Ecosystem Services Delivery Project Final Presentation

Department of Geographical and Sustainability Sciences

The University of Iowa
IOWA INITIATIVE
FOR SUSTAINABLE COMMUNITIES

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Effects of Contrasting Management Scenarios on Ecosystem Services Delivery in Iowa City, IA

GEOG: 3340

FALL 2015

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Agenda

- Background
- Carbon Storage and Sequestration
  - Methodology
  - Current Ecosystem Service Delivery
  - Potential Future Ecosystem Service Delivery
- Crop Pollination
  - Methodology
  - Current Ecosystem Service Delivery
  - Potential Future Ecosystem Service Delivery
- Conclusion

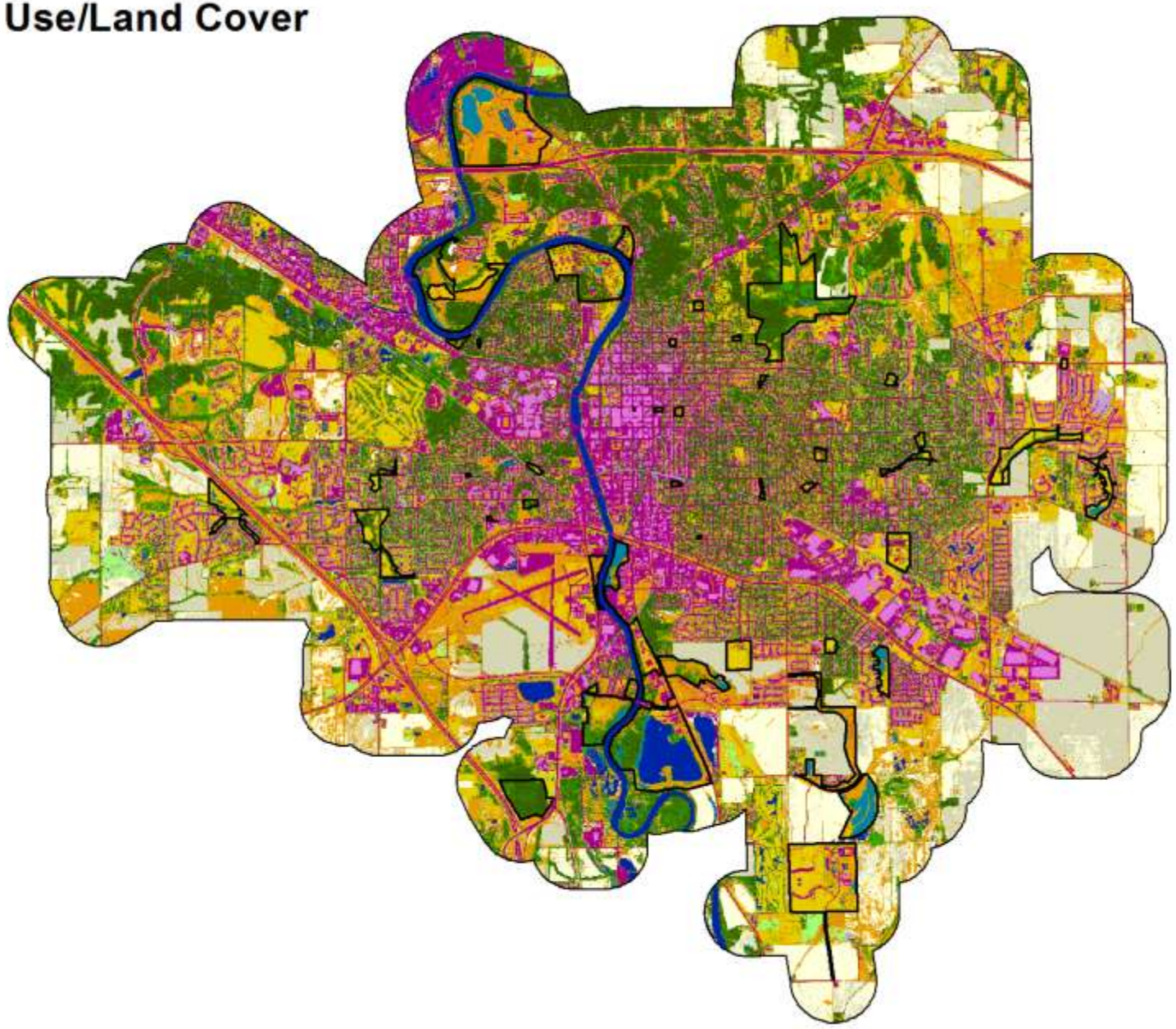
Background

Purpose: Evaluate how changes in land cover on Iowa City's protected open spaces might affect the delivery of ecosystem services

Based on data availability and time constraints, the services analyzed in this study are:

- Carbon Sequestration
- Crop Pollination

Iowa City:
2009 Land Use/Land Cover
Updated



N

Legend

Iowa City Parks

- Barren / Fallow
- Corn
- Cut Hay
- Deciduous Medium
- Deciduous Short
- Deciduous Tall
- Grass 1
- Grass 2
- Roads / Impervious
- Shadow / No Data
- Soybeans
- Structures
- Water
- Wetlands

0 0.5 1 2 Miles

Data Sources: Iowa DNR NRGIS Library and Iowa GIS Data Repository

Carbon Storage and Sequestration

Ecosystems remove carbon from the atmosphere, thus reducing the amount of greenhouse gases.

Carbon storage keeps carbon from reentering the atmosphere and reduces global warming.

Climate regulation is a valuable service that depends on vegetation types.

We expect to see a correlation between the increase of tree abundance and carbon storage.

Carbon Storage and Sequestration Model

InVEST Carbon and Sequestration model uses land cover and carbon pool values to estimate carbon storage and carbon sequestration over time.

