



Southeast Alaska Network

Freshwater Water Quality Monitoring Program

2012 Annual Report

Natural Resource Technical Report NPS/SEAN/NRTR—2013/706



ON THE COVER

The Taiya River flows through Dyea and into Taiya Inlet, Klondike Gold Rush National Historical Park
Photograph by: Christopher J. Sergeant, Southeast Alaska Network, National Park Service

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Freshwater Water Quality Monitoring Program

2012 Annual Report

Natural Resource Technical Report NPS/SEAN/NRTR—2013/706

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Contents

	Page
Figures.....	v
Tables.....	vii
Appendices.....	vii
Executive Summary	ix
Acknowledgments.....	x
List of Acronyms and Abbreviations.....	x
Introduction.....	11
Study Areas.....	13
Salmon River (GLBA).....	13
Taiya River (KLGO).....	14
Indian River (SITK).....	15
Methods.....	17
Station instrumentation.....	17
Data processing.....	17
Results.....	19
Data collection	19
Comprehensive time series data	19
Salmon River	19
Temperature	19
Specific conductance, DO, and pH	20
Taiya River	22
Temperature	22
Turbidity	23

Contents (continued)

	Page
Specific conductance, DO, and pH	24
Indian River	24
Temperature	24
Specific conductance, DO, and pH	25
Compliance with water quality standards	25
Discussion	29
Salmon River	29
Taiya River	29
Indian River	29
Network-wide observations	29
Considerations	30
Literature Cited	31

Figures

	Page
Figure 1. SEAN park locations	12
Figure 2. Monitoring station on the Salmon River in GLBA	13
Figure 3. Monitoring station on the Taiya River in KLGO	14
Figure 4. Monitoring station on the Indian River in SITK	15
Figure 5. Daily mean water temperature for the Salmon River	20
Figure 6. Box plots of pH, dissolved oxygen (DO), and specific conductance for the Salmon, Taiya, and Indian Rivers.....	22
Figure 7. Daily mean water temperature for the Taiya River	23
Figure 8. Daily mean turbidity for the Taiya River	24
Figure 9. Daily mean water temperature for the Indian River	25
Figure 10. Hourly water quality data for the Salmon River.....	33
Figure 11. Hourly water quality data for the Taiya River.....	34
Figure 12. Hourly water quality data for the Indian River.....	35
Figure 13. Daily average streamflow versus daily averages for all water quality parameters in the Taiya River	37
Figure 14. Daily average streamflow versus daily averages for all water quality parameters in the Indian River.....	38

Tables

	Page
Table 1. Water quality sampling instruments.....	17
Table 2. 2012 freshwater water quality sampling effort.	17
Table 3. 2012 freshwater water quality data grades.....	19
Table 4. Monthly mean, minimum daily mean, and maximum daily mean water temperature	20
Table 5. Period of record and summary statistics for all water quality data	26
Table 6. Alaska Department of Environmental Conservation water quality standards	27

Appendices

	Page
Appendix A: Hourly time series data by river for all water quality parameters.....	33
Appendix B: Taiya River streamflow time series versus all water quality parameters	37
Appendix C: Indian River streamflow time series versus all water quality parameters	38

Executive Summary

Freshwater water quality is an indicator of aquatic and terrestrial ecosystem health and one of twelve priority Vital Signs monitored in the National Park Service's Southeast Alaska Network (SEAN). In 2012, hourly water temperature, specific conductance, dissolved oxygen, and pH data were collected in the Salmon River (Glacier Bay National Park and Preserve) from April 25 through October 31, and in the Indian River (Sitka National Historical Park) from April 30 through November 2. The same parameters plus turbidity were collected in the Taiya River (Klondike Gold Rush National Historical Park) from April 16 through November 19.

Annual reports are concise data summaries that establish a regular and timely product for park staff, managers, superintendents, and other interested parties. This third annual water quality report from the SEAN represents the continuation of a long-term, high resolution water quality dataset in Southeast Alaska National Parks. All annual reports and data products are available at the SEAN freshwater water quality website:

http://science.nature.nps.gov/im/units/sean/FQ_Main.aspx

The Salmon and Indian Rivers demonstrated seasonal temperature trends generally similar to 2010 and 2011. 2012 daily mean water temperature in the Salmon River ranged from 2.0 to 9.8°C, peaking on August 7, while daily mean water temperature in the Indian River ranged from 2.5 to 8.7°C and peaked on August 23. Summer daily mean water temperatures in both rivers were slightly cooler than in previous years. Patterns in the medians and distributions of specific conductance, dissolved oxygen, and pH for each river were similar to previous years for each river.

Due to the strong influence of glacial meltwater, the Taiya River had a lower median temperature than the mostly ground- and surface-water influenced Salmon and Indian Rivers. In 2012, daily mean water temperature ranged from 0.0 to 6.4°C, peaking on July 27. The ranges of seasonal values for specific conductance, dissolved oxygen, and pH were generally small. Turbidity ranged from 0 to 194 NTU and appeared synchronized with high flow events caused by heavy rain and glacial melt.

No observed values or trends signaled point source pollution or a change to the fundamental water quality of the Salmon, Taiya, or Indian Rivers. Throughout the monitoring period, all three rivers exhibited water quality conditions within expected natural ranges.

Acknowledgments

2012 was the most successful SEAN water quality monitoring season to-date. C. Murdoch, L. Skora, C. Smith, and J. Wilbarger deserve special thanks for efficiently conducting quality field work and transmitting data for processing. The SEAN Vital Signs program is supported by funding from the NPS National Inventory and Monitoring Program and the NPS Water Resources Division.

List of Acronyms and Abbreviations

°C	Degrees Celsius
cfs	Cubic feet per second
DO	Dissolved oxygen
GLBA	Glacier Bay National Park and Preserve
KLGO	Klondike Gold Rush National Historical Park
mg/L	milligrams per liter
mS/cm	Milli-Siemens per centimeter
NPS	National Park Service
NTU	Nephelometric Turbidity Units
SEAN	Southeast Alaska Network
SITK	Sitka National Historical Park
SOP	Standard Operating Procedure
USGS	United States Geological Survey

Introduction

Water quality is an indicator of aquatic and terrestrial ecosystem health in Southeast Alaska, a rainforest landscape dominated by a wet and mild maritime climate. The Southeast Alaska Network (SEAN; Figure 1) of the National Park Service (NPS) has prioritized Freshwater Water Quality as one of 12 Vital Signs for long-term ecological monitoring based on its vulnerability to alteration by human stressors and sensitivity for detecting fundamental environmental changes (Moynahan et al. 2008). Trends in water quality can signify chronic or developing watershed issues within national parks.

