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Evaluating Water Temperature, Habitat, and Fish Communities in Candidate Coolwater Streams in Illinois

Annual Project Report 2009

Brian A. Metzke, Leon C. Hinz Jr.,
Ann Marie Holtrop,
and John Epifanio

Submitted to

Illinois Department of Natural Resources
One Natural Resources Way
Springfield, Illinois 62702

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**Illinois Natural History Survey
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University of Illinois**

(October 1, 2008 - September 30, 2009)

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Project: T-13-P-001

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Dr. Brian Anderson,
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PROJECT TITLE: Evaluating Water Temperature, Habitat, and Fish Communities in Candidate Coolwater Streams in Illinois.

Summary:

Work during this reporting period focused on characterizing temperature, habitat, and biological communities at candidate coolwater sites. During the past year we have collected additional temperature data from 48 candidate streams and other locations and now have records from 188 stream reaches. Sixty-three sites in Illinois have been identified as cool- or coldwater based on these records. Physical habitat surveys have been conducted at 68 sites where temperature data were available. Fish and macroinvertebrate data were obtained from the cooperative basin survey program data managers for candidate sites whenever possible and added to collections made during previous project years. This report summarizes progress for the period beginning 1 October 2008 and ending 30 September 2009. Additional analyses associated with this project are ongoing and results will be presented in a final report to be submitted upon completion of this project.

JOB 1. Review list of candidate coolwater streams and identify a subset of streams for validation.

We focused temperature logger deployment during the summer of 2009 at sites containing known populations of fish used to develop the candidate coolwater list (Figure 1) or at sites that were predicted cool by the temperature and Darcy groundwater models. We targeted sites with records of mottled sculpin, Ozark minnow, longnose dace, and Iowa darter to improve our understanding of the conditions where these species are located (Table 1). Final determination of indicator status for each fish species will be presented in the final report.

JOB 2. Characterize the thermal regime, habitat (e.g., channel morphology), and vegetation in each stream identified in Job 1.

Temperature data were collected at 48 sites during summer 2009 increasing the number of sites with available records to 188 statewide. Sixty-three sites have met the criteria for cold- or coolwater during at least one year. We now have a total of 223 temperature records statewide with twenty-eight having met the criterion for coldwater streams (mean daily temperature in July < 19 C) and 49 for coolwater (19 C > mean daily July Temp < 22 C).

Instream physical habitat surveys were conducted at an additional 68 sites which also had water temperature data. These data will be used to determine if instream habitat and vegetative communities can be used to differentiate cold and cool streams from warm and allow for rapid determination of thermal patterns in unsampled streams. Final analysis of habitat and vegetative patterns will be presented in the final report.

Candidate coolwater streams were initially identified using the presence of “coolwater” fish species and output from the Darcy groundwater delivery model. We have temperature records from 57 of the original coolwater candidate sites at this time. Seventy-nine percent (22/28) of candidate sites selected due to fish presence and high ground water delivery potential were found to be correctly identified as coolwater. Sites selected with presence of candidate fish species but without high ground water delivery potential were correctly identified thirty-eight percent of the time (11/29).

JOB 3. Determine availability and applicability of other data to predict additional coolwater streams.

Upon consultation with Kevin Cummings (INHS malacologist) we are evaluating the potential of two mussel species as indicators of coolwater conditions. Statewide distributions of the Elktoe (*Alasmidonta marginata*) and the Ellipse (*Venustaconcha ellipsiformis*) were obtained from the INHS mussels database and matched with our observed and modeled temperature records. Analysis of these data is underway.

JOB 4. Characterize a subset of streams identified in Job 3.

Further evaluation of the temperature model (Figure 1) using field based temperatures indicates that the model has an overall accuracy of 64% and does an excellent job predicting warm water sites (84%) that make up the majority of Illinois streams. However, the model is less accurate at predicting coldwater (19% correctly identified) and coolwater stream segments (31%). We plan to refine the temperature model in the future to more accurately identify coolwater streams using the temperature records collected in this study.

A subset of the sites with field based temperature records are being used to examine inter-annual temperature variation. We have a total of 22 sites that have multiple year records. These data suggest that while interannual variation occurs the majority of these sites maintain the same thermal class (i.e., cold, cool, or warm) each year.