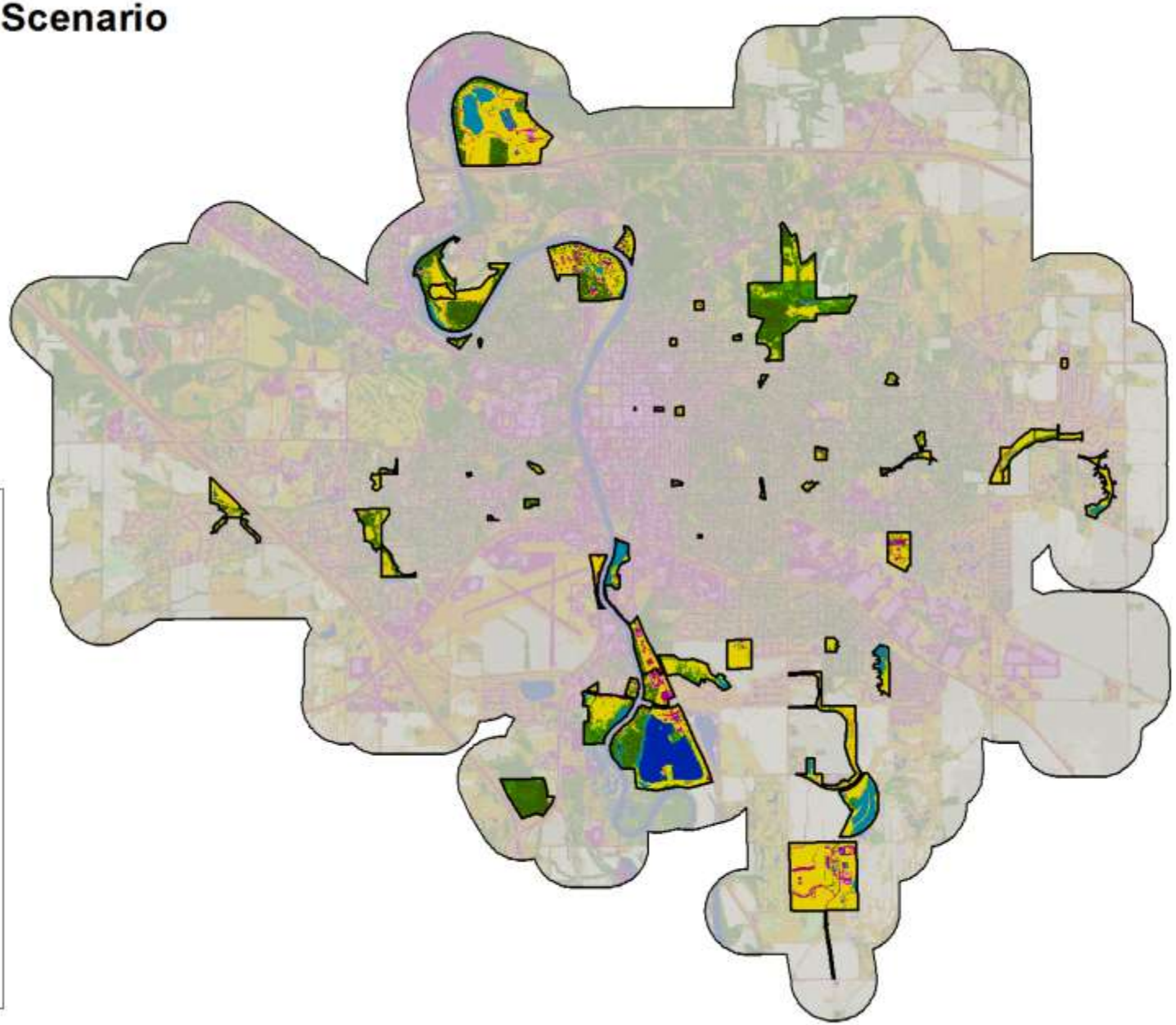
We used only parks as our study area to value carbon services.

Future scenarios used for our study to determine changes in sequestration and storage over time are:

- Change all park land cover to forest
- Change all park land cover to tall grass

Carbon sequestration is valued using the current social cost of carbon.

Iowa City Parks:
Tall Grass Scenario



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Legend

Iowa City Parks

Land Use/ Land Cover

- Barren / Fallow
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0 0.5 1 2 Miles

Data Sources: Iowa DNR NRGIS Library and Iowa GIS Data Repository

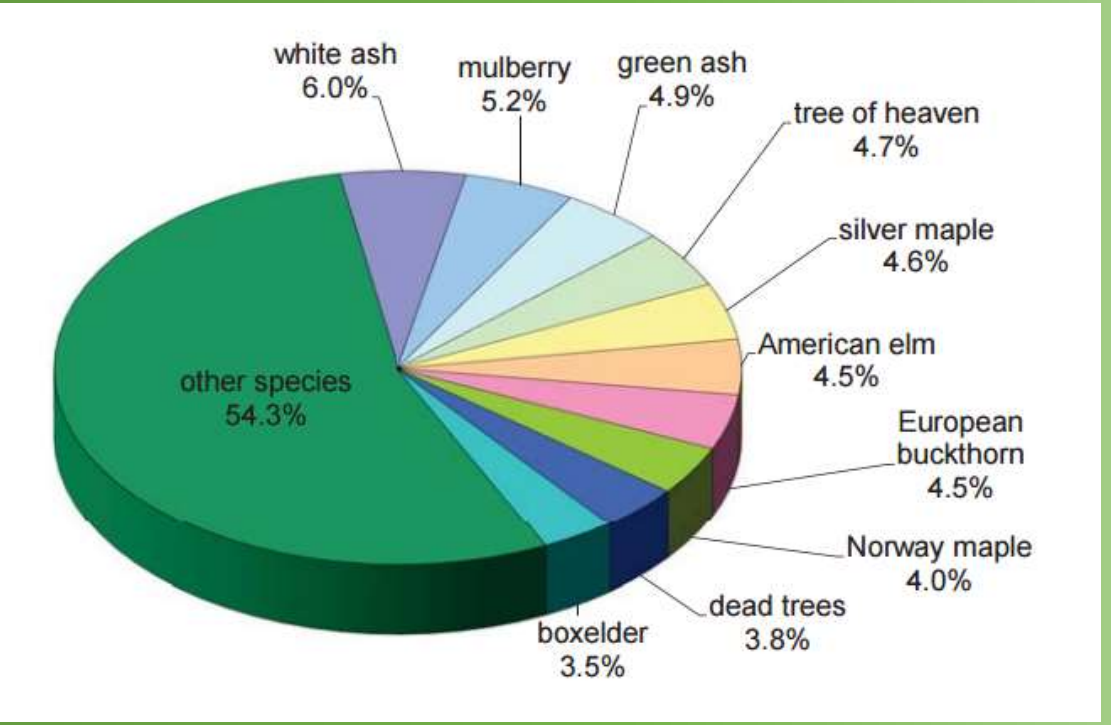
Carbon Storage and Sequestration - Methodology

- Each LULC type has an estimate of carbon stored in the basic carbon pools.
- The model uses estimates of carbon storage for each parcel on the grid to analyze changes in land use.