The SEAN water quality monitoring program has the following objectives:

- Track the status and trends of each core water quality parameter (specific conductance, dissolved oxygen, pH, and water temperature; plus turbidity in the Taiya River)
- Describe the timing and magnitude of seasonal and annual variation for each core water quality parameter
- Evaluate whether state and/or federal water quality standards are met or exceeded

The SEAN water quality monitoring protocol (Nagorski et al. 2012) includes an extended description of each water quality parameter (Sections 1.3-1.7). Briefly, specific conductance measures the ability of water to conduct an electrical current at a standardized temperature of 25°C, with higher values generally representing groundwater influence and lower values representing rain and snow runoff. Dissolved oxygen is a measure of the amount of microscopic oxygen bubbles in water and is essential for aquatic organism respiration. The pH of water is a unit-less measure of acidity or alkalinity and affects aquatic organism respiration, salt exchange, and many biogeochemical processes. Turbidity is a measure of water clarity.

This report concisely summarizes results from the 2012 sampling season and compares past data. After the completion of the 2014 field season, a five-year synthesis report will present more in-depth trend analyses and broadened discussion. Guidance for annual report formatting and analysis is described in Standard Operating Procedure (SOP) 10 of the water quality monitoring protocol (Nagorski et al. 2012).



Figure 1. SEAN park locations and surrounding lands.

Study Areas

The sampling goal of this monitoring program is to track water quality status and trends in at least one river in each of the three SEAN parks. In 2010, sondes were installed in the Salmon (GLBA) and Indian (SITK) Rivers. The Taiya River (KLGO) was added in 2011. Sampling sites were chosen based on individual park interest and dependable long-term site access. Until the SEAN freshwater water quality monitoring program began, no consistent or long-term data were available for these three rivers (Eckert *et al.* 2006a; Eckert *et al.* 2006b; Hood *et al.* 2006).

Salmon River (GLBA)

GLBA, the largest unit in SEAN, has more than 310 streams (Soiseth and Milner 1995) flowing for over 3,380 km through a diverse landscape. The Salmon River is 32.7 km long within an 11,552 ha watershed that collects most of its water from Excursion Ridge. The lowermost portion of the river (river km 0.0 to 9.0) is outside of NPS boundaries and within the town of Gustavus. The Salmon River has gravel riverbed habitat and supports populations of gamefish species such as pink salmon (*Oncorhynchus gorbuscha*), chum salmon (*O. keta*), coho salmon (*O. kisutch*), steelhead (*O. mykiss*), cutthroat trout (*O. clarkii*), and Dolly Varden (*Salvelinus malma*; Eckert *et al.* 2006a). Staghorn (*Leptocottus armatus*) and coastrange sculpin (*Cottus aleuticus*) have been documented in the river but not formally reported (C. Soiseth personal communication). Although there is no direct evidence from past data, due to septic system design and proximity, sewage input from Gustavus residents may affect Salmon River water quality downstream of the park boundary and sampling site. The water quality monitoring site is located on the river left bank at approximately river km 9.0 (Figure 2) several meters upstream of the NPS boundary.

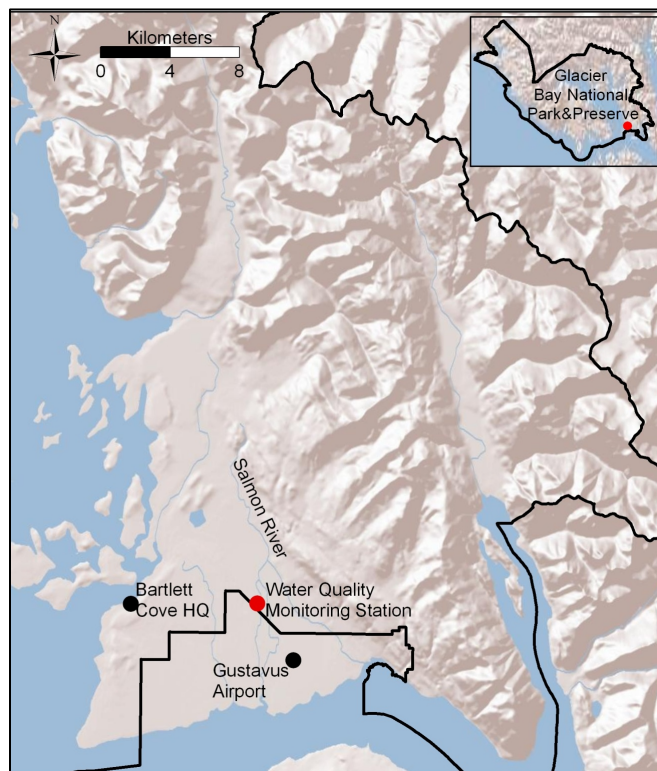


Figure 2. Monitoring station on the Salmon River in GLBA (red circle near S edge of map). The black line denotes park boundary.

Taiya River (KLGO)

The Taiya River, located west of Skagway and one of two major drainages within KLGO boundaries, is approximately 25.7 km long and drains a watershed of approximately 46,361 ha (Hood *et al.* 2006). The water quality monitoring site is located on the river left bank slightly downstream of the Taiya River Bridge (Figure 3) and adjacent to the USGS streamflow gaging site. From 1970 to 2012, the annual mean discharge from the Taiya has ranged from a minimum of $24.9 \text{ m}^3 \text{ s}^{-1}$ in 1973 (880 cfs) to $40.3 \text{ m}^3 \text{ s}^{-1}$ in 2004 (1,424 cfs). Peak flows typically occur in August and September (USGS website for Taiya River gage 15056210: http://waterdata.usgs.gov/nwis/nwisman/?site_no=15056210&agency_cd=USGS).

Skagway is notably drier than other Southeast Alaska communities, averaging 69 cm of precipitation per year, in comparison to 142 cm in Gustavus and 217 cm in Sitka and (Western Regional Climate Center Data: <http://www.wrcc.dri.edu/summary/Climsmak.html>). The glacial influence on the Taiya watershed is unique among streams currently monitored in the SEAN. As of the mid-1990s, approximately 33% of the watershed was covered by glaciers (Hood *et al.* 2006). Glacial outburst events have led to large flooding events and created a highly dynamic physical environment (Hood *et al.* 2006). The Taiya watershed supports chum, pink, and coho salmon populations, as well as Dolly Varden. Eulachon (*Thaleichthys pacificus*) have been reported to run up the Taiya River in the spring (Hood *et al.* 2006).



