USGS
science for a changing world

Prepared in cooperation with Snohomish County Public Works

Thermal Profiles for Selected River Reaches in the Stillaguamish River Basin, Washington, August 2011

Data Series 654

U.S. Department of the Interior
U.S. Geological Survey

Thermal Profiles for Selected River Reaches in the Stillaguamish River Basin, Washington, August 2011

By Andrew S. Gendaszek

Prepared in cooperation with Snohomish County Public Works

Data Series 654

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

U.S. Geological Survey, Reston, Virginia: 2011

Suggested citation:
Gendaszek, A.S., 2011, Thermal profiles for selected river reaches in the Stillaguamish River basin, Washington, August 2011: U.S. Geological Survey Data Series 654, 4 p.

Contents

Figures

Tables

Conversion Factors and Datum

Conversion Factors

Multiply	By	To obtain
mile (mi)	1.609	kilometer (km)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F=(1.8 \times °C)+32.$$

Datum

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Thermal Profiles for Selected River Reaches in the Stillaguamish River Basin, Washington, August 2011

By Andrew S. Gendaszek

Abstract

Longitudinal profiles of near-streambed temperature were collected for eight river reaches in the Stillaguamish River basin, Washington, during August 2011, to provide information about areas of groundwater discharge to streams. During summer, groundwater discharge can be a source of cold water to streams that regulates warm stream temperatures creating cold-water thermal refugia for native stream biota including salmon and trout. To assess areas of groundwater discharge to streams, temperature was measured using a probe with an internal datalogger towed behind a watercraft moving downstream at ambient stream velocity. The data were referenced to location, concurrently surveyed with a Global Positioning System, during collection of the water temperature data. Data are presented as Microsoft Excel® files consisting of date and time, near-streambed water temperature, and latitude and longitude.

Introduction

Longitudinal profiles of near-streambed temperatures surveyed at ambient river velocity in a Lagrangian framework provide information about potential areas of groundwater discharge as well as salmonid habitat and thermal refugia (Vaccaro and Maloy, 2006). Longitudinal thermal profiles have previously been surveyed in several rivers in Washington, including the Yakima River and tributaries (Vaccaro and others, 2008) and the Nooksack River (Cox and others, 2005). This report presents eight thermal profiles within the Stillaguamish River basin including parts of the North Fork Stillaguamish River, South Fork Stillaguamish River, Jim Creek, and Pilchuck Creek (fig. 1). This data augments previous investigations of longitudinal temperature variations within the Stillaguamish River and tributaries by thermal infrared radar by the Washington State Department of Ecology (Watershed Sciences, 2002), and may be used as a tool to develop a better understanding of groundwater/surface-water interactions within the Stillaguamish River basin.

The purpose of this report is to present longitudinal thermal profiles of stream temperature of streams within the Stillaguamish River basin including the North Fork Stillaguamish River, the South Fork Stillaguamish River, Pilchuck Creek, and Jim Creek. This data may be used to determine zones of groundwater discharge and improve understanding of the relation between the groundwater and surface water systems of the Stillaguamish River basin.

Description of Study Area

The Stillaguamish River basin is in northwestern Washington and is bounded to the east by the Cascade Mountains, to the west by Puget Sound, to the north by the Skagit River basin, and to the south by the Snohomish River basin (fig. 1). The Stillaguamish River basin is characterized by cool, wet winters and warm, dry summers. Mean annual discharge of the North Fork Stillaguamish River (North Fork Stillaguamish River near Arlington, Washington, USGS gaging station 12167000) for water years 1929–2010 is 1,898 ft^3/s and mean annual discharge of the South Fork Stillaguamish River (South Fork Stillaguamish River near Granite Falls, Washington gaging station 12161000) for water years 1929–1980 is 1,071 ft^3/s. Jim Creek is a tributary of the South Fork Stillaguamish River and Pilchuck Creek is a tributary of the mainstem Stillaguamish River.

