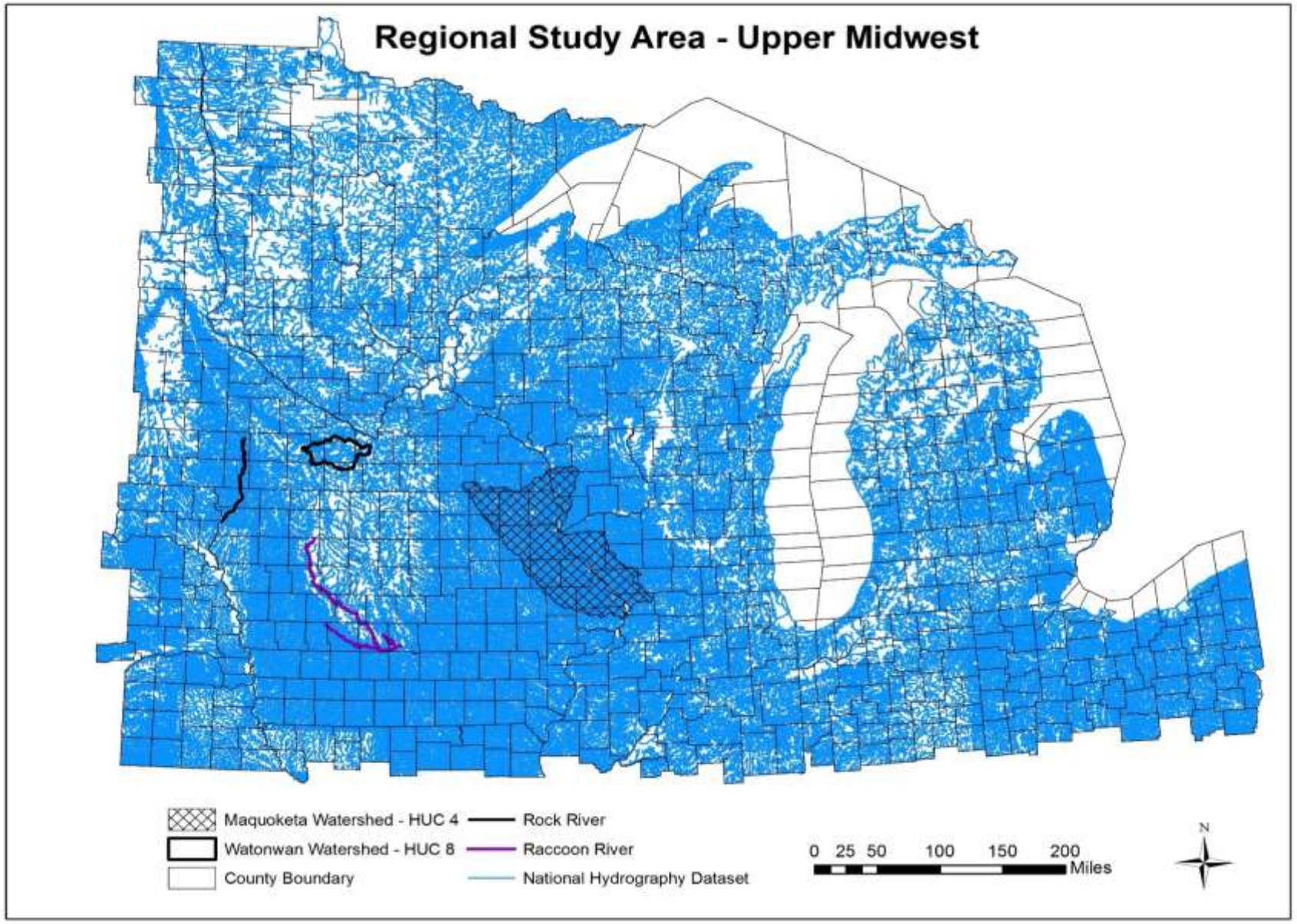
Photo Credit: Steve Hilburger




**Annual Multigenerational cycle of the Monarch Butterfly**

Thogmartin and Semmens et al. (in press)

# Study Area


Regional Study Area - Upper Midwest
Maquoketa Watershed - HUC 4
Watonwan Watershed - HUC 8
County Boundary
Rock River
Raccoon River
National Hydrography Dataset
0 25 50 100 150 200
Miles
N

# Riparian Buffer Creation by Stream Order

- National Hydrography Dataset Plus V2 (NHD) filtered to include stream orders from 1 to 5
  - Stream orders larger than 5 excluded due to width
- Buffers created in ArcGIS for the modeling of three scenarios that target varying buffer widths
  - **Scenario 1:** 30 meter buffers
  - **Scenario 2:** 100 meter buffers
  - **Scenario 3:** Varying buffer widths; First order streams (80 meters), Second order streams (100 meters), and Third through Fifth order streams (120 meters)

