Jane Earle, Research Associate Academy of Natural Sciences of Philadelphia, 20 Red Fox Lane, Mechanicsburg, PA, 17050, janeearle7@msn.com

Continuing studies of Pennsylvania stoneflies as of December 2009: an update of the Pennsylvania species list with additional records, locations and habitat information on rare species is ready for pre-publication review; GIS mapping of Pennsylvania A species; interpretation of distribution maps in relation to ancient and present day river flow directions; stonefly tolerance to acid deposition and coal mine drainage.

Also a publication in April 2009 issue of Entomological News on stoneflies of a small stream in New Jersey. I am requesting unpublished records for Pennsylvania stonefly species to add to my database, and maps for distribution studies.

From the Dr. Romolo Fochetti Laboratory:

"I and my PhD student Valentina Amore are studying hemocyanin in the Plecoptera.We have extended the search for hemocyanin to several species of European Plecoptera families, with the aim to verify how this ancient trait is still retained across the order and to investigate why stoneflies have retained it."

Dr. Ken W. Stewart, University of North Texas, Denton, Texas.

In my "pseudoretirement" since 2000, I have continued to concentrate on increasing taxonomic resolution of stonefly nymphs of workable sized genera to species level, and life histories of species especially in Oregon temporary streams, with Norm Anderson. Genera or species recently published or in various stages of progress:

1. *Strophopteryx* nymphs with Jane Earle- published 2008.
2. *Malenka bifurcata*, *Ostrocerca dimicki* and *Soyedina producta* nymphs with Norm Anderson- published 2008.
3. *Sweltsa* nymphs with Bill Stark- in progress.
4. *Capnia* nymphs (California) and *Paracapnia disala* nymphs with Eugene Drake- in progress.
5. *Oemopteryx vanduzeea* nymphs.
6. *Megarcys* nymphs with Boris Kondratieff- in progress.
7. Life history and nymphal generic character development of *Sweltsa adamantea* with Norm Anderson- In Press Trans. Amer. Ent. Soc.
8. Life history and nymphal generic character development of *Malenka bifurcata* with Norm Anderson-In Press, Proceedings of last summer's International stonefly symposium- Aquatic Insects.

Also, working with Dick Baumann on additional records of stoneflies from Alaska to supplement those in the 2006 book, and other projects.

SHORT ARTICLES

Modeling of Stonefly Historical Distributions Using Museum Specimens

R. E. DeWalt, Yong Cao, Leon Hinz, and Tari Tweddale. Illinois Natural History Survey

The stonefly fauna of Illinois is probably the best known of any large geographic area in the world. The state supported at least 77 species historically (DeWalt 2008), but 20 have been extirpated and two are extinct (*Alloperla roberti* Surdick and *Isoperla conspicua* Frison) (DeWalt et al. 2005). The reason these statements are possible is due to the vast number specimens that have been deposited over the years by the likes of C. A. Hart, Benjamin D. Walsh, Theodore H. Frison, Herbert H. Ross, William E. Ricker, Donald W. Webb, and others. The 5,770 Illinois specimen records (= specimens in vials or on a pin), representing 41,399 specimens, have been used in several analyses of assemblage change within the state. Still, we do not know what lived in every drainage, nor can we say with confidence what factors contributed to their natural distribution.

We are currently modeling historic (pre-1970) distributions to produce natural occurrence probabilities for watersheds across the state and examining which local and watershed scale factors might explain these distributions. The model used was Random Forests (Cutler et al. 2007), which builds many dendrograms (>5,000) using random subsets of predictors and then averages the predictions. It eliminates "over-fitting" common to other modeling techniques and the use of multiple correlated preditors is not problematic. The model requires both presence and absence data. This technique uses bootstrapping to create an average result for each species. Additionally, it uses only 67% of the records for any one of thousands of iterations, and as such, validates itself with unused or "out-of-bag" sites. Three accuracy measures express the model's ability to effectively match prediction with observation. These include PCC = Overall Percentage Correctly Classified, Sensitivity = percentage of absences correctly classified, Kappa = measure of agreement between predicted presences and absences with observed presences and absences corrected for agreement that might be due to chance alone. Kappa values may be given the following qualitative ratings: ≤0= agreement less than chance alone, 0.01-0.2 = slight agreement, 0.21-0.4 = fair agreement, 0.41-0.60 = moderate agreement, 0.61-0.80 = substantial agreement, and 0.81-0.99 = almost perfect agreement.

Modeling efforts utilized INHS Insect Collection and Frison (1935, 1942) records for which the taxonomy was certain. Only spring and summer emerging species were modeled, a guild that experienced the greatest decline in Illinois (DeWalt et al. 2005). The work utilized 1,500 specimen records, resulting in a species presence/absence-by-site data matrix with 53 taxa and 203 unique locations. Negative records for a given species were derived from the positive records of other species available at the same time, e.g. the presence of *Perlesta* sp. nymphs or adults, but no *Agnetina,* would be regarded as a negative record for species of *Agnetina*. This precluded use of a large number of winter stonefly records since most of them would have been adult collections and could not, therefore, have an equal probability of obtaining nymphs of summer-emerging species.

