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Solar and Topographical Breeding Habitat Preferences of Two Damselflies Calopteryx aequabilis and Calopteryx maculata

Christopher St. Andre

Chris is a senior majoring in Envrinomental Biology. His research was made possible through the Adrian Tinsley Program summer grant, and the guidance of his mentor Dr. Darcy Boellstorff. Mr. St. Andre has presented his research at the 2008 Adrian Tinsley Summer Research Symposium, and at the Association of American Geographers 2009 Annual meeting in Las Vegas, Nevada.

As the global climate changes many species are forced to adapt, but if the climate changes beyond their tolerance levels they can face extinction[1]*. Scientists need to work fast in order to mitigate these extinctions. Using field observations of species' habitats coupled with the use of geographic information systems (GIS), researchers can model the locations of ideal habitats. Using these models, scientists can work to improve conservation efforts by raising the populations of dwindling species or predicting locations to place new subpopulations. Data used in GIS are spatially explicit, so stored within individual data sets and information systems are locational references. GIS data are widely available and can be applied at large spatial scales. In a study on songbirds in southern Ohio, researchers were able to predict habitat areas, as well as the number of individual territories in the area using GIS. The information determined with the aid of GIS was analyzed to accurately measure population size for the habitats*[2].

Habitat modeling using GIS can be applied to species' niches within large environments. Specific niches can be defined by subtle differences that distinguish them from the larger ecosystem. Damselflies occur in three niches throughout their life cycle. During the nymph stage damselflies inhabit riparian zones on emergent and submerged vegetation. After several instars they molt into a flying adult and enter adjacent forests to forage on small flying insects throughout the light gaps in the tree canopy. They will remain in the forests until they obtain sufficient energy reserves to defend territories and breed[3].

Male damselflies will either fly around the stream searching opportunistically for a mate or they will stay in one place and defend a territory. In a case study observing damselfly territories researchers observed that males that did not wander were more likely to maintain a territory or recapture their lost territory. They determined that energy reserves aid in the competitive ability of damselflies[4]. Energy reserves are depleted rapidly when territory battles occur in areas of high light intensity due to an increase in metabolic activity. Light intensity may also be important in determining the type and extent of vegetation growth along the banks where females deposit their eggs.

Two closely related damselfly species the River Jewelwing (*Calopteryx aequabilis*) and the Ebony Jewelwing (*Calopteryx maculata*) were observed along the

Hockomock River in West Bridgewater, Massachusetts during the summer of 2008. The aim of this project was to determine variations in habitat selection between both species. Using field observations and spatial modeling techniques predictive models of both damselfly species were created. Because these two species inhabit the same stretches of river but at different times of the year it is assumed there is no difference in their habitat preference.

Methods

During summer 2008 (June 2 – July 20), 434 breeding adult Ebony and River Jewelwing damselflies were recorded during 20 kayaking sessions along a 1 km stretch of the Hockomock River (Figure 1). Because damselflies need to build energy reserves in forested light gaps, all damselflies found along the river were assumed to be mature breeding adults[5]. Observations were collected only on the initial pass through the site, as a strategy used to reduce the chance of counting the same damselfly multiple times on a given day. The variables recorded for each observation included: species, sex, behavior (perching, flying, fighting, copulating, or depositing eggs), GPS coordinates (recorded using a Garmin handheld Etrex GPS), light intensity (recorded using Calright CI-1010 Digital Light Meter: 50,000 Lux). Both light intensity and GPS coordinates were taken from the location where the damselfly was first observed while moving through the site.

Figure 1: Field Site in West Bridgewater, Massachusetts, Hockomock River

Using GIS software three predictive models were created: River Jewelwing, Ebony Jewelwing and both species as one. GPS coordinates of all observations were entered into a GIS using ESRI's ArcMap software. Using a digital elevation model (DEM), a data layer with elevation information for a continuous area obtained from MassGIS, the solar radiation of each damselfly location was calculated. Solar radiation was calculated using a script created by N. Zimmerman, which uses day number to determine the date, and outputs solar radiation[6]. Solar radiation GIS layers were created throughout a 5 Km stretch of the Hockomock River for different time intervals: individual days, the two week span of peak activity and throughout the duration of the study. These radiation layers were overlaid with GPS coordinates of the damselflies to obtain the solar radiation range for the damselfly populations.

