AFS NCD Rivers and Streams Technical Committee
2013 Wisconsin Chapter Report

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WISCONSIN INTENSIFICATION OF THE USEPA NATIONAL RIVERS AND STREAMS ASSESSMENT

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As part of U.S. EPA's National Rivers and Streams Assessement (NRSA), the department collected physical, chemical, and biological data from 27 randomly-selected boatable river sites in 2014 that were part of the NRSA 2013-2014 sample population. In order to better describe Wisconsin's overall river population we added an additional 15 random sites to the sample population. The field sampling was done following nationally-consistent (EPA) methods and analyzed using EPA lab protocols. Assessment reaches were based on a distance of 40 times the mean wetted width of each river site. Each site was visited once. Physical habitat was measured or visually estimated at each of 11 transects. Composite sediment samples were collected to test for pesticides, metals, nutrients, PCBs and PAHs. Water column grab samples were collected to measure nutrients, suspended sediments, chlorophyll, algal toxin, and bacteria, concentrations. Composite diatom and algal samples were collected from hard substrates or vacuumed off of surficial sediment. Composite macroinvertebrate samples were collected using shoreline sweeps. Fish were collected using a "mini-boom" electrofishing boat with one netter. Sediment, water chemistry, periphyton, and macroinvertebrate samples are being analyzed by WI labs. All data should be available in early 2016, and data analyses will start when all data are available. The river data will be combined with data from 50 randomly-selected "wadeable" stream sites sampled in 2013 as part of NRSA for a statewide characterization of Wisconsin rivers and streams.

PREDICTED EFFECTS OF CLIMATE CHANGE ON WISCONSIN STREAM FISHES

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STUDY OBJECTIVES:

1. Improve the sensitivity of an existing GIS-based, watershed-scale model that predicts stream suitability for stream fish species to variation in climate and groundwater flows by developing a hydrologic model to link changes in air temperature and precipitation to changes in water temperature and stream flow

2. Use the improved model to predict how various climate change scenarios predicted specifically for Wisconsin will alter the distribution and abundance of Wisconsin stream fishes

3. Examine long-term datasets on fish reproduction to determine if migrations and spawning have changed in response to climate warming over the last 50 years.

PERFORMANCE ON SCHEDULED ACTIVITIES:

1. During the past year, the study team, consisting of participants from the Wisconsin Department of Natural Resources, Michigan Department of Natural Resources, International Joint Commission, U.S. Geological Survey, and Michigan State University, developed improved versions of the stream temperature and stream flow models. Outputs from these models were linked with updated climate, geology, land-cover, and stream channel characteristics in a Geographic Information Systems (GIS) framework. New species distribution models were then developed from this framework for 13 stream fish species using Random Forests statistical software. These models were tested with independent data and found to have accuracies of 75-90% in predicting species occurrence under current climate conditions. This objective is now complete.

2. Collaborators from the University of Wisconsin-Madison developed downscaled climate projections for Wisconsin and the entire Great Lakes Basin for 13 Global Climate Models under one Emissions Scenario (A1B). The study team then ran these projections through the new stream temperature, stream flow, and fish species distribution models for all streams in Wisconsin and the Upper Great Lakes Basin (1:100,000 mapping scale) to estimate the range of fish habitat suitability at mid century under predicted climate change. Outputs were portrayed in maps and tables that have been made available in a public website “FishVis” (http://wim.usgs.gov/FishVisDev/FishVis.html#). Not surprisingly, the models predicted warmer stream temperatures, modest flow changes, sharp declines in the distribution of coldwater and coolwater fish species, and moderate gains in the distribution of warmwater fish species. The team then sponsored two two-day workshops of representatives from government agencies, academic institutions, and conservation organizations with interests and expertise in stream fisheries management to critique the website. The website has been revised and improved in

response to feedback from the workshop and is now complete. A manuscript has been completed and accepted for publication describing how projected future changes in thermal habitat suitability may affect lake sturgeon distribution in Wisconsin's rivers. This objective is now complete.

3. In collaboration with Wisconsin DNR fish managers, data were gathered from long-term (> 20 years) surveys of fish reproduction (migration and spawning). Data from spawning surveys in the Great Lakes indicated that yellow perch were tending to spawn earlier in the spring in Lake Michigan in response to warming spring climate trends. Lake trout in Lake Michigan and Lake Superior had less certain responses in the timing and duration of their fall spawning and fall climate warming trends were not clearly evident. A manuscript is in preparation describing these results. Efforts are underway to capture and summarize data on trends in anadromous salmonid migrations in the Bois Brule River, a tributary to Lake Superior, and in walleye reproduction in Escanaba Lake in northern Wisconsin.

STUDY PUBLICATIONS:

Stewart, J. S., S. M. Westenbroek, M. G. Mitro, J. Lyons, L. Kammel, and C. A. Buchwald. 2014. A model for evaluating stream temperature response to climate change in Wisconsin. USGS Technical Report, Reston, Virginia. In press.

Lyons, J., and J. S. Stewart. 2014. Predicted effects of future climate warming on thermal habitat suitability for lake sturgeon (*Acipenser fulvescens*, Rafinesque, 1817) in rivers in Wisconsin, USA. Journal of Applied Ichthyology. In Press.

Mitro, M. G., J. Lyons, and S. Sharma. 2011. Appendix: Coldwater fish and fisheries working group report. Wisconsin's changing climate: impacts and adaptation. Wisconsin Initiative on Climate Change Impacts, Madison. http://www.wicci.wisc.edu/report/Coldwater-Fish-and-Fisheries.pdf

Sharma, S., M. J. Vander Zanden, J. J. Magnuson, and J. Lyons. 2011. Comparing climate change and species invasions as drivers of coldwater fish population extirpations. Public Library of Science (PLoS) ONE 6(8):e22906. 9 pages.

Lyons, J., J. S. Stewart, and M. Mitro. 2010. Predicted effects of climate warming on the distribution of 50 stream fishes in Wisconsin, U.S.A. Journal of Fish Biology 77:1867-1898.

Mitro, M. G., J. Lyons, and J. S. Stewart. 2010. Predicted effects of climate change on the distribution of wild brook trout and brown trout in Wisconsin streams. Proceedings of Wild Trout X, West Yellowstone, MT, September 28-30, 2010.

Westenbroek, S., J. S. Stewart, C. A. Buchwald, M. Mitro, J. Lyons, and S. Greb. 2010. A model for evaluating stream temperature response to climate change scenarios in

Wisconsin. Proceedings of the 2010 Watershed Management Conference, American Society of Civil Engineers, Madison, WI, August 23-27, 2010.

STUDY PRESENTATIONS:

Stewart, J., A. Covert, N. Estes, J. Bruce, S. Westenbroeck, D. Krueger, D. Wieferich, M. Slattery, J. Lyons, J. McKenna, and D. Infante. 2014. FishVis: a regional decision support tool to map the response of riverine fish to climate change in the Great Lakes Region of the United States. Annual Meeting of the American Fisheries Society, August 17-21, 2014, Quebec City, Canada.

Lyons, J., and J. M. Stewart. 2014. Conserving riverine lake sturgeon in Wisconsin under a warming climate: the importance of connectivity. Fourth Fish Passage Symposium, June 9-11, 2014, Madison, Wisconsin.

Lyons, J. 2014. Effects of climate change on cisco, a keystone fish species in Wisconsin's deepest lakes. 36th Annual Wisconsin Lakes Convention, April 24-26, 2014, Stevens Point, Wisconsin.

Mitro, M. G., J. Lyons, J. Stewart, and S. Westernbroek. 2014. Climate change impacts on Wisconsin's trout streams. Citizens' Climate Lobby – Central Wisconsin Chapter. Invited panel forum on "Climate Change and Wisconsin Hunting and Fishing, Stevens Point, WI, April 2014.

Lyons, J., A. Rypel, T. Burzyinski, J. Myers, T. Paoli, and P. B. McIntyre. 2014. Effects of climate change on the reproductive phenology of two Great Lakes fishes. Annual Meeting of the Wisconsin Chapter of the American Fisheries Society, February 25-27, 2014, Green Bay, Wisconsin.

Mitro, M. G., S. Marcquenski, K. Soltau, and P. Kanehl. 2014. Gill lice as a proximate cause of brook trout loss under changing climatic conditions. Annual Meeting of the Wisconsin Chapter of the American Fisheries Society, February 25-27, 2014, Green Bay, Wisconsin.

Mitro, M., J. Lyons, J. Stewart, S. Westenbroek, L. Kammel, and C. Buchwald. 2014. Modeling and monitoring to understand climate change impacts on Wisconsin trout streams. Annual Meeting of the Wisconsin Chapter of the American Fisheries Society, February 25-27, 2014, Green Bay, Wisconsin.

Parks, T., and J. Kampa. J. 2014. Long-term patterns of white sucker reproductive phenology associated with climate change in northern Wisconsin lakes. Annual Meeting of the Wisconsin Chapter of the American Fisheries Society, February 25-27, 2014, Green Bay, Wisconsin.

Mitro, M., J. Lyons, J. M. Stewart, S. Westenbroek, L. Kammel, and C. Buchwald. 2014. Modeling and monitoring to understand climate change impacts on Wisconsin trout streams. Poster presented at the Wisconsin Chapter of the American Fisheries Society, February 25-27, 2014, Green Bay, Wisconsin.

McKenna, Jr., J. E., J. M. Stewart, J. Lyons, and D. Infante. 2014. Tools for evaluation of climate change effects on fish habitat. Annual Meeting of the New York Chapter of the American Fisheries Society, February 5-7, 2014, Geneva, New York.

Cunningham, P., M. Diebel, J. Griffin, J. Lyons, M. Mitro, and J. Pohlman. 2014. Adaptation strategies for brook trout management in the face of climate change. Annual Driftless Area Symposium, February 4-5, 2014, LaCrosse, Wisconsin.

Mitro, M., J. Lyons, J. M. Stewart, S. Westenbroek, L. Kammel, and C. Buchwald. 2013. Modeling and monitoring to understand climate change impacts on Wisconsin trout streams. Poster presented at the University of Wisconsin Center for Climatic Research/Nelson Institute 50th Anniversary, October 2013, Madison, Wisconsin.

Mitro, M., J. Lyons, J. M. Stewart, S. Westenbroek, L. Kammel, and C. Buchwald. 2013. Modeling and monitoring to understand climate change impacts on Wisconsin trout streams. Poster presented at the Wild Trout Symposium, October 1-3, 2013, Yellowstone National Park, Wyoming.

Krueger, D. M., J. M. Stewart, L. Wang, D. Infante, J. Lyons, J. McKenna, K. Wehrly, A. Covert, D. Wieferich, S. Westenbroek, S. Niemela, M. Mitro, J. Bruce, and N. Estes. 2013. Assessing Midwest stream fish habitat in the face of a changing climate: an adaptive management approach using the FishVis mapping tool. 1st Annual National Adaptation Forum, April 1-5, 2013, Denver, Colorado.

Lyons, J., and J. M. Stewart. 2013. FishVis: A web-based system for visualizing predicted effects of climate change on stream fishes in the Great Lakes region. Presentation given to the Wisconsin Department of Natural Resources Fisheries Management Biennial Training Session, Wisconsin Dells, WI, February 26-28, 2013.

Lyons, J., and J. M. Stewart. 2013. FishVis: A web-based tool for predicting responses of stream fishes and their habitats to climate change in the Great Lakes region. Wisconsin Chapter of the American Fisheries Society, Wausau, WI, February 5-7, 2013.

Sharma, S., M. J. Vander Zanden, J. J. Magnuson, and J. Lyons. 2012. Comparing climate change and species invasions as drivers of coldwater fish population extirpations. Annual Meeting of the American Fisheries Society, August 19-23, St. Paul, Minnesota.

Stewart, J., S. Westenbroek, M. Mitro, J. Lyons, and L. Kammel. 2012. Effects of future climate projections on stream temperatures and fish thermal habitat for Upper Midwest and Great Lakes streams. Annual Meeting of the American Fisheries Society, August 19-23, St. Paul, Minnesota.

Lyons, J. 2012. Climate change influences on streams and fish. Presentation to U.S. Fish and Wildlife Service Land Conservation Cooperative workshop on climate change, Ann Arbor, MI, June 21, 2012.

Lyons, J. 2012. Assessing vulnerability of fish to climate change. Presentation to U.S. Fish and Wildlife Service Land Conservation Cooperative workshop on climate change, (June 21) Ann Arbor, MI, June 21, 2012.

Stewart, J., S. Westenbroek, M. Mitro, J. Lyons, and C. Buchwald. 2011. An approach to model and evaluate stream temperature response to climate change in Wisconsin. Annual Meeting of the American Fisheries Society, September 4-8, 2011, Seattle, Washington.

Mitro, M., J. Lyons, and J. Stewart. 2011. Use of models to predict climate change impacts and inform adaptation strategies for trout in all Wisconsin streams. Upper Midwest Stream Restoration Symposium, February 27-March 2, 2011, Oconomowoc, WI.

Mitro, M., J. Lyons, and J. Stewart. 2010. Predicted effects of climate change on the distribution of brook trout and brown trout in Wisconsin streams. 71st Midwest Fish and Wildlife Conference, Minneapolis, MN, December 12-15, 2010

Mitro, M., J. Lyons, and J. Stewart. 2010. Predicted effects of climate change on the distribution of wild brook trout and brown trout in Wisconsin streams. Wild Trout X, September 28-30, 2010, West Yellowstone, MT.

Lyons, J., J. Stewart, and M. Mitro. 2010. Use of a watershed-scale GIS model to predict responses of 50 Wisconsin stream fishes to climate warming. Annual Meeting of the American Fisheries Society, September 12-16, 2010, Pittsburgh, PA.

Stewart, J., S. Westenbroek, M. Mitro, J. Lyons, S. Greb, and C. Buchwald. 2010. Integrating a soil water balance model with an artificial neural network model to predict stream temperature for Wisconsin streams under current conditions and future

climate-change scenarios. 2010 Watershed Management Conference, American Society of Civil Engineers, Madison, WI, August 23-27, 2010.

Lyons, J. J. Stewart, and M. Mitro. 2010. Predicted shifts in broad-scale distribution of stream fishes in Wisconsin, USA, in response to climate change. Fish and Climate Change, Fisheries Society of the British Isles Annual Symposium, July 26-30, 2010, Belfast, Northern Ireland.

Sharma, S., J. Vander Zanden, J. Magnuson, and J. Lyons. 2010. Predicting the effects of climate change and invasion of rainbow smelt on cisco extinctions. American Society of Limnology and Oceanography, June 6-11, 2010, Santa Fe, NM.

Lyons, J. 2009. Effects of climate change on Wisconsin's fishes. Seminar presented to the UW-Madison Center for Climate Change, April 24, 2009, Madison, WI.

Lyons, J. 2009. Effects of climate change on Wisconsin's coolwater and warmwater fishes. Presentation in UW-Madison's "Bracing for Impact: Climate change in Wisconsin" series, February 26, 2009, Madison, WI.

Mitro, M. G., J. Lyons, and J. Stewart. March 2009. Response of Wisconsin's coldwater fishes to climate change. Bracing for Impact-Climate Change Adaptation in WI, sponsored by the Wisconsin Initiative on Climate Change Impacts, University of Wisconsin, Madison, Wisconsin. Invited talk.

Lyons, J. 2009. A statewide model to predict the effects of land use and climate change on stream fishes in Wisconsin. Seminar present to WDNR Bureau of Fisheries Management, March 5, 2009, Madison, WI.

Mitro, M. G. January 2009. Trout stream habitat restoration and climate change in Wisconsin. WDNR Fisheries Management Statewide Meeting, Wisconsin Dells, Wisconsin.

Lyons, J. 2008. Climate change impacts on Wisconsin's fish and fisheries. Sustaining Wisconsin's Environment and Economy: Responding to Climate Change. Second Annual Nelson Institute Earth Day Conference, April 16, 2008, Madison, WI.

Lake Sturgeon Distribution, Movement and Stocking Success in the Upper St. Croix River and Namekagon River

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Background:

Sturgeons are declining worldwide and threatened with extinction yet fishable populations of lake sturgeon occur in Wisconsin. The Wisconsin Department of Natural Resources Fish Management (WDNR) program goals for lake sturgeon (Acipenser fulvescens) are to manage lake sturgeon populations as sustainable fisheries and restore lake sturgeon populations in their native range. The Wisconsin Lake Sturgeon Management Plan (WLSMP) further defined information needs to manage lake sturgeon populations. According to the WLSMP, basic information on lake sturgeon population dynamics is needed to set biologically sound population goals. Assessing the success of reintroductions was listed as a high priority in the WLSMP.

The WDNR Endangered Resources program has listed lake sturgeon as a special concern species in Wisconsin. The Endangered Resources Wisconsin Wildlife Action Plan identifies the following information needs to better inform and focus management and conservation efforts for lake sturgeon: population trends, reproduction, recruitment, seasonal migration, and the success of reintroduction efforts.

The Upper St. Croix River Basin Sturgeon Plan (USCRBSP) defines system specific goals and objectives to maintain and enhance existing lake sturgeon populations and assess reintroduction efforts in suitable portions of their former range. The USCRBSP recommends developing a stocking assessment plan for waters receiving rehabilitation stocking. WDNR Fish Management staff has been working on a joint population assessment study with the Minnesota Department of Natural Resources (MNDNR) in the lower portions of the upper St. Croix River below the confluence with the Namekagon River. No population assessment work has been conducted on the St. Croix River above the confluence with the Namekagon River or in the Namekagon River. Reintroductions have occurred above movement barriers in this portion of the system.

Results and Benefits:

We will determine whether fishable populations exist above the confluence of the St. Croix River and Namekagon River. Currently there is no open season for fishing lake sturgeon in these sections of the rivers. Describing recruitment of lake sturgeon in the study area below barriers will contribute to understanding whether these populations are sustainable with or without fishing seasons. If adult lake sturgeon aggregate below the St. Croix Flowage dam during spawning season, a fish bypass may be considered to allow lake sturgeon access to upriver habitat. The United States Army Corps of Engineers and local WDNR Fish Management staff have expressed interest in investigating the potential for fish passage at this site in the past (personal communication, Scott Toshner, WDNR, Brule, WI). In addition, the Army Corps of Engineers has expressed interest in fish passage around the power dam on the Eau Claire River to allow access to spawning habitat upstream from the dam.