- Model simplifies carbon cycle
- Pool types (Mg C/ha)
  - aboveground carbon
  - belowground carbon
  - carbon stored in dead biomass
  - soil carbon

Carbon Storage and Sequestration - Methodology

- Carbon pool values are found using biomass data
- The forest service has methods for calculating the amount of carbon in a certain amount of biomass
- Ex: urban forest in Chicago area.



(Nowak et al, 2010)

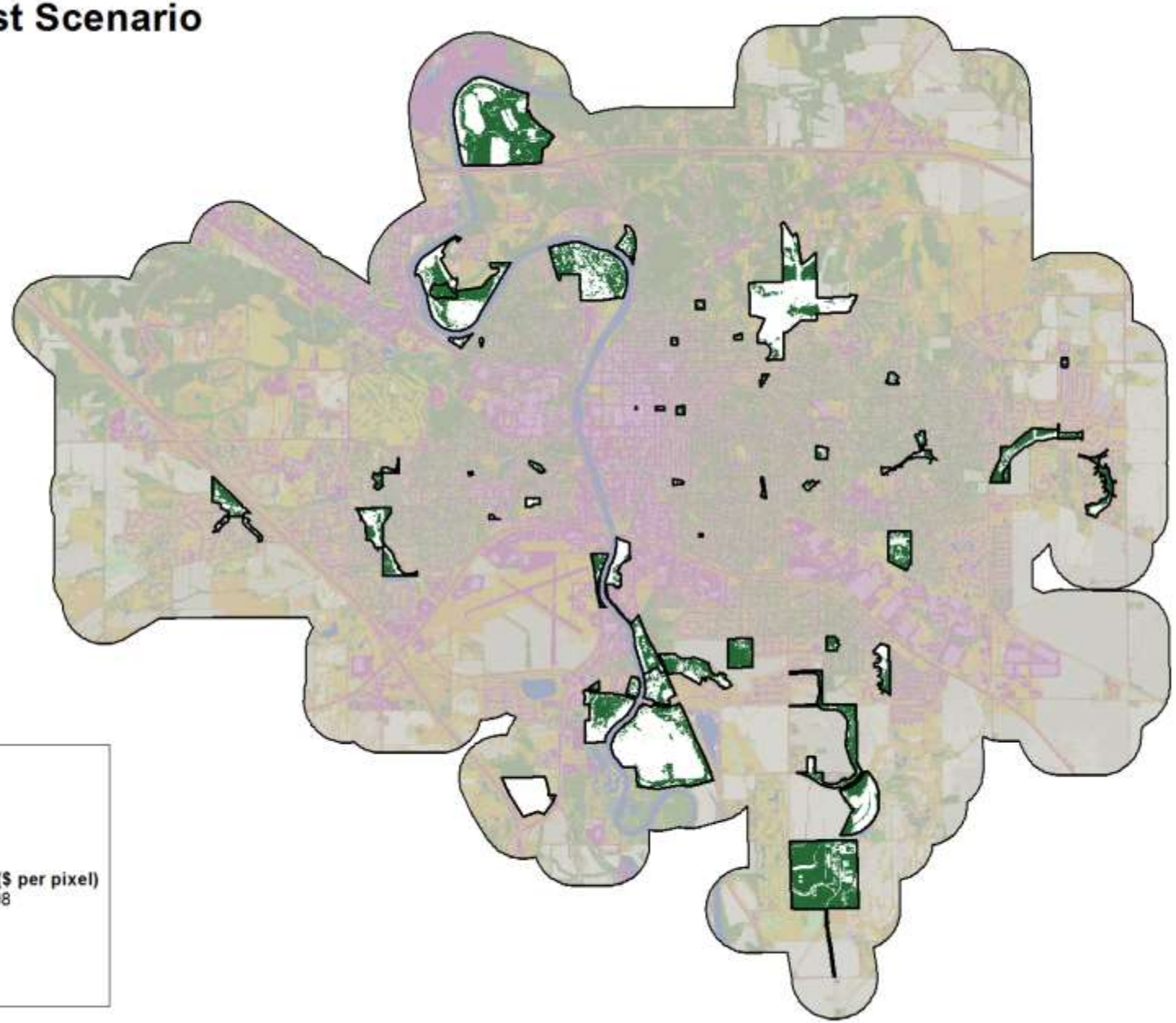
Carbon Pool Table

LULC_name	Above Ground Carbon (mg C/ha)
Open water	0
Wetlands	7.6
Deciduous Short	50.9
Deciduous Medium	49.5
Deciduous Tall	48.4
Grass 1	4.5
Grass 2	4.5
Cut Hay	5.1
Corn	5.1
Soybeans	5.1
Barren / Fallow	1
Structures	0
Roads/Impervious	0
Shadow/No Data	0