Figure 3. Monitoring station on the Taiya River in KLGO (red circle near SW corner of map). The green lines denote park boundaries (the park units are not contiguous).

Indian River (SITK)

The lowest 1 km of the Indian River is the only significant riverine habitat within the SITK boundary and can be characterized as a low gradient alluvial channel with gravel-cobble substrate that supports anadromous fish species, including coho, pink, chum, and Chinook salmon (*O. tshawytscha*), steelhead, Dolly Varden, and non-anadromous species such as resident rainbow trout (*O. mykiss*), three-spine stickleback (*Gasterosteus aculeatus*), and coastrange sculpin (Eckert et al. 2006b). The Indian River is approximately 19.8 km long within a steep and well-drained 3,185 ha watershed. The water quality monitoring site is located on the river right bank approximately 60 m upstream of park boundaries at river km 0.8 (Figure 4).

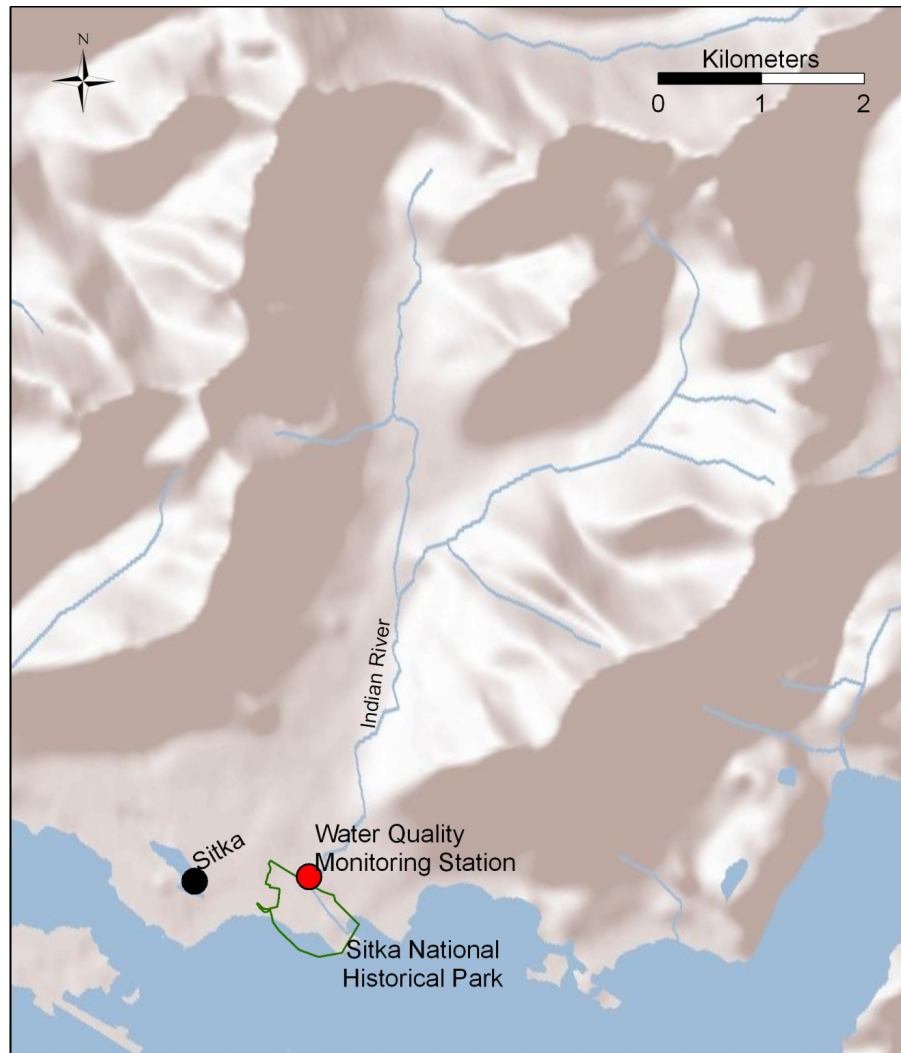


Figure 4. Monitoring station on the Indian River in SITK slightly upstream of park boundary (red circle near SW corner of map). The green line denotes park boundaries.

Methods

Station instrumentation

The Salmon, Taiya, and Indian Rivers were sampled hourly for specific conductance (mS/cm), dissolved oxygen (mg/L), pH, and water temperature (°C). Additionally, turbidity (NTU) was measured in the Taiya River. Multi-parameter water quality sondes (Table 1) collected and logged data at single fixed sites in the Salmon River from April 25 through October 31, the Taiya River from April 16 through November 19, and the Indian River from April 30 through November 2 (Figures 2-4; Table 2). Each year, sampling is planned to regularly occur from at least May 1 through October 31, possibly into November if ice conditions and staff resources allow.

Table 1. YSI, Inc. instruments used for 2012 water quality sampling.

Equipment description	Model number
Multi-parameter water quality logger	6920V2-2
Multi-parameter display system	650
Conductivity/temperature probe	6560
pH probe	6561
Optical oxygen sensor	6150
Optical turbidity sensor	6136

In all three rivers, a sonde was mounted inside a perforated 4-inch ABS pipe. In the Salmon River the pipe was attached to an angle-iron rod set in the streambed, while in the Taiya and Indian Rivers the pipe was bolted to a large boulder in the stream channel. A bolt mounted through the ABS pipe set the sonde height in the water column. When sondes were installed, Park Leads visited the sondes approximately once per month to check calibration for each sensor and clean components, as needed. These calibration checks were used to assess data quality and ensure that the water quality instruments were functioning properly.

Table 2. Summary of 2012 freshwater water quality sampling effort.

River	Month								Core parameters collected?
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	
Salmon									Y
Taiya									Y
Indian									Y

 Full month
 Partial month

Data processing

The protocol narrative and SOPs 1 through 3 describe the data collection, calibration checks, and data processing in detail (Nagorski et al. 2012). Except for one instance in 2012, park staff conducted calibration checks monthly at each water quality station within one week of the first day of each month from May through November. On the Taiya River, the November calibration

check did not occur until November 19 due to staffing limitations (the previous check occurred on October 1).