Three additional stream networks were examined for spatial and longitudinal extent of thermal conditions by monitoring temperature in adjacent and neighboring stream segments (11 total networks sampled during the project). These records suggest that thermal conditions within a stream network can be a complex mosaic of cool and warm waters related to the interconnectedness of the stream channels and the differential effects of instream cover and ground water inputs (Figure 5).

JOB 5. Conduct macroinvertebrate sampling at a subset of sites.

Records from IEPA cooperative basin survey macroinvertebrate collections were used to compare macroinvertebrate species distributions to thermal regime. Analysis is ongoing and will be presented in the final report.

JOB 6. Compile and analyze data and write a report.

This annual report was completed that identifies 63 sites in Illinois with observed cold- or coolwater conditions (i.e., summer temperatures below 22 C; Figure 6). Preliminary results were presented at the 69th Midwest Fish and Wildlife Conference, (Metzke et al. 2008, December 2008, Columbus, OH), the Annual Meeting of Illinois Fisheries Society Meeting (Metzke et al. 2009, February 2009, Rock Island, IL), and the 57th Annual Meeting of the North American Benthological Society (Hinz and Metzke 2009, May 2009, Grand Rapids, MI).

LITERATURE CITED:

- Aquatic Research Center of the Indiana Biological Survey. 2007. Development of Coolwater Index of Biotic Integrity Expectations for Use in Streams and Rivers of Indiana and Review of Existing Data. Technical Report 2007-01. Indiana Biological Survey, Aquatic Research Center, Bloomington, IN.
- Hinz Jr., L. C. and B. A. Metzke. 2009. Developing an inventory of coolwater streams for Illinois. 57th Annual Meeting of the North American Benthological Society, Grand Rapids, MI.
- Metzke, B. A., L. Hinz Jr., A. Holtrop, and J. Epifanio. 2008. Evaluating water temperature, habitat, and biotic communities in candidate coolwater streams in Illinois. 69th Midwest Fish and Wildlife Conference, Columbus, OH.
- Metzke, B. A., L. Hinz Jr., A. Holtrop, and J. Epifanio. 2009. Evaluating water temperature, habitat, and biotic communities in candidate coolwater streams in Illinois. Illinois Fisheries Society Meeting, Rock Island, IL.

Table 1. Observed thermal conditions for sites containing candidate coolwater fish species in Illinois.

<u>Species</u>	<u>Number of Sites with Temp. Records</u>	<u>Mean Temp. of Occurrence</u>	<u>Range of Mean Temps.</u>	<u>Proportion of Cool Occurrences</u>	<u>Max. Daily Temp. Range</u>
Northern brook lamprey	0	n/a	n/a	n/a	n/a
American brook lamprey	0	n/a	n/a	n/a	n/a
Least brook lamprey	0	n/a	n/a	n/a	n/a
Brown trout	3	19.4	18.1-21.3	3	9.8
Rainbow trout	2	19.7	18.2-21.3	2	4.7
Southern redbelly dace	20	21.8	17.9-28.3	9	9.8
Blacknose dace	19	19.9	14.6-25.3	12	13.1
Longnose dace	2	21	20.6-21.3	2	7.5
Ozark minnow	5	20.8	18.2-22.3	4	9.3
Weed shiner	3	24.3	23.7-25.3	0	11.8
Ironcolor shiner	4	23	20.7-25.3	1	13.3
Ninespine stickleback	1	21.3	n/a	1	4.5
Brook stickleback	5	18.2	14.2-21.7	5	13.1
Banded sculpin	9	24.4	22.1-27.5	0	6.8
Mottled sculpin	4	19.3	15.9-21.8	4	7.3
Iowa darter	0	n/a	n/a	n/a	n/a
Least darter	3	23.5	22.5-24.2	0	11.7

