Monarch Conservation:
Identifying Iowa Highways Suitable for Roadside Projects

INTRODUCTION

The monarch is a migratory species of butterfly whose primary habitat includes milkweed and native flowering plants. The population of eastern monarch butterflies is under threat: it declined 84% between 1996 and 2014 and faces a risk of extinction (Thogmartin et al. 2017). Primary threats to the population in Iowa include habitat loss, in the form of decreased milkweed, pesticide and insecticide use. The pesticide glyphosate is a principal contributor to milkweed decline in Iowa (Thogmartin et. al. 2017). Spatial analysis of monarch oviposition has established that more dense milkweed patches can support more monarchs (Blader 2018). Recent conservation projects seed milkweed and native plants in empty roadside spaces. However, traffic-related pollution has been found to harm plants and herbivores (Snell-Rood et al. 2014), so restoration projects should prioritize roads with low- or medium- traffic levels. In our analysis, we will use Iowa milkweed density, glyphosate and insecticide use, and traffic data to identify Iowa counties and highways which are most suited to monarch conservation projects.

Figure 1. Locator Map.

IDENTIFYING SUITABLE COUNTIES

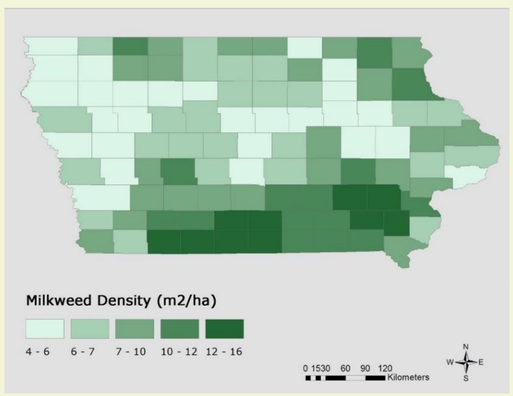

Figure 2. Estimated Milkweed Density (m2/ha).

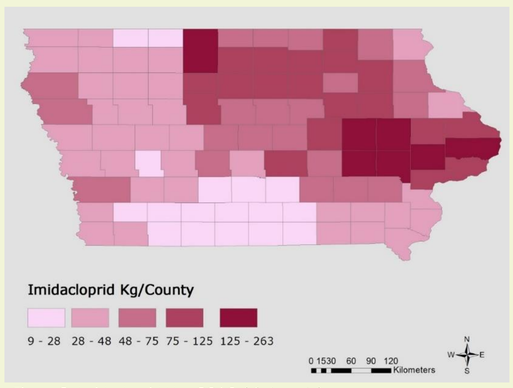

Figure 3. Imidacloprid Use 2016 (Kg/county).

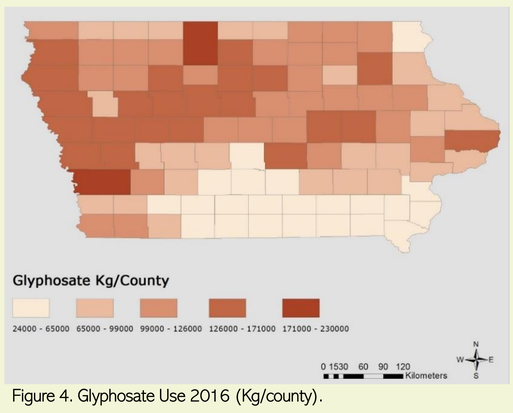

Figure 4. Glyphosate Use 2016 (Kg/county).

Using the geoprocessing software ArcMap 10.7.1, we began our analysis by Selecting by Attribute to identify Iowa-specific data from the monarch county summaries layer. We joined .xls tables of glyphosate and neonicotinoid data to the Iowa county summaries layer via state fips code. Next, we used Select by Attribute to separate Iowa land use data from the National Milkweed Seamless Summaries source layer, then used a Milkweed Density Calculator tool to estimate the average density of milkweed (m2/ha) per Iowa county based on land type and-usage. This tool was provided by the USGS with other monarch data and tools. We then used the Join function to add this data to Iowa county summaries. We created maps displaying each of these factors by Iowa county (Figures 2,3,4).

Next, we used the County Ranking Tool, provided by USGS, which ranks counties based on input criteria specified by the user. We selected the most suitable counties for monarch conservation based on low levels of glyphosate and imidacloprid and low milkweed density. We divided all counties into five quantile groups, then Selected by Attribute for the most suitable counties and exported the data into a new layer (Figure 5).

IDENTIFYING SUITABLE HIGHWAYS

To find highways suitable for conservation, we had to identify the lowest-traffic highway segments. First, we Joined a data table of 2016 Iowa traffic to an Iowa primary roads layer. Then we divided highways into four quantile groups based on average annual daily traffic (Figure 6) and selected the lowest traffic highways (Figure 7). We exported the data and used Select by Location to identify low traffic highways within the most suitable counties, producing our final map (Figure 8).