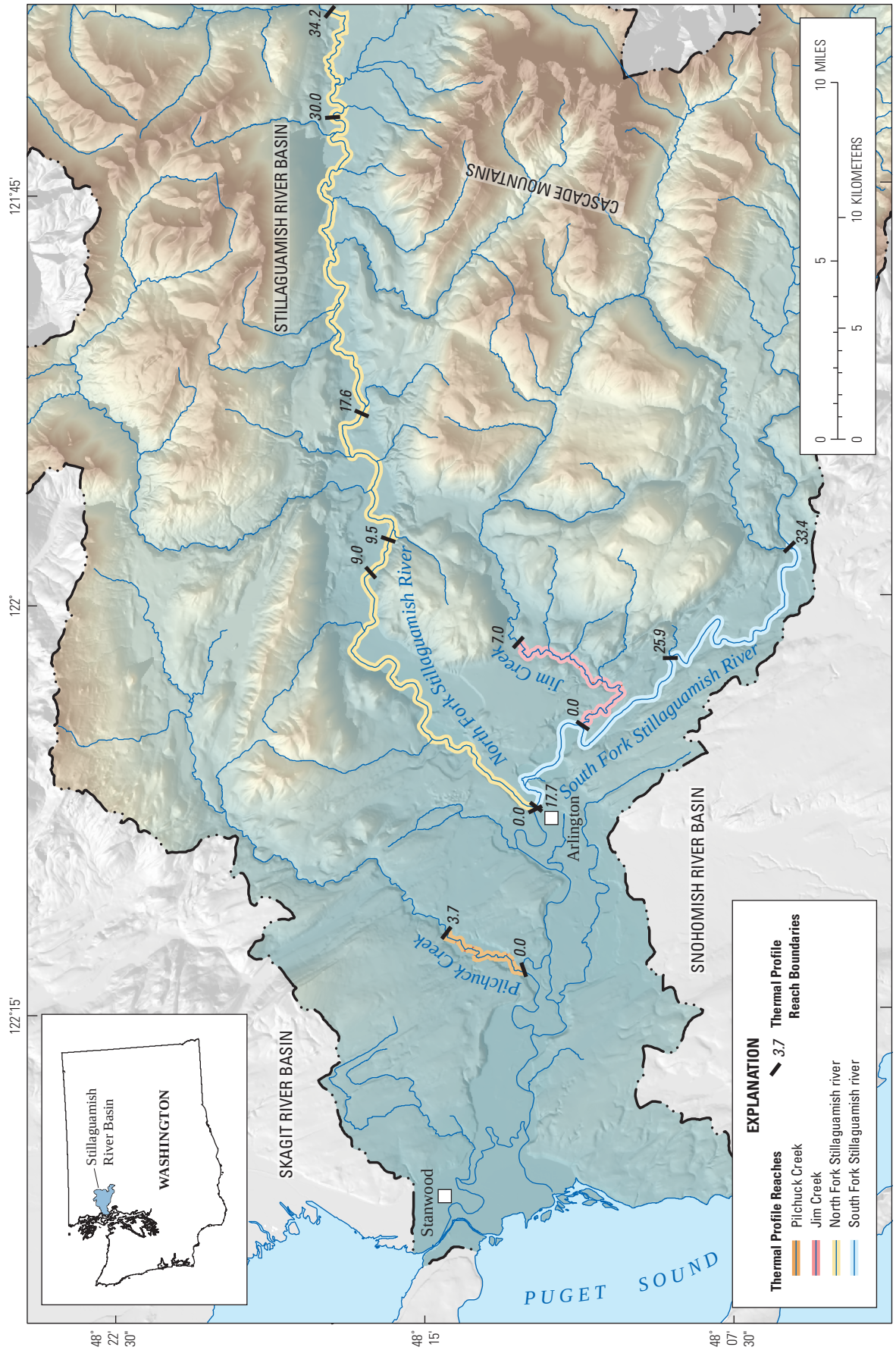

Figure 1. Location of the study area where stream water temperature profiles were measured on the North Fork and South Fork of the Stillaguamish River, Jim Creek, and Pilchuck Creek, Washington.