We will document the degree of movement between river segments upstream and downstream of the confluence of the St. Croix River and Namekagon River as well as movement of lake sturgeon between Minnesota and Wisconsin jurisdictions. The degree of movement may dictate joint management of the lake sturgeon resource in the St. Croix River system.

Fry, fingerling, and yearling lake sturgeon have been stocked in the Namekagon River and upper St. Croix River above movement barriers. The yearlings stocked in 2003 were PIT tagged and could be distinguished from other sizes of sturgeon that were stocked. In addition, ageing lake sturgeon will assign them to a particular year class and allow further description of stocking success by size. Documenting the outcome of the reintroductory stocking efforts above movement barriers can be used to refine stocking approaches in the system. Refining stocking practices will allow Fish Management to establish minimum viable adult populations to promote self-sustaining lake sturgeon populations.

Implementation and Results:
First, to meet the information needs outlined in management plans we conducted population assessment surveys to document abundance, distribution, and movement of lake sturgeon from the confluence of the St. Croix and Namekagon Rivers upstream to the St. Croix Flowage dam and Trego Dam. Data from the Namekagon River was compared to historical records of abundance of lake sturgeon. The attached publication presents study results.

Secondly, we evaluated the status of lake sturgeon stocked above the Trego Flowage Dam on the Namekagon River and the St. Croix Flowage Dam on the St. Croix River. Lake sturgeon were reintroduced above the Trego Dam on the Namekagon River beginning in 1995 (Table 1). Lake sturgeon stocking above the St. Croix Flowage Dam on the Upper St. Croix River system began in 2002 with stocking events occurring in the St. Croix River, St. Croix Flowage, Upper St. Croix Lake, and Eau Claire River (Table 2). We assisted Spooner Fish Management staff and Wild Rose Hatchery staff with dip netting lake sturgeon brood stock and gamete collection on the Yellow River for rearing and reintroduction efforts in the Namekagon River and St. Croix River annually. Anecdotal information indicated some lake surgeon survived, but the outcome for several year classes remains unclear and the distribution of stocked fish above the Trego Flowage and St. Croix Flowage is unknown.

We conducted visual reconnaissance surveys to document river access from the Gordon Dam to Upper St. Croix Lake and from the Trego Dam to Stinnett Landing to determine which sampling gears could be deployed in these river reaches. Inaccessibility, low bridge crossings, and shallow water limited the use of a DC boat-mounted electrofishing unit to the reach of the St. Croix River from the St. Croix Flowage upstream to the Old Hwy 53 bridge. We electrofished above the St. Croix Flowage during May, 2011.

Macrophyte growth and shallow water conditions did not allow us to electrofish from the widening of the river upstream of Old Hwy 53 upstream to Upper St. Croix Lake and seasonally restricted the use of a 14-ft Jon boat and outboard. We angled for lake sturgeon above Old Hwy 53.

We electrofished the Namekagon River from the Trego Flowage 1.5 km upstream to the Wagon Bridge below the Trego Town Park landing (N45°54'32.9" W91°49'29.8") and from the Trego Park Landing 1.9 km upstream to the National Park Service Hiking Trail (N45°54'20.8" W91°48'12.9") with a DC boat-mounted unit during May and September, 2009 – 2011 and September, 2008. Spooner Fish Management staff electrofished below Earl Landing (N45°54'47" W91°46'21") on the Namekagon River during September, 2011.

Visual reconnaissance and angling was conducted on the Namekagon River during June 23, 2009 and August 17, 2010 from Big Bend Landing (N45°55'57.0" W91°45'1.7") downstream 12.4 km to the National Park Service Visitor Center at Trego, Wisconsin. In cooperation with Spooner Fish Management staff, we angled for lake sturgeon in the Trego Flowage during August and September, 2010 – 2012.

We deployed graded mesh horizontal gill nets for two short-term (2-hour) sets for lake sturgeon in the Trego Flowage on August 1 and August 27, 2012. Gill net mesh sizes were 2", 2 ½", 3", and 3 ½". Gill nets were fished on the bottom after verifying dissolved oxygen levels were adequate for lake sturgeon. Gill net mesh sizes were selected to capture immature lake sturgeon because most stocking occurred after 2001. Gill nets were deployed in an area Fish Management staff had collected lake sturgeon by angling on August 1and we set in the deep basin near the dam on August 27.

Captured lake sturgeon were inspected for external dangler tags and scanned with an Avid Power Tracker V for passive integrated transponder (PIT) tags. If present, tag information was recorded as well as total length (TL, cm), weight (kg), and location on the river which was determined with a hand held Garmin Global Positioning System (GPS) Model 76S unit. Unmarked fish were given a dangler tag secured with a 0.20 gauge wire through the base of the dorsal fin and a 12.5 mm, 125 kHz PIT tag was injected in the fleshy base of the left pectoral fin with a 12 gauge needle. Approximately 15 mm of the base of the right pectoral spine was removed for aging and all fish were released at the sampling site.

Pectoral spines were aged as described by Bruch et al. (2009) with the exception that spines were dried from one to three months prior to processing. Pectoral spines were cross sectioned with a Buehler Model 11-1280-160 Isomet slow speed saw and examined under a Nikon Model Labophot-2 binocular microscope at a magnification of 40x to count annuli and determine age.

We collected 16 lake sturgeon from 16.1 km upstream from the Trego flowage to 16.4 km downstream from the Trego Flowage (Figure 1). Stocked lake sturgeon were most common in the Trego Flowage which is consistent with the broodstock source population from Yellow Lake. Lake sturgeon in the Yellow River system reside in Yellow Lake until spring spawning movements into the Yellow River during April and May. The lake sturgeon captured downstream from the Trego Flowage on August 13, 2012 was PIT tagged and stocked on October 19, 2011. Stocked lake sturgeon fingerlings will be PIT tagged in Fall 2012 and 2013 in the Trego Flowage and Namekagon River providing an opportunity to assess movement of stocked lake sturgeon below the Trego Flowage Dam in the future. Aquatic Engineering Incorporated (Josh Britton) collected an additional lake sturgeon 30.1 km upstream from the Trego Flowage while conducting a mussel survey in the Namekagon River during 2006 (Figure 1).

Stocked lake sturgeon ranged from 31cm to 106cm in total length and represented 6 of 7 stocked year classes based and ageing and recovery of PIT tagged fish. Capturing lake sturgeon from 6 of the 7 stocked year classes was encouraging and provides support to continue the lake sturgeon stocking program on the Namekagon River. We did not detect natural reproduction of lake sturgeon above the Trego Flowage or the St. Croix Flowage. Male lake sturgeon from the 2003 stocked year class may be sexually mature, but it is unlikely female lake sturgeon have reached maturity in the restoration reach of either river

STUDY PUBLICATIONS:

Kampa, J. M., G. R. Hatzenbeler, and M. J. Jennings. 2014. Status and Management of Lake Sturgeon in the upper St. Croix River and Namekagon River, Wisconsin, USA. Proceedings of the International Sturgeon Symposium. doi: 10.1111/jai.12541

STUDY PRESENTATIONS:

Kampa, J. and G. Hatzenbeler. 2009. Lake sturgeon reintroduction and population assessment in the Namekagon River and St. Croix River, Wisconsin. Bureau of Science Services Poster Session, April 28, 2009, Madison, WI.

Kampa, J. and G. Hatzenbeler. 2009. Lake sturgeon reintroduction and population assessment in the Namekagon River and St. Croix River, Wisconsin. Poster Presentation at Twenty-first Annual St. Croix River Research Rendezvous, St. Croix Watershed Research Station, Science Museum of Minnesota, Warner Nature Center, October 23, 2009, Marine on St. Croix, MN.

Kampa, J. M., G. R. Hatzenbeler, and M. J. Jennings. 2011. Lake sturgeon movement and abundance in the Namekagon River and St. Croix River during the 1960s and 2000s. Wisconsin Chapter of the American Fisheries Society 40th Annual Meeting, January 31-February 2, Stevens Point, Wisconsin.

Kampa, J. M., G. R. Hatzenbeler, and M. J. Jennings. 2011. Lake sturgeon movement and abundance in the Namekagon River and St. Croix River during the 1960s and 2000s. Bureau of Science Services Poster Series, February 17, Madison, Wisconsin.

Kampa, J., G. Hatzenbeler, J. Wendel, and M. Jennings. 2012. Status of lake sturgeon restoration in the Namekagon River, Wisconsin. Poster presentation at 24th Annual St. Croix River Research Rendezvous, Science Museum of Minnesota, Warner Nature, October 16, Marine on St. Croix, MN.

Kampa, J. M., G. R. Hatzenbeler, and M. J. Jennings. 2013. Lake Sturgeon in the upper St. Croix and Namekagon Rivers: Status and Restoration. St. Croix River Association Speakers Series, National Park Service Visitor Center, January 19, St. Croix Falls, WI.

Kampa J. M., G. R. Hatzenbeler, J. Wendel and M. J. Jennings. 2013. Status of Lake Sturgeon restoration in the Namekagon River, Wisconsin. , Wisconsin Chapter of the American Fisheries Society 42nd Annual Meeting, February 5 – 7, Rothschild, WI.

Kampa, J., G. Hatzenbeler, J. Wendel, and M. Jennings. 2013. Status of lake sturgeon restoration in the Namekagon River, Wisconsin. Bureau of Science Services Poster Series, March 1, Madison, WI.

RESTORATION OF A BROOK TROUT FISHERY IN TENNY SPRING CREEK USING AN ARTIFICIAL BARRIER

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(Mike Aquino, Jason Himebauch, Gene Van Dyck, and Jordan Weeks, DNR cooperators)

STUDY OBJECTIVE:

In this study we are investigating the restoration of a Brook Trout population in Tenny Spring Creek via installation of a barrier and mechanical removal of a Brown Trout population. Specific objectives include evaluating changes in the trout population and stream fish community following restoration, evaluating movement across the stream barrier (upstream and downstream), and determining if Brook Trout restoration upstream of the barrier in Tenny Spring Creek improves the Brook Trout population downstream of the barrier in Elk Creek.

PERFORMANCE ON SCHEDULED ACTIVITIES:

The restoration of Brook Trout is a priority management goal for the Wisconsin DNR, but to date the installation of a barrier to fish movement has not been used in Wisconsin for Brook Trout restoration. Habitat restoration work on Tenny Spring Creek provided the opportunity to install a barrier to fish movement for the sole purpose of excluding Brown Trout and restoring Brook Trout. The barrier has proved to serve as only a partial barrier to upstream movement of Brown Trout, but the suppression of Brown Trout by mechanical removal during our surveys has allowed stocked Brook Trout to survive and grow such that a Brook Trout fishery now exists in Tenny Spring Creek. The following sections describe our work on Tenny Spring Creek prior to 30 June 2011, from 1 July 2011 to 30 June 2012, and from 1 July 2012 to 30 June 2014.

Summary of work through 30 June 2011

Habitat restoration work began on Tenny Spring Creek in summer 2007 with the installation of a waterfall-type rock barrier at the lower end of the stream (Figure 1). The fisheries crew from La Crosse conducted a mechanical removal of Brown Trout in September 2007 using three passes with electrofishing equipment. All captured Brown Trout were removed and placed downstream of the barrier. Instream habitat restoration was delayed in 2008 and continued upstream of the barrier in 2009. In 2009 the barrier was reconfigured (Figure 2) because the previously installed barrier was not successful at blocking Brown Trout movement upstream.

We surveyed Tenny Spring Creek beginning at the barrier and working upstream on 30 September 2009. We collected 355 Brown Trout and 5 Brook Trout in the first 500 m surveyed. The Brook Trout were released upstream of the barrier and the Brown Trout, including 172 age 1+ trout tagged with visible implant elastomer tags, were released immediately downstream of the barrier.

We surveyed Tenny Spring Creek about two weeks later, on 15 October 2009, to see if any tagged trout had moved upstream through the barrier. Brown Trout typically attempt to move upstream to spawn during autumn. We captured 271 Brown Trout and none were previously tagged. We tagged 39 of the age 1+ Brown Trout and released all of them downstream of the barrier.

We surveyed Tenny Spring Creek the following spring on 7 April 2010 to further investigate whether any trout had moved upstream through the barrier. We captured 349 Brown Trout, 4 of which had been tagged in autumn 2009 (total lengths 146, 207, 223, and 329 mm). Most of the Brown Trout were yearlings (324 Brown Trout < 170 mm total length).

The data suggest that the barrier is not functioning as an absolute block to upstream migration but is providing some level of impediment to upstream movement.

We had anticipated stocking Tenny Spring Creek with Brook Trout in autumn 2010 to determine if a barrier that prevents some level of upstream movement by Brown Trout would allow for the establishment of a Brook Trout population. The stocking of Tenny Spring Creek was delayed until September 2011.

We continued monitoring the trout population in Elk Creek with surveys in October 2010 and April 2011. Brown Trout continue to be the most abundant trout species at over 95% of the population. On 26 April 2011, one day after our last spring survey on Elk Creek, a manure spill occurred on a tributary to the stream, about four miles upstream of the confluence of Tenny Spring Creek. The impact of the spill on the trout population was limited to the unnamed tributary, but Brook Trout were disproportionately affected.

A survey of the impacted tributary showed the following numbers of dead trout: 51 young-of-year Brook Trout, 7 yearling Brook Trout, 10 adult Brook Trout, 9 yearling Brown Trout, and 9 adult Brown Trout. The largest concentrations of Brook Trout in Elk Creek tend to occur in the colder tributaries, such as the one impacted by the manure spill. Most of the tributaries are small, but Tenny Spring Creek is the largest tributary and offers the opportunity to significantly increase Brook Trout numbers in the Elk Creek system.

Summary of work from 1 July 2011 to 30 June 2012

We stocked Tenny Spring Creek in September 2011 with 1,010 Brook Trout derived from the Ash Creek stock, which included 505 F1- and 505 F2-generation Brook Trout. We used this stocking opportunity to evaluate the survival of F1 versus F2 Brook Trout. The F1 Brook Trout were obtained by spawning wild Ash Creek Brook Trout and the F2 Brook Trout were obtained by spawning F1 Brook Trout (See Study SSLT). Each stocked Brook Trout had a fin clip to identify whether it was a F1 (left ventral fin) or F2 (right ventral fin) Brook Trout.

Prior to stocking Brook Trout, we collected and removed 1,279 Brown Trout on 20 September 2011 from about a 1 km section of Tenny Spring Creek upstream from the barrier. (We did not remove trout from the upper 0.5 km of Tenny Spring Creek.) We transferred the Brown Trout to the Kickapoo River, which is downstream from Tenny Spring Creek and Elk Creek.

We surveyed Tenny Spring Creek the following spring in 19 March, 11 April, and 4 June 2012. We continued to capture many Brown Trout, most of which were yearling trout that likely moved downstream from the upper section of Tenny Spring Creek. All Brown Trout were transferred downstream of the barrier and a subsample of the Brown Trout were tagged with a visible implant tag to further monitor upstream movement across the barrier.

Return rates for F1 Brook Trout were consistently greater than return rates for F2 Brook Trout (Table 1 and Figure 3). There were no significant differences in length between groups of F1 and F2 Brook Trout on each sample date (Table 2). We also captured some wild Brook Trout which ranged in length from 115 mm to 297 mm, indicating multiple age classes of Brook Trout were present (Table 1).

We installed a water level monitor immediately downstream of the barrier to document any changes in water level that might compromise the ability of the barrier to prevent upstream migration of Brown Trout. We suspect that flood conditions in Tenny Spring Creek and Elk Creek during heavy precipitation events may compromise the effectiveness of the barrier.

Summary of work from 1 July 2012 to 30 June 2014

We stocked Tenny Spring Creek again in 27 September 2012 with 508 F1 and 504 F2 Brook Trout and in 25 September 2013 with 500 F1 and 500 F2 Brook Trout. Each stocked Brook Trout in 2012 had an adipose clip and a ventral fin clip (F1 = left ventral fin and F2 = right ventral fin); in 2013 each stocked Brook Trout had a pectoral fin clip (F1 = left pectoral fin and F2 = right pectoral fin). We also continued to monitor the trout population by surveying the stream on multiple dates through April 2014 (Table 1). All Brown Trout collected during these surveys were transferred downstream of the barrier to Elk Creek. Return rates continued to be greater for F1 Brook Trout as compared to F2 Brook Trout for both the 2011, 2012, and 2013 cohorts (Table 1 and Figure 3). Also of note was that the average size of both F1 and F2 Brook Trout from the 2011 cohort was about 9 inches by September 2012, indicating that many of these age 1 Brook Trout were legal for anglers to harvest (9 inch minimum size limit).

Gill lice

We have also observed Brook Trout in Tenny Spring Creek infected with gill lice. We first observed gill lice in Tenny Spring Creek Brook Trout in May 2012, but we were not able to complete a survey of the stream at that time. We documented the gill lice infection rate in subsequent surveys from June 2012 to April 2014 (Table 2). The gill lice infection intensity ranged from 1 to 15 gill lice per individual infected trout.

STUDY PRESENTATIONS:

Mitro, M. G. June 2014. Update on wild trout stocking program issues concerning Ash Creek Brook Trout. WDNR Fisheries Management Board Meeting, Antigo, Wisconsin.

Mitro, M. G. May 2014. Update on wild trout stocking program issues concerning Ash Creek Brook Trout. WDNR Trout Team Meeting, Madison, Wisconsin.

Mitro, M. G. March 2014. Wisconsin DNR trout research. Orientation for New Fisheries Staff Meeting, Madison, Wisconsin.

Mitro, M. G., S. Marcquesnski, K. Soltau, and P. Kanehl. February 2014. Gill lice as a proximate cause of Brook Trout loss under changing climatic conditions. Wisconsin Chapter of the American Fisheries Society 2014 Annual Meeting, Green Bay, Wisconsin.

Mitro, M. G. February 2014. Research to support inland trout fisheries management. Science Services Open House, Madison, Wisconsin.

Mitro, M. G. February 2014. Monitoring gill lice and trout population dynamics in Wisconsin streams. 7th Annual Driftless Area Symposium, La Crosse, Wisconsin.