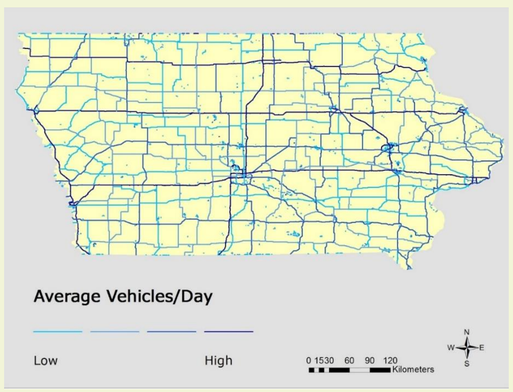

Figure 6. Primary Road Traffic 2016 (Avg Vehicles/Day).

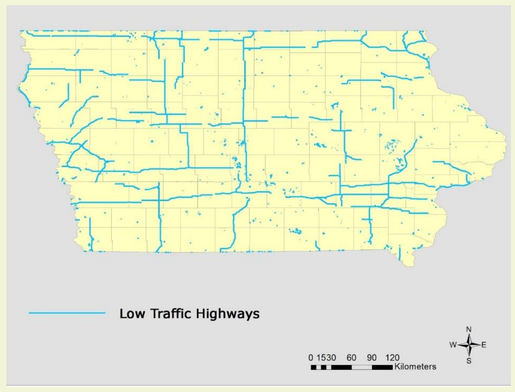

Figure 7. Low traffic Primary Roads 2016 (Avg Vehicles/Day).

RESULTS

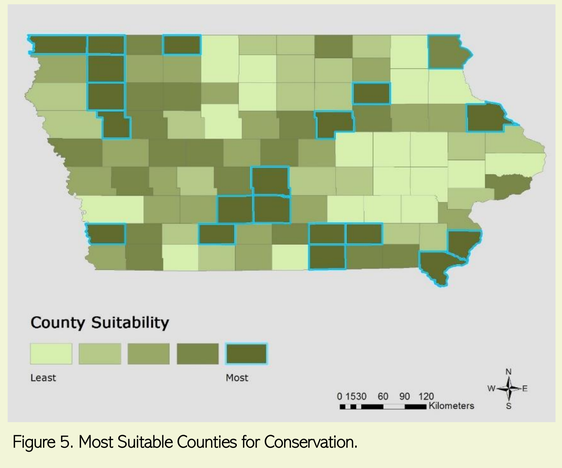

Figure 5. Most Suitable Counties for Conservation.

According to our analysis, we suggest that conservationists focus their efforts to plant milkweed in these counties: Allamakee, Appanoose, Bremer, Cherokee, Des Moines, Dubuque, Emmet, Grundy, Ida, Lee, Lyon, Madison, Mills, Monroe, O'Brien, Osceola, Polk, Union, Wapello, and Warren (Figure 5). By identifying low-traffic primary roads in regions with low quantities of glyphosate, imidacloprid, and milkweed, we select roadsides conducive to monarch population health that could be improved with increased habitat.