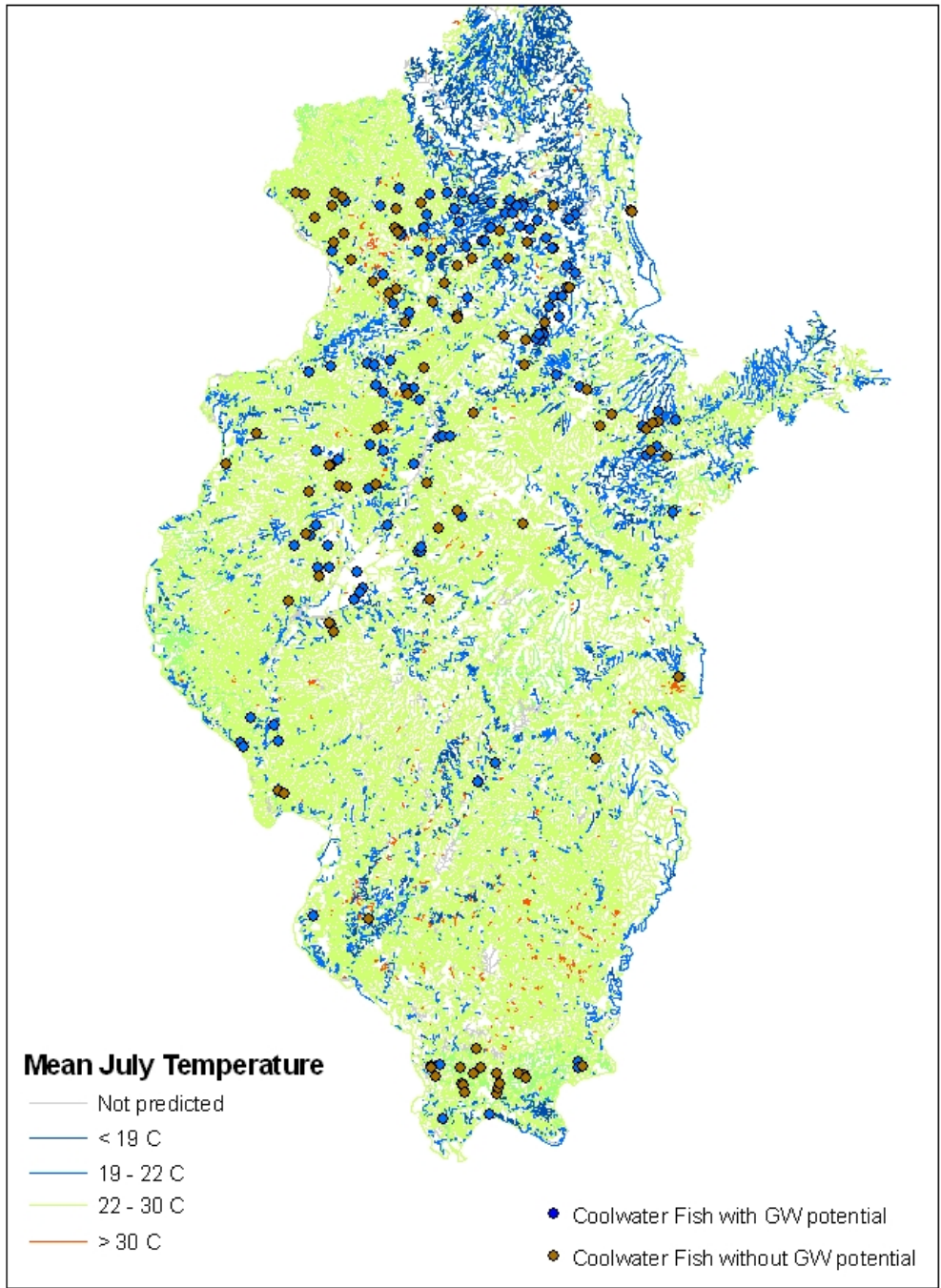


Figure 1. Candidate Coolwater sites and Summer Stream Temperatures based on model output.