SEAN has established data “ratings” and “grades” to describe overall data quality. “Ratings” denote unusable data for reasons such as the sonde being out of water during a calibration check or a spurious value due to instrument error. Before analysis, data with a ‘2’ or ‘3’ quality rating were removed from the dataset. Data with ‘0’ (no question of accuracy) or ‘1’ (determined useable by Project Leader despite potential mistakes in precisely following protocols) quality ratings were used for analysis. SOP 13 of the water quality protocol (Nagorski et al. 2012) describes each data rating in detail. Comments contained in the water quality database are available on the SEAN website (http://science.nature.nps.gov/im/units/sean/FQ_Main.aspx) and contain justifications for each assigned rating other than zero.

Data “grades” refer to the point-in-time accuracy of each water quality sensor during regular calibration checks and range from ‘Poor’ to ‘Excellent’. The grades determined by these point checks were back-dated to the previous calibration check and applied to all data during that time period. SEAN does not correct (adjust) data values based on calibration checks (as described in Wagner et al. 2006), but sensor values from calibration checks are available by downloading field sheets from the SEAN website (linked above).

The final datasets were analyzed and summarized according to the guidelines in SOP 10 (Nagorski et al. 2012).

Results

Data collection

Minimal problems were encountered with data collection in all three rivers during the 2012 sampling season. In the Indian River from September 7 to October 3, dissolved oxygen, pH, and specific conductance data were removed from analyses due to sediment and salmon eggs clogging the sensor guard and sensors. These sediments were removed during the monthly site inspection in October.

Data grades could not be calculated for Salmon River pH from July 30 to September 5 and from October 4 to October 31 because protocol calibration check procedures were not followed. Despite these data grading gaps (Table 3), the reported pH values in this report from the Salmon River appear very reasonable and are supported by a calibration check on October 4 grading pH data as ‘Excellent.’ Turbidity quality grades for the Taiya River were generally poor but within acceptable standards. Turbidity values are best used for relative seasonal trends in water clarity and less appropriate as absolute individual measurements.

Table 3. Summary of 2012 freshwater water quality data grades. E = Excellent, G = Good, F = Fair, P = Poor. Definitions for each grade are found in SOP 2 (Nagorski et al. 2012) and are based on USGS recommendations (Wagner et al. 2006).

		Date ranges						
River	Parameter	4/25 - 6/1	6/1 - 7/5	7/5 - 7/30	7/30 - 9/5	9/5 - 10/4	10/4 - 10/31	
Salmon	Conductivity (mS/cm)	E	E	E	E	E	E	
	Dissolved Oxygen (mg/L)	E	E	E	E	E	E	
	pH	G	E	E		E		
	Temperature (°C)	E	E	F	G	G	G	
		Date ranges						
		4/16 - 5/4	5/4 - 6/4	6/4 - 7/3	7/3 - 8/1	8/1 - 9/6	9/6 - 10/1	10/1 - 11/19
Taiya	Conductivity (µS/cm)	E	F	G	E	G	G	G
	Dissolved Oxygen (mg/L)	E	G	E	E	E	E	E
	pH	E	E	E	E	E	E	E
	Turbidity (NTU)	P	P	P	F	P	P	P
	Temperature (°C)	E	F	P	G	G	G	F
		Date ranges						
		4/30 - 5/31	5/31 - 7/2	7/2 - 7/26	7/26 - 8/27	8/27 - 10/3	10/3 - 11/2	
Indian	Conductivity (µS/cm)	E	E	E	E	G	G	
	Dissolved Oxygen (mg/L)	E	E	E	E	E	E	
	pH	E	E	E	E	E	E	
	Temperature (°C)	E	G	G	G	E	F	

Comprehensive time series data

Hourly time series data for all water quality parameters in all three rivers are included in Appendix A. Daily average streamflow time series data from the Taiya and Indian Rivers are compared to daily average water quality data in Appendices B and C. Streamflow data was collected in the same location as water quality data. At this time, the Salmon River is not monitored for streamflow.

Salmon River

Temperature

The early season warming trend of 2012 Salmon River water temperatures was similar to the average of 2010 and 2011 seasons, but from June through August, temperatures remained cooler than average (Figure 5). In 2012, the daily mean water temperature in the Salmon River ranged from 2.0 to 9.8°C and

peaked on August 7 (2011 peak was July 23; 2010: August 6). Median daily mean water temperature during the monitoring period was 6.7°C. Monthly mean daily average temperatures ranged from 4.3 to 9.0°C (Table 4). October daily mean temperatures were quite variable, demonstrating a standard deviation 2 to 3 times higher than other months (sd = 1.9; Figure 5 and Table 4).

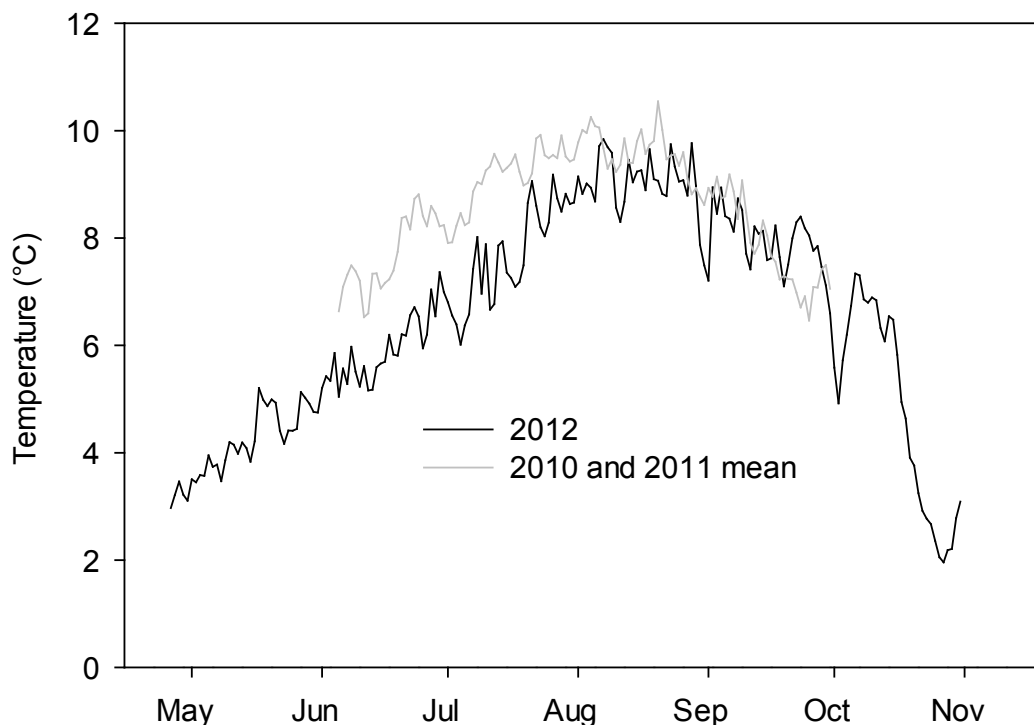


Figure 5. Daily mean water temperature for the Salmon River in 2012 and averaged across commonly measured dates in 2010 and 2011.