Fifty-seven stream reach- and watershed-level variables were accumulated from an Illinois Department of Natural Resources dataset at the 1:100,000 scale for stream arcs, e.g., a stream segment confluence to confluence (Holtrop et al. 2005). These variables include climate parameters, slope, geology, soil types, presettlement vegetation, drainage area, stream width, modeled stream temperature, and drainage basin affiliation. The values of these variables are largely independent of human disturbance, and as such, are useful for modeling historic distributions.

We limited model entry to those species with eight positive records, resulting in 14 species being modeled. These included five perlodids, most of which are relatively abundant in Illinois, but may be restricted to certain regions or to streams of a given size. Seven species of Perlidae were modeled, their habitat needs spanning the full range of stream sizes available in Illinois. Several have experienced dramatic range reduction, two have been extirpated (DeWalt et al. 2005).

The performance of the models was assessed using four parameters: Overall Percentage Correctly Classified (PCC); Sensitivity, the percentage of presences correctly classified; Specificity, the percentage of absences correctly classified; and Kappa, a measure of agreement between predicted presences and absences with actual presences and absences corrected for agreement that might be due to chance alone. The values of Kappa may be categorized in the following way: ≤0= agreement less than chance alone, 0.01-0.2 = slight agreement, 0.21-0.40 = fair agreement, 0.41-0.60 = moderate agreement, 0.61-0.80 = substantial agreement, and 0.81-0.99 = almost perfect agreement (Citation).

Four reasonably good distribution models resulted from our research (Table 2). Sensitivity averaged 68% with *Clioperla clio* presences being predicted 100% of the time. The model predicted absences much better than it did presences (mean = 88%). Kappa values varied greatly, with three of four species having fair and substantial agreement of predicted with actual presences and absences.

We were also able to assess which variables were influential in the distribution of species (Fig. 1). *Acroneuria frisoni* was found to be eastern distributed, Ohio and Wabash rivers inhabiting, and a mostly glaciated landscape Illinois species. These predictors agree well with the distribution of the species in Illinois (Fig. 2). Other species were influenced by other combinations of variables, the specifics of which will be shared in the upcoming Proceedings of our latest mayfly & stonefly international meeting.

Of course, this modeling effort is focused on Illinois, so the results may not be reflective of the historical distributions across a wider geographic region. In this respect, it is a test case for expanding our efforts into all the Midwest of the USA and Canada. We have recently amassed all Midwest stonefly specimen records from regional museums, representing about 27,000 records. This is a rich source of distributional data that will undoubtedly improve our models for a number of species. Refinement of the models is possible through addition of more environmental variables and by use of models that require only positive data. The latter would allow us to use both historic and contemporary records simultaneously for all species, since we would not have to generate meaningful negative records that would force us to use only subsets of the data.

This work is significant in that it may allow for more accurate determination of loss of species from the region and states, help us determine what factors are important in species distribution, and help to inform a number of conservation related issues such as reintroduction efforts and the building of a "Red Book" for stoneflies for the region.

Reference Cited

Cutler, D.R., T.C. Edwards Jr., K.H. Beard, A. Cutler, K.T. Hess, J. Gibson, J. J. Lawler. 2007. Random Forests for classification in ecology. *Ecology* 88: 2783-2792.

DeWalt, R. E. 2008. Checklist of Known Illinois Plecoptera (Stoneflies) http://www.inhs.uiuc.edu/animals_plants/insect/ILplecoptera.html.

DeWalt, R. E., C. Favret, and D. W. Webb. 2005. Just how imperiled are aquatic insects? A case study of stoneflies (Plecoptera) in Illinois. Ann. Entomol. Soc. Am. 98: 941-950.

Favret, C., and R. E. DeWalt. 2002. Comparing the Ephemeroptera and Plecoptera specimen databases at the Illinois Natural History Survey and using them to document changes in the Illinois fauna. Ann. Entomol. Soc. Am. 95: 35-40.

Table 1. Stonefly species modeled, the number of unique positive and negative sites, and the total number of museum specimen records from the INHS Insect Collection. Conservation status is from DeWalt et al. (2005), increasing number indicates lower imperilment, SX=extirpated.

