The Influence of Landscape Semi-Natural Habitat on Dragonfly Abundance

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Introduction

The order odonata (dragonflies) is approximately 300 million years old and believed to have been one of the first insect species to evolve (Zielinski, 2011). Dragonflies are sensitive to environmental changes and their aquatic larval stage can be used as a bioindicator of water quality. Sensitive to high water temperature, low levels of dissolved oxygen, high amounts of sediment in water, and toxic and heavy metals, dragonflies prefer environments that contain clear, cool water, high oxygen content, shade, and are relatively undisturbed (Aquatic Benthic Macroinvertebrates As Water Quality Indicators, n.d.). Forests can help provide an ideal environment for dragonflies by preventing sediment slippage into water sources through their root system and leaves, in addition to shade provision over and around areas of water (Forests and water quality, n.d.). Forested areas also tend to be relatively undisturbed, preventing runoff and negative human and developmental factors from influencing water quality.

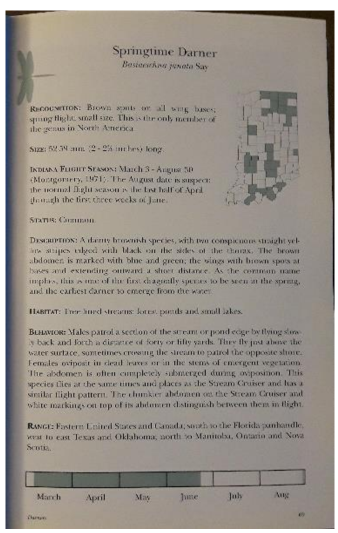
Originally 90% forested at the time of its official statehood in 1816, Indiana had approximately 20 million acres of forest cover. However, by 1920, the amount of forest covering Indiana was around 6%. Realizing this rapid decline, the Indiana Forest Classification Act was created and provided an incentive to keep property forested (Nelson, n.d.). From the 1960s on, the area of forest in Indiana has steadily increased. In 1967 there were 3.9 million acres of forest in Indiana, increasing to 4.3 in 2008 (United States, Forestry, DNR: Indiana Department of Natural Resources, n.d.). Of course, forest is still being cut down for agricultural, industrial, and urbanization purposes. With each of these areas of development, the loss of forest leaves negative impacts on the environment and—more importantly—the water in the area. Agricultural runoff can be in the form of fertilizers and other chemicals; industrial runoff can be in the form of oil, chemicals, and heavy metals; urbanization runoff can be in the form of fertilizers, salt, and suspended solids (United States, Office of Infrastructure R&D, Federal Highway Administration, 2016). Each of these various types of runoff can negatively affect water quality in different ways.

Hypothesis

Since forest removal affects water quality and water quality affects dragonfly abundance, to what extent will the percentage of forest coverage in a county in Indiana influence dragonfly species abundance for that county? The following hypothesis was used: forest cover preserves water conditions that dragonfly species require.

Materials and Methods

With the book *Dragonflies of Indiana* (Curry, 2012) and Microsoft Excel, a list of dragonflies by county for all 92 counties was created (Figure 1). Each county received its own row and each dragonfly species received its own column; then, within each column, an ‘X” was placed in each row for each county the species was found in (Figure 2). Once all species from the book were complied into Excel, each county’s dragonfly abundance was calculated by using the Excel formula “=COUNTIF(A1:A500,"X"),” with the range adjusted to the county’s span. Forest coverage data was provided by Dr. Jeffery D. Holland. Forest coverage was calculated by using the National Land Cover Dataset and writing a Python script for the amount that was forest (class=40, 41, or 42) and the amount that was other land covers. The percent forest was then calculated with the formula % forest = # pixels forest / # pixels forest + # pixels other. With forest coverage as the independent variable and dragonfly abundance as the dependent variable, a linear regression model was calculated in Excel (Figure 3). This data was then transferred to the program Sigma Plot, where a clearer graph was created.