Mitro, M. G., S. Marcquenski, K. Soltau, P. Kanehl, D. Walchak, J. Haglund, E. Struck, and A. Nolan. March 2013. Gill lice infection of Brook Trout in Driftless Area streams in Wisconsin. 6th Annual Driftless Area Symposium (invited), La Crosse, Wisconsin.

Mitro, M. G., S. Marcquenski, K. Soltau, P. Kanehl, D. Walchak, J. Haglund, E. Struck, and A. Nolan. March 2013. Gill lice infection of Brook Trout in Wisconsin streams. Poster presented at WDNR Science Services Open House, Madison, Wisconsin.

Mitro, M. G., S. Marcquenski, K. Soltau, P. Kanehl, D. Walchak, J. Haglund, E. Struck, and A. Nolan. February 2013. Gill lice infection of Brook Trout in Wisconsin streams. Poster presented at WDNR Fisheries Management Statewide Meeting, Wisconsin Dells, Wisconsin.

Mitro, M. G., S. Marcquenski, K. Soltau, P. Kanehl, D. Walchak, J. Haglund, E. Struck, and A. Nolan. February 2013. Gill lice infection of Brook Trout in Wisconsin streams. Wisconsin Chapter of the American Fisheries Society 2013 Annual Meeting, Wausau, Wisconsin.

Mitro, M. G. December 2012. Trout research update presented to the Wisconsin DNR Fisheries Management Board, Madison, Wisconsin.

Mitro, M. G., P. Kanehl, D. Walchak, and E. Struck. August 2012. Viability of a Brook Trout source population used for egg collection in Wisconsin's wild trout stocking program. American Fisheries Society 142nd Annual Meeting, Minneapolis-St. Paul, Minnesota.

Mitro, M. G., P. Kanehl, D. Walchak, and E. Struck. July 2012. Survival and recruitment in a Brook Trout source population used for egg collection in Wisconsin's wild trout stocking program. 10th International Congress on the Biology of Fish, Madison, Wisconsin.

Mitro, M. G., P. Kanehl, D. Walchak, and E. Struck. March 2012. Monitoring trout response to stream habitat development in Wisconsin: lessons from Elk Creek. 5th Annual Driftless Area Symposium (invited), LaCrosse, Wisconsin.

Mitro, M. G. March 2011. Climate change and the future of inland trout distribution in Wisconsin. Coulee Region Chapter of Trout Unlimited meeting (invited), LaCrosse, Wisconsin.

Mitro, M. G., J. D. Lyons, and J. S. Stewart. April 2010. Climate change, trout ecology, and the future of inland trout distribution and management in Wisconsin. UW-Richland Natural Resources Club, Richland Center, Wisconsin. (Invited)

Mitro, M. G. November 2008. Trout research in Wisconsin streams. Blackhawk Chapter of Trout Unlimited meeting, Janesville, Wisconsin.

FISH PASSAGE AND STREAM CONNECTIVITY RESEARCH

By: Matthew Diebel Matthew.Diebel@Wisconsin.gov, WDNR

STUDY OBJECTIVES:

1. Develop infrastructure for collection, storage, and analysis of barrier data across the Great Lakes Basin.
2. Develop a volunteer monitoring program for evaluating fish passage at road crossings.

PERFORMANCE ON SCHEDULED ACTIVITIES:

- Leading development of guidelines for prioritizing fish passage at road culverts statewide.
- Used LiDAR-derived elevation data to assess passage barriers at all road crossings in 6 Wisconsin counties.
- Working with DNR Water Division staff to incorporate road crossing inventory information into the SWIMS database.
- Served on organizing committee for 2014 Fish Passage conference held in Madison
- Co-PI on LCC-funded Great Lakes connectivity project.

STUDY PUBLICATIONS:

Kornis, M., B. Weidel, S. Powers, T. Cline, M. Diebel, J. Fox, and J. Kitchell. In review. Partial biotic homogenization following removal of an impassable barrier separating two disparate stream fish communities. Aquatic Sciences.

Diebel, M. W., M. Fedora, S. Cogswell, and J.R. O'Hanley. In press. Effects of road crossings on habitat connectivity for stream-resident fish. River Research and Applications.

Januchowski-Hartley, S., M. Diebel, P. Doran, P. McIntyre. In press. Predicting road culvert passability for migratory fishes. Diversity and Distributions.

STUDY PRESENTATIONS:

Diebel M., P. McIntyre, P. Doran, T. Neeson, S. Januchowski-Hartley, M. Guyette, M. Ferris, J. O'Hanley, M. Herbert, M. Khoury, E. Yacobson. (26 June 2014). A Decision Support System for Managing Aquatic Connectivity in the Great Lakes Basin. Upper Midwest/Great Lakes Landscape Conservation Cooperative Steering Committee Meeting. Traverse City, MI.

Diebel, M., D. Winston, A. Polebitski, Z. Wallin. (10 June 2014). A Screening Method for Identifying Fish Passage Barriers at Road Crossings Using LiDAR-Derived Elevation Data. International Conference on Engineering and Ecohydrology for Fish Passage. Madison, WI.

Januchowski-Hartley, S., M. Diebel, P. McIntyre, P. Doran. (9 June 2014). A predictive method for quantifying road culvert passability. International Conference on Engineering and Ecohydrology for Fish Passage. Madison, WI.

Guyette, M., T. Neeson, M. Kornis, M. Diebel, P. Doran, P. Esselman, S. Januchowski-Hartley, P. McIntyre. (9 June 2014). Accounting for invasive species when prioritizing barrier removals in Great Lakes tributaries. International Conference on Engineering and Ecohydrology for Fish Passage. Madison, WI.

McIntyre, P., M. Diebel, P. Doran, T. Neeson, S. Januchowski-Hartley, M. Guyette, M. Ferris, J. O'Hanley, M. Herbert, M. Khoury, E. Yacobson. (9 June 2014). A Decision Support System for Managing Aquatic Connectivity in the Great Lakes Basin. International Conference on Engineering and Ecohydrology for Fish Passage. Madison, WI.

Diebel, M., T. Paoli, P. McIntyre, D. Oele, E. Childress, J. Maxted, A.Somor, A. Shaw, N. Van Helden. (1 April 2014). Prioritizing barrier removal for northern pike spawning migration in Green Bay tributaries. Road/Stream Crossings – Inventory, Assessment, Design and Construction Workshop. Green Bay, WI.

Diebel, M., M. Fedora. (1 April 2014). Fish passage barrier inventory, assessment and prioritization. Road/Stream Crossings – Inventory, Assessment, Design and Construction Workshop. Green Bay, WI.

Diebel, M., C. Hardin. (1 April 2014). How streams work. Road/Stream Crossings – Inventory, Assessment, Design and Construction Workshop. Green Bay, WI.

Diebel, M. (14 February 2014). Approaches for Balancing Fish Passage with Invasive Species Management. Science Services Open House, Madison, WI.

Diebel, M., S. Januchowski-Hartley, P. Doran, P. McIntyre. (7 November 2013). A model of road crossing passability for the Great Lakes Basin. UMGL LCC Fish Vulnerability to Climate Change workshop, Middleton, WI.

Diebel, M., T. Paoli, P. McIntyre, D. Oele, E. Childress, J. Maxted, A.Somor, A. Shaw, N. Van Helden. (24 September 2013). Prioritizing barrier removal for northern pike spawning migration in Green Bay tributaries. Northern Pike Research Meeting. Green Bay, WI.

LONG-TERM VIABILITY OF SOURCE POPULATIONS OF WILD BROOK TROUT AND BROWN TROUT FOR WISCONSIN'S WILD TROUT STOCKING PROGRAM

By: Matthew Mitro Matthew.Mitro@wisconsin.gov and Paul Kanehl paul.kanehl@wisconsin.gov, WDNR
(Mike Aquino, Robert Fahey, Jason Himebauch, John Komassa, Gene Van Dyck, and Jordan Weeks, DNR cooperators)

STUDY OBJECTIVES:

This study investigates the long-term viability of wild Brook Trout and Brown Trout populations as source populations for Wisconsin's wild trout stocking program. Specific objectives include:

1. Quantify the apparent survival, recruitment, and population growth rates of Brook Trout and Brown Trout in Ash Creek, Timber Coulee Creek, and two control streams (one Brook Trout and one Brown Trout).

2. Quantify the proportion of Brook Trout and Brown Trout removed from populations in Ash Creek and Timber Coulee Creek during spawning season each year.

3. Quantify the annual apparent survival rate of trout removed, brought to the hatchery, and later returned to the streams versus the apparent survival rate of trout remaining in the stream (i.e., determine if there is a hatchery effect on apparent survival rate).

4. Test predictions of stock-recruitment models for each trout population in terms of age-0 recruitment and population size and age structure.

5. Quantify the population-level effects of egg collection on the source populations for the wild trout stocking program using matrix population models.

6. Quantify the relative return of F1 and F2 generation Brook Trout stocked in streams.

7. Quantify the prevalence, intensity, and population-level impact of gill lice infection in Ash Creek Brook Trout

PERFORMANCE ON SCHEDULED ACTIVITIES:

Below we summarize performance through June 2014 on scheduled activities outlined above in objectives 1-7. In this study we have collected detailed information describing the characteristics and dynamics of wild Brook Trout and Brown Trout populations in four Wisconsin streams, two of which have served as source populations for broodstock for Wisconsin's "wild" trout stocking program.

Over the course of this study, some questions have been answered, new questions have been raised, and our understanding of how trout populations work has begun to improve. There has been no evidence of any negative population-level effects of egg collection on either Brook Trout or Brown Trout recruitment to the source populations. However, the removal of adult trout for spawning appears to negatively affect Brown Trout survival but not Brook Trout survival. We detected a negative impact on Brown Trout survival in Timber Coulee Creek for trout removed for spawning, but the percentage removed was small relative to total population size such that we detected no population-level impact on abundance, production, or recruitment.

Although high proportions of reproductive output have been removed from the Brook Trout population in Ash Creek, we have yet to see a consequent impact on age-0 trout production and recruitment that can be solely attributed to reductions in stock size, as measured by egg production. We did, however, see changes in the dynamics of the Brook Trout population coincident with an increase in a sympatric Brown Trout population and an epizootic of gill lice infection of Brook Trout.

The increase in the Brown Trout population in Ash Creek was a consequence of restrictions on wild fish transfers following the emergence of viral hemorrhagic septicemia in the state of Wisconsin. Wisconsin DNR Fisheries Management readdressed the Ash Creek Brown Trout issue by the resumption in June 2011 of Brown Trout removal.

A relatively new and now primary concern about Ash Creek Brook Trout is the infection of Brook Trout by gill lice. Gill lice are a parasitic copepod that only infect Salvelinus species such as Brook Trout. Anecdotal observations of gill lice by anglers and DNR fisheries biologists suggested gill lice may be infecting more fish and spreading to more streams in Wisconsin. Gill lice infection of Ash Creek Brook Trout was first observed in a routine 2010 health check of Ash Creek Brook Trout (Sue Marcquenski, WDNR fish health specialist). A higher incidence of infection was observed in the 2011 health check. We began quantifying the prevalence and intensity of gill lice infection in Ash Creek Brook Trout in spring 2012, which has since increased to become epizootic and has now been documented to have impacted Brook Trout recruitment. Continued surveys of tagged Ash Creek Brook Trout will help us understand the impacts of gill lice infection on Brook Trout growth, survival, and recruitment.

New questions had also been raised on the utility of using F2 generation Brook Trout to supplement or eventually replace stocking of F1 generation Brook Trout. The use of F2 Brook Trout has successfully addressed the difficulty of meeting hatchery and stocking demands for ‘wild’ Brook Trout eggs. We have conducted paired stockings of F1 and F2 Brook Trout to determine whether or not we can meet stocking goals with F2 Brook Trout. Questions have also been raised on Brook Trout versus Brown Trout age and life history and how they influence population dynamics in response to egg collection and interspecific competition.

The results of this study have led to a recommendation to Fisheries Management to not collect eggs from Ash Creek Brook Trout in 2014. Two successive years of poor recruitment and a continuing gill lice epizootic indicate the necessity of rebuilding the Brook Trout population in Ash Creek. There will be no collection of eggs from Ash Creek

Brook Trout in 2014 so that all potential reproductive output can remain in the stream and be directed towards stock rebuilding. Egg production for the wild trout stocking program will therefore be limited to F2 eggs collected from F1 generation captive brood stock. Plans are being made to identify a new source of F1 eggs in 2015.

Activity # 1 – Tag and recapture trout to estimate population abundance and to compile capture histories for estimating population vital rates:

Brook Trout and Brown Trout were collected by electrofishing for a tenth year in autumn 2013 and spring 2014 in the following study streams: Ash Creek, Big Spring Branch, Elk Creek, and Timber Coulee Creek.

Up through autumn 2006 trout from Ash and Timber Coulee creeks were brought to the Nevin Fish Hatchery for spawning. The discovery of viral hemorrhagic septicemia virus (VHSV) in Wisconsin waters in spring 2007 necessitated changes in the wild trout spawning program. Newly-enacted Wisconsin DNR emergency rules pertaining to VHSV prohibit the transfer of fish from one water body to another unless they have been certified VHSV-negative. State fish hatcheries were also prohibited from receiving untested wild fish because of the risk of contaminating VHSV-negative hatchery facilities. A negative test for VHSV currently requires 28 days during which the fish are held at a bio-secure facility where they cannot potentially become infected or infect other fish. Although testing for VHSV in wild trout collected for spawning has routinely been conducted, it was not feasible to test for VHSV and obtain a negative result prior to bringing wild trout to a state hatchery. Therefore, alternate arrangements were made for spawning wild trout in autumn 2007 and thereafter.

Ash Creek Brook Trout were collected and held in two stream-side rearing tanks. Water for the tanks was supplied by a spring near Ash Creek. Whereas trout previously brought to Nevin Fish Hatchery were held for about eight weeks, the trout held streamside were released after about four to eight weeks. Timber Coulee Creek Brown Trout were collected and held at a private cooperative rearing facility. Spawned trout from Timber Coulee Creek were also released after about four to eight weeks.

Trout were tagged either at the stream (if released directly back into the stream) or at the holding facility (if held for spawning). Ash Creek Brook Trout were tagged with PIT tags or visible implants of elastomer (VIE) tags. Trout in all other streams were tagged with VIE tags. All trout were measured; all PIT-tagged trout were weighed and a subset of VIE-tagged trout were weighed. All Brook Trout were also inspected for gill lice infection.

We also tagged known-age Brook Trout and Brown Trout with either PIT tags (Ash Creek) or coded wire tags (Big Spring Branch, Elk Creek, and Timber Coulee Creek) to establish groups of known-age trout for future age-structure validation.

In 2008 we began fin-clipping age-0 trout in autumn to establish a group of known-aged trout in each stream. These cohorts were identifiable at age 1 in spring and were clipped then as well, if not previously clipped in autumn. In spring 2010 we switched from fin clipping to tagging with coded wire tags in each of the four streams, and in 2011 we switched to using PIT tags in the known-age Ash Creek trout. Whereas fin clips may remain recognizable for one to two years, coded wire tags remain with the fish and are detectable through the life of the fish, which for stream trout may be up to eight or more years. We continued to tag known-age trout (age 1) each spring and began collecting otoliths from known-age trout to validate the use of otoliths for ageing purposes. We will use otoliths from know-aged trout to validate the use of otoliths for ageing trout, to determine length at age, to determine age at maturity, and to establish growth rates for Brook Trout and Brown Trout. This information will aid in the development and parameterization of population models for trout. All trout otolith samples collected through autumn 2013 have been sectioned, mounted, and imaged for reading.

Capture histories for 20 occasions (spring and autumn, from autumn 2004 to spring 2014) have now been compiled for all streams.

Activity # 2 – Quantify population size and the proportion of trout removed from each source population for hatchery spawning:

We estimated the stream-wide abundance of Brook Trout and Brown Trout in Ash Creek by extrapolating abundance estimates from three sampling stations. The catch of Brook Trout and Brown Trout in a sampling station were not independent and therefore could not be estimated separately. To estimate the stream-wide abundance of Brook Trout versus Brown Trout, we multiplied the stream-wide estimate of abundance of all trout by the sample ratio of Brook Trout or the sample ratio of Brown Trout. Likewise, we further multiplied Brook Trout and Brown Trout abundance estimates by sample ratios to estimate abundances by age group or sex. Error estimates included error associated with estimating abundance at each station, extrapolation error to sections of the stream not sampled, and error associated with sample ratios (e.g., species, age group, and sex).

The overall abundance of Brook Trout in Ash Creek has fluctuated from year to year but has generally decreased from 2006 to the present (Tables 1-3 and Figures 1 and 2). Brown Trout abundance was actively suppressed by removal except during 2007-2010. The relative numbers of Brook Trout and Brown Trout have changed over time (Figure 2). Age 1 and older Brook Trout decreased in abundance and Brown Trout increased, with similar numbers of both species in 2009 and with Brown Trout exceeding Brook Trout in 2010. The removal of Brown Trout from Ash Creek in June 2011 (Gene Van Dyck, WDNR) resulted in a decrease in Brown Trout abundance in autumn 2011 (Figure 2).

The abundance of Brook Trout spawners identified as male or female in Ash Creek has fluctuated during autumn 2004-2013 from a high of 1,750 in 2006 to a low of 380 in 2011 and 391 in 2013, with a now apparent decreasing trend from 2006 to the present

(Table 3 and Figure 1). The proportion of female Brook Trout removed for hatchery spawning from Ash Creek has fluctuated from 16% to 63% from 2004 to 2013. In 2011, 84% of the female Brook Trout were removed for spawning. This number raised concern, and many female Brook Trout were returned prior to spawning, reducing the percent removed to 32%. Since 2011, a target of 50 female Brook Trout have been removed for egg collection. This number had been determined to be sufficient to meet genetic diversity objectives in producing and maintaining a captive broodstock of F1-generation Brook Trout at the Nevin Fish Hatchery. In 2013, 71 female Brook Trout (27%) were removed from the population for egg collection.

