Literature Review:

'Temperature is the most critical habitat factor'

Where can I find out more?

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The Vermillion River Watershed encompasses an area of approximately 335 square miles, including portions of two counties and all or portions of 20 cities, towns, and townships. The main stem of the river begins in southeastern Scott County in New Market Township flowing east through central Dakota County, passing over a waterfall in the City of Hastings, and then discharging to the Mississippi River both through a northerly flowing outlet near the City of Hastings as well as through a southerly flowing outlet near the City of Red Wing, Minnesota.

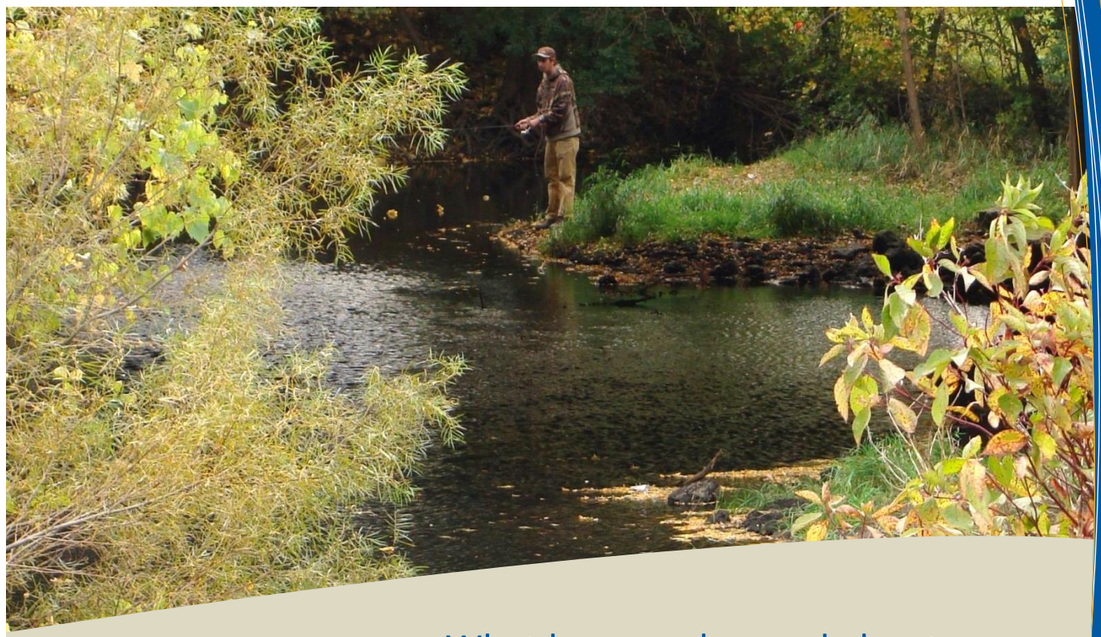
Last Update: 5/2017

How can we preserve the cold-water fishery in the Vermillion River?

Here are some ideas.

- **Manage stormwater runoff.** Pavement, commercial roofs, and bare soil send the most heat to our waters. Permeable pavement, raingardens, vegetated ponds, and practices that allow runoff to infiltrate are great cooling strategies.
- **Recharge the groundwater.** In addition to preventing fast infusions of heat, infiltration practices also recharge the groundwater. Groundwater is a major cooling force in the Vermillion River Watershed trout streams.
- **Conserve water.** It is also important for residential, agricultural, or industrial groundwater users to conserve water. Strategies include using less water for lawn irrigation, planting drought-tolerant native species, installing a rain barrel to contain and use runoff, or use of moisture sensors to detect if irrigation is needed. These efforts ensure that a supply of cool groundwater maintains trout-friendly stream temperatures.
- **Use Low Impact Development (LID) strategies.** We have evaluated LID practices implemented at sites near the river, streams, or lakes for heat contributions. Sites with LID practices had almost no negative impact on stream temperatures. Consult Dakota or Scott County Soil and Water Conservation Districts (SWCDs) to learn more about LID practices.
- **Continue monitoring stream temperature.** A network of sensors throughout the watershed measures (among other pollutants) stream temperature. This helps to identify what stream reaches may be warming.
- **Implement biomonitoring.** The VRWJPO monitors fish and insect populations during summer months. The abundance and diversity of fish, insects, and wildlife is a clear indicator of the river's health.

Trout Habitat
Temperature
Fact Sheet



When summer stream temperatures climb above 64 degrees F, brown trout become stressed, struggling to grow and reproduce. At sustained average stream temperatures above 73 degrees F, trout begin to die.

The Vermillion River's temperature can reach that threshold each summer. Even still, the trout population survives and expands into new stream reaches.

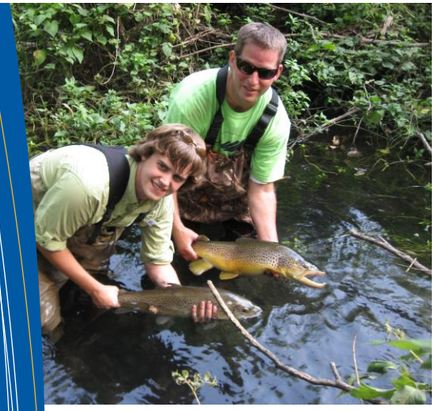
How do Vermillion River trout continue to thrive? What can we do to ensure that the temperatures stay cool?

What have we learned about stream temperature and trout?