To determine important habitat criteria in the three predicative models, a two-sample t-test (assuming equal variances) was used to compare mean light intensity of habitats between the two species. Mean values for categories with significant differences were calculated, and ranges for solar radiation and slope were estimated using +/- 3 standard deviation from the mean. Weights were given to the attributes according to how the observed data points coincided with the range. Weights were individually determined for each model created (Table 1). Weighted attributes were input into GIS to generate three predictive models. A GIS data layer of each attribute was created and intersected with a data layer of the Hockomock River, downloaded from MassGIS. The river layer was buffered at 15 m to include the adjacent riparian zone. Using a combine feature in GIS the attribute layers and their respective weights were combined to calculate the probability of damselflies occurring at any point along the 5 Km stretch of river. The new layers were overlayed with GPS coordinates of the observed damselflies to identify the optimal range of solar radiation for each species.

Table 1: Weighting for Criteria Used in Creating Habitat Models.

	Both Species	River Jewelwing	Ebony Jewelwing
Slope	.240	.260	.335
July 1^{st}	.240	.180	.000
Peak Activity Solar Radiation	.260	.275	.345
Summer Solar Radiation	.260	.285	.320

Results

Both species inhabited areas with varying levels of light intensity. Rainy and overcast days showed no signs of damselfly activity.

Table 2: Two Sample T-Test (Assuming Equal Variance) of Light Intensity of River Jewelwing vs. Ebony Jewelwing Habitats.

	River Jewelwing	Ebony Jewelwing
Mean	911.9416342	434.9151515
Variance	56567.52392	140612.9928
Observations	257	165
Pooled Variance	89385.27842	
Hypothesized Mean Difference	0	
df	420	
t Stat	15.99417339	
P(T<=t) one-tail	1.30919E-45	
t Critical one-tail	1.648489714	
P(T<=t) two-tail	2.61839E-45	
t Critical two-tail	1.965628207	

Consequently, data were not collected on non-sunny days. The River Jewelwing inhabited areas with an average light intensity value of 911x 100 Lux and the Ebony Jewelwing inhabited areas that averaged 435x100 Lux. Using a two sample t-test assuming equal variances there was a significant difference ($P < 0.05$) between the two species light intensity (Table 2). Predictive models were created to determine probability of both species of damselfly along the Hockomock River (Figure 2), and individual species (Figure 3 and 4). The models created show a high probability for both species throughout the 5 Km stretch of the Hockomock River. Both species together had the

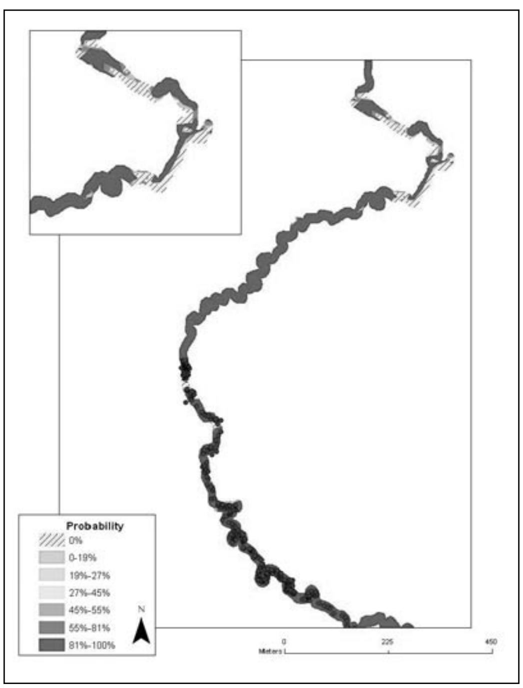

Figure 2: Predictive Model for Jewelwings along the Hockomock River, West Bridgewater, MA.