Table 4. Monthly mean, minimum daily mean, and maximum daily mean water temperature for the Salmon, Taiya, and Indian Rivers in 2012. See the methods section for sonde installation dates for each river.

Month	Salmon			Taiya			Indian		
	Mean daily average (SD)	Min	Max	Mean daily average (SD)	Min	Max	Mean daily average (SD)	Min	Max
May	4.3 (0.5)	3.5	5.2	4.3 (0.6)	3.3	5.9	4.6 (0.3)	4.1	5.3
June	5.9 (0.6)	5.0	7.4	4.8 (0.5)	3.8	5.7	5.5 (0.4)	4.9	6.6
July	7.7 (0.9)	6.0	9.2	5.5 (0.5)	4.6	6.4	6.9 (0.7)	5.8	8.4
August	9.0 (0.5)	7.5	9.8	5.7 (0.3)	5.2	6.3	7.6 (0.4)	7.1	8.7
September	8.0 (0.6)	6.6	8.9	5.4 (0.3)	4.8	6.1	7.3 (0.5)	6.3	8.3
October	4.8 (1.9)	2.0	7.3	4.0 (1.2)	0.8	5.6	5.1 (1.6)	2.5	7.5

Specific conductance, DO, and pH

The 2012 ranges for specific conductance, DO, and pH values in the Salmon River (Figure 6) were generally similar to 2011, although direct comparisons of the distributions are difficult due to differing sampling windows between years. In 2012, individual specific conductance measurements ranged from 0.04 to 0.40 mS/cm with a median of 0.18 mS/cm. DO ranged from 8.9 to 12.8 mg/L with a median of

10.6 mg/L. DO dropped slightly but steadily from May through August (most likely in response to warming water temperature) and reached the minimum observed value on August 22. In September and October DO was relatively steady but fluctuating around the mean (Appendix A; Figure 10). Values for pH ranged from 7.3 to 8.0 with a median of 7.8. Similar to previous years, pH values were relatively stable through mid-July but began demonstrating greater variation from mid-July through October.

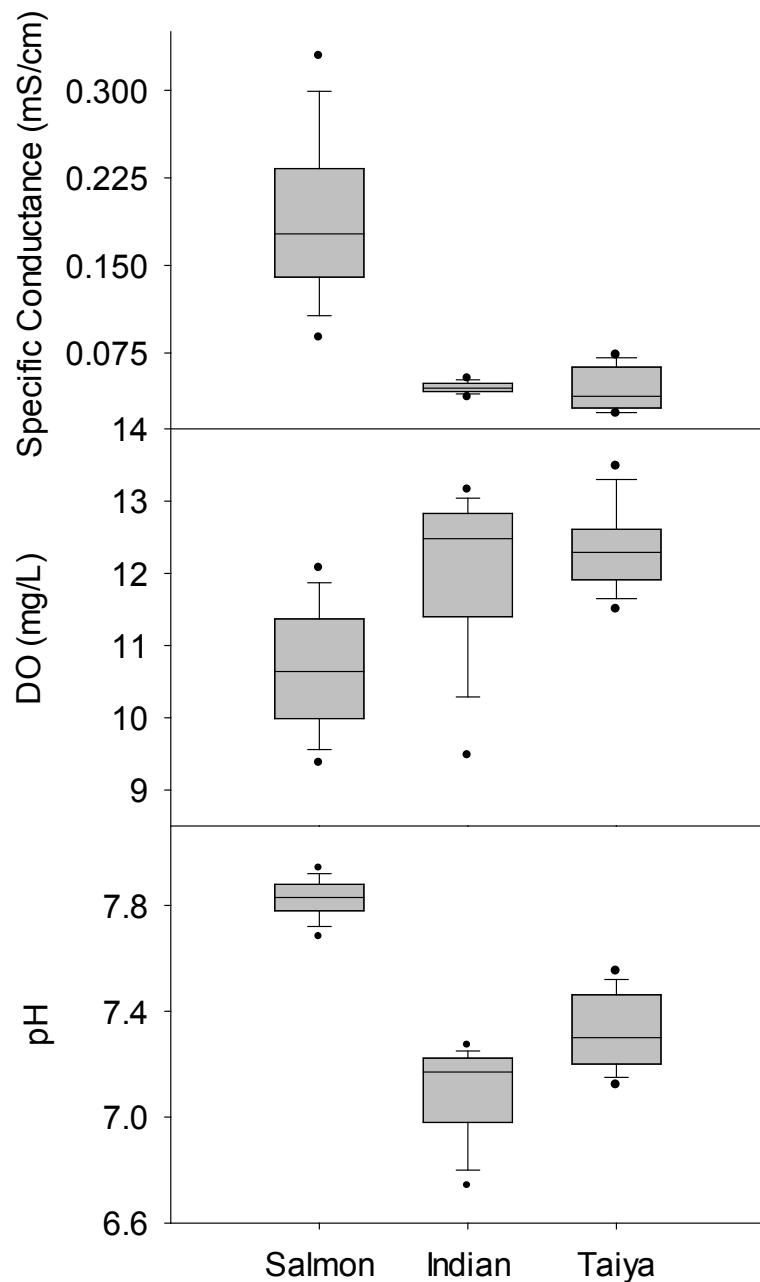


Figure 6. Box plots summarizing all valid measurements for pH, dissolved oxygen (DO), and specific conductance for the Salmon, Taiya, and Indian Rivers in 2012. The central horizontal line within each box indicates median values, horizontal lines bounding the upper and lower portion of the boxes represent 25th and 75th percentiles, lower and upper whiskers represent 10th and 90th percentiles, and single points represent 5th and 95th percentiles.