The number of eggs per female has varied from 385 to 661 eggs per female (Table 4). We estimated the number of eggs potentially spawned in Ash Creek in 2004-2013 based on abundance estimates from removal samples and fecundity estimates from Brook Trout spawned by Wisconsin DNR hatchery personnel (Table 4). The number of eggs potentially spawned by Brook Trout remaining in Ash Creek varied from 50,000 to 331,000 (Table 5). The number of eggs or reproductive output removed from Ash Creek varied from 24,000 to 215,000 (Table 5). In 2013, about 44,000 eggs were collected from 71 female wild Brook Trout.

The variability in the ability of the Ash Creek Brook Trout population to be able to provide adequate numbers of eggs to support the wild Brook Trout stocking program had led to the development of a captive broodstock of F1-generation Ash Creek Brook Trout to supplement egg collection. In 2010, eggs collected from wild Brook Trout were supplemented with 878,000 eggs collected from 507 captive Brook Trout. However, the use of F1-generation Brook Trout to produce eggs raised questions on the effectiveness of stocking F2- (derived from captive F1 parents) versus F1- (derived from wild parents) generation Brook Trout as a trout management tool. (See activity #6.)

Current VHS rules prohibit the transfer of untested fish from one stream to another. Up until 2007, Brown Trout had been routinely collected and transferred out of Ash Creek when Brook Trout were collected for spawning. Beginning in 2007, there was no active suppression of Brown Trout numbers in Ash Creek, and the ratio of Brook Trout to Brown Trout had decreased, particularly for age 1 and older trout in autumn 2009. In autumn 2004 there were 17.5 times more age 1+ Brook Trout than Brown Trout and from 2005 through 2008 there were 3.5 to 7 times more age 1+ Brook Trout than Brown Trout. Age 1+ Brown Trout and Brook Trout abundance were similar in autumn 2009, with less than 50% of the age 1 and older trout in Ash Creek being Brook Trout (Figure 2). This trend continued, and by spring 2011, the Ash Creek trout population comprised 30.5% Brook Trout and 69.5% Brown Trout. Recognizing the threat to Brook Trout by increasing numbers of Brown Trout we identified in our surveys, WDNR Fisheries Management resumed Brown Trout removal in June 2011 and has continued through 2013. The June 2011 removal of Brown Trout significantly reduced the number of age 1 and older Brown Trout such that by spring 2012, about 95% of the Brown Trout in our survey area were age 1 trout from the 2010 spawning class (Figure 2). The abundance of age 1+ Brook Trout and Brown Trout have fluctuated but remained about the same through autumn 2013 (Figure 2).

Timber Coulee Creek is a much larger stream system than Ash Creek, with an adult female Brown Trout population of about 2,000. An average of 190 female Brown Trout have been removed annually for spawning from 2004 to 2010, or about 11% of the female Brown Trout population. In 2010, 34,000 eggs were collected from 74 female wild Brown Trout. Unlike Brook Trout, the wild Brown Trout stocking program has historically relied on a captive brook stock to supplement eggs collected from wild trout. In 2010, 1,411,000 eggs were also collected from 859 captive Brown Trout.

Activity #3 – Quantify apparent survival rates

We estimated apparent survival rates for Brook Trout in Ash Creek and Brown Trout in Timber Coulee Creek using multi-strata tag-recapture models in program MARK. Two strata include instream spawners (trout that remain in the stream to potentially spawn) and hatchery spawners (trout removed from the stream for hatchery spawning and later returned to the stream). Model structure and parameterization are shown in Figure 3. Model parameters included apparent survival □, capture probability p, and movement rate □. Trout collected in autumn were assigned to a stratum and remained in that stratum through the spring (i.e., □ = 0 between autumn and spring) until the following autumn when recaptured trout could potentially move between strata (□ estimated). Capture probability was estimated for each strata in each season but was fixed at p = 1 for hatchery spawners in autumn (i.e., all trout collected for hatchery spawning were identified such that this stratum was completely known). Apparent survival □ was estimated for each stratum between seasons. This model parameterization was designed to determine whether or not there was an effect of spawning strata during the year following spawning. (A future analysis will include a parameterization to investigate whether or not there were any longer-term effects of spawning strata on apparent survival.) Multi-strata models for apparent survival □ included models with constant survival and with time effects, strata effects, seasonal trends, and interactions thereof on survival. Capture probability p and movement □ were modeled with strata □ time effects with fixed parameters as described above.

Model analyses indicated there was no significant effect of spawning strata on apparent survival of Brook Trout in Ash Creek. The model with the greatest support included only a time effect on apparent survival (AICc weight = 0.80) and there was marginal support for a strata □ time effect (AICc weight = 0.20). Model averaged estimates of apparent survival for each strata varied but tracked each other over time (Figure 4). The average annual apparent survival rate for Ash Creek Brook Trout was 0.15. Additional data in future tag-recapture surveys will help improve these estimates such that we can better discern trends over time.

Model analyses for Timber Coulee Creek Brown Trout showed strong support for a strata □ time effect (AICc = 1.00) and no support for any other models. The 6-month apparent survival of the hatchery spawners was on average about 23% lower than the apparent survival of instream spawners (Figure 5). The average annual apparent survival rate for Timber Coulee Creek Brown Trout was 0.39 for instream spawners and

0.20 for hatchery spawners. Timber Coulee Brown Trout were negatively affected by the hatchery spawning process, unlike Ash Creek Brook Trout. Apparent survival for the hatchery stratum was unusually low during the autumn 2007-to-spring 2008 period (□ = 0.14) and the autumn 2008-to-spring 2009 period (□ = 0.01) because of a disease issue at the private cooperative rearing facility. (These apparent survival rates were not included in the 0.20 average for in-hatchery spawners.) In autumn 2007, all hatchery-spawned Brown Trout were tagged and a portion were returned to the stream, but then the discovery of ferunculosis in the fish health check required the remaining hatchery spawners to be killed and not returned to the stream. This situation occurred again in autumn 2008. Therefore, we knew that a large proportion of the hatchery spawners did not survive, and this was reflected in the modeling results. We discontinued the tagging of hatchery spawning Brown Trout in 2010.

Activities # 4 and 5 – Test predictions of stock-recruitment models and matrix population models:

Data collected and parameters derived in activities #1-3 have been used to develop and parameterize stock-recruitment models and matrix population models for Brook Trout. The relationship between Brook Trout stock size and recruitment for Ash Creek is shown in Figure 6. Stock size was measured as the number of Brook Trout eggs potentially spawned in the stream (see Table 5). Recruitment was measured as the abundance of age-0 Brook Trout in the following autumn (Table 2). The stock-recruitment data suggest a potential for stock size to limit recruitment but also that other factors such as environmental conditions may have a greater influence on recruitment.

The Ash Creek Brook Trout stock-recruitment data can be interpreted a number of ways. Stock size may exert some influence on recruitment level in that the observed number of recruits appears to be limited at lower levels of stock size (e.g., 2010; Figure 6) and on occasion recruitment has been observed at higher levels at higher levels of stock size (e.g., 2006 and 2005; Figure 6). However, recruitment has at times remained at a somewhat fixed level over broad ranges of stock size (e.g., 2010, 2011, 2008, 2009, and 2007; Figure 6) and recruitment has at times varied over a broad range at a somewhat fixed level of stock size (e.g., 2013, 2011, and 2006; Figure 6).

The variation in the Ash Creek stock-recruitment data may be explained by environmental events and interspecific interactions between Brook Trout and Brown Trout. Large-scale flooding events occurred in Ash Creek in August 2007 and June 2008. Data points for these years were lower than data points for previous years in which large-scale flooding did not occur. Stock sizes in 2007 and 2008 were intermediate to stock sizes in previous years in which higher levels of recruitment were observed. Such flooding events may limit recruitment via the loss of the more vulnerable age-0 year class. No large-scale flooding events occurred after 2008, and we had expected that recruitment would return to previously observed higher levels. This was not the case, as recruitment of age-0 Brook Trout in 2009, 2010, and 2011 was similar to that in 2007 and 2008. Although flooding did not occur during these years, the abundance of Brown Trout had increased significantly (see Figure 2) and may have acted to suppress Brook Trout recruitment. WDNR Fisheries Management had ceased the annual transfer of Brown Trout out of Ash Creek in 2007 following the restrictions imposed by new VHS rules. Following the latest results of this study on the increase in Brown Trout abundance and decrease in Brook Trout abundance and recruitment, we resumed the collection and removal of Brown Trout from Ash Creek in June 2011. The Brown Trout were held in the streamside tanks used for holding spawning Brook Trout in autumn until fish disease testing was completed and the trout were cleared for transfer. Brown Trout removal continued in 2012 and 2013 and, should we be able to sufficiently suppress Brown Trout numbers, we will determine if this competitive release will allow for increases in Brook Trout recruitment to levels last seen in 2006.

The conclusion that changes in stock size have not necessarily negatively impacted Brook Trout recruitment in Ash Creek is a significant result given the sometimes large proportion of eggs removed from the population each autumn and the year-to-year variability in the abundance and fecundity of female Brook Trout (Table 4 and Figure 1). Of particular note, however, is the low recruitment in 2012 that coincided with the relatively low 2011 stock size (Figure 6). Given the observed stock size in 2011 (greater than in 2009 and less than in 2010) and environmental conditions similar to the previous five years (no major floods but continued presence of Brown Trout), we expected recruitment to remain relatively unchanged. A significant change, however, was the presence of gill lice, which became epizootic in Ash Creek during 2012.

A significant development in Ash Creek has been the appearance of gill lice Salmincola edwardsii and subsequent increase in gill lice infection rate in Brook Trout. Salmincola edwardsii is an ectoparasite that can infect Brook Trout but not Brown Trout (Figure 7). Salmincola edwardsii have a direct life cycle with no intermediary host. Free-swimming larvae hatch from Salmincola edwardsii eggs and generally have a 24-hour period to detect and attach to a Brook Trout host. Salmincola edwardsii generally permanently attach to Brook Trout gill filaments for the remainder of its life cycle (about 30 days). Salmincola edwardsii can accumulate on a host over time.

Wisconsin DNR Fish Health Specialist Sue Marcquenski noted in her autumn 2010 fish health check of Ash Creek Brook Trout that, “at least 4 of the 60 fish had Salmincola infections,” and in 2011, “virtually all 60 fish were infected.” She suspects that gill lice showed up or the prevalence increased to detectable levels in Ash Creek in 2009-2010.

In April 2012 we began documenting gill lice infections in our field surveys of Ash Creek Brook Trout (Table 6). We surveyed Ash Creek again in October 2012 and found that the overall infection rate increased from 42% to 95% (Table 6). The infection rate for age 0 versus age 1 and older Brook Trout was similar in October 2012.

We counted the number of gill lice on 93 infected age 0 Brook Trout and 67 infected age 1 and older Brook Trout while measuring Brook Trout during our October 2012 field survey. We counted individual gill lice up to 19; thereafter, any infected fish with 20 or more gill lice were noted as having □20 gill lice. Infected age 0 Brook Trout had from 1 to 11 gill lice per trout (average = 5). Infected age 1 and older Brook Trout had from 2 to more than 20 gill lice per trout (Figure 8). In October 2013 an age-0 Brook Trout was observed with 16 gill lice (Figure 8). A laboratory examination of a sample of infected Brook Trout collected for a fish health assessment revealed infection intensities up to 97 gill lice infecting an individual Brook Trout (Figure 9). By April 2013 and 2014, some of the age 0 Brook Trout that survived to age 1 now had in excess of 20 gill lice (Figure 10). The intensity of infection was greater in April 2014 versus April 2013 (Figure 10). In April 2013 about 14% of Brook Trout were infected with 20 or more gill lice; in April 2014 that level of infection increased to 29% of sampled Brook Trout (Figure 10). However, in April 2013 and 2014 some Brook Trout were observed to have no gill lice but had inflammation on multiple gill filaments indicating previous attachment of gill lice. This observation suggests that gill lice infection is not necessarily a permanent condition.

Stock-recruitment data for Ash Creek Brook Trout suggested an average recruitment level can be realized over a broad range of stock size (Figure 6) and the level of recruitment is likely limited by environmental constraints such as flooding and Brown Trout abundance (Table 1 and Figure 2). The 2011 Brook Trout stock size combined with the lack of flooding and suppressed Brown Trout abundance in 2012 suggested we would see an improvement in recruitment in 2012. Rather, we observed a small fraction of what was expected, and this low recruitment level may be attributable to the 94% gill lice infection rate among age 0 Brook Trout observed in October 2012 (Table 6). Brown Trout, by contrast, exhibited relatively strong recruitment (Figure 2), particularly given the suppression of Brown Trout stock size. The relatively strong recruitment of Brown Trout versus the low recruitment of Brook Trout suggested that environmental conditions (i.e., no flooding events) were favorable for trout recruitment in 2012. Gill lice infection appears to be an important factor that may have limited Brook Trout recruitment in 2012 and again in 2013. The potential physical impact of gill lice infection on young Brook Trout can be seen in Figure 11 in which the trout’s gill plates appear to have become deformed in the presence of multiple gill lice attached to gill filaments. Also of note in 2013 is that a flooding event may have contributed to lower recruitment levels of both Brook Trout and Brown Trout, along with continued suppression of adult Brown Trout contributing to lower recruitment of Brown Trout (Figure 2)

Activity #6 – Stocking F1 versus F2 Brook Trout

In a departure from the original intent of producing and stocking F1 Brook Trout as part of our wild trout stocking program, the WDNR has developed a captive brood stock of F1 Brook Trout from which F2 Brook Trout are produced. We currently consider F1 and F2 Brook Trout as equivalent “wild” Brook Trout for stocking purposes. A key benefit of using F2 Brook Trout is stable and increased production relative to the variability encountered in producing F1 Brook Trout from the wild source stock. Studies in the literature on the reproductive fitness of stocked salmonids, however, suggest fitness can be rapidly and significantly reduced between F1 and F2.

We began evaluating the field performance of stocked F1 and F2 Brook Trout in 2009 and 2010 by following paired stockings of F1 and F2 trout in four streams (Cutler Creek, Deer Creek, Fryes Feeder, and Primrose Branch). Return rates ranged from 0.4% to 3.8% and were too low to draw any conclusions about the performance of F1 versus F2 Brook Trout (Table 7). Low return rates may have been attributable to the presence of wild Brook Trout and Brown Trout and natural reproduction in each of the study streams.

In 2011 we dropped three of the study streams and added Tenny Spring Creek. We chose Tenny Spring Creek because a waterfall structure installed as part of a recent habitat development project acted as a partial barrier to Brown Trout movement into Tenny Spring Creek under low flow conditions (see study SSDX). This allowed us the opportunity to remove Brown Trout to reduce their negative influence on Brook Trout that appears to have occurred in the other study streams.

Return rates for F1 and F2 Brook Trout in Primrose Branch in 2012 were low and inconclusive as in previous years, despite stocking at a significantly higher rate (1,120 versus 250 each for F1 and F2).

In Tenny Spring Creek, however, return rates for F1 Brook Trout were consistently greater than return rates for F2 Brook Trout on each sampling date from March 2012 to April 2014 (Table 8). These observations suggest it may be inappropriate to treat F1 and F2 Brook Trout as equivalents in the WDNR wild trout stocking program.

STUDY PUBLICATIONS:

Report (white paper) for internal distribution to Fisheries Management; drafts for publication in a peer-reviewed journal and as a DNR technical bulletin.

Mitro, M. G., S. Marcquenski, K. Soltau, and P. Kaneh. In press. Gill lice as a proximate cause of Brook Trout loss under changing climatic conditions. Proceedings of Wild Trout XI. Bozeman, Montana.

STUDY PRESENTATIONS:

Mitro, M. G. June 2014. Update on wild trout stocking program issues concerning Ash Creek brook trout. WDNR Fisheries Management Board Meeting, Antigo, Wisconsin.

Mitro, M. G. May 2014. Update on wild trout stocking program issues concerning Ash Creek brook trout. WDNR Trout Team Meeting, Madison, Wisconsin.

Mitro, M. G. March 2014. Wisconsin DNR trout research. Orientation for New Fisheries Staff Meeting, Madison, Wisconsin.

Mitro, M. G., S. Marcquesnski, K. Soltau, and P. Kanehl. February 2014. Gill lice as a proximate cause of brook trout loss under changing climatic conditions. Wisconsin Chapter of the American Fisheries Society 2014 Annual Meeting, Green Bay, Wisconsin.

Mitro, M. G. February 2014. Research to support inland trout fisheries management. Science Services Open House, Madison, Wisconsin.

Mitro, M. G. February 2014. Monitoring gill lice and trout population dynamics in Wisconsin streams. 7th Annual Driftless Area Symposium, La Crosse, Wisconsin.

Mitro, M. G., S. Marcquenski, K. Soltau, P. Kanehl, D. Walchak, J. Haglund, E. Struck, and A. Nolan. March 2013. Gill lice infection of Brook Trout in Driftless Area streams in Wisconsin. 6th Annual Driftless Area Symposium (invited), La Crosse, Wisconsin.

Mitro, M. G., S. Marcquenski, K. Soltau, P. Kanehl, D. Walchak, J. Haglund, E. Struck, and A. Nolan. March 2013. Gill lice infection of Brook Trout in Wisconsin streams. Poster presented at WDNR Science Services Open House, Madison, Wisconsin.

Mitro, M. G., S. Marcquenski, K. Soltau, P. Kanehl, D. Walchak, J. Haglund, E. Struck, and A. Nolan. February 2013. Gill lice infection of Brook Trout in Wisconsin streams. Poster presented at WDNR Fisheries Management Statewide Meeting, Wisconsin Dells, Wisconsin.

Mitro, M. G., S. Marcquenski, K. Soltau, P. Kanehl, D. Walchak, J. Haglund, E. Struck, and A. Nolan. February 2013. Gill lice infection of Brook Trout in Wisconsin streams. Wisconsin Chapter of the American Fisheries Society 2013 Annual Meeting, Wausau, Wisconsin.

Mitro, M. G. December 2012. Trout research update presented to the Wisconsin DNR Fisheries Management Board, Madison, Wisconsin.

Mitro, M. G., P. Kanehl, D. Walchak, and E. Struck. August 2012. Viability of a Brook Trout source population used for egg collection in Wisconsin’s wild trout stocking program. American Fisheries Society 142nd Annual Meeting, Minneapolis-St. Paul, Minnesota.