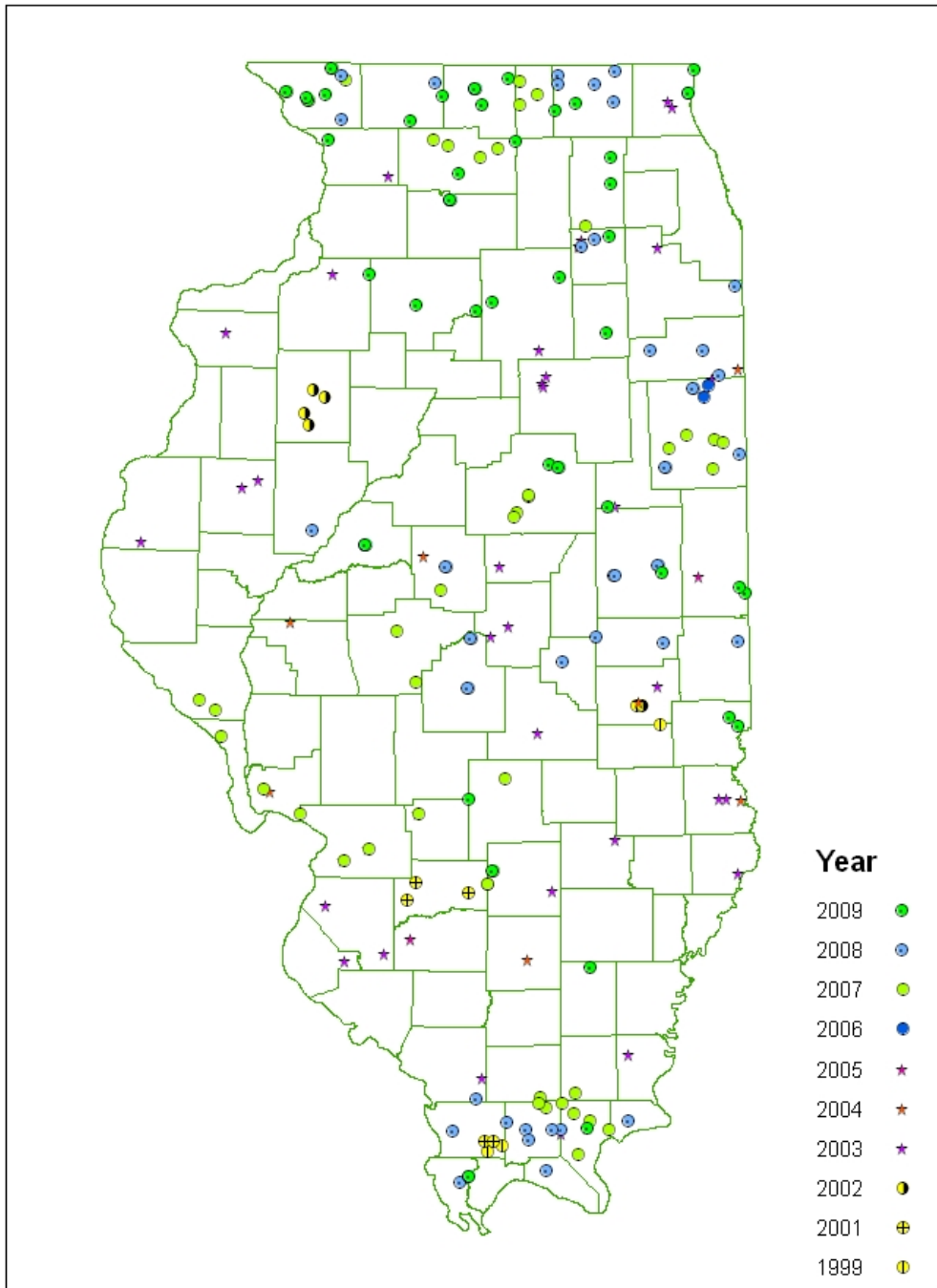


Figure 2. Water Temperature Monitor Locations 1999-2009.