Springtime Darner

Basiaeschna janata Say

RECOGNITION: Brown spots on all wing bases; spring flight; small size. This is the only member of the genus in North America.

SIZE: 52-59 mm (2 - 2⅓ inches) long.

INDIANA FLIGHT SEASON: March 3 - August 30 (Montgomery, 1971). The August date is suspect: the normal flight season is the last half of April through the first three weeks of June.

STATUS: Common.

DESCRIPTION: A dainty brownish species, with two conspicuous straight yellow stripes edged with black on the sides of the thorax. The brown abdomen is marked with blue and green; the wings with brown spots at bases and extending outward a short distance. As the common name implies, this is one of the first dragonfly species to be seen in the spring, and the earliest darner to emerge from the water.

HABITAT: Tree-lined streams; forest ponds and small lakes.

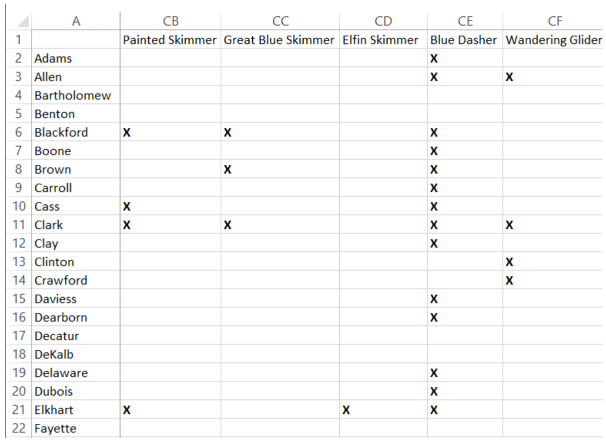
BEHAVIOR: Males patrol a section of the stream or pond edge by flying slowly back and forth a distance of forty or fifty yards. They fly just above the water surface, sometimes crossing the stream to patrol the opposite shore. Females oviposit in dead leaves or in the stems of emergent vegetation. The abdomen is often completely submerged during oviposition. This species flies at the same times and places as the Stream Cruiser and has a similar flight pattern. The chunkier abdomen on the Stream Cruiser and white markings on top of its abdomen distinguish between them in flight.

RANGE: Eastern United States and Canada; south to the Florida panhandle, west to east Texas and Oklahoma, north to Manitoba, Ontario and Nova Scotia.

March April May June July Aug

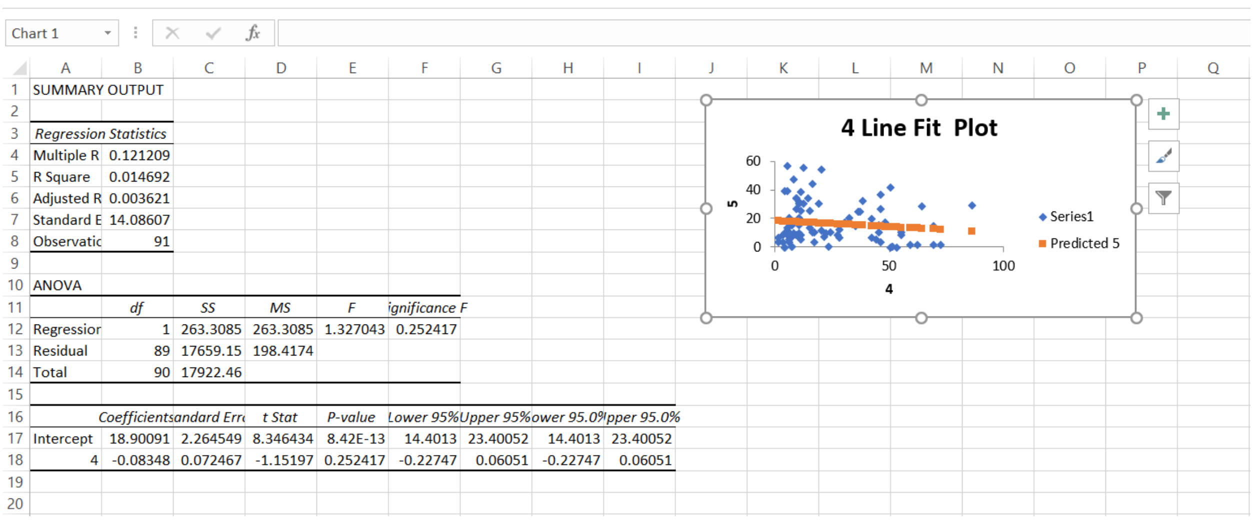
Figure 1. Example of species location from

Dragonflies of Indiana.