Carbon pool data- Chang Zhao, Ulowa grad student

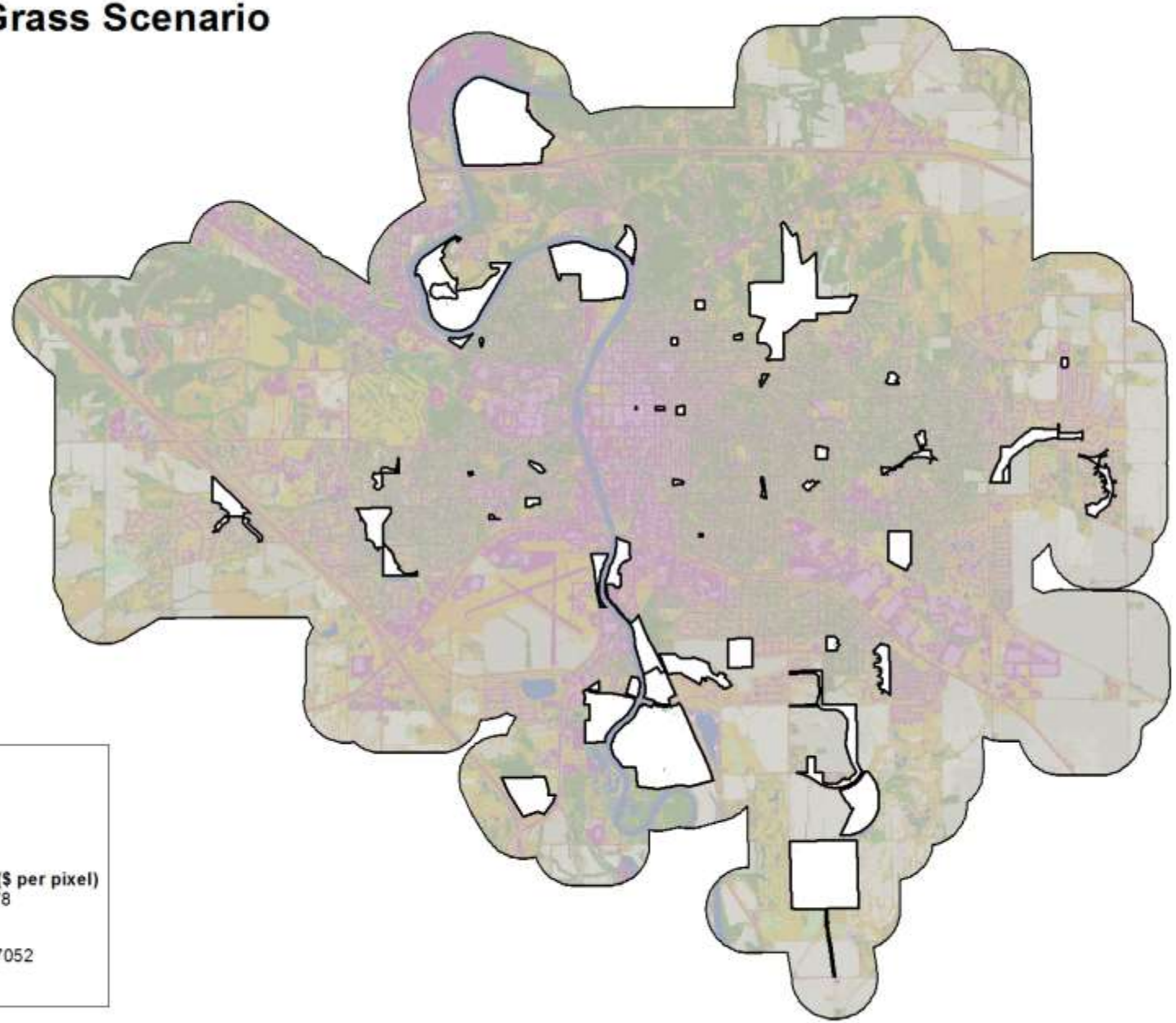
- used area statistics and biomass information to come up with these estimates.

Iowa City Carbon Sequestation: 2020 Forest Scenario Value



Data Sources: Iowa DNR NRGIS Library and Iowa GIS Data Repository

Iowa City Carbon Sequestation:
2020 Tall Grass Scenario
Value



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Legend

Iowa City Parks

Sequestration Value ($ per pixel)

High : 0.012078

Low : -0.00207052

0 0.5 1 2 Miles

Data Sources: Iowa DNR NRGIS Library and Iowa GIS Data Repository

Results

Biophysical Results

Scenario	Total Carbon (Mg of carbon)	Sequestered carbon (compared to current scenario) (Mg of carbon)
Current	12,444.86	N/A
Forest 2020	27,013.67	14,568.82
Tall Grass 2020	12,446.07	1.22

Valuation Results

Scenario	Sequestered carbon (Mg of carbon)	Net present value (USD)
Forest 2020	14,568.82	$502,750.84
Tall Grass 2020	1.22	$41.99

Crop Pollination: Pollinator Abundance

75% of globally important crops rely in part or completely on animal pollination

Important for urban vegetation/gardens, agriculture, & natural habitats

- Increases yield
- Plant quality
- Plant stability

Quantity & diversity of animal pollinators critical to assessing pollination services, habitat protection, & agricultural vulnerability

Crop Pollination Model

InVEST Pollinator Abundance Model uses nesting sites availability, flower resources, and bee flight ranges to map the abundance of bee pollinators in a landscape.

Future scenarios are used to determine the changes in pollinator abundance. The scenarios used in our study are:

- Convert all parks into forest
- Convert all parks into tall grassland/prairie
- Convert all parks into developed land

Crop Pollination Model

Input Data

1. Current Land Cover Map: designates LULC code for each cell, edited with proposed management to landscape
2. Pollinator Species/Guild Table: containing information on each species of pollinator
   - based on relevant literature or expert opinion
3. Land Cover Attributes Table: containing data on each class in the LULC map, based on relevant literature or expert opinion

Crop Pollination Model - Methodology

Study area

Our focus is on Iowa City as a whole with a 500 m. buffer and we plan on using the model to calculate the pollinator abundance across the entire city

- Focused on city owned property
- Want to see if biodiversity made a difference

Change resolution from 1 m to 5 m due to time restraints

Crop Pollination Model - Methodology

Expert Information for bee guilds and land cover information:

Dr. Stephen Hendrix, Professor Emeritus - Department of Biology

- Greenleaf et al. (2007) formula to determine foraging distance
- Maximum homing distance was used to determine values of *log a* and *b*
  - IT - Intertegular span, the distance between the wing bases

$$\log Y = \log a + b \log IT$$

$$log\ (foraging\ distance) = (-1.363) + 3.366 \cdot \log\ (IT)$$

Crop Pollination Model - Methodology

These are the most prominent species....what percentage...distance based on body length