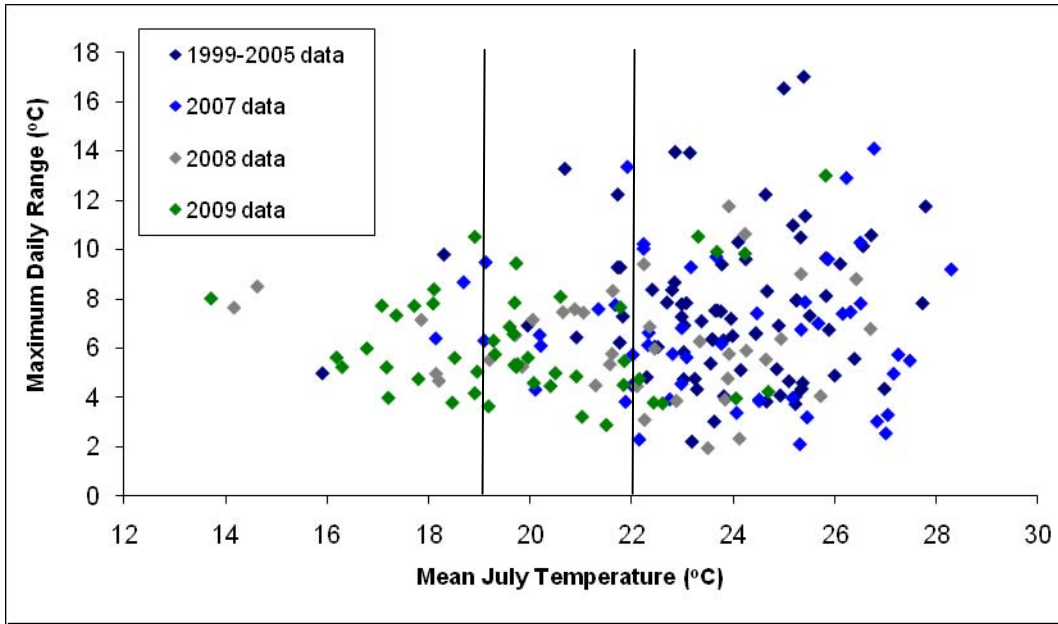


Figure 3. Mean summer water temperatures from 224 temperature samples. We have identified coldwater streams as those that have mean daily temperatures below 19 °C, and coolwater streams as those between 19 and 22 °C.

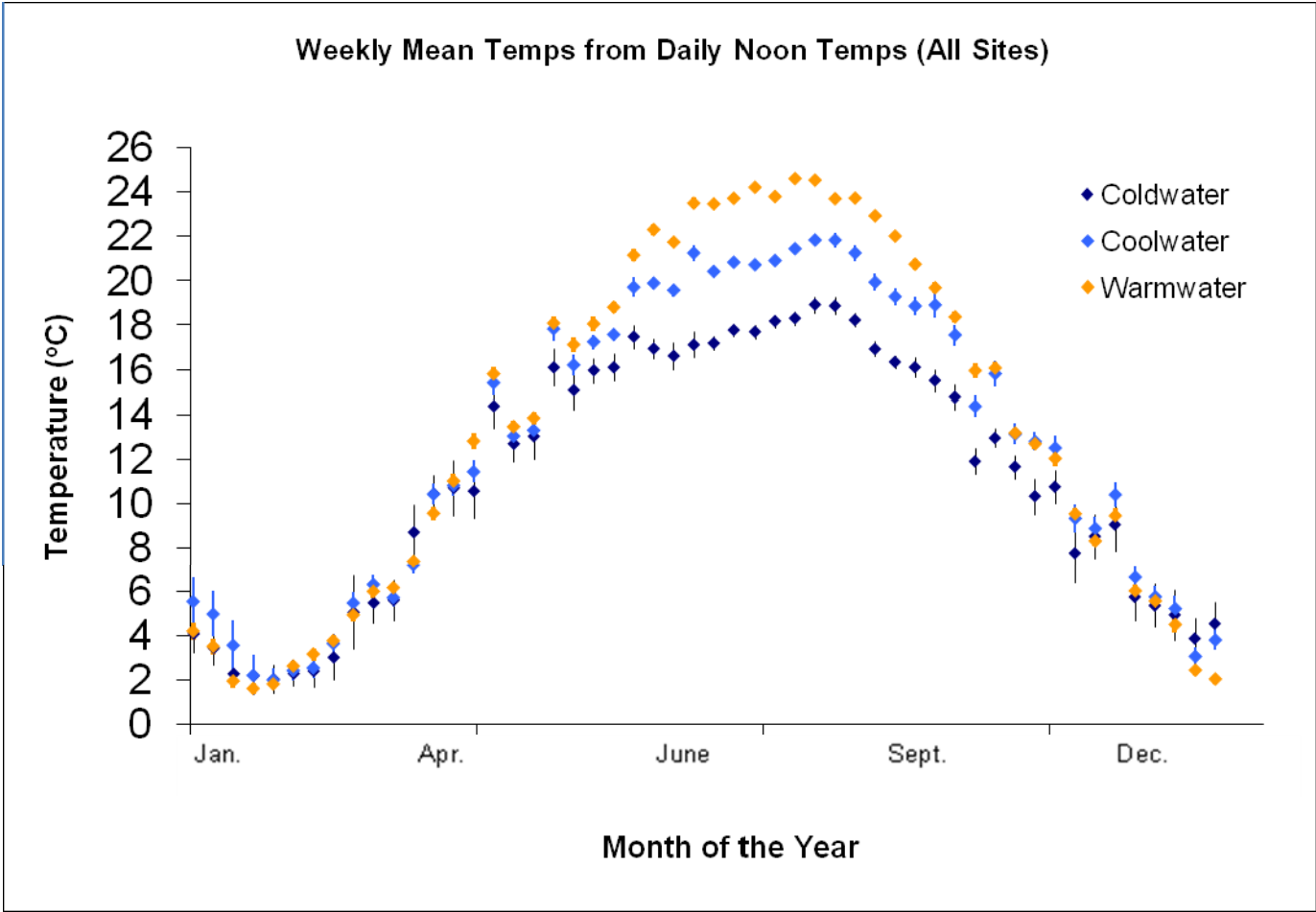


Figure 4. Distribution of weekly mean temperatures for streams with characteristic cold, cool, and warm summer conditions based on approach used by the Indiana Biological Survey in the development of coolwater index of biotic integrity (ARC 2007). Note the good separation between the thermal classes during the summer months.