Mitro, M. G., P. Kanehl, D. Walchak, and E. Struck. July 2012. Survival and recruitment in a Brook Trout source population used for egg collection in Wisconsin’s wild trout stocking program. 10th International Congress on the Biology of Fish, Madison, Wisconsin.

Mitro, M. G. March 2011. Wisconsin’s wild trout stocking program: source population viability and F1 vs. F2. WDNR Fisheries Management Statewide Meeting (invited), Wisconsin Dells, Wisconsin.

Mitro, M. G., J. D. Lyons, and J. S. Stewart. April 2010. Climate change, trout ecology, and the future of inland trout distribution and management in Wisconsin. UW-Richland Natural Resources Club, Richland Center, Wisconsin. (Invited)

Mitro, M. G., P. Kanehl, B. Fahey, J. Komassa, G. Van Dyck, D. Vetrano, and J. Weeks. March 2009. Survival and demographics of wild Brook Trout and Brown Trout in source populations for Wisconsin's wild trout stocking program. WDNR Winter Science Services Seminar Series, Madison, Wisconsin. http://intranet.dnr.state.wi.us/int/es/science/seminars.htm

Mitro, M. G., P. Kanehl, B. Fahey, J. Komassa, G. Van Dyck, D. Vetrano, and J. Weeks. February 2009. Survival and demographics of wild Brook Trout and Brown Trout in source populations for Wisconsin's wild trout stocking program. WDNR Science Services Statewide Meeting, Wausau, Wisconsin.

Mitro, M. G., P. Kanehl, B. Fahey, J. Komassa, G. Van Dyck, D. Vetrano, and J. Weeks. February 2009. Survival and demographics of wild Brook Trout and Brown Trout in source populations for Wisconsin's wild trout stocking program. Wisconsin, Minnesota, and Ontario Chapters of the American Fisheries Society 2009 Annual Meeting, Duluth, Minnesota.

Mitro, M. G. November 2008. Trout research in Wisconsin streams. Blackhawk Chapter of Trout Unlimited meeting, Janesville, Wisconsin.

DEVELOPMENT AND EVALUATION OF WATERSHED MODELS FOR PREDICTING STREAM FISHERY POTENTIAL

By: John Lyons john.lyons@wisconsin.gov, Matthew Diebel Matthew.Diebel@Wisconsin.gov, and Matthew Mitro Matthew.Mitro@wisconsin.gov, WDNR

STUDY OBJECTIVES:

The primary goal of this project is to develop and evaluate watershed models that quantify the inherent fisheries potential of streams and predict how watershed land-use will influence the realization of this potential. Specific model-development objectives are:

1. Modify as necessary existing Michigan models for predicting stream groundwater delivery, water temperature regime, and overall stream flow regime based on climate, surficial geology, topography, soils, vegetation, and land uses for various regions of Wisconsin. Test model predictions against observed temperatures and flows in stream reaches throughout the state.

2. Develop and test statistical models that relate observed stream temperatures and flows to observed fish community and fishery attributes in stream reaches throughout the state.

3. Link the models from 1) and 2) and classify and map Wisconsin stream reaches based on their actual and potential fisheries. Use current land-use data to estimate actual conditions and historical and “least-impacted” data to estimate potential.

4. For selected watersheds, use the models to explore how projected changes in land-use may affect stream fisheries.

PERFORMANCE ON SCHEDULED ACTIVITIES:

Activity # 1 - Prepare GIS layers and implement Michigan ground water delivery model:

GIS data layers for land use/cover, surficial geology, soil, bedrock type, bedrock depth, digital elevation model, precipitation, air temperature, degree growing days, conductivity, slope, and ground water delivery potential are now complete for the entire state of Wisconsin at both the 1:100,000 and 1:24,000 scales. Work has also been finished on a layer containing variables that indicate proximity to lakes, dams, and large rivers. This activity is now complete.

Activity # 2: Develop and validate GIS-based watershed model that predict stream flow, water temperature, and fish community characteristics:

New and improved versions of models have been developed to predict site-specific stream flows and water temperatures from the GIS layers. A database on fish community, habitat, temperature, predicted flow, and GIS variables from 393 sites on 287 streams has been assembled and has been used to develop new models that predict the occurrence and abundance of 79 stream fish species, including all of the major game and non-game fishes found in Wisconsin streams. These new fish models have accuracies of 65-95% (mean about 80%) in predicting species occurrence. This activity is now complete.

Activity # 3: Develop a statewide classification system for Wisconsin streams:

Two different GIS layers of stream segment classification based on watershed landscape characteristics, watershed land use, stream size, stream channel morphology, and biological communities have been developed. One is for Fisheries Management and emphasizes smallmouth bass occurrence and abundance. The other is for Watershed Management and emphasizes potential fish assemblages and biotic integrity. Both rely on a detailed thermal and stream-size classification framework that has been developed and is described in part in Lyons et al. (2009). Using this framework, all streams in the state have been classified at the 1:24,000 scale. This activity is now complete.

Activity # 4: Explore how projected changes in land-use may affect stream fisheries:

A model has been developed to project the spatial pattern and extent of future land-cover in Wisconsin, and this model has been coupled with models from Activity # 3 to predict impacts of both past and future land-use change on stream fisheries. Local applications of the model for fisheries and watershed managers have been carried out for parts of southwestern, northwestern, and north-central Wisconsin. This activity is now complete.

STUDY PUBLICATIONS:

Stewart, J. S., S. M. Westenbroek, M. G. Mitro, J. Lyons, L. Kammel, and C. A. Buchwald. 2014. A model for evaluating stream temperature response to climate change in Wisconsin. USGS Technical Report, Reston, Virginia. In press.

Wang, L., T. Brenden, J. Lyons, and D. Infante. 2013.Predictability of in-stream physical habitat for Wisconsin and northern Michigan wadeable streams using GIS-derived landscape data. Riparian Ecology and Conservation. 2013:11-24. Doi: 10.2478/remc-2013-0003.

Lyons, J. 2012. Development and validation of two fish-based indices of biotic integrity for assessing perennial coolwater streams in Wisconsin, USA. Ecological Indicators. 23:402-412.

Wang, L., D. Infante, J. Lyons, J. Stewart, and A. Cooper. 2011. Effects of dams in river networks on fish assemblages in non-impoundment sections of rivers in Michigan and Wisconsin, USA. River Research and Application 27:473-487.

Lyons, J. 2010. Indices of environmental integrity: a state agency's perspective. Pages 357-358 in W. Hubert and M Quist, editors. Inland fisheries of North America, Third Edition. American Fisheries Society, Bethesda, Maryland.

Lyons, J., T. Zorn, J. Stewart, P. Seelbach, K. Wehrly, and L. Wang. 2009. Defining and characterizing coolwater streams and their fish assemblages in Michigan and Wisconsin, USA. North American Journal of Fisheries Management. 29:1130-1151.

McKenna, J. E., P. J. Steen, J. Lyons, and J. Stewart. 2009. Applications of a broad-spectrum tool for conservation and fisheries analysis: aquatic gap analysis. U.S. Geological Survey GAP Bulletin 16:44-51.

Lyons, J. 2008. Seeing the "big picture" for Wisconsin stream fisheries. Science in the Spotlight. Page 4, 2008 Wisconsin Fishing Report, Wisconsin Department of Natural Resources, Madison. PUB-FH-506 2008.

Stewart, J., M. Mitro, E. A. Roehl, Jr., and J. Risley. 2006. Numerically optimized modeling of highly dynamic, spatially expansive, and behaviorally heterogeneous hydrologic systems – Part 2. In Proceedings of the 7th International Conference on Hydroinformatics, Nice, France. 8 pages.

Roehl, E. A., Jr., J. Risley, J. Stewart, and M. Mitro. 2006. Numerically optimized modeling of highly dynamic, spatially expansive, and behaviorally heterogeneous hydrologic systems – Part 1. In Proceedings for the Environmental Modeling and Software Society Conference, Burlington, VT. 6 pages.

STUDY PRESENTATIONS:

Lyons, J. 2014. Everything you always wanted to know about fish bioassessment in streams but were afraid to ask. Workshop presented at annual training session for Wisconsin DNR water quality biologists, Tomahawk, WI, March 11-13, 2014.

Diebel, M., A. Ruesch, D. Menuz, J. Lyons, J. Stewart, and C. Burchwald. 2014. Predicting effects of stream flow reductions on fish to support groundwater use permitting decisions. Presentation at annual training session for Wisconsin DNR water quality biologists, Tomahawk, WI, March 11-13, 2014.

Lyons, J., and M. Diebel. 2014. Fish-based stream classification for management and classification. Presentation to WDNR Staff, Madison, WI, February 12, 2014.

Lyons, J. 2013. Stream natural communities: applications for bioassessment. Presentation during U.S. Environmental Protection Agency review of the Wisconsin DNR biomonitoring program, Madison, WI, May 1, 2013.

Lyons, J. 2013. Validating/modifying stream Natural Community classifications with field data. Presentation given to the Wisconsin Department of Natural Resources Annual water Quality Biologists Training Session, Tomahawk, WI, March 6-7, 2013.

Lyons, J. 2012. The role of the IBI in fisheries management. Lecture and field training session for new staff of WDNR Fisheries Management, Dodgeville, WI, July 2012.

Lyons, J. 2012. Development of multimetric biotic indices (IBI's) to assess aquatic ecosystem integrity in Wisconsin. Lecture given to the Stream Ecology Class, Wisconsin Lutheran College, Wauwatosa, WI, October 2012.

Lyons, J. 2012. The role of the IBI in fisheries management. Lecture and field training session for new staff of WDNR Fisheries Management, July 12, 2012, Dodgeville, WI.

Stewart, J., J. Lyons, M. Mitro, L. Wang, and B. Weigel. 2010. A landscape approach to select stream sites for long-term biomonitoring in Wisconsin. Annual Meeting of the American Fisheries Society, September 12-16, 2010, Pittsburgh, PA.

Wang, L., D. M. Infante, J. Lyons, J. Stewart, and A. Cooper. 2010. Effects of dams in river networks on fish assemblages in non-impoundment sections of rivers in Michigan and Wisconsin. Annual Meeting of the American Fisheries Society, September 12-16, 2010, Pittsburgh, PA.

Stewart, J., J. Lyons, and L. Wang. 2010. A framework for selecting least impacted reference streams based on landscape models for use in assessing biotic integrity of wadeable streams in Wisconsin. U.S. EPA National Water Quality Monitoring Council, Monitoring Conference, April 25-29, 2010, Denver, CO.

Lyons, J. 2010. The Wisconsin stream model: function and application. Presentation to the Wisconsin DNR Office of the Great Lakes, February 24, 2010, Madison, WI.

Stewart, J., and J. Lyons. 2008. Fish distribution in Wisconsin streams: estimating changes from the mid 1800's to the present with a GIS-based, watershed-scale, predictive model. Annual Meeting of the American Fisheries Society, August 17-21, 2008, Ottawa, Ontario.

Lyons, J., and J. Stewart. 2008. Stream fish distribution and abundance: estimating changes from 1850 to the present. Annual Meeting of the Wisconsin Chapter of the American Fisheries Society, February 6-7, 2008, Wausau, Wisconsin.

STATUS AND TRENDS IN SPORTFISH POPULATIONS OF SOUTHWESTERN WISCONSIN WARMWATER STREAMS

By: John Lyons john.lyons@wisconsin.gov and Paul Kanehl paul.kanehl@wisconsin.gov, WDNR

STUDY OBJECTIVES:

1. Monitor sportfish abundance, reproductive success, size structure, and growth rate each year in seven streams in southwestern Wisconsin, continuing annual surveys begun in 1989.

2. Maintain a database containing information from 1).

3. Produce annual report.

PERFORMANCE ON SCHEDULED ACTIVITIES:

1) Assess sportfish populations in seven southwestern Wisconsin streams: Although this study began in 2000, these seven stations have been sampled annually in the same manner as part of other studies since 1989-1991, depending on the station. On each of these warmwater streams, we survey single 950 to 1900-m-long stations (Table 1) in late August or early to mid September following standardized wading electrofishing procedures (single stream DC shocker with 3 anodes, fish upstream in a single pass without block nets). The primary gamefish at each station is smallmouth bass; northern pike, channel catfish, bluegill, rock bass, and walleye are encountered at a few of the stations in generally low numbers. The seven streams represent a range of habitat and

population conditions. The Galena and Little Platte sites have some of the best stream smallmouth bass habitat in southwestern Wisconsin and are capable of supporting excellent fisheries. The Ames, Rattlesnake, and Sinsinawa sites have more typical habitat for the region and are capable of supporting fair to good fisheries. The Mineral Point Branch site is a “nursery” stream, too small to support large numbers of adults throughout the summer but providing good habitat for juveniles. The Otter Creek site has been plagued by fish kills caused by episodes of poor water quality, and its population is depressed. Recently, stocking has been undertaken there to try and increase smallmouth bass numbers.

Overall smallmouth bass catches in 2013 were about average. Age-0 smallmouth bass were produced in all streams, but catch rates were well below the maximum values observed over the course of the study suggesting that year-class strength was at best only moderate. Catch rates of juveniles (age-1 and age-2) and adults (> age-3) were variable among streams.

2) Maintain a database: All data from 2013 have been entered into a PC-SAS database maintained at the WDNR Science Operation Center in Madison.

3) Produce annual report: This performance report constitutes the annual report for this study.

STUDY PUBLICATIONS:

Fayram, A. H., B. M. Weigel, J. Lyons, and T. Simmons. 2014. Evaluating impairment in Wisconsin Areas of Concern using relative abundance of smallmouth bass. Aquatic Ecosystem Health and Management 17:107-114.

Rabeni, C., J. Lyons, J. Peterson, and N. Mercado-Silva. 2009. Sampling fish in wadeable warmwater streams. Pages 43-58 in S. Bonar, D. Willis, and W. Hubert, editors. Standard methods for sampling North American freshwater fishes. American Fisheries Society, Bethesda, Maryland.

Lyons, J., and P. Kanehl. 2002. Seasonal movements of smallmouth bass in streams. Pages 149-160 in D. P. Philipp and M. S. Ridgway, editors. Black bass: ecology, conservation, and management. American Fisheries Society, Bethesda, Maryland.

RECENT STUDY PRESENTATIONS:

Lyons, J. 2012. Smallmouth bass fisheries in wadeable streams. Lecture and field training session for new staff of WDNR Fisheries Management, Dodgeville, WI, July 2012.

Lyons, J, and P. Kanehl. 2010. Understanding (or not…) recruitment of smallmouth bass in southwestern Wisconsin streams. Annual Meeting of the Wisconsin Chapter of the American Fisheries Society, February 1-3, 2010, Green Bay, WI.

Rabeni, C., J. Lyons, J. Peterson, and N. Mercado-Silva. 2009. Sampling fish in wadeable warmwater streams. Poster presented at the Annual Meeting of American Fisheries Society, August 30-September 3, 2009, Nashville, Tennessee.

Rabeni, C., J. Lyons, J. Peterson, and N. Mercado-Silva. 2009. Sampling fish in wadeable warmwater streams. Poster presented at the Annual Meeting of the Western Division of the American Fisheries Society, May 3-7, 2009, Albuquerque, New Mexico.

Lyons, J. 2008. Characterizing warmwater streams for fisheries management. Office and field training session for new staff of WDNR Fisheries Management, July 11, 2008, Dodgeville, WI.

STATUS AND TRENDS IN THE FISH COMMUNITY OF THE LOWER WISCONSIN RIVER

BY: JOHN LYONS john.lyons@wisconsin.gov, WDNR

STUDY OBJECTIVES:

1. Monitor long-term fish community dynamics each year over the entire Lower Wisconsin River.

2. Evaluate sportfish abundance, reproductive success, size structure, and growth rate each year for the Prairie du Sac Dam tailwater, continuing annual surveys begun in 1987.

3. Maintain a database containing information from 1) and 2)

PERFORMANCE ON SCHEDULED ACTIVITIES:

1) Assess fish communities over the entire Lower Wisconsin River: In late August 2013, the fish assemblage of the main-channel-border habitat was monitored by standardized daytime boat electrofishing at 10 one-mile-long stations along the 92.3-mile length of the Lower Wisconsin River (Table 1). These 10 stations have been sampled in the same manner each year in August/September since 1999. An attempt was made to capture all fish observed. Captured fish were identified, counted, weighed, and checked for disease and deformities and the resulting data were used to calculate an index of biotic integrity (IBI) as a measure of river health (Table 2). In 2013, a total of 35 species (plus 3 hybrids) and 862 fish were collected from all 10 stations combined. Included in the 35 species were nine game fishes and one state-threatened species (40 blue suckers). Three species (quillback, shorthead redhorse, smallmouth bass) occurred at all 10 stations (Table 3). The most numerous species were shorthead redhorse (208 individuals), spotfin shiner (111), gizzard shad (57), and quillback (38) (Table 4); the greatest biomass was collected for shorthead redhorse (116 kg), blue

sucker (98 kg), common carp (52 kg), and quillback (38 kg) (Table 5). Among the game fishes, the most numerous species with the most biomass were smallmouth bass (45 individuals; 10.3 kg), channel catfish (24, 23.7 kg), walleye (24; 15.4 kg), bluegill (18; 1.8 kg), and sauger (13, 4.3 kg). Index of biotic integrity scores ranged from 70-100, and 9 of 10 stations were rated as excellent with the other rated good, similar to previous years (Table 6).

2) Estimate sportfish population parameters for the Prairie du Sac Dam tailwater: On October 23 and again on October 24, 2013, standardized nighttime boat electrofishing was used to monitor populations of sauger, walleye, largemouth bass, smallmouth bass, muskellunge, and northern pike over a 1.86-mile length of shoreline in the Prairie du Sac Dam tailwater. Although this study began in 2000, monitoring has been conducted since 1987 as part of other studies. The emphasis of the monitoring is to determine the relative abundance and growth of young-of-the-year (YOY) sauger and walleye in order to assess yearly fluctuations in recruitment. In 2013, a total of 97 sauger (6.1-17.5”), 147 walleye (6.9-23.6”), no saugeye (sauger X walleye hybrid), 12 largemouth bass (4.7-16.0“), 22 smallmouth bass (7.5-17.1”), 3 northern pike (25.4-32.0”), and 17 muskellunge (27.3-46.7“) were collected. Walleye, largemouth bass, and smallmouth bass catches were relatively low, whereas sauger, northern pike, and muskellunge catches were near average (Table 7). The catch rate of 6.7 YOY sauger per mile was identical to the 27-year median but the catch rate of 9.9 walleye per mile was well below the median (34.1) (Table 8). Mean sizes of YOY sauger (7.1”) and walleye (8.2”) were similar to the long-terms medians (7.2” and 8.2”, respectively).