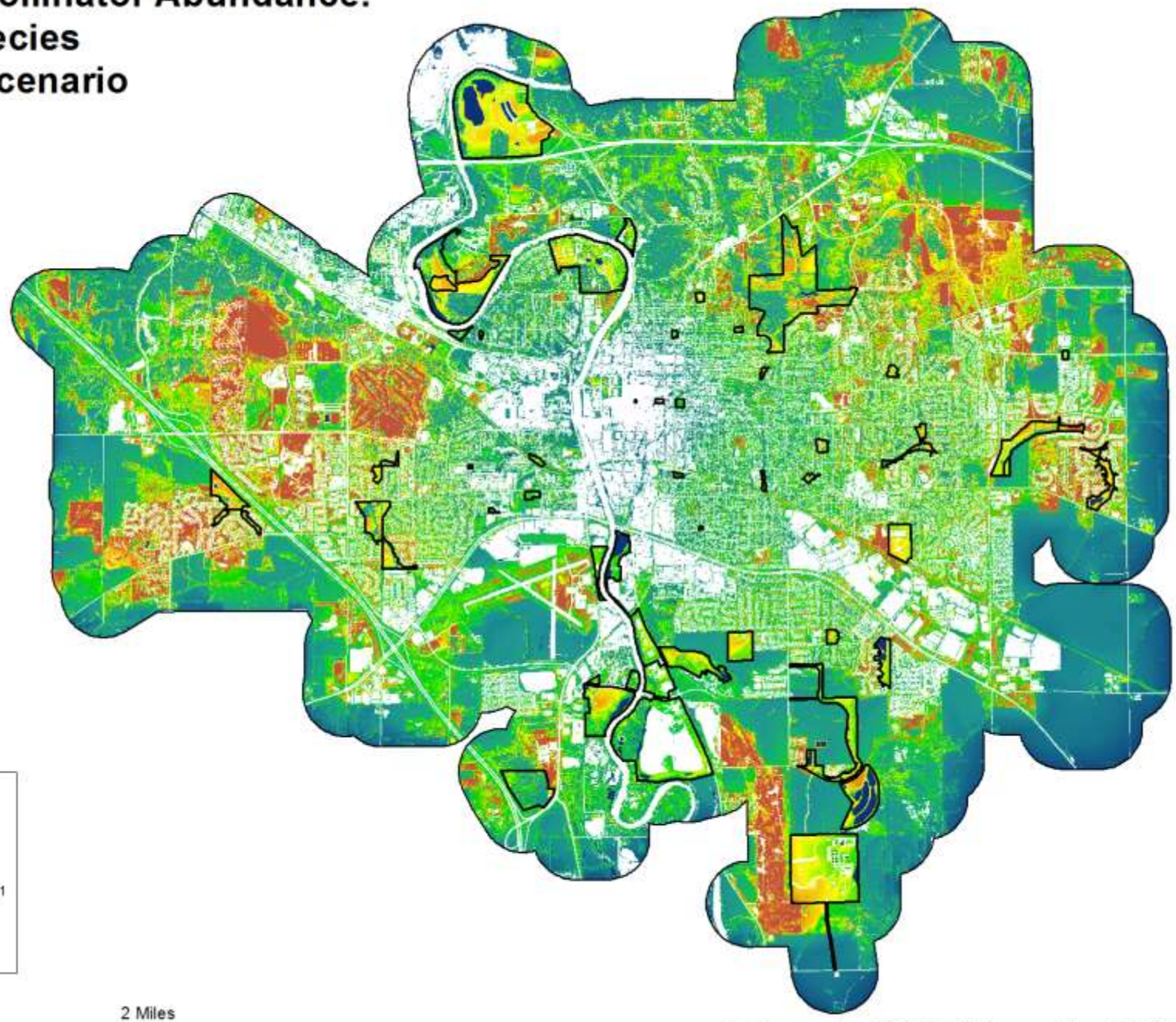
Species	NS_cavity	NS_ground	FS_April-May	FS_June-July	FS_Aug-Sept	Body Length (IT)	Distance (meters)
Bombus griseocollis	1	0	0	1	0.5	4.16	5258.58
Lasioglossum (Dialictus) prunosium	0	1	0.7	1	0	1.22	84.66
Halictus ligatus	0	1	0.2	1	0.5	1.44	147.93
Andrena wilkelli	0	1	0	1	0	2.23	644.75
Bombus impatiens	1	0	0	0.6	1	3.7	3544.60
Lasioglossum (Dialictus) rohweri	0	1	0.6	1	0.1	1.16	71.44
Halictus confusus	0	1	0.9	1	0.2	1.44	147.93
Andrena zizia	0	1	0.7	1	0	1.34	116.10

Crop Pollination Model - Methodology

- Land use
- Different scenarios (Within park boundaries):
  - Grass to forest
  - Turf grass to tall grass
  - All land to developed land (except water)

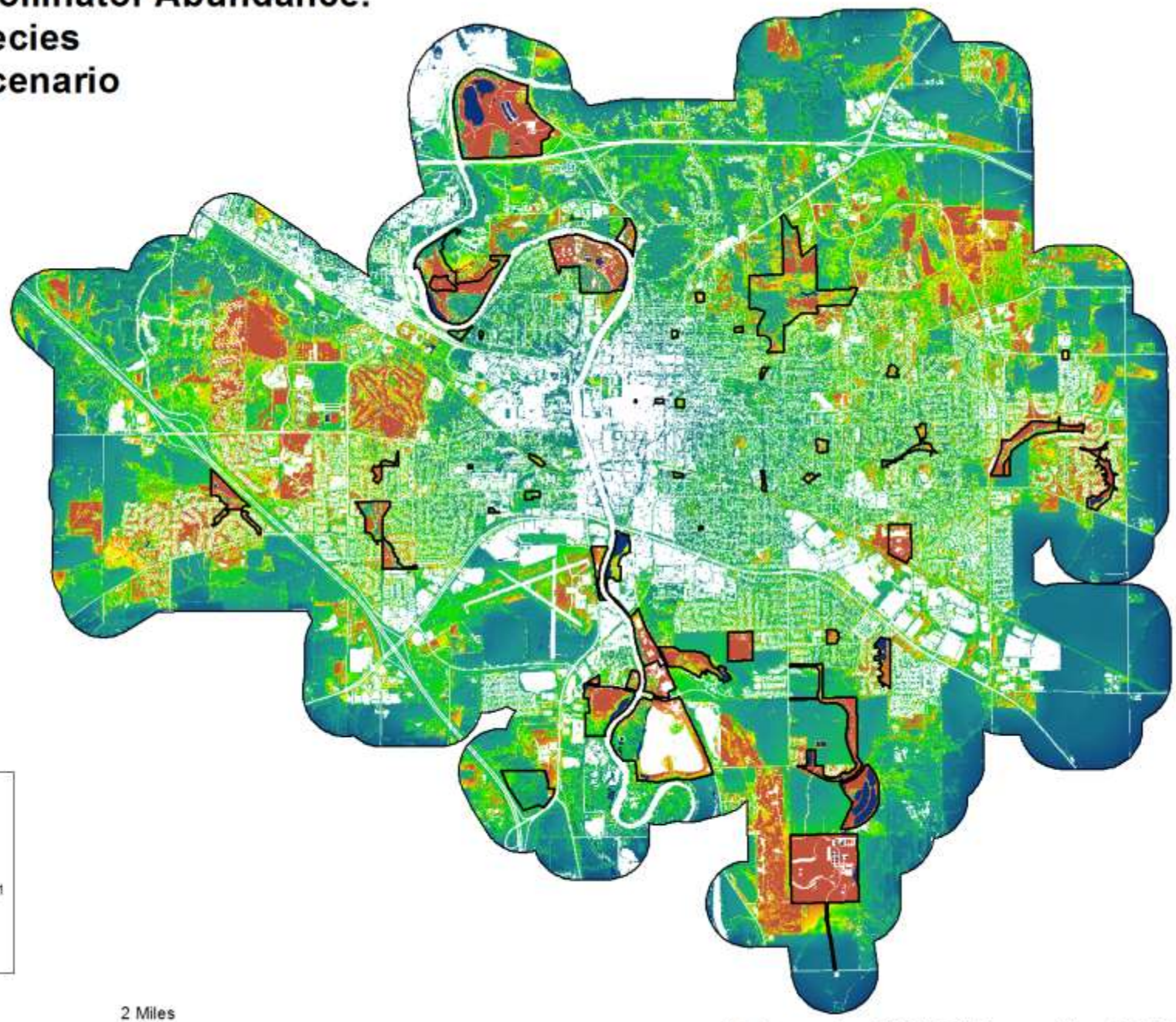
LULC	Description	LULC Group	Nesting: cavity	Nesting: ground	April-May	June-July	Aug-Sept
1	Water	Water	0	0	0	0	0
2	Wetland	Water	0.2	0	0	0.5	0.2
3	Coriferous forest	Forest	0.3	0.3	0.2	0	0
4	Decidous short	Forest	0.7	0.7	0.3	0.2	0.2
5	Decidous medium	Forest	0.5	0.5	0.3	0.2	0.2
6	Decidous tall	Forest	0.2	0.2	0.3	0.2	0.2
7	Grassland 1	Unkn	0	0.5	0.2	0.2	0.2
8	Grassland 2	Unkn	1	1	0.2	1	0.7
9	Cut hay	Ag	0.5	0.7	0.1	0.5	0.3
10	Corn	Ag	0	0.3	0.1	0.1	0.1
11	Soybeans	Ag	0	0.3	0.1	0.1	0.1
12	Barren/fallow	Ag	0.5	1	0.2	0.5	0.3
13	Structures	Built	0	0	0	0	0
14	Roads	Built	0	0	0	0	0
15	Shadow/no data	Unkn	0	0	0	0	0