# Cropland and Natural Areas Data and Methods

- National Resource Conservation Service (NRCS) Cropland Data Layer used to create subgroups of land-cover classes to determine percentages of land that are considered “Natural”, “Corn & Soybean”, or “Other Crops & Fruit/Trees/Vines”

| | Total Area (acres) | Natural Areas (percent) | Corn & Soybean (percent) | Other Crops & Fruit/Trees/Vines (percent) |
|---|---|---|---|---|
| Scenario 1 | 9,145,090 | 45% | 53.6% | 1.4% |
| Scenario 2 | 30,623,983 | 40% | 58.4% | 1.6% |
| Scenario 3 | 28,112,219 | 42% | 56.5% | 1.5% |

# Milkweed Habitat Restoration Results

| | Total Acres | Natural Areas (percent) | Total Acres Non-Natural | Milkweed Potential (CRP) | Milkweed Potential (Grassland) |
|---|---|---|---|---|---|
| Scenario 1 (30 Meter) | 9,145,090 | 45% | 5,029,800 | 564,041,772 | 15,542,082 |
| Scenario 2 (100 Meter) | 30,623,983 | 40% | 18,374,389 | 2,060,504,072 | 56,776,864 |
| Scenario 3 (80-120 Meter) | 28,112,219 | 42% | 16,305,087 | 1,828,452,458 | 50,382,719 |

**Table 1: Summary of scenario results** (Milkweed Potential calculated as number of milkweed stems under given management scenarios)

*Goals for Milkweed Restoration: 1 to 1.5 billion milkweed stems*

# Benefits from Riparian Buffers

Wildlife/Pollinator Habitat

Nutrient Retention

Riparian Buffer

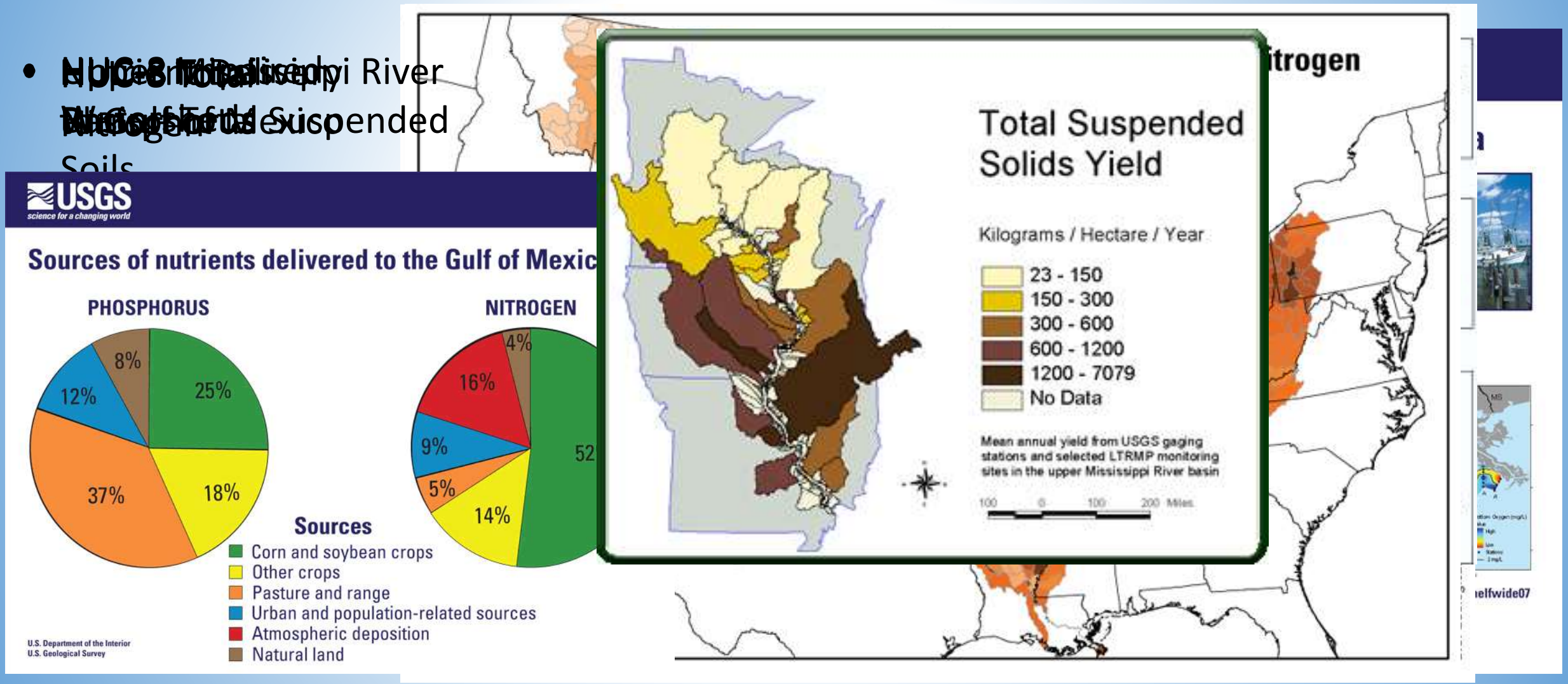
Flood Reduction

Bank Stability

Sediment Retention

# Impaired Watersheds of the United States

- Upper Mississippi River
- Suspended Soils



# Sediment and Nutrient Trapping Efficiency

| Water Quality Indicator | 20-30 Meter - Grass Buffers | 40+ Meter - Grass/Woody Buffers |
|---|---|---|
| Nitrogen | 61% | 92% |
| Phosphorus | 72% | 93% |