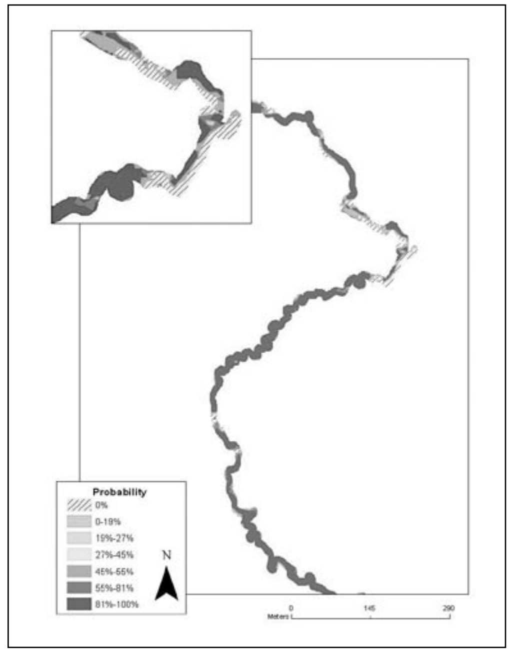

Figure 3: Predictive Model of River Jewelwing along the Hockomock River,

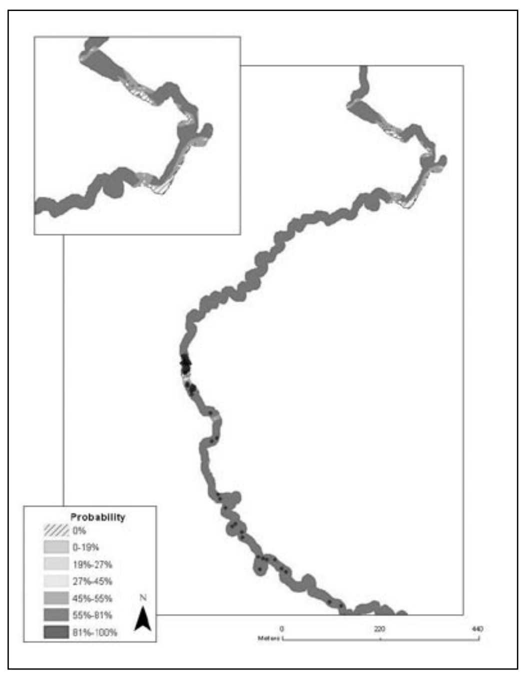

Figure 4: Predictive Model of Ebony Jewelwing along the Hockomock River,

highest probability throughout the river. The River Jewelwing had a slightly reduced probability of inhabiting areas than the Ebony Jewelwing. Although the model predicts that the Ebony Jewelwing should have a higher probability of inhabiting areas of the river, the River Jewelwing was observed more frequently and in more areas.

Discussion

Damselflies are important part to many river and pond ecosystems. As nymphs they provide a food source for many species of fish, tadpoles and turtles. Mature adults are preyed upon by larger dragonflies, amphibians and birds. Pollution has reduced the populations of damselfly species throughout the Hockomock River. As pollution and other anthropogenic stresses accumulate in the river, the damselflies can become isolated from other populations and experience high levels of fluctuating asymmetry, uneven growth of limbs or wings. High levels of stress result in high fluctuating asymmetry which can be detrimental to the fitness of individuals[7]. Isolation is a severe problem that can lead to extinction of the species along areas of the river. The American Rubyspot Damselfly (*Hetaerina Americana*) is an example of one damselfly species that has already gone extinct in the Hockomock River. To deter populations from being isolated predicative models can be created to monitor damselfly ranges to make sure existent populations can still interact with and breed with other populations.