Future Pollinator Abundance: Four Species Forest Scenario



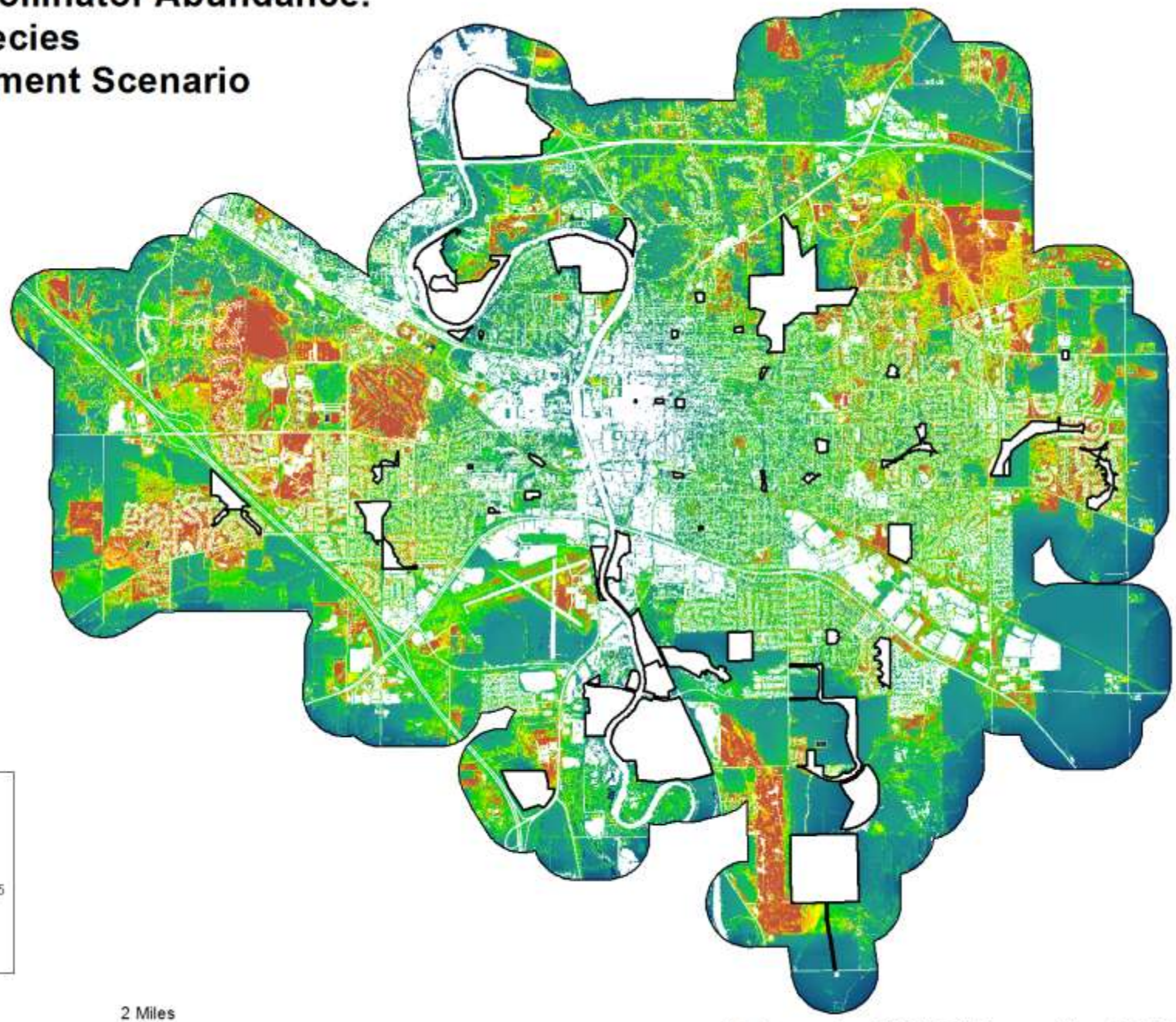
Data Sources: Iowa DNR NRGIS Library and Iowa GIS Data Repository

