PROJECT SUMMARY

Title	Impacts of Land Use and Groundwater Flow on the Temperature of Wisconsin Trout Streams
Project I.D.	WRI #: R/UW-GSI-005, GCC #: 02-GSI-3
Investigator(s)	*Principal Investigators:* Stephen J. Gaffield, Hydrogeologist, Wisconsin Geological and Natural History Survey Lizhu Wang, Supervisory Research Biologist, Michigan Department of Natural Resources *Other Contributors:* Todd W. Rayne, Professor, Hamilton College Department of Geology Kenneth R. Bradbury, Hydrogeologist, Wisconsin Geological and Natural History Survey
Period of Contract	July 1, 2001 – June 30, 2003
Background/Need	Groundwater discharge to streams is critical for maintaining coldwater fisheries. Habitat management is made difficult by a lack of detailed understanding of the controls over summer stream temperature.
Objectives	We evaluated the utility of models of stream temperature, groundwater flow, and groundwater recharge as decision-making tools for stream and watershed management.
Methods	We adapted the method used in the existing stream-temperature models SSTEMP and SNTEMP for application to small Wisconsin streams. Our stream-temperature model predicts water temperature as a function of groundwater inflow, channel shape, weather conditions, and shade from riparian vegetation. We tested model parameters previously calibrated for the Driftless Area to determine their suitability for use in the Northern Lakes and Forests, the North-Central Hardwood Forest, and the Southeast Wisconsin Till Plain Ecoregions of Wisconsin. Model simulations were compared to field data collected from five streams in the summer of 2001. For one of these streams, Rowan Creek in Columbia County, we linked the stream-temperature model to models of groundwater

recharge and groundwater flow. By jointly using these three models, we evaluated the impact of future land-use changes on the infiltration of rain and snowmelt into the soil, stream baseflow supplied by the groundwater flow system, and stream temperature.

Results and Discussion

The stream-temperature model matched measured temperatures for three streams reasonably well, but it performed poorly for two streams with extensive wetlands. Assumptions upon which the model is based may not be valid for wetland stream channels.

Linked models of groundwater recharge, groundwater flow, and stream temperature for Rowan Creek predicted changes in stream temperature of up to 0.8°C related to drought, conversion from native vegetation to agricultural land use, and groundwater extraction from a well near the stream. Simulations of increased urban and suburban land covers predicted little change in temperature.

Conclusions, Implications, and Recommendations

Our stream-temperature model is well suited for assessment of many small Wisconsin streams. Where extensive wetlands are present, caution must be used in applying the model because it may not adequately represent the processes controlling stream temperature. More research is needed to determine the best approach for simulating the temperature of streams flowing through large wetlands.

The linked models indicate that daily mean stream temperature is rather insensitive to changes in the groundwater flow system related to human activities. Daily maximum temperature is likely to be more sensitive, but is not simulated by our technique. Human land use can have numerous other impacts on stream habitat that are not represented by our models, including changes in channel width, burial of pools and gravel spawning beds by sediment, and inflows of runoff heated by paved surfaces.

Related Publications

Rayne, T.W., S.J. Gaffield and K.R. Bradbury (in press). Linking Groundwater Recharge, Flow, and Stream-Temperature Models to Simulate the Effects of Local Land-Use on a Stream. Geological Society of America 2003 Annual Meeting, Abstracts and Programs, abstract 65887.

Key Words

Stream temperature; groundwater; recharge; land use; coldwater fisheries; mathematical models

Funding

University of Wisconsin System