3) Maintain a database: All data from 2013 have been entered into a PC-SAS database maintained at the WDNR Science Operations Center in Madison.

4) Produce annual report: This performance report constitutes the annual report for this study.

STUDY PUBLICATIONS:

Fayram, A. H., B. M. Weigel, J. Lyons, and T. Simmons. 2014. Evaluating impairment in Wisconsin Areas of Concern using relative abundance of smallmouth bass. Aquatic Ecosystem Health and Management 17:107-114.

Weigel, B. M., J. Lyons, and P. W. Rasmussen. 2006. Fish assemblages and biotic integrity of a highly modified floodplain river, the Upper Mississippi, and a large relatively unimpacted tributary, the lower Wisconsin. River Research and Applications 22:923-936.

Weigel, B. M., J. Lyons, P. W. Rasmussen, and L. Wang. 2006. Relative influence of environmental variables at multiple spatial scales on fishes in Wisconsin’s warmwater rivers. Pages 493-511 in R. M. Hughes, L. Wang, and P. W. Seelbach, editors. Influences of landscapes on stream habitats and biological assemblages. American Fisheries Society Symposium Number 48, Bethesda, Maryland.

Lyons, J. 2005. Fish assemblage structure, composition, and biotic integrity of the Wisconsin River. Pages 345-363 in R. Calamusso, R. Hughes, and J. Rinne, editors. Historical changes in large river fish assemblages of North America. American Fisheries Society Symposium 45, Bethesda, Maryland.

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Lyons, J., and K. Welke. 1996. Abundance and growth of young-of-year walleye (Stizostedion vitreum) and sauger (S. canadense) in Pool 10, upper Mississippi River, and at Prairie du Sac Dam, lower Wisconsin River, 1987-1994. Journal of Freshwater Ecology 11:39-50.

STUDY PRESENTATIONS:

Cochran, P. A., and J. Lyons. 2014. The silver lamprey and the paddlefish. Annual Meeting of the American Fisheries Society, August 17-21, 2014, Quebec City, Canada.

Lyons, J. 2014. The walleye fishery of the Lower Wisconsin River: the challenges of understanding and managing an open and highly mobile population. Presentation to the Fitchburg Fisheries Team of the Wisconsin DNR, Fitchburg, WI, June 4, 2014.

Lyons, J. 2014. The walleye fishery of the Lower Wisconsin River: the challenges of understanding and managing an open and highly mobile population. Presentation to the Fisheries Management Board of the Wisconsin DNR, Oshkosh, WI, May 22, 2014.

Lyons, J., D. Rowe, and J. Unmuth. 2011. Fishes and fisheries of the Lower Wisconsin River. Presentation to the Wisconsin Department of Natural Resources Board, August 9, 2011, Spring Green, WI.

Lyons, J. 2011. Paddlefish and lampreys in the Lower Wisconsin River. Filming and interview for National Geographic Television, June 8, 2011, Prairie du Sac, WI.

Lyons, J. 2009. Application of a fish IBI to assess the Upper Mississippi River and Wisconsin's large rivers. U.S. EPA Workshop on the Ecological Assessment of the Upper Mississippi River, May 5-7, 2009, Dubuque, IA.

Lyons, J. 2009. Using fish assemblages to assess the ecological health of the Upper Mississippi River. Invited Plenary Presentation, Annual Meeting of the Mississippi River Research Consortium, April 30-May 1, 2009, LaCrosse, WI.

Lyons, J. 2009. Assessing smallmouth bass in non-wadeable rivers. Presentation to the statewide Annual WDNR Fisheries Management Training Session, January 20-22, 2009, Wisconsin Dells, WI.

Marshall, D., J. Lyons, and J. M. Unmuth. 2008. Survey of lower Wisconsin River oxbows: lakes the river made. Annual Meeting of the Wisconsin Chapter of the American Fisheries Society, February 6-7, 2008, Wausau, Wisconsin.

Lyons, J. 2007. What lurks beneath? Fishes of the Lower Wisconsin River. Field presentation at the Annual Meeting of the Wisconsin River Alliance, October 8, 2007, Prairie du Sac, WI.

EVALUATION OF FISH PASSAGE AT THE PRAIRIE DU SAC DAM, WISCONSIN RIVER

By: John Lyons john.lyons@wisconsin.gov, WDNR

STUDY OBJECTIVES:

1. Determine the attributes (i.e., number, species, size, age, maturity) of fish using the newly constructed (completion date uncertain) upstream fish passage facility at the Prairie du Sac Dam, and compare with fish populations found above and below the dam.

2. Identify the conditions (i.e., time of day, season, water temperature, river flows) during which upstream movement through the dam is most likely to occur.

3. Estimate the contribution of fish using the passage facility to fish populations above the dam.

4. Document whether shovelnose sturgeon, paddlefish, and blue sucker have used the fish passage facilities to become re-established above the dam.

PERFORMANCE ON SCHEDULED ACTIVITIES:

Since 2008 data have been collected on the population characteristics, distribution, and movements in the Lower Wisconsin River downstream of the Prairie du Sac Dam for two of the four target species for fish passage, shovelnose sturgeon and blue sucker. Knowledge of the spawning ecology, life history, abundance, and age and growth for both species has increased greatly. This information can serve as important “pre-passage” data for an evaluation of fish passage effectiveness at the Prairie du Sac Dam. Additionally, much time and effort has been spent in planning for fish passage at the dam. However, the type and timing of fish passage implementation is now uncertain, calling into question whether study objectives can be achieved (see next section).

STUDY PUBLICATIONS:

Lyons, J. 2014. Shovelnose sturgeon, Scaphirhynchus platorynchus. Online account in: Lyons, J., editor. 2014. Fishes of Wisconsin E Book. Wisconsin Department of Natural Resources, Madison, and U. S. Geological Survey, Middleton, WI, http://www.fow-ebook.us

Pracheil, B. M., J. D. Hogan, J. Lyons, and P. B. McIntyre. 2014. Using hard-part microchemistry for conservation and management of North American freshwater fishes. Fisheries 39: in press.

Lyons, J. 2013. Blue sucker, Cycleptus elongatus. Online account in: Lyons, J., editor. 2013. Fishes of Wisconsin E Book. Wisconsin Department of Natural Resources, Madison, and U. S. Geological Survey, Middleton, WI, http://www.fow-ebook.us

Pracheil, B. M., P. B. McIntyre, and J. Lyons. 2013. Enhancing conservation of large-river biodiversity by accounting for tributaries. Frontiers in Ecology and the Environment 11:124-128. (http://dx.doi.10.1890/12179).

STUDY PRESENTATIONS:

Lyons, J., and J. M. Stewart. 2014. Conserving riverine lake sturgeon in Wisconsin under a warming climate: the importance of connectivity. Fourth Fish Passage Symposium, June 9-11, 2014, Madison, Wisconsin.

Pracheil, B. M., P. McIntyre, and J. Lyons. 2013. Connectivity of large-river networks is important throughout fish life history. Annual Meeting of the American Fisheries Society, September 8-12, 2013, Little Rock, Arkansas.

Lyons, J., N. Utrup, and J. A. Morton. 2012. Fish passage at the Prairie du Sac Dam on the Wisconsin River. Presentation to Alliant Energy Staff, October 31, 2012, Madison, WI.

Lyons, J., N. Utrup, and J. A. Morton. 2012. Sturgeon and paddlefish restoration through implementation of fish passage at the Prairie du Sac Dam on the Wisconsin River. Annual Meeting of the American Fisheries Society, August 19-23, St. Paul, Minnesota.

Pracheil, B. M., P. McIntyre, and J. Lyons. 2012. Movements of shovelnose sturgeon throughout life history inferred from otolith microchemistry. Annual Meeting of the American Fisheries Society, August 19-23, St. Paul, Minnesota.

Lyons, J., and D. Rowe. 2012. Prairie du Sac Dam fish passage project. Lecture and field training session for new staff of WDNR Fisheries Management, July 11, 2012, Sauk City and Prairie du Sac, WI.

Lyons, J. 2012. Prairie du Sac Fish Passage. Presentation to the WDNR Water Leaders and Fisheries Board, May 30, 2012, Prairie du Sac, WI.

Lyons, J. 2012. Biological basis for fish passage at the Prairie du Sac Dam on the Lower Wisconsin River. Presentation to employees of Alliant Energy, Feb 23, 2012, Madison, WI.

Lyons, J. 2012. Spawning ecology of shovelnose sturgeon and blue sucker in the Lower Wisconsin River. Annual Meeting of the Wisconsin and Michigan Chapters of the American Fisheries Society, February 7-9, 2012, Marinette, WI.

Pracheil, B. M., P. B. McIntyre, J. Lyons, and M. A. Pegg. 2011. Defining the riverscape: tributaries as a key to Great River fish conservation. Annual Meeting of the American Fisheries Society, September 4-8, 2011, Seattle, Washington.

Lyons, J. 2011. Balancing the benefits of reconnecting fish populations with the risks of spreading invasive species in the design and operation of fish passage projects. Invited Plenary Talk at 1st Annual National Conference on Engineering and Ecohydrology for Fish Passage, June 27-29, 2011, Amherst, MA.

Lyons, J. 2011. Upstream fish passage at the Prairie du Sac Dam on the Wisconsin River. Presentation to the Lower Wisconsin Riverway Board, April 14, 2011, Sauk City, WI.

Lyons, J. 2010. The challenge of reconnecting streams in the age of AIS: Prairie du Sac Dam experience. Presentation at the WDNR Annual Statewide Watershed Management Training Conference, March 5-6, 2010, Amherst, WI.

Lyons, J. 2010. Upstream fish passage at the Prairie du Sac Dam on the Wisconsin River: the challenges of reconnecting at fragmented river system while preventing the spread of aquatic invasive species. Presentation to Wisconsin DNR Central Office Staff, February 25, 2010, Madison, WI.

Lyons, J. 2009. Restoration of fish populations via upstream fish passage at the Prairie du Sac Dam, Wisconsin River. Poster presented to Wisconsin DNR Central Office Staff, March 8, 2009, Madison, WI.

EFFECTS OF FLOW ALTERATIONS ON STREAM FISHES

By: Matthew Diebel Matthew.Diebel@Wisconsin.gov, WDNR

STUDY OBJECTIVES:

1. Develop hydrologic models that relate climate and landscape characteristics to temporal and spatial variation in stream flows across Wisconsin.
2. Use hydrologic model predictions to calculate hydrologic indicators that describe components of flow regime that may be related to stream ecological structure and function.
3. Develop statistical models that relate modeled hydrologic indicators to the measured occurrence and abundance of fish species in Wisconsin streams.

STUDY PUBLICATIONS:

Diebel, M., A. Ruesch, D. Menuz. Ecological limits of hydrologic alteration in Wisconsin streams. Project report to the Bureau of Drinking Water and Groundwater, April 2014.
Diebel, M., A. Ruesch, D. Menuz. Ecological limits of hydrologic alteration in Dane County streams. Project report to the Capital Area Regional Planning Commission, April 2014.
Menuz, D.R., A.S. Ruesch, and M.W. Diebel. 2013. 1:24K Hydrography Attribution Metadata. ftp://dnrftp01.wi.gov/geodata/hydro_va_24k/WDNR_Hydro_VA_metadata/hydro_va_documentation.pdf
Ruesch, A.S., D.R. Menuz, and M.W. Diebel. 2013. 1:24K Hydrography Creation Toolset. ArcGIS Toolbox.

STUDY PRESENTATIONS:

Diebel, M., A. Ruesch, D. Menuz. (15 April 2014). Ecological Limits of Hydrologic Alteration in Dane County Streams. Dane County Land Conservation Department, Madison, WI.

Diebel, M., A. Ruesch, D. Menuz. (13 March 2014). Ecological Limits of Hydrologic Alteration in Dane County Streams. Capital Area Regional Planning Commission, Madison, WI.

Diebel, M., A. Ruesch, D. Menuz, J. Stewart, and S. Westenbroek. (11 March 2014). Predicting Effects of Stream Flow Reductions on Fish to Support Groundwater Use Permitting Decisions. Water Resources Statewide Meeting, Treehaven, WI.

Diebel, M., A. Ruesch, D. Menuz, J. Stewart, and S. Westenbroek. (14 February 2014). Effects of Flow Alteration on Stream Fish: Implications for Groundwater Use. Science Services Open House, Madison, WI.

Diebel, M. , A. Ruesch, D. Menuz, J. Stewart, and S. Westenbroek. (12 February 2014). Ecological Limits of Hydrologic Alteration in Wisconsin Streams. The Center for Limnology Seminar Series, Madison, WI.

Diebel, M., A. Ruesch, D. Menuz, J. Stewart, and S. Westenbroek. (21-22 January 2014). Groundwater withdrawals: modeling fisheries responses. 2014 WDNR Fisheries Biologist and Supervisors Meeting, Wausau, WI.

Diebel, M., A. Ruesch, and D. Menuz. (25 November 2013). Introduction to WDNR's new waterbody and watershed attribute database, WDNR seminar. Madison, WI.

Diebel, M., A. Ruesch, D. Menuz, J. Stewart, and S. Westenbroek. (22 November 2013). Ecological limits of hydrologic alteration in Wisconsin streams. Wisconsin Groundwater Coordinating Council meeting, Madison, WI.

EFFECTS OF KNOWN EXPLOITATION RATES ON TROUT POPULATION DYNAMICS

By: Matthew Mitro Matthew.Mitro@wisconsin.gov and Paul Kanehl paul.kanehl@wisconsin.gov, WDNR (Gene Van Dyck and Jordan Weeks, DNR cooperators)

STUDY OBJECTIVE:

In this study we are investigating the effects of a known exploitation rate on a Brown Trout in a Driftless Area stream in Wisconsin. Specific objectives include quantifying the effects of a known exploitation level of trout under a maximum size limit on trout population abundance, size structure, recruitment, growth, and mortality.

PERFORMANCE ON SCHEDULED ACTIVITIES:

In this study we proposed to experimentally simulate trout angling exploitation by removing a known proportion of trout from a stream population. The rationale behind this project is to improve our understanding of how angling regulations may impact trout populations. Recognizing the difficulty in implementing experimental angling regulations and quantifying angler catch, effort, and harvest, an alternative approach is to experimentally control the removal of trout.

We are interested in evaluating a maximum size limit that restricts harvest to trout under a certain size. That is, we will remove trout under a certain size yet large enough that a typical angler would consider keeping it to eat. This design will allow us to protect larger and older trout and to significantly lower the density of typically abundant size and age classes to evaluate how the change in density impacts the trout population. The ideal candidate population would have high productivity of age 0 trout, a high abundance of age 1 and 2 trout of a harvestable size, and the potential to grow older and larger trout.

In 2012 we completed pilot surveys to help identify an appropriate stream for the study and to obtain trout population data prior to an experimental removal future years. Trout

Creek (Iowa County) was considered because of the presence of a dry dam and current catch-and-release trout fishing regulations; trout could be moved from the catch-and-release section and released downstream of the dry dam structure. Preliminary surveys, however, showed limited productivity in terms of low numbers of age 0 trout and an abundance of older and larger trout. The current catch-and-release regulation appears appropriate and any experimental harvest is unlikely to improve the already high-quality size structure.

Spring Coulee Creek (Vernon County) was also considered. Extensive surveys of Spring Coulee by both Fisheries Management and Fisheries Research show a high density Brown Trout population with an abundance of age 0 and age 1 trout and the potential to grow large trout. A single-pass survey of a 290-m section showed a density of 3.6 trout per meter. Although current regulations allow harvest, a recent creel survey from nearby Timber Coulee shows that a majority of anglers in the area practice catch-and-release.

In 2012-2013 we continued to survey Spring Coulee as part of study SSTP to monitor trends in trout populations in relation to baseflow and in preparation of experimental exploitation.

In June 2013 and May 2014 we conducted the experimental exploitation of the Brown Trout population in Spring Coulee by focusing on a 400 m section of Spring Coulee at Willow Creek Farm, which is known to have a high density of small trout but with the potential to grow large trout. In a single electrofishing pass in June 2013 we captured 878 Brown Trout. We removed 808 Brown Trout < 12" total length, transferring them to a downstream location in Coon Creek. We returned 70 Brown Trout to the stream, including all trout ≥ 12" total length. All returned trout were tagged with a PIT tag, measured, and weighed. Figure 1 shows the length-frequency distribution for Brown Trout, including all 70 trout tagged and returned to the stream in June 2013. Figure 2 shows the condition of a typical Brown Trout found in Spring Coulee in June 2013. In a single electrofishing pass in May 2014 we captured 381 Brown Trout and removed 100 Brown Trout < 12" total length, again transferring them to a downstream location.

We also surveyed adjacent sections of the stream, including a 200-m section upstream and a 100-meter section downstream. (Additional sections of Spring Coulee further away from the experimental section have been surveyed and trout tagged as part of study SSTP, with the next survey scheduled for July 2013.) A subsample of 50 trout were tagged with PIT (passive integrated transponder) tags and released in each adjacent section, and an additional 150 trout were tagged with VIE (visible implant elastomer) tags and released in each adjacent section. All tagged trout will be used to document movement (or the lack thereof) and survival and PIT-tagged trout will also be used to quantify growth.

Assuming a 0.75 capture efficiency, the single pass catch indicated a total abundance of 1,171 brown trout in June 2013 and 508 brown trout in May 2014 in the 400-m section. The removal of 808 brown trout in 2013 effected a 69% exploitation rate and the removal of 100 brown trout in 2014 effected a 20% exploitation rate. These abundance estimates and exploitation rates suggest a remaining abundance of 346 brown trout in 2013 June and 406 brown trout in 2014 May.