Future Pollinator Abundance: Four Species Grass Scenario



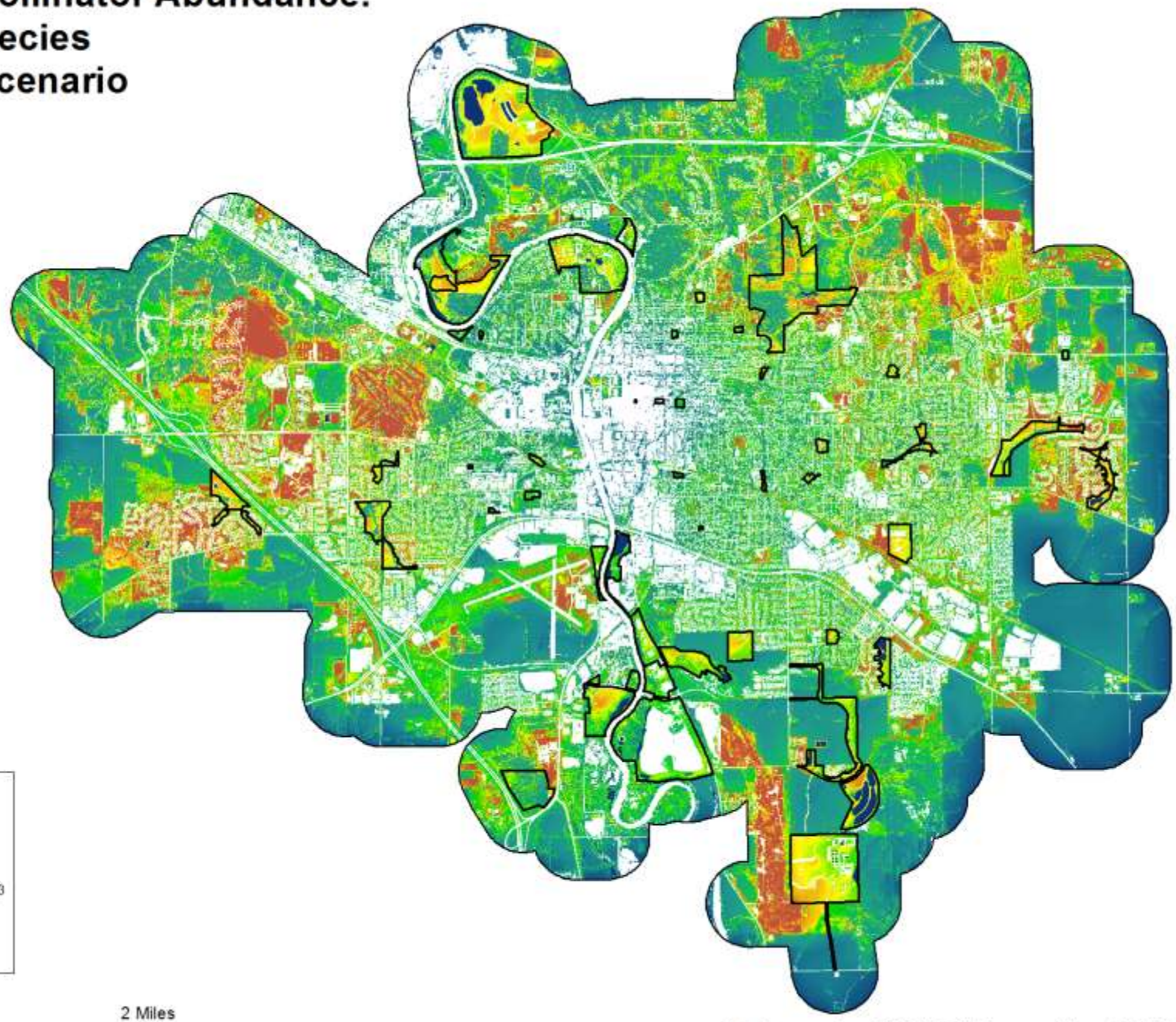
Data Sources: Iowa DNR NRGIS Library and Iowa GIS Data Repository

Future Pollinator Abundance: Four Species Development Scenario



Data Sources: Iowa DNR NRGIS Library and Iowa GIS Data Repository

Future Pollinator Abundance: Eight Species Forest Scenario



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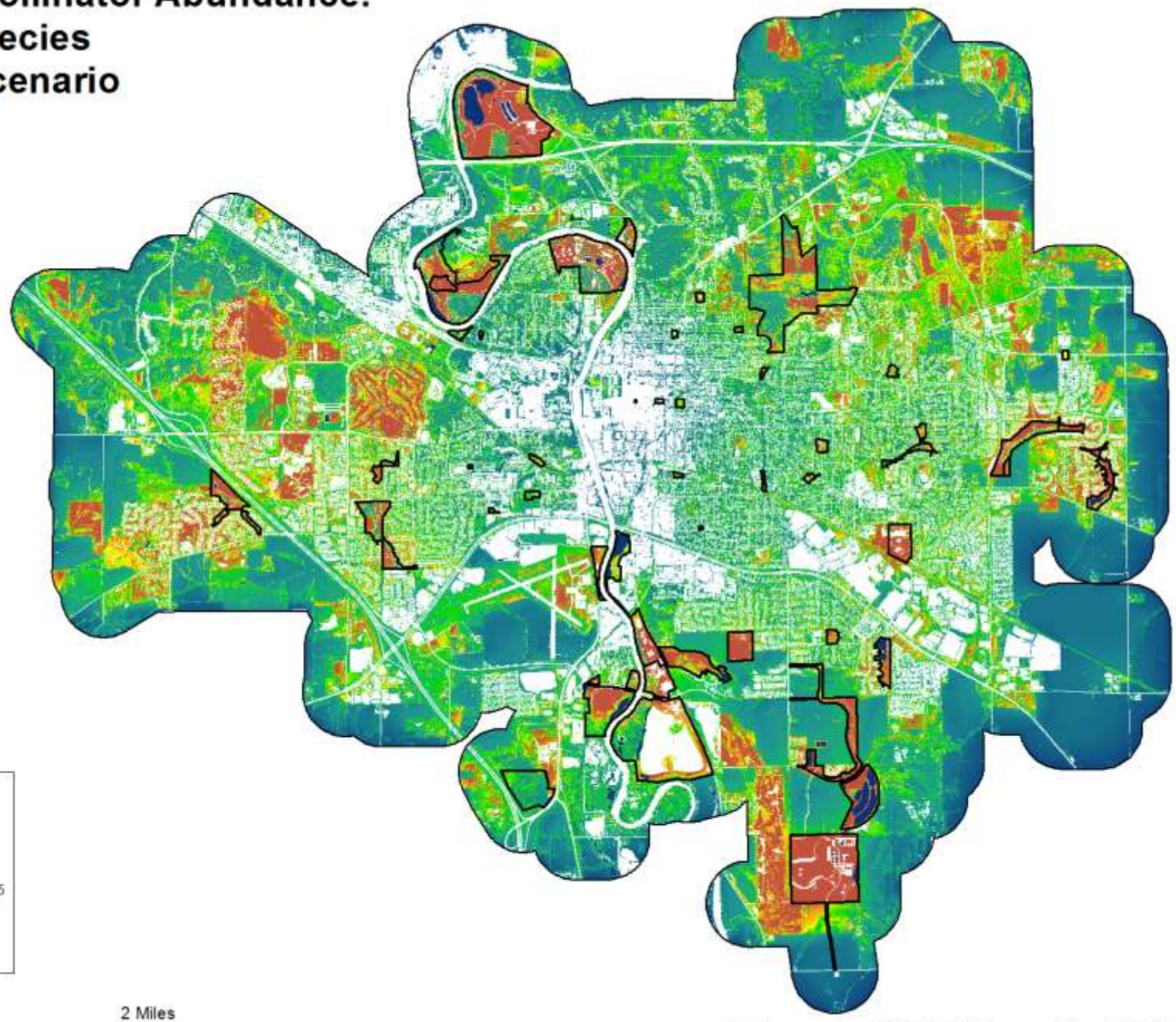
Future Pollinator Abundance: Eight Species Grass Scenario