Thermal Profile Survey

Continuous water temperature and Global Positioning System (GPS) data were collected at 3-second intervals while drifting downstream at ambient stream velocity in a Lagrangian framework following the method of Vaccaro and Maloy (2006) for Pilchuck Creek between river mile (RM) 0.0 and 3.7 (table 1); the North Fork Stillaguamish River between RM 0.0 and 34.2 (tables 2–5); South Fork Stillaguamish River between RM 17.7 and 33.4 (tables 6–7); and Jim Creek between RM 0.0 and 7.0 (table 8). Profiling at ambient stream velocity in a Lagrangian framework tracks a parcel of water as it moves downstream during the day; departures from the diurnal heating cycle may be due to groundwater input, surface-water inflows, or riparian shading. Continuous temperature was measured using a Solinst® Levelogger LT temperature probe verified by a National Institute of Standards and Technology (NIST) certified thermistor and position data was measured using a Garmin® GPSmap® 60Csx for the eight surveys during August 15–26, 2011. The temperature probe was towed behind a watercraft following the stream thalweg and dragged along the streambed except when in-stream obstacles prevented probe movement downstream. The location of each temperature measurement was determined by relating the time stamp of the GPS data to the temperature data. If a GPS location was not recorded at the same time as a temperature measurement, the location of the temperature measurement was determined by linear interpolation of the two GPS known locations that bracket the time of the temperature measurement. A 0.5-mi gap exists between the beginning of the North Fork Stillaguamish datasets collected on August 18 (table 4) and August 22 (table 5) because of inadequate equilibration of the temperature probe to ambient stream temperature during the initial 0.5 mi of the August 22 survey.

Distribution of Information

A Microsoft Excel® file of tables 1–8 that include the thermal-profile data for each longitudinal thermal profile is available at http://pubs.usgs.gov/ds/654/.

Table 1. Temperature and Global Positioning System location data for the Pilchuck Creek (RM 0.0–3.7), August 15, 2011.

Table 2. Temperature and Global Positioning System location data for the North Fork Stillaguamish River (RM 30.0–34.2), August 16, 2011.

Table 3. Temperature and Global Positioning System location data for the North Fork Stillaguamish River (RM 17.6–30.0), August 17, 2011.

Table 4. Temperature and Global Positioning System location data for the North Fork Stillaguamish River (RM 9.5–17.6), August 18, 2011.

Table 5. Temperature and Global Positioning System location data for the North Fork Stillaguamish River (RM 0.0–9.0), August 22, 2011.

Table 6. Temperature and Global Positioning System location data for the South Fork Stillaguamish River (RM 25.9–33.4), August 24, 2011.

Table 7. Temperature and Global Positioning System location data for the South Fork Stillaguamish River (RM 17.7–25.9), August 26, 2011.

Table 8. Temperature and Global Positioning System location data for Jim Creek (RM 0.0–7.0), August 25, 2011.

Acknowledgments

This study was jointly funded by the U.S. Geological Survey and Snohomish County Public Works through a Washington State Department of Ecology Centennial Clean Water Program grant. The author would like to thank Frank Leonetti of Snohomish County Public Works for assistance in collecting thermal profile data.

References Cited

Cox, S.E., Simonds, F.W., Doremus, L., Huffman, R.L., and Defawe, R.M., 2005, Ground water/surface water interactions and quality of discharging ground water in streams of the lower Nooksack River Basin, Whatcom County, Washington: U.S. Geological Survey Scientific Investigations Report 2005-5255, 46 p.

Vaccaro, J.J., Keys, M.E., Julich, R.J., and Welch, W.B., 2008, Thermal profiles for selected river reaches in the Yakima River basin, Washington: U.S. Geological Survey Data Series 342. (Also available at http://pubs.usgs.gov/ds/342/.)

Vaccaro, J.J., and Maloy, K.J., 2006, A thermal profile method to identify potential ground-water discharge areas and preferred salmonid habitats for long river reaches: U.S. Geological Survey Scientific Investigations Report 2006-5136, 16 p.

Watershed Sciences, LLC, 2002, Aerial surveys in the Stillaguamish and Skagit River Basins—Thermal infrared and color videography: Corvallis, Oreg., Water Sciences, for Washington State Department of Ecology, 28 p.

This page intentionally left blank.

Publishing support provided by the U.S. Geological Survey
Publishing Network, Tacoma Publishing Service Center

For more information concerning the research in this report, contact the

Director, Washington Water Science Center
U.S. Geological Survey
934 Broadway, Suite 300
Tacoma, Washington 98402
http://wa.water.usgs.gov