During the summer observations, it was found that the River Jewelwing inhabited areas of higher light intensity than the Ebony Jewelwing. Only a few fights between males were observed. Because battles for territories involve maintaining an adequate energy reserve, it may be more beneficial for the damselflies to find a different territory than battle with other males. Another explanation for this observation could be that some trait indicates to other damselflies that they are not fit enough to capture the territory. Females were not seen fighting over territory, suggesting that there may be little competition for places to lay their eggs in the water.

River Jewelwings were widely spread out throughout the field site; in contrast the Ebony Jewelwing's habitat was much more condensed to about a 20-meter range of moderately flowing water. In the predictive models the ranges of both species were throughout most of the Hockomock River. This suggests that they could inhabit most of the areas, but they still appear grouped into smaller fragmented habitats. Other characteristics of habitats need to be considered to explain the fragmented groups of these damselflies. The water flow in the Hockomock River varies from a standstill to a moderate flow. *Calopteryx* species have been observed to develop faster in areas of fast water flow and have a reduced chance of nymph mortality[8]. Differences in water flow throughout the Hockomock River could suggest that the Ebony Jewelwing may be restricted to areas of faster moving water to increase nymph survival rates.

Damselflies nymphs rely heavily on vegetation for protection from small fish and tadpoles. Different vegetation types cause different responses in anti-predator behaviors. Damselflies are able to better protect themselves by hiding and moving in thicker vegetation[9]. Examining and mapping vegetation types throughout the river may help to make the model more accurate. A lack of proper vegetation could explain why areas of suitable light intensity were not inhabited by either species.

Conclusion

Due to the end of emergence for both species the models cannot be verified until further field sessions can be conducted. To verify the models, damselflies need to be observed in areas of high probability and not in the areas of low probability. During new field sessions water flow and vegetation would be modeled throughout the river to incorporate more variables into the model. Water flow and vegetation may play a part in determining where females lay their eggs, largely based on food availability, the ability of nymphs to cling onto vegetation during times of heavy flow and the ability to escape predators in the vegetation[10]. In conclusion, the model shows promise to predict probability of damselflies, but needs to be tested and verified with additional attributes incorporated into the models.

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Works Cited

(Endnotes)

[1] Davis, R., Shaw, R., & Etterson, J (2005). Evolutionary Responses to Climate Change. *Ecology*. 86, 1704-1714.

[2] Dettmers, R., & Bart, J. (1999). A GIS Modeling Method Applied to Predicting Forest Songbird Habitat. *Ecological Applications*. 9, 152-163.

[3] Kirkton, D., & Schultz, T. (2004). Age-Specific Behavior and Habitat Selection of Adult Male Damselflies, Calopteryx maculata (Odonata: Calopterygidae) . *Insect Behavior*. 14, 545-556.

[4] Lefevre, K., & Muehter, V. (2004). Competition for Mating Resources in a Territorial Damselfly (Odonata: Calopterygidae) . *Studies on Neotropical Fauna and Environment*. 39, 159-165.

[5] Purse, B., Hopkins, G., Day, K., & Thompson, D. (2003). Dispersal Characteristics and Management of a Rare Damselfly . *The Journal of Applied Ecology*, *40*, 716-728.

[6] Kumar, L., Skidmore, A., & Knowles, E. (1997). Modelling topographic variation in solar radiation in a GIS environment. *International Journal for Geographical Information Science*. 11, 475-497.

[7] Hardersen, S. (2001).The role of behavioural ecology of damselflies in the use of fluctuating asymmetry as a bioindicator of water pollution . *Ecological Entomology*. 25, 45-53.

[8] Silva-Jothy, M., Gibbons, D., & Pain, D. (1995). Female oviposition-site preference and egg hatching success in the damselfly Calopteryx splendens xanthostoma ." *Behavioral Ecology and Sociobiology*, 37, 39-44.

[9] Dionne, M., Butler, M., & Folt, C. (1990). Plant-specific expression of antipredator behaviour by larval damselflies. *Oecologia*. 83, 371-377.

[10] Gibbons, D., & Pain, D. (1992). The Influence of River Flow Rate on the Breeding Behaviour of Calopteryx Damselflies. *Animal Ecology*. 61, 283-289.