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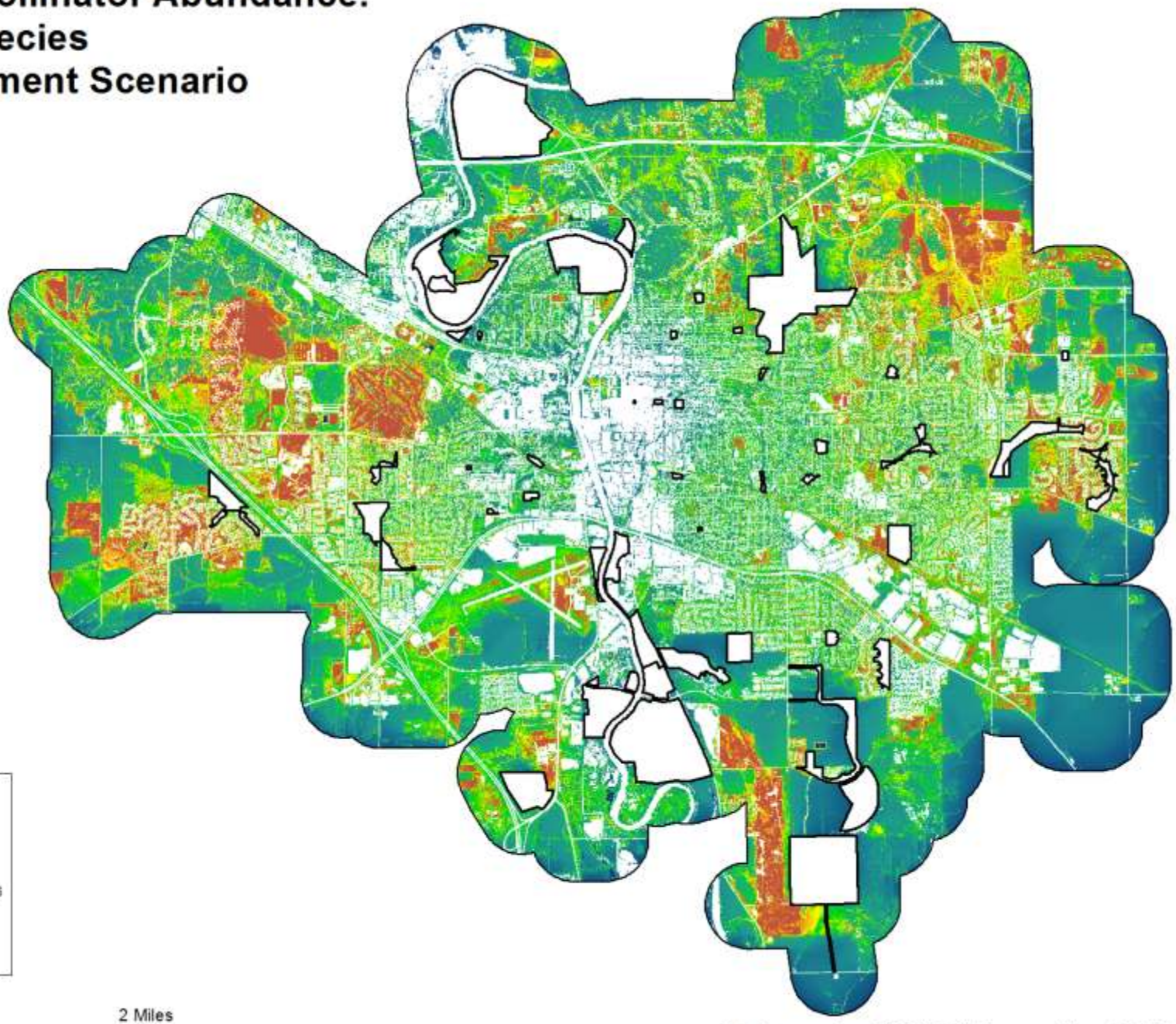
Future Pollinator Abundance: Eight Species Development Scenario



Data Sources: Iowa DNR NRGIS Library and Iowa GIS Data Repository

Results

Number of Species	Scenario	Maximum Pollinator Abundance
4	Current	0.5849
4	Forest	0.5838
4	Grass	0.5984
4	Development	0.5823
8	Current	0.6767
8	Forest	0.6767
8	Grass	0.6844
8	Development	0.6742

Recommendations for the City

- Preserve parks and their green spaces
  - Plant additional trees for carbon storage
  - Add prairie for higher pollinator abundance
- Community gardens near areas of tall grass
  - Increase productivity

Questions?

References

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- Klein, AM, BE Vaissiere, JH Cane, I. Steffan-Dewenter, SA Cunningham, C. Kremen, and T. Tscharntke. 2007. Importance of pollinators in changing landscapes for world crops. Proceedings of the Royal Society B-Biological Sciences 274: 303-313.