Taxon			**Records**	
Perlodidae	**Status**	**Positive**	**Negative**	**Museum**
Clioperla clio (Newman, 1839)	S2	19	175	71
Hydroperla crosbyi (Needham & Claassen, 1925)	S2	17	177	48
Isoperla bilineata (Say, 1823)	S5	64	130	273
Isoperla decepta Frison, 1935	S5	19	175	57
Isoperla nana (Walsh, 1862)	S5	9	185	33
Perlidae				
Acroneuria abnormis (Newman, 1838)	S2	30	164	260
Acroneuria frisoni Stark & Brown, 1991	S2	28	166	201
Agnetina capitata (Pictet, 1841)	SX	17	177	114
Attaneuria ruralis (Hagen, 1861)	SX	27	167	71
Perlesta decipiens (Walsh, 1862)	S5	23	171	132
Perlesta lagoi or *nitida*—or a new species	S5	18	176	31
Perlesta Banks, 1906	Most S5	36	158	79
Perlinella drymo Newman, 1839	S2	17	177	32
Pteronarcyidae				
Pteronarcys pictetii Hagen, 1873	S3	16	178	98
				1,500

Table 2. Results of Illinois stonefly distribution modeling, predicted and observed presence and absence and four measures of accuracy: Percentage Classified Correctly (PCC), Sensitivity, Specificity, and Kappa. See text for definition of measures of accuracy.

Species	**Predict Type**	**O_Pres**	**O_Abs**	**Total**	**PCC**	**Sensitivity**	**Specificity**	**Kappa**	**Agreemt**
Agnetina	**P_Pres**	12	6	18					
capitata	**P_Abs**	5	171	176	94	71	97	0.65	Substantial
		17	177						
Clioperla	**P_Pres**	5	15	20					
clio	**P_Abs**	0	175	175	92	100	92	0.37	Fair
		5	190						
Acroneuria	**P_Pres**	6	22	28					
frisoni	**P_Abs**	9	157	166	84	40	88	0.20	Slight
		15	179						
Isoperla	**P_Pres**	30	34	64					
bilineata	**P_Abs**	19	111	130	73	61	77	0.34	Fair
		49	145						

Figure 1. Predictors for one *Acroneuria frisoni*. Y axis is the log of probabilities, X axis is the value for environmental variables.

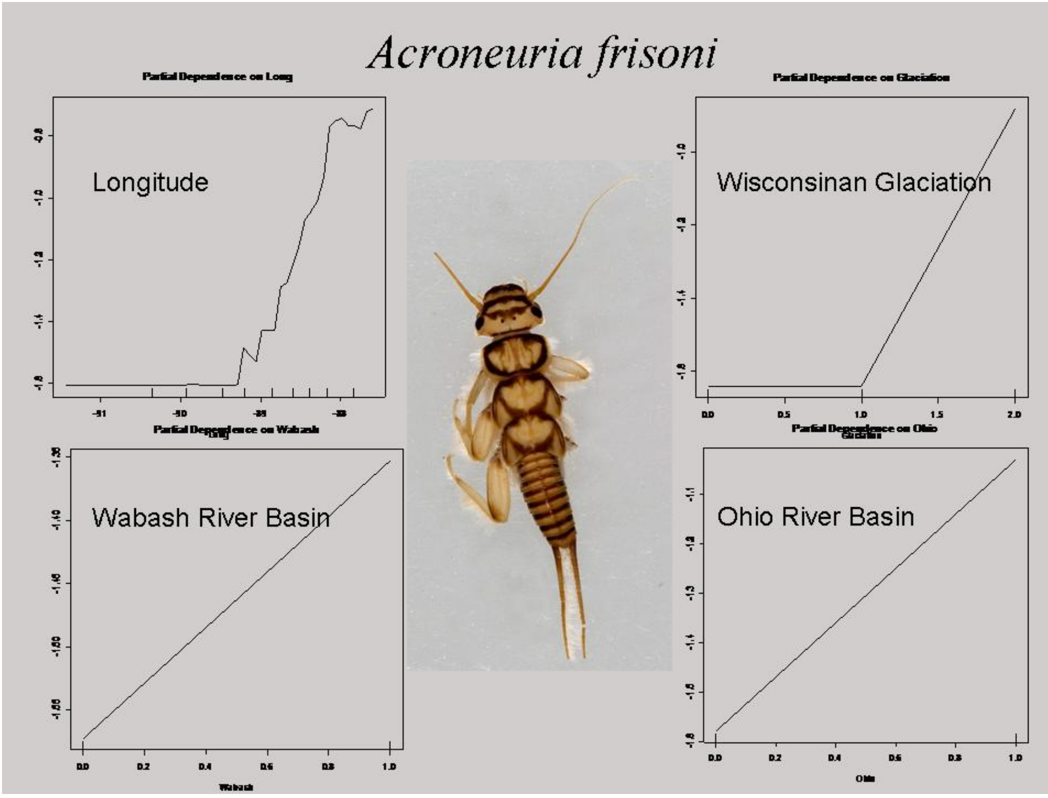

Figure 2. Historical and contemporary range for Frison's Stonefly.