	A	CB	CC	CD	CE	CF
1		Painted Skimmer	Great Blue Skimmer	Elfin Skimmer	Blue Dasher	Wandering Glider
2	Adams				x	
3	Allen				x	x
4	Bartholomew					
5	Benton					
6	Blackford	x	x		x	
7	Boone				x	
8	Brown		x		x	
9	Carroll				x	
10	Cass	x			x	
11	Clark	x	x		x	x
12	Clay				x	
13	Clinton					x
14	Crawford					x
15	Daviess				x	
16	Dearborn				x	
17	Decatur					
18	DeKalb					
19	Delaware				x	
20	Dubois				x	
21	Elkhart	x		x	x	
22	Fayette					

Figure 2. Example of dragonfly abundance in Excel.



	A	B	C	D	E	F	G	H	I
1	SUMMARY OUTPUT								
2									
3	*Regression Statistics*								
4	Multiple R	0.121209							
5	R Square	0.014692							
6	Adjusted R	0.003621							
7	Standard E	14.08607							
8	Observatic	91							
9									
10	ANOVA								
11		*df*	*SS*	*MS*	*F*	*ignificance F*			
12	Regressior	1	263.3085	263.3085	1.327043	0.252417			
13	Residual	89	17659.15	198.4174					
14	Total	90	17922.46						
15									
16		*Coefficients*	*andard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
17	Intercept	18.90091	2.264549	8.346434	8.42E-13	14.4013	23.40052	14.4013	23.40052
18	4	-0.08348	0.072467	-1.15197	0.252417	-0.22747	0.06051	-0.22747	0.06051
19									
20									

Figure 3. Linear regression calculated in Excel.

Results and Discussion

For the analysis, 97 different dragonfly species were used. The average number of species per county was approximately 17 (16.79 actual) with a range of 0 to 57 found amongst the counties. Maps of county species abundance and forest coverage were created, with a scale with 0-10 as red, 11-20 as orange, 21-30 as yellow, 31-40 as green, 41-50 as blue, 51-60 as purple, 61-70 as white, 71-80 as black, and 81-90 as gray (Figures 4 and 5). From the maps, counties with high species abundance do not always have high forest coverage and vice versa.

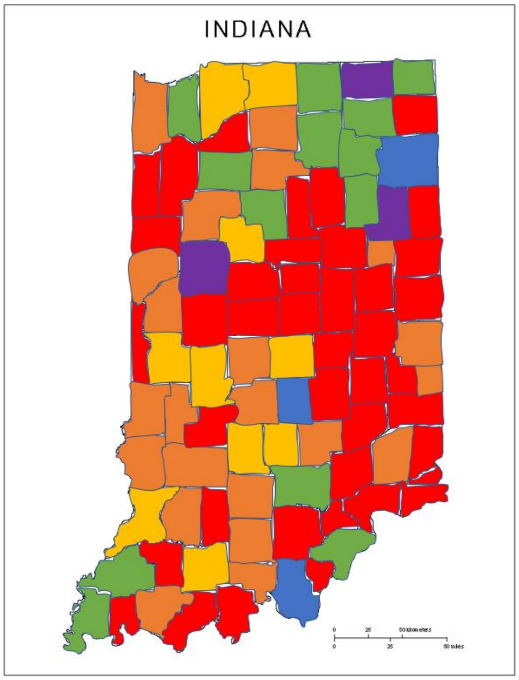


Figure 4. County species abundance map.

