AFFILIATED RESEARCHERS
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METHODS AND FINDINGS
MICHIGAN HABITAT IMPROVEMENT PROGRAM
PROJECT 01-022
AQUATIC TEMPERATURE MAPPING
OF THE AUSABLE RIVER FROM
MIO DAM TO 4001 BRIDGE

PREPARED FOR
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INTRODUCTION

To continue in providing for an effective fishery management program, the Michigan Department of Natural Resources Fisheries Division has identified a need for accurate mapping of cold-water habitat that exists throughout the summer season in certain sections of the AuSable and Manistee Rivers. The limited amounts of cold-water refugia during the warmer season can result in massive losses of "cold water" fish species (i.e. trout). The benefits of an otherwise effective fishery management program (i.e. fish plantings or placement of woody debris) can become jeopardized when a single critical habitat element, such as cold water habitat, becomes lacking.

Approximately 22.1 river miles of the AuSable River (424.4 acres), from the State launch approximately ¼ mile below the Mio Dam, to the 4001 Bridge crossing (Alcona and Oscoda Counties; Figure 1) was surveyed with a sub-meter accurate GPS, aquatic temperature recorder, and sonar equipment to develop a precise aquatic temperature and depth mapping of this riverine section. This project was conducted under a grant issued by the Michigan Department of Natural Resources under the Michigan Habitat Improvement Program.

The objective of this project was to delineate the cold-water habitat existing within the described section of river during the warmest season of the year. During the summer months, existing impoundments on a stream add significantly to the warming of downstream riverine temperatures, and thereby limiting the cold water habitat. On certain streams having several upstream impoundments, cold-water can become limited to a few isolated locations which are served by underground springs or well-shaded tributaries. Cold-water can become a critical element of fish habitat; a “refugia” necessary for the survival of many fishery species during durations of warm aquatic temperatures (i.e. at or above 70^0F) in the summer months.

This project provides resource managers a valuable mapping of a critical element of fish habitat, for use in quantifying existing conditions (baseline), future monitoring, and development of effective and appropriately focused management programs. Mapping of the cold-water refugia allows: 1) resource managers to know the location and extent of the critical habitat elements and thereby employ measures for its protection and enhancement; 2) resource managers to direct their management programs more efficiently; and will result in, 3) an increased survivability and numbers of cold water fish species in this section of the river.

In addition to the described mapping of the aquatic temperatures of the river, thousands of water depths were collected simultaneously and in conjunction with the GPS positions. This depth-position data was collected to provide the development of an accurate and complete contour mapping of the stream bed (stream bathymetry). Stream bathymetry is an important aspect of fish habitat, and serves the resource manager with a significantly greater understanding of the critical element of cold-water refugia when viewed in concert.

METHODS

During August and September of 2004, aquatic temperatures, water depths, and GPS positions were collected simultaneously utilizing computer hydrographic software, while transversing the defined section of the river.

Two vessels were used in order to effectively survey both the shallow and the deeper portions of the river. The thalweg and the centerline of the river were transversed on two separate "drifts" along a longitudinal-meandering course line in a 14 foot fiberglass rowboat (Figure 2). The rowboat contained onboard a *Trimble ProXRS*[tm] differential GPS for sub-meter real-time positioning, *YSI 6000* aquatic temperature sonde, *Horizon DS150* sonar, and a laptop computer with hydrographic and GIS softwares.

Figure 2.

From the rowboat, the *YSI 6000* temperature sonde was lowered into the stream directly below the GPS antenna, and collected over 35,800 aquatic temperature data points during the two longitudinal drifts of the defined section of the river. The sonar, also located directly below the GPS antenna collected over 29,800 depth data points during the two drifts. The temperature and depth data points were combined to simultaneously obtain GPS positions by means of hydrographic software contained on onboard laptop computer.

The banks of the river were surveyed on two separate “drifts” from a 8 foot kayak (Figure 3). The kayak contained onboard a *Trimble XRS*[tm] differential GPS for sub-meter real-time positioning, and a *YSI 6000* aquatic temperature sonde for recording aquatic temperatures. A trained technician “manned” the kayak and collected temperature and position data at shoreline points approximately every 150 feet along the river bank. The shoreline data points were not only needed to complete the river’s thermographics but also to develop a GIS mapping of the river banks. Temperature and location data were also collected at all noted tributaries during the drifts of the river banks in order to further complete the temperature regime of the river.

Figure 3.

The process of mapping the aquatic temperature regime throughout a section of river also requires data of the daily fluctuation of the aquatic temperatures throughout that section. Daily temperature fluctuation of the water temperatures were recorded with automatic temperature recording devices (*Tidbits*™) placed at the upper end, midpoint, and the lower end of the described section of river. Aquatic temperatures were recorded every hour to provide a "control" for correlating the daily fluctuations in riverine temperatures with the collected thermographic data. Temperature recorders were fastened with stainless steel bolts to the inside of concrete blocks (Figure 4) and then placed within deeper, flowing, and shaded areas of the river for several days.

Figure 4.

At the end of the survey period, data from the *Tidbit*s were downloaded and used to provide an accurate "temperature alignment" of the thermographic regime with that of the daily maximum temperature. The thermographic data was adjusted with respect to the collected *Tidbit* data (with the exception of the thermographic data collected at the tributaries) as to provide a depiction of river temperatures as they would occur during the warmest part of the diurnal cycle.