Over the course of the year between June 2013 and May 2014 there was recruitment of a new year class (indicated by brown trout in the smaller length classes) and natural mortality, which may have been higher than normal because of the unusually cold winter of 2013-2014 (See study SSTP).

A 2013 follow-up survey in September showed that a lower density was maintained in the removal section compared to adjacent control sections and that there did appear to be a positive growth response for trout in the removal section (Figure 3). Figure 3 shows box plots of growth as measured by change in weight of Brown Trout tagged with PIT tags in June and recaptured in September.

STUDY PRESENTATIONS:

Mitro, M. G. March 2014. Wisconsin DNR trout research. Orientation for New Fisheries Staff Meeting, Madison, Wisconsin.

Mitro, M. G. February 2014. Research to support inland trout fisheries management. Science Services Open House, Madison, Wisconsin.

Mitro, M. G. December 2012. Trout research update presented to the Wisconsin DNR Fisheries Management Board, Madison, Wisconsin.

MONITORING TEMPORAL TRENDS IN TROUT POPULATIONS AND BASE FLOW IN STREAMS

By: Matthew Mitro Matthew.Mitro@wisconsin.gov and Paul Kanehl paul.kanehl@wisconsin.gov, WDNR (Jordan Weeks, DNR cooperator)

STUDY OBJECTIVES:

1. Determine the utility of temporal-trend monitoring of fixed sites in coldwater streams as part of the statewide baseline monitoring of wadeable streams.

Data collected from fixed sites sampled over time will allow the separation of temporal and spatial variability in baseline monitoring and will provide the information necessary to formulate insightful hypotheses about how and why trout populations vary over time.

2. Quantify the relationships between stream base flow and annual flow variability, precipitation, and trout population dynamics in coldwater wadeable streams.

A better understanding of stream flow dynamics and trout population response may assist in determining appropriate minimum flows, and in identifying risks to base flow and trout populations from changing land and groundwater use and from changing climate regimes.

PERFORMANCE ON SCHEDULED ACTIVITIES:

Trout and habitat monitoring

In this study we are monitoring stream fishes, water temperature, and stream flow in Driftless Area streams in Wisconsin. Objectives include determining the utility of temporal-trend monitoring of fixed sites in coldwater streams as part of the statewide baseline monitoring of wadeable streams and quantifying the relationships between stream base flow and annual flow variability, precipitation, and trout population dynamics in coldwater wadeable streams.

We continued monitoring trout populations and daily water level and temperature in a set of 23 streams (Table 1). We added four streams that we are currently studying as parts of other studies: Tenny Spring Creek (SSDX), Trout Creek (study SSTE) and Chase Creek and Lynch Branch (study SSLT). We have been monitoring trout populations in 8 of the 23 streams as part of other research projects (studies SSDX, SSLT, and SSTE). Each of the remaining streams are monitored according to baseline wadeable streams monitoring protocols, including fish and index of biotic integrity (IBI) surveys conducted during the June-August summer time period.

We have 11 streams with multiple monitors (i.e., from two to five monitors per stream) recording hourly water temperature data (Table 1). Four of these 11 streams also have 2 to 3 monitors that record hourly water level data. These additional monitors will allow for temperature and flow profiles along the length of each stream.

At each water level monitoring site we installed a HOBO Water Level 13-Foot Data Logger to continuously record water pressure and water temperature at one hour intervals. Water pressure data are corrected with air pressure data to yield an estimate of water level above the data logger. We measure hourly air pressure at three regional sites (Table 1). We also measured flow at each stream when the water level monitors were installed and again when data are downloaded from the monitors. We will use flow measurements to construct rating curves that can be used to convert water levels to estimates of stream flow (except for extreme flow events).

In addition to the standard fish survey, we tagged all trout age 1 and older in a subset of seven streams using elastomer visible implant tags or passive integrated transponder (PIT) tags to establish annual capture histories. This subset of streams included four streams surveyed since 2004 (Ash Creek, Big Spring Branch, Elk Creek, and Timber Coulee Creek), one stream surveyed since 2010 (Spring Coulee Creek), and two streams surveyed since 2011 (Tenny Spring Creek and Trout Creek). We also established groups of tagged, known-aged Brook Trout and Brown Trout in six streams (Ash Creek, Big Spring Branch, Elk Creek, Tenny Spring Creek, Timber Coulee Creek, and Trout Creek). We used coded wire tags or PIT tags to tag yearling trout captured in our spring surveys during the month of April. At this time of year, age 1 trout can still be identified by length. Capture history data will allow for the estimation of abundance, apparent survival, recruitment, and population growth by year. Variables such as stream water level and temperature will be included in models of population vital rates to determine how trout populations respond to changes in these habitat variables.

Gill lice Salmincola edwardsii, an ectoparasite that infects Brook Trout, has been observed in three of the streams in which we tag Brook Trout (Ash Creek, Big Spring Branch, and Tenny Spring Creek). The prevalence and intensity of gill lice infection in a Brook Trout population may be related to the host Brook Trout density, water temperature, and streamflow. Higher host density and lower streamflow may facilitate the transmission of the parasite. The gill lice life cycle is also dependent on water temperature. The trout and habitat data collected in this study will be instrumental in developing an understanding of the dynamics of gill lice in Brook Trout populations and in understanding conditions that may lead to an epizootic of gill lice.

Climate change

The Wisconsin Initiative on Climate Change Impacts (WICCI) released its first adaptive assessment for the state of Wisconsin in 2011. We contributed to the WICCI Coldwater Fish and Fisheries Working Group report, in which we discussed potential climate change impacts on Wisconsin trout streams, trout distribution in Wisconsin under the current climate and predicted climate scenarios, and adaptation strategies that can be used to protect coldwater resources from changes in climate. The monitoring work in this study strongly supports climate change-related monitoring goals for streams and coldwater fishes such as trout in Wisconsin. A new climate-related project that began in 2012 (Matt Diebel, WDNR principal investigator) involves the collection of year-round water temperature data in streams across Wisconsin. We have been collecting similar data in this project for the Driftless Area of Wisconsin since 2007. Our data will be contributed to the new project, allowing their effort to be redirected to parts of the state for which data coverage is poor.

Climate projections for Wisconsin have been based on modeling efforts by researchers at the University of Wisconsin Center for Climatic Research. This research group ‘downscaled’ continental climate predictions from global circulation models (GCM) from 150-km-square grids to 10-km-square grids, resulting in more specific predictions for Wisconsin. They generated 45 climate change scenarios using 15 GCM with 3 emission scenarios projected over 50 years. The models predict significant warming in all months (with higher low temperatures), more extreme heat and less extreme cold, greater total precipitation (primarily in winter and spring), and more heavy precipitation events and fewer light precipitation events.

In Wisconsin we experienced two heavy precipitation events consistent with predicted changes in climate in 2007 and 2008. These events occurred in the Driftless Area in August 2007 and June 2008, coincident with the start of this study. Many of the water level loggers initially installed in July 2007 were lost in the floods, but those that were retrieved recorded the magnitude and duration of the rise in water level that occurred in surveyed streams. Some examples of retrieved data are described below.

Both flood events, as well as flooding in 2010, occurred and were documented by data loggers in Mormon Coulee Creek and Timber Coulee Creek (Figures 1-2). The greatest changes in water level were observed in Mormon Coulee Creek, a highly entrenched stream (Figure 1). Mormon Coulee Creek has an improving Brown Trout fishery but is threatened by urban development. The baseline water level in Timber Coulee Creek increased by about 13% following the August 2007 flood and by another 13% following the June 2008 flood (Figure 2). Continued monitoring will help in understanding flood-base flow dynamics and trout population response.

Levis Creek (Figure 3) and other Jackson County streams in our survey were not affected by the extreme precipitation events of August 2007 and June 2008, and exhibited different flow dynamics in response to different precipitation regimes.

Climate models for Wisconsin also predict significant warming in all months including higher low temperatures. Water temperature data collected in this study will be used to identify such trends and their impact on trout. In 2010 we acquired a long-term stream temperature dataset for Kinnickinnic River and its tributaries dating back to 1992 (Figure 4). We updated this dataset with water temperature data collected through the summer of 2012 (Figures 5-10). An analysis of this dataset showed changes in stream temperatures from 1992 to 2012 were consistent with climate predictions of warming air temperatures and higher low nighttime temperatures.

An analysis of long-term (1992-2012) stream temperature data from three sites on the Kinnickinnic River and one site on a tributary show increasing trends in maximum daily minimum, mean, and maximum temperatures as exposure period increases from 1 to 63 days (Figures 5-10). The daily mean temperature was calculated for each date from 15 May to 15 September by year, the maximum daily mean temperature was calculated for each year, and a moving average of the maximum daily mean temperature was calculated for exposure periods of 3, 7, 14, 21, 28, 35, 42, 49, 56, and 63 days. Statistics for maximum daily minimum and maximum were calculated similarly. In our previous analysis of data through 2009, there was generally no change or a decrease in the maximum daily mean temperature measured by 1 day (Figure 4). With the additional observations through 2012, this changed, particularly for Rocky Branch Creek (Figure 5). In general, the addition of more recent observations shows continued warming in summer stream temperature data.

As exposure period increased from 7 to 63 days, the maximum daily mean and maximum temperature (and to a lesser extent the maximum daily minimum temperature) tended to increase with year (Figures 5-10). The maximum daily mean temperatures for all exposure periods were less than thermal tolerances for brook and Brown Trout, which were estimated using stream temperature and fish data for Wisconsin and Michigan streams collected in 1991-2000 (Wehrly et al. 2007, Transactions of the American Fisheries Society 136:365-374). The 1992-2012 temperature data for the four Wisconsin stream sites suggests a warming trend in water temperature has been occurring, consistent with the observed warming trend in Wisconsin air temperature for the same time period. This warming has not occurred in short term peaks in stream temperature but rather as increases in temperatures as measured over broader exposure periods.

Weather conditions in 2012 were unusual compared to those in 2007-2011. We experienced unusually warm air temperatures in March 2012, which resulted in significant warming of stream water temperatures. In Ash Creek, for example, daily minimum water temperatures in March 2012 clearly exceeded daily maximum water temperatures in March 2011 (Figure 11). The March 2012 water temperatures were similar to water temperatures typically encountered during the June-August summer period. Water temperatures decreased to a more seasonable range by the end of March 2012. The warmer stream temperatures in Ash Creek in March 2012 were ideal for the growth and reproduction of gill lice and may have contributed to the epizootic observed in Ash Creek in 2012.

We have also experienced heat waves (multiple days with air temperatures > 90 °F) and drought conditions during the summer beginning in June 2012. Climate models predict we will see more days with air temperatures exceeding 90 °F and higher nighttime low temperatures, and this was what we experienced in 2012 as compared to previous years during this study (2007-2011). However, despite the higher air temperatures in 2012, our data indicated that warmer stream temperatures were observed in 2010 versus 2012 (Figures 5-14).

Stream temperature data from 2010-2012 for Big Spring Branch illustrates the dynamics of stream conditions in relation to weather patterns. Daily mean air temperature at Big Spring was generally greater during summer (June-August) 2012 compared to the previous two years (Figure 12), but water temperature in Big Spring, measured about 200 m downstream from a major groundwater source, remained relatively constant and unresponsive to day-to-day changes in air temperature (Figures 12 and 13) in 2012. The water temperature repeatedly increased during summer 2010, however, in response to precipitation events (Figure 2010). It appears that streams driven by cold groundwater input are resilient to high air temperature in the absence of precipitation events (Figure 13) and that observed increases in stream temperature are influenced by warm surface water during precipitation events when they occur (Figure 14). In the absence of precipitation events, stream water temperature does begin to respond to changes in air temperature as the distance from the groundwater source increases (Figure 15). In Big Spring, daily mean water temperature measured about 2,000 m downstream of the major groundwater source showed changes consistent with changes in the daily mean air temperature.

The long-term air temperature, water temperature, and water level data collected in this study have begun to highlight the importance of considering both temperature and precipitation in understanding climate impacts on stream conditions. Although summer air temperature was unusually high in 2012, stream temperatures were unusually cool because of the lack of precipitation.

Winter 2013-2014 was unusually cold in Wisconsin, both in severity and duration. Trout streams may be “warm” in winter because of groundwater inputs, even during severe winters. Groundwater-fed streams are “warm” in that they do not freeze over during winter. Big Spring Branch in Iowa and Grant counties is one such stream. Despite multiple days of sub-zero (°F) air temperatures, the average daily water temperature near the Big Spring Road bridge remained in the mid-40’s°F through winter, only dipping below 40°F during snowmelt events in March (Figure 16). The influence of air temperature on stream temperature did become evident a couple miles downstream near the Pine Tree Road bridge where the stream temperature was lower and more variable (Figure 16).

Some of the most comprehensive work on water temperature and Brown Trout was conducted by J. Malcolm Elliott and his colleagues in Great Britain. Their models showed that even if food is not limiting, there is zero growth in Brown Trout at temperatures less than about 39°F. Using 39°F as a cut-off value to measure the severity of winter stream temperatures (and 34°F as a further measure of severity), the winter 2013-2014 environment at the upstream area of Big Spring was relatively benign (Figure 16). There were only 2 days with an average daily stream temperature <39°F (0 days <34°F) for the 151-day period between November 1 and March 31. But there were 72 days <39°F (5 days <34°F) at the downstream area.

Other trout streams with areas less-influenced by groundwater experienced a greater severity and duration of cold water temperatures during winter 2013-2014. In the catch-and-release area of Timber Coulee Creek, there were 118 days <39°F and 82 days <34°F in winter 2013-2014 (Figure 17). By contrast, during the relatively mild winter of 2011-2012, there were only 63 days <39°F and 14 days <34°F (Figure 17). In winter 2010-2011 there were 92 days <39°F and 37 days <34°F, and in winter 2012-2013 there were 103 days <39°F and 45 days <34°F (Figure 17).

STUDY PUBLICATIONS:

Stewart, J. S., S. M. Westenbroek, M. G. Mitro, J. D. Lyons, L. Kammel, and C. A. Buchwald. In press. A model for evaluating stream temperature response to climate change in Wisconsin. U.S.G.S. Report.

Mitro, M., J. Lyons, and S. Sharma. 2011. Executive summary: coldwater fish and fisheries. Pages 170-173 in E. Katt-Reinders, editor. Wisconsin’s changing climate: impacts and adaptations. Wisconsin Initiative on Climate Change Impacts. Nelson

Institute for Environmental Studies, University of Wisconsin-Madison and the Wisconsin Department of Natural Resources, Madison, Wisconsin.

Mitro, M. G., J. Lyons, and J. Stewart. 2010. Predicted effects of climate change on the distribution of wild Brook Trout and Brown Trout in Wisconsin streams. Pages 69-76 in R. F. Carline and C. LoSapio, editors. Conserving wild trout: Proceedings of Wild Trout X. Bozeman, Montana.

Mitro, M., J. Lyons, and S. Sharma. 2011. Wisconsin Initiative on Climate Change Impacts: Coldwater Fish and Fisheries Working Group Report. 31 pp.

Lyons, J., J. S. Stewart, and M. Mitro. 2010. Predicted effects of climate warming on the distribution of 50 stream fishes in Wisconsin, U.S.A. Journal of Fish Biology 77:1867-1898.

Mitro, M. G. 2010. Groundwater key for trout as our climate warms. Wisconsin Trout 22(1):6.

STUDY PRESENTATIONS:

Mitro, M. G., J. Lyons, J. Stewart, and S. Westenbroek. April 2014. Climate change impacts on Wisconsin trout streams. Citizens' Climate Lobby-Central Wisconsin Chapter panel forum on "Climate Change and Wisconsin Hunting & Fishing" (invited), Stevens Point, Wisconsin.

Mitro, M. G. March 2014. Wisconsin DNR trout research. Orientation for New Fisheries Staff Meeting, Madison, Wisconsin.

Mitro, M. G., J. Lyons, J. Stewart, S. Westenbroek, L. Kammel, and C. Buchwald. February 2014. Modeling and monitoring to understand climate change impacts on Wisconsin trout streams. Poster presented at Wisconsin Chapter of the American Fisheries Society 2014 Annual Meeting, Green Bay, Wisconsin.

Mitro, M. G., S. Marcquesnski, K. Soltau, and P. Kanehl. February 2014. Gill lice as a proximate cause of Brook Trout loss under changing climatic conditions. Wisconsin Chapter of the American Fisheries Society 2014 Annual Meeting, Green Bay, Wisconsin.

Mitro, M. G. February 2014. Research to support inland trout fisheries management. Science Services Open House, Madison, Wisconsin.

Mitro, M. G., J. Lyons, J. Stewart, S. Westenbroek, L. Kammel, and C. Buchwald. October 2013. Modeling and monitoring to understand climate change impacts on Wisconsin trout streams. Poster presented at the University of Wisconsin Center for Climatic Research/Nelson Institute 50th Anniversary, Madison, Wisconsin.

Mitro, M. G., J. Lyons, J. Stewart, and S. Westenbroek. March 2013. Climate change impacts on Driftless Area trout streams: observations, projections, and adaptation strategies. 6th Annual Driftless Area Symposium (invited), La Crosse, Wisconsin.

Mitro, M. G. March 2013. Adaptation in action: putting climate change adaptation strategies to work for fisheries and wildlife. Climate Academy Webinar, U.S. Fish & Wildlife Service (invited).
http://nctc.fws.gov/courses/climatechange/climateacademy/home.html

Mitro, M. G. December 2012. Trout research update presented to the Wisconsin DNR Fisheries Management Board, Madison, Wisconsin.

Mitro, M. G., P. Kanehl, D. Walchak, and E. Struck. March 2012. Monitoring trout response to stream habitat development in Wisconsin: lessons from Elk Creek. 5th Annual Driftless Area Symposium (invited), La Crosse, Wisconsin.

Mitro, M. G. March 2011. Climate change and the future of inland trout distribution in Wisconsin. Coulee Region Chapter of Trout Unlimited meeting (invited), La Crosse, Wisconsin.

Mitro, M. G., Lyons, J. D., and J. S. Stewart. March 2011. Predicted effects of climate change on the distribution of Brook Trout and Brown Trout in Wisconsin streams. 4th Annual Driftless Stream Restoration Symposium (invited), La Crosse, Wisconsin.