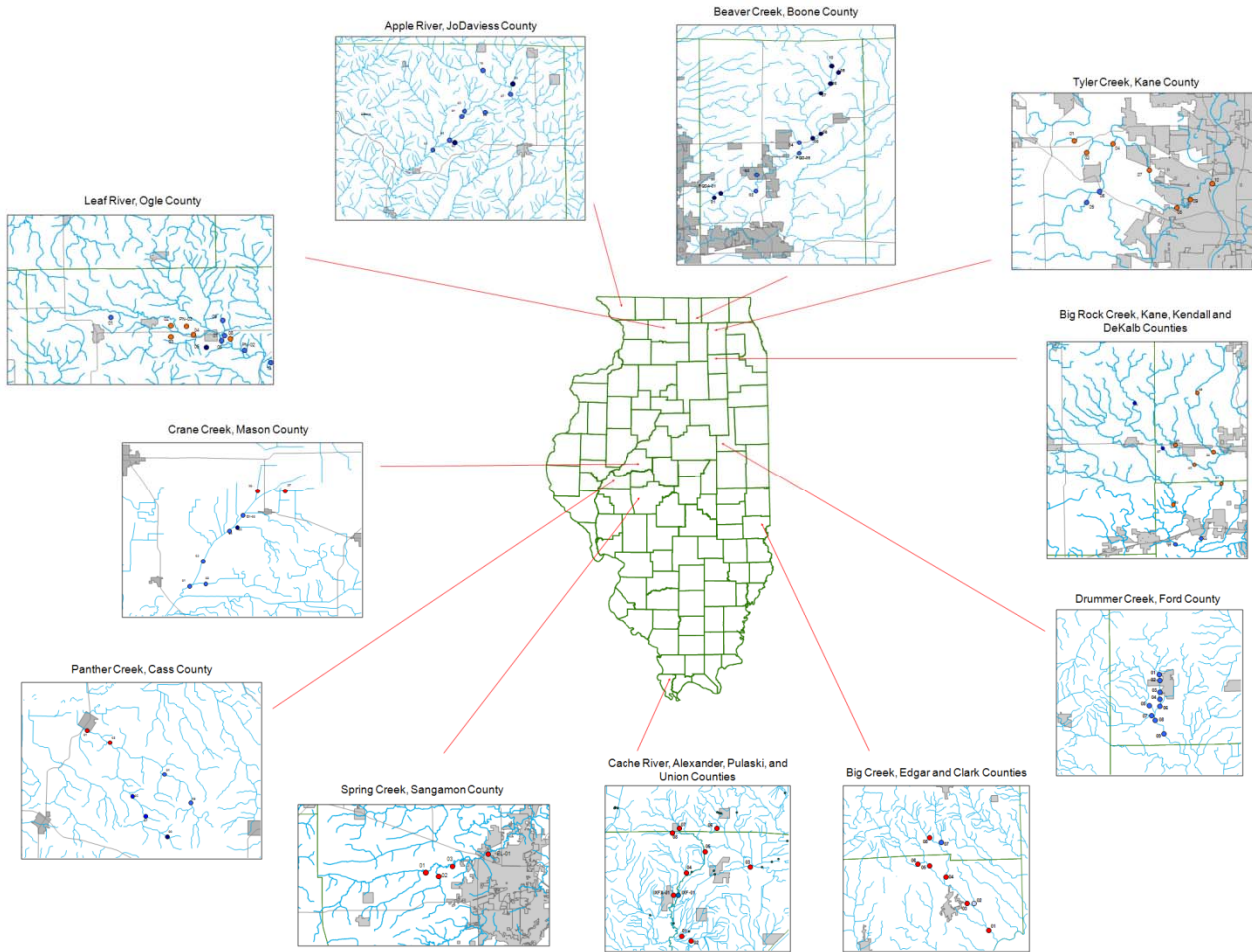


Figure 5. Statewide thermal patterns for network sampling, summers 2007-2009. Coolwater sites had mean daily temperatures less than 22°C during the sampling interval and are shaded in blue, warmwater sites had mean daily temperatures of greater than 22°C and are shaded in red.