The Vermillion River Watershed Joint Powers Organization (VRWJPO) conducted a scientific review and series of demonstration projects to determine if warm stormwater adversely affects the health of the Vermillion River Watershed's 49 miles of designated trout streams.

The Vermillion River Watershed is the largest in the Twin Cities metropolitan area, consisting of 335 square miles in central Dakota County and southeast Scott County, Minnesota. The Vermillion River is a slow-flowing river, moving through farm fields, pasture land, and suburban areas. Rapid development pressures during the last 25 years have changed the landscape, land use, and health of the river system.

The Vermillion River is impaired for many uses because of turbidity (cloudy water); bacteria; low dissolved oxygen; and toxic substances, such as mercury and PCBs. It has not been designated as impaired for temperature, and the VRWJPO continues to work to prevent the river from becoming impaired because of temperature.



Why do we want to keep stream temperatures cool?

Data shows that the Vermillion River trout streams are at risk of warming to levels that would affect trout populations. Temperature is one important factor affecting the growth of trout, especially in areas where seasonal air temperature and rainfall vary throughout the year. Most scientists classify the brown trout's (*Salmo trutta L.*) reactions to temperature in one of four ways:

- Preference range: brown trout experience little or no temperature stress.
- Tolerance range: brown trout begin to experience stress.
- Resistance range: brown trout resist moving into an area because stress is too great.
- Instantaneous mortality: brown trout mortality occurs from brief exposure.

Data collected indicate that temperatures exceed the tolerance range at several locations in the trout streams for short periods of time during summer months.

How does temperature affect trout growth?

Brown trout need oxygen to grow and thrive, and when water temperature increases, dissolved oxygen in the water decreases.

Increasing surface water runoff and variation in stream flow have impacts on trout health. Effects can include temperature stress, reduction of dissolved oxygen, decreased survival in early life stages, and habitat alteration.

Where is the heat coming from?

In rapidly developing watersheds (such as the Vermillion River Watershed), farmland, forests and prairies are giving way to pavement and rooftops. Commercial (flat) roofs, concrete, asphalt, and bare soil; all surfaces that are mostly impervious (i.e., do not allow stormwater to soak into soil) deliver the most heat to the rivers during storm events. To ensure that existing and future developments do not carry too much heat to the trout streams, the VRWJPO finds cost-effective best management practices (BMPs) that address water temperature.

What are potential BMPs?

Several BMPs were analyzed to answer questions on trout mortality and growth in order to model, implement, and measure the impacts of thermal reduction stormwater BMPs at sites within the upper Vermillion River Watershed, thereby identifying cost-effective methods of maintaining or reducing temperature in trout stream reaches including:

- Bioretention or Rain Garden
- Bioswales
- Bottom Draw Pond Outlet
- Grass channel
- Pond Bench Filters
- Pond Shading
- Rock crib

Where were the BMPs installed?

The demonstration sites chosen to test stream cooling were located in the upper Vermillion River Watershed within 1,000 feet of the Vermillion River or its tributaries. All facilities were publicly owned facilities and had the potential to contribute a thermal load. Each site was able to be monitored for "before" and "after" temperature information.

Demonstration sites were in:

- Empire Township
- Farmington
- Lakeville
- Vermillion Township

What did the demonstrations show?

Temperature reduction was shown at all demonstrations sites except the pond bench filter trial. Sizable reductions were shown with the rain gardens, ponds with shading, and bottom draw pond outlets.

Are there any recommendations?

Many aspects of the physical environment affect stream temperature, and many of these are beyond the VRWJPO's control, such as climate and weather. Further studies on strategies to reduce stream temperatures are warranted. However, the studies on the Vermillion River conducted to date give the VRWJPO sufficient information to assist with management decisions within the watershed. Among some of the most important:

- The VRWJPO's Runoff Volume Control Standard should be sufficient to prevent heat loading to the Vermillion River from new development. Practices that infiltrate stormwater, like rain gardens, are critical to limiting temperature increases.
- Shade reduces runoff temperatures and protects the river from the hottest conditions.
- Bottom draw pond outlets discharge water from the bottom of the pond which has shown to be much cooler than surface pond water which is typically discharged and could be designed in development planning phases.

What if I have a project idea?

The VRWJPO invests in capital improvement projects that protect or improve water resources and will lead implementation efforts to accomplish specific projects in the Watershed Plan.

The VRWJPO also partners with stakeholders to implement projects of mutual interest and watershed-wide benefits. Projects that restore or protect the watershed's natural resources are eligible for VRWJPO funding, with a maximum potential VRWJPO contribution of $250,000.

Stewardship Grant applications are also available year-round for projects that educate and engage people in protecting or improving water quality and natural resources. The maximum grant is $5,000.

Information on both funding opportunities is available on the VRWJPO website under Get Involved.

In addition, Scott Soil and Water Conservation District and Dakota County Soil and Water Conversation District offer technical assistance and funding assistance for native plantings, shoreline stabilization, and rain gardens.

Rain Garden

Do trout move to avoid temperature increases?

Investigators found that brown trout in the Vermillion River move when temperatures exceed 68 degrees F. They move to areas where banks are undercut and vegetation overhangs the water, pools where cool groundwater seepage maintains the temperature, and deep pools that stay cool despite adjacent water temperature increases. Circumstances that can prevent brown trout from escaping high water temperatures include low water levels, surges of heated stormwater, predators (such as herons), or chronic temperature stress that leaves the trout with insufficient energy to move to a cooler spot.