Taiya River

Temperature

From April through September, 2012 water temperature trends in the Taiya River were generally similar to 2011 (Figure 7). In October, water temperature began dropping much earlier than in 2011. Daily mean

water temperature during the monitoring period ranged from 0.0 to 6.4°C and peaked on July 27 (2011: July 13). Median daily mean temperature was 4.9°C. Monthly mean daily average temperatures ranged from 4.0 to 5.7°C. Like the Salmon River, October daily mean temperatures were quite variable, demonstrating a standard deviation 2 to 4 times higher than other months ($sd = 1.2$; Figure 7 and Table 4).

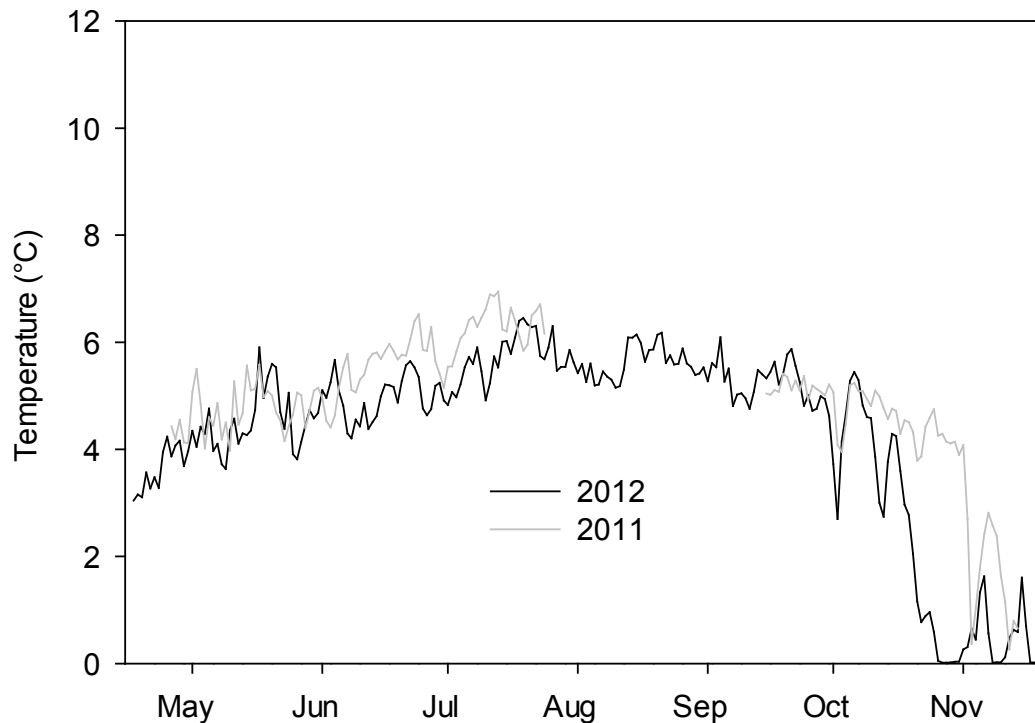


Figure 7. Daily mean water temperature for the Taiya River in 2012 and 2011 (no data collected in 2010).

Turbidity

In 2012, Taiya River hourly turbidity measurements ranged from 0 to 194 NTU during the sampling season, with the largest peak events occurring in spring and early summer (Figure 8). Turbidity remained low before mid-May and began dropping again and stabilizing after mid-October, when cooler temperatures began to moderate or prevent glacial melt. Turbidity events were reliably timed with high flow events (Appendix B; Figure 13).

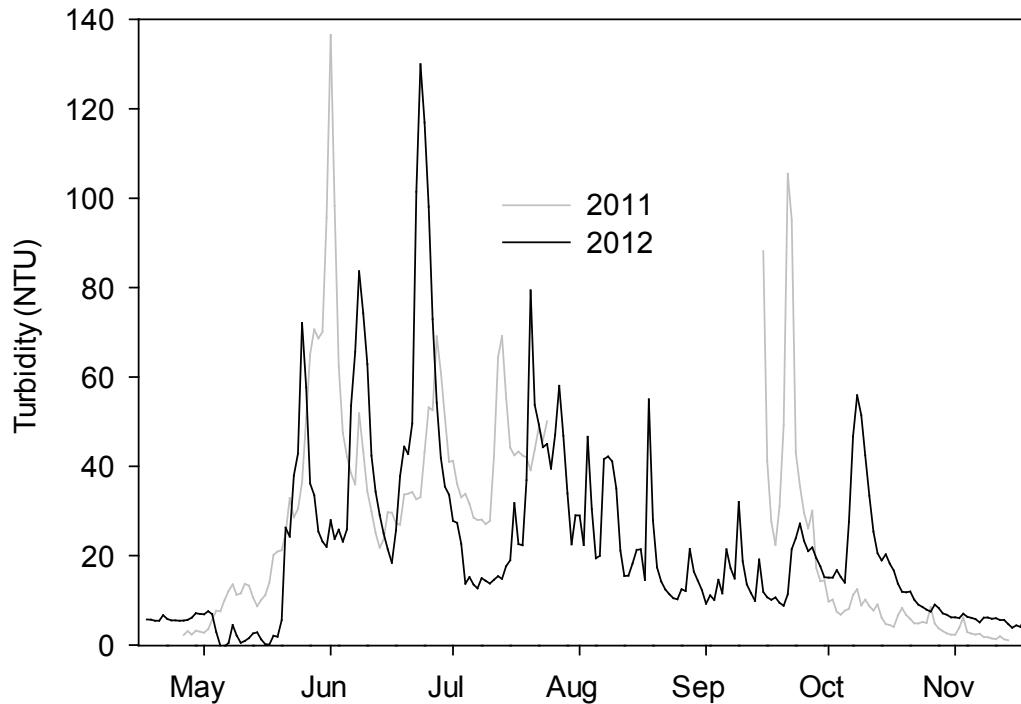


Figure 8. Daily mean turbidity for the Taiya River in 2012 and 2011 (no data collected in 2010).

Specific conductance, DO, and pH

In the Taiya River in 2012, individual specific conductance measurements ranged from 0.00 to 0.08 mS/cm with a median of 0.04 mS/cm. From May through August, specific conductance steadily dropped, while after mid-September, values began steadily rising. Unseasonably cold air temperatures in early October corresponded to a short-term but sharp drop in specific conductance (Appendix A; Figure 11). DO ranged from 10.7 to 14.1 mg/L with a median of 12.3 mg/L. Values for pH ranged from 7.0 to 7.6 with a median of 7.3.