Mitro, M. G., Lyons, J. D., and J. S. Stewart. March 2011. Climate change and the distribution of trout in Wisconsin streams: impacts and adaptation strategies. Climate Change Graduate Seminar (invited), University of Wisconsin, Madison, Wisconsin.

Mitro, M. G., Lyons, J. D., and J. S. Stewart. March 2011. Climate change and the distribution of trout in Wisconsin streams: impacts and adaptation strategies. Joint Meeting of the Wisconsin Society of American Foresters and The Wisconsin Chapter of the Wildlife Society (invited), Wisconsin Dells, Wisconsin.

Mitro, M. G., Lyons, J. D., and J. S. Stewart. December 2010. Predicted effects of climate change on the distribution of Brook Trout and Brown Trout in Wisconsin streams. Midwest Fish and Wildlife Conference, Minneapolis, Minnesota.

Mitro, M. G., J. D. Lyons, and J. S. Stewart. September 2010. Climate change and the future of inland trout distribution and management in Wisconsin. DNR Science Seminar Series, Madison, Wisconsin.

Mitro, M. G., J. D. Lyons, and J. S. Stewart. September 2010. Predicted effects of climate change on the distribution of wild Brook Trout and Brown Trout in Wisconsin streams. Wild Trout X Symposium, West Yellowstone, Montana.

Mitro, M. G. May 2010. Coldwater Fish and Fisheries Working Group Adaptive Assessment Report. WICCI Advisory Council Meeting, Madison, Wisconsin.

Mitro, M. G., J. D. Lyons, and J. S. Stewart. April 2010. Climate change, trout ecology, and the future of inland trout distribution and management in Wisconsin. UW-Richland Natural Resources Club, Richland Center, Wisconsin. (Invited)

Mitro, M. G. February 2010. Coldwater Fish and Fisheries Working Group – Adaptive Assessment Report Update. WICCI Science Council Meeting, Madison, Wisconsin.

Mitro, M. G., J. Lyons, and J. Stewart. March 2009. Response of Wisconsin's coldwater fishes to climate change. Bracing for Impact-Climate Change Adaptation in WI, sponsored by the Wisconsin Initiative on Climate Change Impacts, University of Wisconsin, Madison, Wisconsin.

Mitro, M. G. January 2009. Trout stream habitat restoration and climate change in Wisconsin. WDNR Fisheries Management Statewide Meeting, Wisconsin Dells, Wisconsin.

Mitro, M. G. November 2008. Trout research in Wisconsin streams. Blackhawk Chapter of Trout Unlimited meeting, Janesville, Wisconsin.

Mitro, M. G., D. Vetrano, and J. Weeks. October 2008. Monitoring temporal trends in trout populations and stream flow in Driftless Area streams. 3rd Annual Driftless Area Symposium, Lanesboro, Minnesota.

Thermal Habitat Use by Coolwater Walleye in the Warm Lower Wisconsin River

By Justin Haglund JustinM.Haglund@wisconsin.gov and Brian Weigel Brian.Weigel@wisconsin.gov, WDNR

INTRODUCTION

STUDY OBJECTIVES:

1) Document the thermal regime of the lower Wisconsin River, particularly the summer maximum water temperature.

2) Determine the water temperatures inhabited by walleye throughout the summer, with special emphasis during peak summer temperatures.

3) Identify any thermal refugia used by walleye and determine the necessity for adapting fisheries management to climate warming.

PERFORMANCE ON SCHEDULED ACTIVITIES:

Objective 1: This study is beginning to understand temporal variability in the thermal regime of the Lower Wisconsin River. Thirteen temperature data loggers were deployed in the Lower Wisconsin and 3 of its coolwater tributaries where it is hypothesized that walleye could seek thermal refuge under stressfully warm water conditions. Summer maximum and mean water temperatures will be calculated at all locations in multiple years. In addition, the USGS flow and temperature gages on the Wisconsin River at Muscoda, WI (river mile 45) and Wisconsin Dells, WI (RM 137) yield an annual picture of hydrography and temperature.

Objective 2: 42 Walleye were implanted with radio tags; 32 tags transmit a temperature signal and the other 10 tags archive temperature data. Tracking was conducted at least bi-weekly during summer, and weekly under the hottest conditions. Location, water temperature, habitat, and dissolved oxygen were collected at each fish location and the data will be entered for analyses.

Objective 3: Preliminary data suggest that the bulk of walleye tend to remain within the first 5km of the dam at Prairie du Sac (RM 92), the upper extent of the Lower Wisconsin River, despite nightly DO sags <3 mg/l. Perhaps this area is in greatest need for resource management, particularly improved water quality. It appears that 5 locations downstream may provide thermal refugia, but several of these locations have the risk of becoming isolated as the river stage drops and stranding fish in very poor physicochemical conditions.

Habitat Use of Sub-Adult Lake Sturgeon in the Lower Wolf River, Wisconsin

Principal Investigators: Daniel Isermann Dan.Isermann@uwsp.edu, Ryan Koenigs Ryan.Koenigs@Wisconsin.gov (WDNR), Ron Bruch (WDNR)
Graduate Student: Zachary Snobl Zachary.R.Snobl@uwsp.edu

Project Start Date: August 1, 2014 Expected Completion Date: July 31, 2016

Project Summary:
Little is known regarding habitat use of sub-adult lake sturgeon in riverine portions of the Lake Winnebago system located in central Wisconsin. Understanding habitat use by sub-adult fish will improve lake sturgeon assessment by allowing biologists to better evaluate recruitment dynamics and identify critical habitat. Characterizing habitat and substrate in aquatic environments using traditional transect-based methods can be difficult, time consuming, and expensive. However, the availability of small, portable, and inexpensive side-scan sonar devices now offers a more efficient means of mapping

physical habitat in aquatic systems. Our objective is to determine if sub-adult lake sturgeon selectively occupy certain habitats in the lower Wolf River based on substrate, depth, and presence of coarse woody debris. Habitat availability in the lower Wolf River will be mapped using side-scan sonar. Twelve sub-adult lake sturgeon were implanted with radio transmitters in fall of 2013. These fish will be located approximately every 2 weeks and habitat variables will be recorded at each location. Selectivity will be evaluated by comparing habitats occupied by fish to habitat availability assessed from side-scan images. In 2014, acoustic tags will be placed into age-0 lake sturgeon to determine movements of these fish.

Oral presentations from this project:

Snobl, Z., R. Koenigs, D. Isermann, B. Sloss, R. Bruch, and J. Raabe. 2014. Using side-scan sonar to assess habitat use of sub-adult lake sturgeon in the Wolf River, Wisconsin. Symposium: Practical applications of sturgeon research, 144th Annual Meeting of the American Fisheries Society, Quebec City, Canada.

Population Characteristics and Movements of Smallmouth Bass in the Menominee River

Principal Investigators: Daniel Isermann Dan.Isermann@uwsp.edu and Michael Donofrio michael.donofrio@wisconsin.gov
Graduate Student: Joshua Schulze Joshua.C.Schulze@uwsp.edu

Project Start Date: May 1, 2014 Expected Completion Date: July 1, 2017

Project Summary:
The Menominee River supports popular, high-quality fisheries for smallmouth bass that attract anglers from all over North America and the popularity of these fisheries has increased, leading to increased fishing effort. Maintaining these fisheries is an important goal of the Wisconsin and Michigan Departments of Natural Resources, but little information is available to help guide management decisions as both agencies do not routinely conduct sampling that specifically targets bass. More information is needed to determine if current management strategies are appropriate for maintaining the quality of these fisheries in the future. To address this need, the Wisconsin Cooperative Fishery Research Unit (WCFRU) at the University of Wisconsin-Stevens Point and the Wisconsin DNR are tagging fish in portions of the Menominee River in order to estimate abundance and survival. This year, tagging occurred in the stretch of river between Grand Rapids and Park Mill dams. Bass will have one or two numbered yellow tags inserted behind their dorsal fin. Anglers that catch a tagged bass are asked to report their catch by phone (715-346-2178) or by visiting www.uwsp.edu/smallmouth. Anglers will be asked to provide a general location of where the fish was captured, the length of the fish, four digit tag number(s), and whether or not the fish was harvested or released. Anglers reporting tags are eligible for cash and other prizes that will be awarded by the Wisconsin Smallmouth Alliance in January of 2015. We hope to conduct tagging on

other portions of the river over the next several years. Additionally, during spring of 2014 WCFRU and the Wisconsin DNR surgically implanted acoustic tags into 30 smallmouth bass. These tags will allow us to monitor the movements of smallmouth bass in the Menominee River. Specifically, previous studies have shown that smallmouth bass in riverine systems move towards deeper water during fall where they spend the winter period. During this fall-winter period, smallmouth bass could occupy relatively small areas making them potentially more vulnerable to anglers. Recently, a few anglers and guides have observed harvest of smallmouth bass occurring during fall and they have voiced concern over this issue. Our objectives are to determine if: 1) smallmouth bass freely move among river sections within an impoundment; 2) smallmouth bass occupy relatively small overlapping home ranges during fall and winter periods and 3) more stringent harvest regulations are predicted to improve the number of smallmouth bass ≥ 16 inches total length (TL).

Oral presentations from this project:
Schulze, J., D. Isermann, and M. Donofrio. 2014. Population characteristics and movements of smallmouth bass in the Menominee River. Annual Meeting of the Walleye, Centrarchid, and Esocid Technical Committees, North Central Division AFS, La Crosse, Wisconsin.

Evaluation of Car Counters and Trail Cameras for Estimating Angler Effort on Wisconsin Lakes and Streams

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Project Start Date: May 1, 2009 Expected Completion Date: TBD
Project Summary:
Angler effort is often estimated using creel surveys; yet creel surveys are rarely conducted because of their high cost, thereby preventing fisheries managers from obtaining estimates of angler effort. Additionally, alternative methods could provide better estimates of angler effort than traditional creel survey designs. Over the past several years, we have been assessing TRAFx ® Vehicle Counters buried at Wisconsin boat ramps as alternative means of estimating angler effort. Initial results from Escanaba Lake (where angler effort is known due to a compulsory creel census) suggests that the car counters provide indices of effort that are significantly correlated to observed measures of effort (see Figure 1 below). Last year we buried counters at three northern Wisconsin lakes where creel surveys were conducted and we now have counters deployed at one Lake Superior access point where creel clerks use interval counts to estimate effort. We will also deploy trail cameras at boat ramps this year to help validate car counter data and determine their effectiveness as a means to estimate effort when compared to creel survey-based estimates. Car counters will also be

deployed on lakes where changes in panfish harvest regulations are expected to determine if changes in regulations affect angler use patterns.

Poster presentations from this project:

Boehm, H., D. A. Isermann, and J. Myers. 2014. Use of Car Counters to Monitor Use of a Boat Launch on Lake Superior. Annual Meeting of the Wisconsin Chapter of the American Fisheries Society, Green Bay, Wisconsin.

Breeggemann, J., D. Isermann, and S. Newman. 2009. Use of remote vehicle counters to estimate angler effort. 70th Midwest Fish and Wildlife Conference and the 39th Annual Meeting, Wisconsin Chapter of the American Fisheries Society.

Movements of Lake Sturgeon after Upstream Passage above Two Dams on the Menominee River

Principal Investigators: Daniel Isermann Dan.Isermann@uwsp.edu, Michael Donofrio michael.donofrio@wisconsin.gov, Steve Cooke (Carleton College), Ed Baker (Michigan DNR), Rob Elliott (USFWS)

Graduate Student: Josh Schulze Joshua.C.Schulze@uwsp.edu

Project Start Date: September 1, 2014 Expected Completion Date: December 31, 2016

Project Summary:

Currently, hydroelectric dams prevent lake sturgeon entering the lower Menominee River from Green Bay from reaching high-quality spawning locations and juvenile fish habitat available upstream. Fish passage through the lower two dams on the Menominee River is targeted to begin in 2014 and fishery managers with the Wisconsin and Michigan Departments of Natural Resources (DNR) will need to determine the numbers and characteristics of lake sturgeon that should be allowed to pass in order to maximize recruitment potential and the return of fish back downstream. Our proposed research will use acoustic telemetry to describe movement of lake sturgeon passed upstream in the Menominee River and will provide fishery managers around the Great Lakes with information that can be used to formulate passage strategies and possibly help design passage facilities for lake sturgeon. Our research objectives are to determine: 1) if adult lake sturgeon passed upstream return downstream to the lower Menominee River or Green Bay within 1 or 2 years of passage; 2) if adult lake sturgeon have the opportunity to spawn at least once above Park Mill Dam within 1-2 years after passage; 3) if spawning opportunity, downstream return rates, and use of the downstream fishway at Park Mill Dam are related to timing of passage, time elapsed since passage occurred, month of year, flow or temperature conditions, or in relation to fish attributes such as sex, length, and maturation status and 4) if the number, length, and sex of fish passed upstream and timing of passage can be manipulated to maximize the number of eggs deposited above Park Mill dam by fish that were passed upstream.

Predicted Effects of Exploitation and Harvest Regulations on Lake Sturgeon Recruitment Potential in the Multiple Sections of the Menominee River

Principal Investigators: Daniel Isermann Dan.Isermann@uwsp.edu, Michael Donofrio michael.donofrio@wisconsin.gov (WDNR), and Ed Baker (Michigan DNR)

Project Start Date: February 1, 2012 Expected Completion Date: December 31, 2014

Project Summary:

Overharvest is a persistent concern for lake sturgeon Acipenser fulvescens stocks that support recreational fisheries. Consequently, selecting harvest regulations for these fisheries is an important process for fishery managers. The Menominee River that borders the states of Wisconsin and Michigan currently supports some of the largest stocks of lake sturgeon associated with Lake Michigan and some of these stocks have supported hook-and-line fisheries for decades. Fishery managers are uncertain as to how angler harvest and changes in harvest regulations affect the sustainability of these lake sturgeon stocks. Our objectives were to use current biological information regarding the lake sturgeon stock in the White Rapids section of the Menominee River to: 1) determine the potential effects of exploitation and minimum

length limits on lake sturgeon recruitment potential and 2) determine if historic levels of exploitation reduced lake sturgeon recruitment potential within this section of river. To address these objectives we conducted two electrofishing surveys during 2012 that were used to estimate the abundance and age structure of lake sturgeon and we used static spawning potential ratios (SPRs) to simulate the effect of exploitation and length limits on recruitment potential. Our results suggest that minimum length limits ≥ 50 inches total length (TL) can be used to prevent overfishing of lake sturgeon in the White Rapids section by maintain static spawning potential ratios (SPRs) ≥ 50%, but overfishing is more likely to occur at length limits ≤ 55 inches, even if relatively low numbers of fish are harvested. Based on previous annual harvests of lake sturgeon, overexploitation of lake sturgeon likely occurred within this section of the river over the last decade, because in several years more than 25 fish ≥ 50 inches TL were removed, resulting in SPRs < 30%. The current 60-inch minimum length limit essentially results in a no-kill fishery for this section of the river; maintaining little to no harvest for another decade will be necessary to determine if the population is still recovering from previous episodes of overexploitation.

Oral Presentations from this project:

Isermann, D. A., M. Donofrio, and E. Baker. 2013. Evaluating harvest regulations for lake sturgeon in the Menominee River. Symposium: Practical Applications of Sturgeon

Research, 144th Annual Meeting of the American Fisheries Society, Quebec City, Canada.
Isermann, D. A., M. Donofrio, and E. Baker. 2013. Evaluating harvest regulations for lake sturgeon in the Menominee River. Wisconsin Lakes Convention, Green Bay, WI.
Isermann, D. A., M. Donofrio, and E. Baker. 2013. Evaluating harvest regulations for lake sturgeon in the Menominee River. Annual Meeting of the Wisconsin Chapter of the American Fisheries Society, Rothschild, WI.
Isermann, D. A., M. Donofrio, and E. Baker. 2012. Evaluating harvest regulations for lake sturgeon in the Menominee River. Great Lakes Sturgeon Coordination Meeting, Ste. Sault Marie, Michigan.

Use of a Portable Ultrasound to Determine Sex and Maturation Status of Lake Sturgeon in the White Rapids Section and Other Portions of the Menominee River

Principal Investigators: Daniel Isermann Dan.Isermann@uwsp.edu, Michael Donofrio michael.donofrio@wisconsin.gov (WDNR), and Ed Baker (Michigan DNR)

Project Start Date: May 1, 2013 Expected Completion Date: June 1, 2016

Project Summary:
The Menominee River currently supports some of the largest stocks of lake sturgeon associated with the Great Lakes, including the section of river between White Rapids and Grand Rapids dams (i.e., White Rapids section). Current management activities include sampling to determine the status of lake sturgeon in the White Rapids section of the river and to capture fish for collection of gametes that will be used in propagation. The inability of biologists to identify sex and maturation status in a nonlethal manner complicates lake sturgeon management and research activities that occur on this and other sections of the river. Specifically, biologists often guess at population sex ratios and they also encounter difficulty in selecting fish for collection of gametes used in propagation or for ongoing research regarding fish passage through or around hydroelectric facilities. Additionally, the potential effects of harvest regulations and future fish passage on lake sturgeon in the White Rapids section and other portions of the Menominee River requires estimates of population sex ratios and the maturation status of adult fish. Consequently, lake sturgeon management and research activities would be greatly enhanced if sex and maturation status can be more accurately determined. Portable ultrasound technology offers a rapid, non-invasive method that can be used to determine the sex and maturation status of several sturgeon species, including lake sturgeon. Our objective is to use a portable ultrasound to determine the sex and maturation status of lake sturgeon in order to improve lake sturgeon assessment, management, and research activities in the White Rapids section and other portions of the Menominee River. Specifically, we will combine the use of passive integrated transponder (PIT) technology with the ultrasound which will allow biologists to better determine population sex ratios and maturation history of individual lake

sturgeon. We will develop a reference guide to help biologists determine the sex and maturation status of lake sturgeon from ultrasound images.

Poster presentations from this project:

Isermann, D. A. 2014. Use of a portable ultrasound to determine sex of largemouth bass. Annual Meeting of the Wisconsin Chapter of the American Fisheries Society, Green Bay, Wisconsin.