HIGHWAY SEGMENTS SUITABLE FOR CONSERVATION

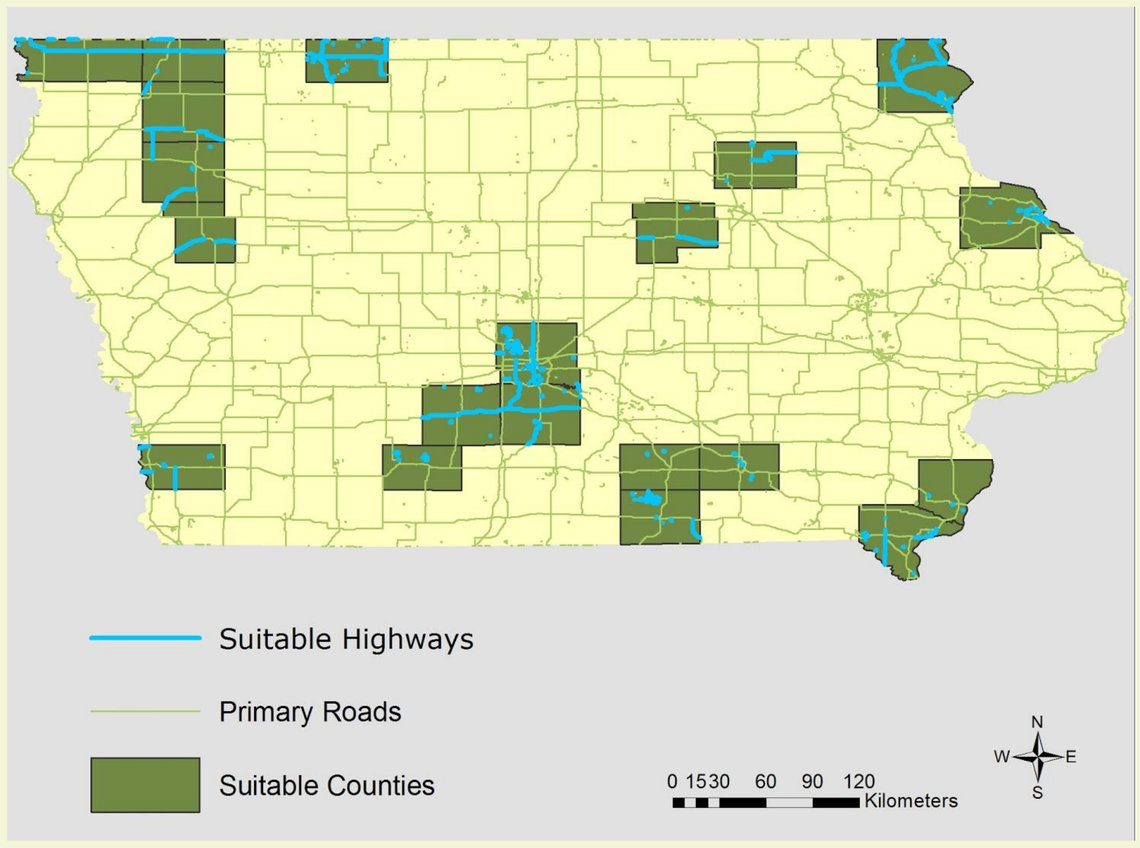

Figure 8. Low-traffic Highway Segments Within Most Suitable Counties.

The southeastern counties of Iowa on average have lower glyphosate and imidacloprid use and higher existing milkweed density (Figures 2,3,4). This supports the previous understanding that glyphosate use directly harms milkweed (Thogmartin et. al. 2017), and is further demonstrated by areas of Northern Iowa that display this pattern.

The counties we identified as most suitable for conservation display no clear spatial pattern. While this is initially surprising, it does not contradict previous studies. Low glyphosate and imidacloprid use correlates with high milkweed density, which can be seen in the southern regions of the state (Figures 2,3,4). However, we selected for low quantities of all three variables. This was done to identify counties most in need of conservation, not ones currently most suitable to monarch habitat.

DISCUSSION

While we are using the most recent data available, a potential limitation is that some of the data are up to four years old. Additionally, data of glyphosate and imidacloprid use is difficult to calculate and could contain inaccuracies. Further, pesticides and insecticides are known to permeate soils and water tables, and thus their effects, while strongest in the regions where they are applied, are difficult to precisely divide by county lines. Additionally, the natural variables that affect monarch populations are complex. We identified the factors which we believe have the largest negative impact, but it is impossible to include every potential variable.

For a more complete understanding of where to plant roadside milkweed, further analysis should be conducted to include more natural variables, better understanding species interactions in Monarch habitats and the effects of climate change. Future analysis should be conducted to predict changes in habitat due to changing weather patterns. Furthermore, we weighted each factor equally for county suitability, but this may not accurately reflect the degree to which it affects Monarch habitat health. It is also important to note that Monarch conservation efforts should not be limited to roadside habitat restoration. Other actions that must occur simultaneously include: prairie restoration, increased research and population monitoring, policy change to decrease pesticide and insecticide use, and international policy with Mexico and Canada.

Blader, T. R. (2018). Milkweed patch size effects on monarch butterfly oviposition within Iowa prairies and roadsides. *Iowa State University Digital Repository*. doi: 10.31274/etd-180810-5949

Snell-Rood, E.C., Espeset, A., Boser, C.J., White, W.A. and Smykalski, R., (2014). Anthropogenic changes in sodium affect neural and muscle development in butterflies. *Proceedings of the National Academy of Sciences*, 111(28), pp.10221-10226.

Thogmartin, W. E., Wiederholt, R., Oberhauser, K., Drum, R. G., Diffendorfer, J. E., Altizer, S., … Lopez-Hoffman, L. (2017). Monarch butterfly population decline in North America: identifying the threatening processes. *Royal Society Open Science*, *4*(9), 170760. doi: 10.1098/rsos.170760

Cartographic Information:
Cartographers: Jenna Clark and Isabel Slaymaker
May 5, 2020
Projection: Iowa State Plane North

Data Sources:
National Milkweed Seamless Summaries, December 2016, United States Geological Survey
Monarch Data County Summaries, December 2016, United States Geological Survey
Milkweed Density Calculator, December 2016, United States Geological Survey
County Ranking Tool, December 2016, United States Geological Survey
Iowa Roads, June 2019, Iowa Department of Transportation
2016 Traffic, June 2016, Iowa Department of Transportation