Indian River Temperature

Like the Salmon River, the general warming trend of 2012 Indian River water temperatures was similar to the average of 2010 and 2011 seasons, but through August, temperatures remained cooler than average (Figure 9). In 2012, the daily mean water temperature in the Indian River ranged from 2.5 to 8.7°C and peaked on August 23 (2011: August 20; 2010: August 18). Median daily mean water temperature during the monitoring period was 6.3°C. Monthly mean daily average temperatures ranged from 2.5 to 7.1°C (Table 4). Like the Salmon and Taiya River, October daily mean temperatures in the Indian River were quite variable, demonstrating a standard deviation 2 to 4 times higher than other months (sd = 1.6; Figure 9 and Table 4).

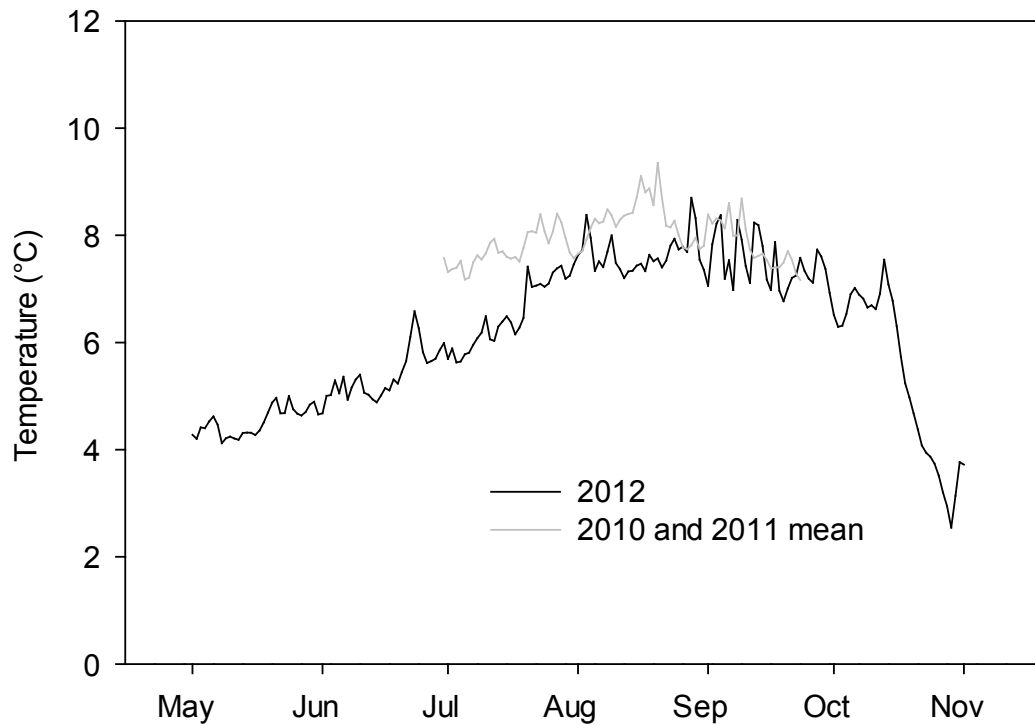


Figure 9. Daily mean water temperature for the Indian River in 2012 and averaged across commonly measured dates in 2010 and 2011.

Specific conductance, DO, and pH

Direct comparisons of specific conductance, DO, and pH values to past data in the Indian River are difficult due to differences in sampling windows, but the ranges of specific conductance and pH have remained relatively similar from 2010 through 2012. The distribution of DO measurements was slightly larger in 2012 than past years (Figure 6). In 2012, individual specific conductance measurements ranged from 0.03 to 0.06 mS/cm with a median of 0.05 mS/cm. DO ranged from 7.0 to 13.4 mg/L with a median of 12.5 mg/L. Values for pH ranged from 6.5 to 7.3 with a median of 7.2. Although the data have not been formally analyzed at the time of this report, the Indian River appeared to demonstrate drops in pH that coincided with precipitation events in 2012, a phenomenon that has been demonstrated in past years (Sergeant et al. 2012a, 2012b).

Compliance with water quality standards

Like the previous two years, 2012 observations (Table 5) do not indicate any chronic exceedances of Alaska Department of Environmental Conservation water quality standards (Table 6; ADEC 2012) and water quality values in the three rivers generally never approached regulatory thresholds. The Taiya River experiences occasional spikes in turbidity caused by the natural condition of glacial runoff conditions (Figure 8; Appendix B, Figure 13). No anthropogenic development exists in the drainage basin upstream of the monitoring station, and the primary human impact in the area involves hiking along the adjacent Chilkoot Trail.

Table 5. Period of record and summary statistics for all freshwater water quality data collected and reported by the SEAN from 2010 through 2012.

River	Parameter	Period of Record	Number of observations ¹	Summary statistics				
				Median	Mean	Standard deviation	Minimum	Maximum
Salmon	Conductivity (mS/cm)	Jun 04 2010 to Oct 31 2012	11,256	0.19	0.20	0.07	0.04	0.40
	Dissolved Oxygen (mg/L)		11,260	10.5	10.6	0.8	8.5	13.0
	Dissolved Oxygen (% Sat)		11,260	88.2	88.0	6.0	73.3	105.9
	pH		11,260	7.8	7.8	0.1	7.1	8.1
	Temperature (°C)		11,260	7.9	7.5	2.0	1.6	12.4
Taiya	Conductivity (mS/cm)	Apr 25 2011 to Nov 19 2012	8,828	0.04	0.05	0.02	0.00	0.09
	Dissolved Oxygen (mg/L)		8,828	12.4	12.4	0.5	10.7	14.3
	Dissolved Oxygen (% Sat)		8,828	96.6	96.2	2.9	79.8	110.5
	pH		8,821	7.4	7.4	0.2	7.0	8.0
	Temperature (°C)		8,828	4.9	4.6	1.8	0.0	9.6
Indian	Turbidity (NTU)	May 26 2010 to Nov 02 2012	8,822	17.0	24.4	23.8	-0.7	229.6
	Conductivity (mS/cm)		8,856	0.05	0.04	0.01	0.01	0.06
	Dissolved Oxygen (mg/L)		8,856	12.0	11.8	1.0	7.0	13.4
	Dissolved Oxygen (% Sat)		8,856	99.9	97.3	6.4	59.8	108.8
	pH		8,853	7.2	7.1	0.2	6.4	7.7
	Temperature (°C)		9,484	7.4	7.0	1.4	2.2	10.7

¹ Data graded '2' or '3' were not counted as observations; Please see SOP 13 of the Freshwater Water Quality protocol (Nagorski et al. 2012) for descriptions of these record quality ratings

Table 6. Currently, the most stringent Alaska Department of Environmental Conservation (ADEC) water quality standards (ADEC 2012; amended April 8, 2012). Superscript numbers denote the category of water quality standard.