Aquatic temperature and depth data collected from this section of the river was compiled into thermographic and bathymetric "contours" using advanced computer software *(Trimble HydroPro™* and *AutoCAD™).* Temperatures were displayed in increments of 1^0F and depths were displayed in increments of 1 foot, in *.dwg* format, in US State Plane 1983 datum. A complete set of full format color drawings, and a complete set of electronic copies of the drawings are provided as part of the project.

As part of the project, color aerial photography of the entire section of river was conducted by a professional service at a scale of 1" = 500'. The photographs were digitized at high resolution for inclusion as "background layers" with the thermographic and bathymetric contour maps. The aerial photographs are important as they add a significant amount of information regarding this section of the river. The digitized aerial photography is available for insertion as "background layers" with the thermographic and bathymetric contours, upon request of the resource manager. The original set of aerial photographs as well as an electronic copy of the complete set are provided as part of the project.

Digital formats of the respective USGS quadrangles are also available for insertion as "background layers" with the thermographic and bathymetric contour maps. The USGS maps will serve to increase the amount of information and understanding of this section of river.

FINDINGS

This project resulting in findings indicating this section of the AuSable River is "fair" in providing critical cold-water habitat for adult cold-water fishery species during the warmers months of the summer season.

- The warmest aquatic temperatures seen during the investigation were 76.5^0F along the bank and 74.0^0F in the channel of the project section of the river. Both of these temperature were observed near the midway portion of the project section of river.

- Approximately 89.3% of the project section of the river was found to have aquatic temperatures at or above 70^0F[1] during the time of this investigation, leaving 45.31 acres of this stream section where aquatic temperatures remain below 70^0F.

- Approximately 90.6% of the project section of the river was found to be shallower than 3 foot in depth.

- Combining the two habitat parameters of aquatic temperature below 70^0F and water depths greater than 3 foot, approximately 0.7% (3.1 total acres) found over 111 separate locations of the 22.1 mile project section of the AuSable River provides water temperatures and water depths suitable for adult cold-water fishery species during the summer season.

- Approximately 62.3% of the project section of the river was found to have aquatic temperatures at or above 72^0F[1] during the time of this investigation, leaving 160.2 acres of this stream section where aquatic temperatures remain below 72^0F.

[1] The determination of the upper limit of aquatic temperature for cold-water freshwater fishery species (brown trout, brook trout, rainbow trout) varies somewhat from 69^0F to 72^0F within the scientific literature. A study published by Ichthyological Associates in 1991 under contract with Consumer Power reported temperature suitability for brown trout in the AuSable, Manistee, and Muskegon Rivers in accordance with a Michigan DNR modification of Bovee (1978) to be less than 70^0F for 90% of the occurrences. An assessment of the AuSable River Watershed by Michigan DNR (Sendick 1994) determined the upper temperature limit for brown trout and brook trout to be $<70^0$F. An assessment of the Manistee River Watershed by Michigan DNR (Rozich 1998) determined the upper temperature limit for brown trout and brook trout to be $<72^0$F.

- Combining the two habitat parameters of aquatic temperature below 72^0F and water depths greater than 3 foot, approximately 2.9% (12.3 total acres) of the 22.1 mile project section of the AuSable River provides water temperatures and water depths suitable for adult cold-water fishery species during the summer season.

COMPARISON OF FINDINGS FROM PREVIOUS STUDIES

This same project was conducted during the late summer of 2003 however, GPS problems rendered the positioning data unreliable. Comparisons can be made however, with some of the other data collected during 2003 and 2004.

These two years differed significantly.

- The year 2003 was the 3rd year in a 3 year drought with above normal temperatures and below normal rainfall.
- Whereas 2004 averaged 3 to 5 degrees (air temperatures ^{0}F) cooler than "normal" during May, July, and August and exceeded normal monthly rainfall by 1 to 2 inches for April and May.

Flows measured at the USGS gage station in the AuSable River below Mio Dam varied significantly in 2003 and 2004 during the period of our studies.

- During August of 2003, the average flow at the gage was 709 cfs.
- During August of 2004, the average flow at the gage was 769 cfs.
- These different flow regimes seem consistent with the weather conditions for the two different years.

The maximum water temperatures during August, were 1.5^0F greater in 2003 than 2004.

- The highest water temperatures recorded during August of 2003 were at the McKinley Tidbit and were 74.6^0F (13 August 2003).
- The highest water temperatures recorded during August of 2004 were also at the McKinley Tidbit and were 73.1^0F (4 August 2003).

The difference in average water temperatures at the McKinley Tidbit station during August, was 4.1^0F greater in 2003 than 2004.

- The average temperature for August 2003 at the Tidbit station was 68.6^0F
- The average temperature for August 2004 at the Tidbit station was 64.5^0F

A summary of this comparison of August 2003 and August 2004 with regards to the effects of weather conditions and flow regime on the water temperatures in the AuSable River, shows that:

- a decrease from normal daily average air temperatures by 3 – 5 degrees (F) and,
- an increase in average flows by 60 cfs,
- can decrease maximum water temperatures by 1.5^0F, and
- can decrease average water temperatures 4.1^0F.