*Credit: Yale, 2005*

| Water Quality Indicator | 6-18 Meter Buffers | 20+ Meter Buffers |
|---|---|---|
| Sediment | 77%-90% | 90%+ |

*Credit: Yuan, 2009*

# Nutrient Retention from Riparian Buffer Strips

- SPARROW model results from 2002 summarize nitrogen and phosphorus concentrations from 259 HUC-8 watersheds in Iowa, Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin
  - Total Nitrogen (434,705 kg/yr) and Phosphorus (32,359 kg/yr) was altered by Natural Area percentage to better reflect only buffered areas

| | Natural Areas (percent) | Total Nitrogen (kg/yr) | Total Nitrogen Retained (kg/yr) | Total Phosphorus (kg/yr) | Total Phosphorus Retained (kg/yr) |
|---|---|---|---|---|---|
| Scenario 1 (30 Meter) | 45% | 239,088 | 145,844 | 17,797 | 12,814 |
| Scenario 2 (100 Meter) | 40% | 260,823 | 159,102 | 19,415 | 13,979 |
| Scenario 3 (80-120 Meter) | 42% | 252,129 | 153,799 | 18,768 | 13,513 |

Nitrogen Trap efficiency of 61% for all scenarios

Phosphorus Trap efficiency of 72% for all scenarios

# Sediment Retention from Riparian Buffer Strips

- USGS stream gauges and Long Term Resource Monitoring provided averages of Total Suspended Sediment deposited in the Gulf of Mexico throughout the Mississippi River basin
  - Total Suspended Sediment (436,000 tons/day) was altered by Natural Area percentage to better reflect only buffered areas

| | Natural Areas (percent) | Total Suspended Sediment (tons/day) | Total Sediment Retained (tons/day) |
|---|---|---|---|
| Scenario 1 (30 Meter) | 45% | 239,800 | 184,646 |
| Scenario 2 (100 Meter) | 40% | 261,600 | 201,432 |
| Scenario 3 (80-120 Meter) | 42% | 252,880 | 194,718 |

Sediment Trap efficiency of 77% for all scenarios

# Pollinator Habitat

- A synthesis of research on 12 species of bees showed flight/foraging distances to be an average of 2,500 meters (NRCS, 2009)

- Total Acres of crops requiring pollination in Upper Midwest estimated to be approximately 7,264,275 Acres
  - Apple, Blueberry, Squash, Pepper, Tomato, Watermelon….

- Pollinator analysis in progress, initial assumptions from pre-processing estimate 75% of crops requiring pollination are within 2500m of buffers
  - Approximately 5,448,206 Acres with an average increase in yield by $1,570 per acre of crops requiring pollination
    - Initial estimates of 8.5 billion dollars from an increase in wild pollinators in this region

| **Crop** | Apple | Blueberry | Squash | Pepper | Tomato | Soybean |
|---|---|---|---|---|---|---|
| **$/Acre** | 1,046 | 1,076 | 3,301 | 513 | 1,907 | 18 |

*USDA NASS, 2011*

# Conclusions

- Monarch habitat restoration goals can be partially if not fully met by implementing riparian buffers alongside agricultural lands in the Upper Midwest's "Central Flyway"
- Nutrients and Sediments from croplands degrade watersheds and impact areas far beyond their footprint, riparian buffers have been proven to significantly reduce the amount of nitrogen, phosphorus and sediment infiltrating into waterways
- Initial estimates show that wild pollinators would increase yields by approximately 1,500 dollars per acre on average to crops that require pollination, with regional increases of over 8.5 billion dollars

# Future Work

- Examine the viability of also targeting riparian buffers for recreational uses (fishing, hunting, hiking, biking, etc)
- Update SPARROW and RUSLE2 models for more recent estimates of nutrient and sediment concentrations in areas where buffers would be present
- Investigate the other benefits that riparian buffers provide (Sediment deposit in dams/locks along the Mississippi River, Commercial Fisheries and the loss from Gulf Hypoxia)
- Explore the market mechanisms that could be used to bring about this large-scale transition from agricultural land to riparian buffers (Subsidy, PES Programs)

# Questions?

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Photo credit: Richard Ellis, Getty Images