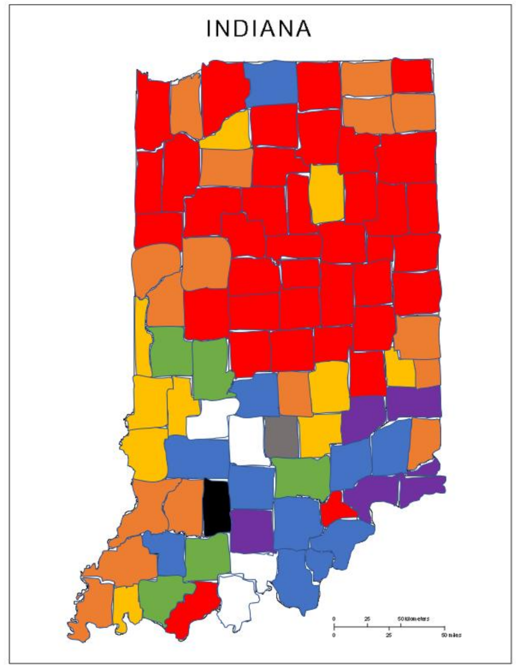


Figure 5. County forest coverage map.

The linear regression graph resulted in an r^2 value of 0.0147, resulting in a low explanation of the variability of the response data around the mean (Figure 6). With this outcome, it can be concluded that forest coverage does not significantly influence dragonfly species abundance within a county.

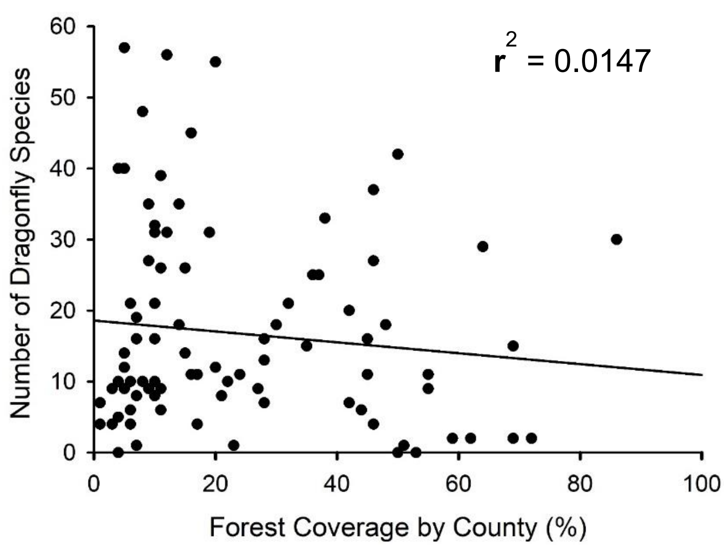


Figure 6. Linear regression created in Sigma Plot.

Forest coverage alone is not sufficient enough to predict dragonfly abundance. Since it is unknown what is replacing the removed forest in each county (e.g. agriculture, industry, urban, etc.) and what kind of runoff results from the development, it is difficult to know in what manner the forest removal and replacement is influencing dragonfly abundance. Each developmental runoff type negatively affects water quality in a different way and thus also affects dragonflies differently.

There were also several potential issues with the data collection itself. *Dragonflies of Indiana* included several rare species of dragonfly, some of which had only been spotted in the county once. There was also no exact location provided for where in each county each dragonfly species was found. Since adult dragonflies can fly, it is possible that dragonflies near the boarders of counties could have flown into the neighboring county where they were then seen and recorded.

While forest coverage is not enough to predict dragonfly abundance, it is possible that in combination with other types of land (e.g. agricultural, industrial, urban, etc.)—and their percent coverage—dragonfly abundance may be able to be predicted. The location of systems of water in each county could also be used with forest coverage to predict abundance. Along with the addition of these new elements, larval sampling—instead of adult—might be beneficial in predicting the dragonfly abundance in that county, in addition to the water quality and the influence on the surrounding area on that quality.

Literature Cited

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