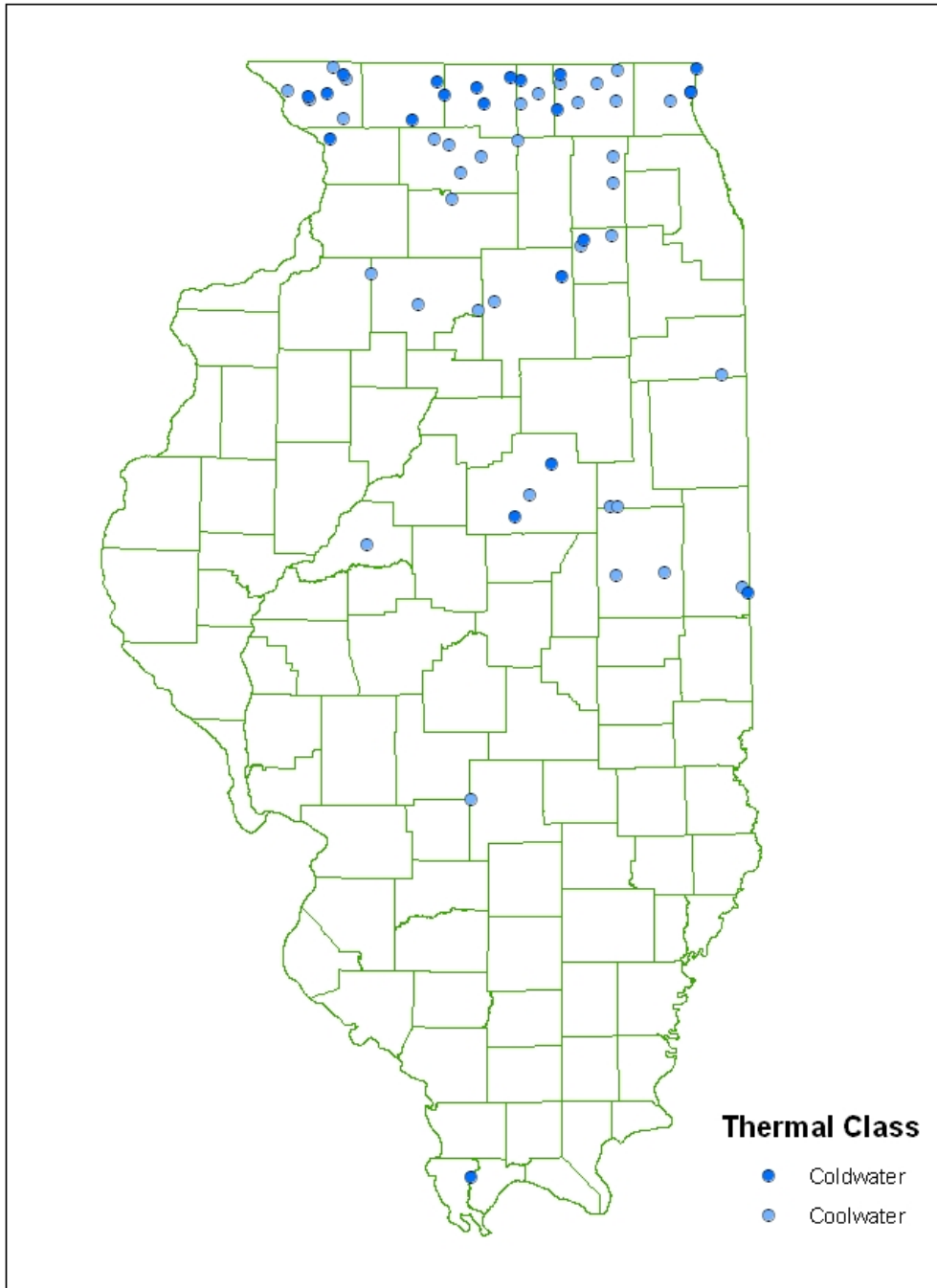


Figure 6. Coolwater and Coldwater sites identified in Illinois streams from measured water temperatures (1999-2009).