Parameter	Criteria
Specific conductance	None listed by ADEC
Dissolved oxygen (DO) ¹	DO must be greater than 7 mg/l in waters used by anadromous or resident fish. In no case may DO be less than 5 mg/l to a depth of 20 cm in the interstitial waters of gravel used by anadromous or resident fish for spawning. For waters not used by anadromous or resident fish, DO must be greater than or equal to 5 mg/l. In no case may DO be greater than 17 mg/l. The concentration of total dissolved gas may not exceed 110% of saturation at any point of sample collection.
pH ^{1,2}	May not be less than 6.5 or greater than 8.5. May not vary more than 0.5 pH unit from natural conditions.
	May not exceed 20°C at any time. The following maximum temperatures may not be exceeded, where applicable:
	Migration routes 15°C
	Spawning areas 13°C
Temperature ^{1,2}	Rearing areas 15°C
	Egg & fry incubation 13°C
	For all other waters, the weekly average temperature may not exceed site-specific requirements needed to preserve normal species diversity or to prevent appearance of nuisance organisms.
Turbidity ³	May not exceed 5 NTU above natural conditions when the natural turbidity is 50 NTU or less, and may not have more than 10% increase in turbidity when the natural turbidity is more than 50 NTU, not to exceed a maximum increase of 15 NTU. May not exceed 5 NTU above natural turbidity for all lake waters.

¹ Growth and propagation of fish, shellfish, other aquatic life, and wildlife

² Water supply/aquaculture

³ Water recreation

Discussion

Salmon River

There were no notable differences in the 2012 ranges of observed Salmon River water quality parameters in comparison to 2010 and 2011. Previous SEAN annual reports provide more in-depth reporting of water quality trends during relatively wet or dry periods (Sergeant et al. 2012a, Sergeant et al. 2012b).

Taiya River

2012 was the first successful year of uninterrupted, continuous hourly water quality monitoring in the Taiya River from mid-April through mid-November. 2012 patterns in water quality were similar to patterns observed in 2011. Notably, 2012 water temperature dropped toward winter temperatures faster than 2011 due to colder than average air temperatures in early October. October 2012 temperatures were quite variable, ranging from 0.8 to 5.6°C (Oct. mean = 4.0°C, sd = 1.2°C), while October 2011 temperatures only ranged from 3.8 to 5.2°C (Oct. mean = 4.5°C, sd = 0.4°C). Continued water temperature monitoring in the fall will provide more insight into the usual thermal dynamics of this glacially-influenced river. Previous SEAN annual reports provide more in-depth reporting of water quality trends during relatively wet or dry periods and compare recently observed water quality values with historical measurements (Sergeant et al. 2012a, Sergeant et al. 2012b).

Indian River

2012 ranges of observed Indian River water quality parameters were generally similar to 2010 and 2011. DO values demonstrated a larger range and were more variable than past years, but this difference may mostly be attributed to differences in sampling windows between years. An increase in DO variability appears to correspond with the annual spawning migration of thousands of pink salmon to the Indian River in July and August (Alaska Department of Fish and Game, unpublished data). Previous SEAN annual reports provide more in-depth reporting of water quality trends during relatively wet or dry periods (Sergeant et al. 2012a, Sergeant et al. 2012b).

From September 7 to October 3, dissolved oxygen, pH, and specific conductance data were unusable due to sediment and salmon eggs clogging the sensor guard and sensors. This clogging was likely caused by the movement of sediment and eggs during salmon redd (egg nest) construction in the vicinity of the sonde. Future staff maintaining the water quality sonde should consider checking the sonde for clogging more than once per month during the peak of salmon spawning from July through September.

Network-wide observations

Three years of water quality observations in the SEAN network are consistent with the expected results for a gradient of streams influenced by glaciers, surface water (including snowmelt), and mature wetland complexes. The water quality parameters in the heavily glaciated Taiya River watershed demonstrate less range in comparison to the Salmon and Indian Rivers and should provide an informative contrast in future years. Each monitored river demonstrates a unique thermal regime. More years of high resolution water temperature data will provide a valuable opportunity to characterize regional thermal regimes across Southeast Alaska.

No observed values or trends appeared to signal point source pollution or a change to the fundamental water quality of the Salmon, Taiya, or Indian Rivers. Throughout the monitoring period, all three rivers exhibited water quality conditions within expected normal ranges.

Considerations

The 2012 SEAN water quality monitoring season collected the most high quality and continuous data points since the start of the program in 2010. No data was lost due to field or office errors. The pre-season field preparations for 2012 adequately addressed training needs and allowed for sufficient dialogue between the project lead and field leads to ensure the protocol was implemented consistently. SEAN recommends continuing pre-installation meetings at the start of each season, even when previously experienced field leads are involved.

In 2013, SEAN will be developing a proposal for year-round temperature monitoring in all parks. Due to the low cost of temperature logging sensors and ease of installation and maintenance, a network of temperature sensors across streams in all three parks is very feasible. Freshwater water temperature is an important environmental driver in Southeast Alaska that is directly influenced by glacial melt and atmospheric temperature shifts due to climate change. The need for high resolution temperature data has been identified across the United States to properly document shifting temperatures, validate predictions of temperature changes due to climate change, and assess biological impacts such as changes in salmon growth and survival.

SEAN is currently preparing a peer-review manuscript describing trends in water quality parameters across the three monitored rivers. In addition to this manuscript, a synthesis report will be planned after the 2014 field season to comprehensively summarize 5 full years of water quality monitoring data and determine whether the current monitoring protocol is adequately fulfilling program objectives.

Readers can access all SEAN water quality data and related products from the SEAN Freshwater Water Quality webpage: http://science.nature.nps.gov/im/units/sean/FQ_Main.aspx

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Appendix A: Hourly time series data by river for all water quality parameters

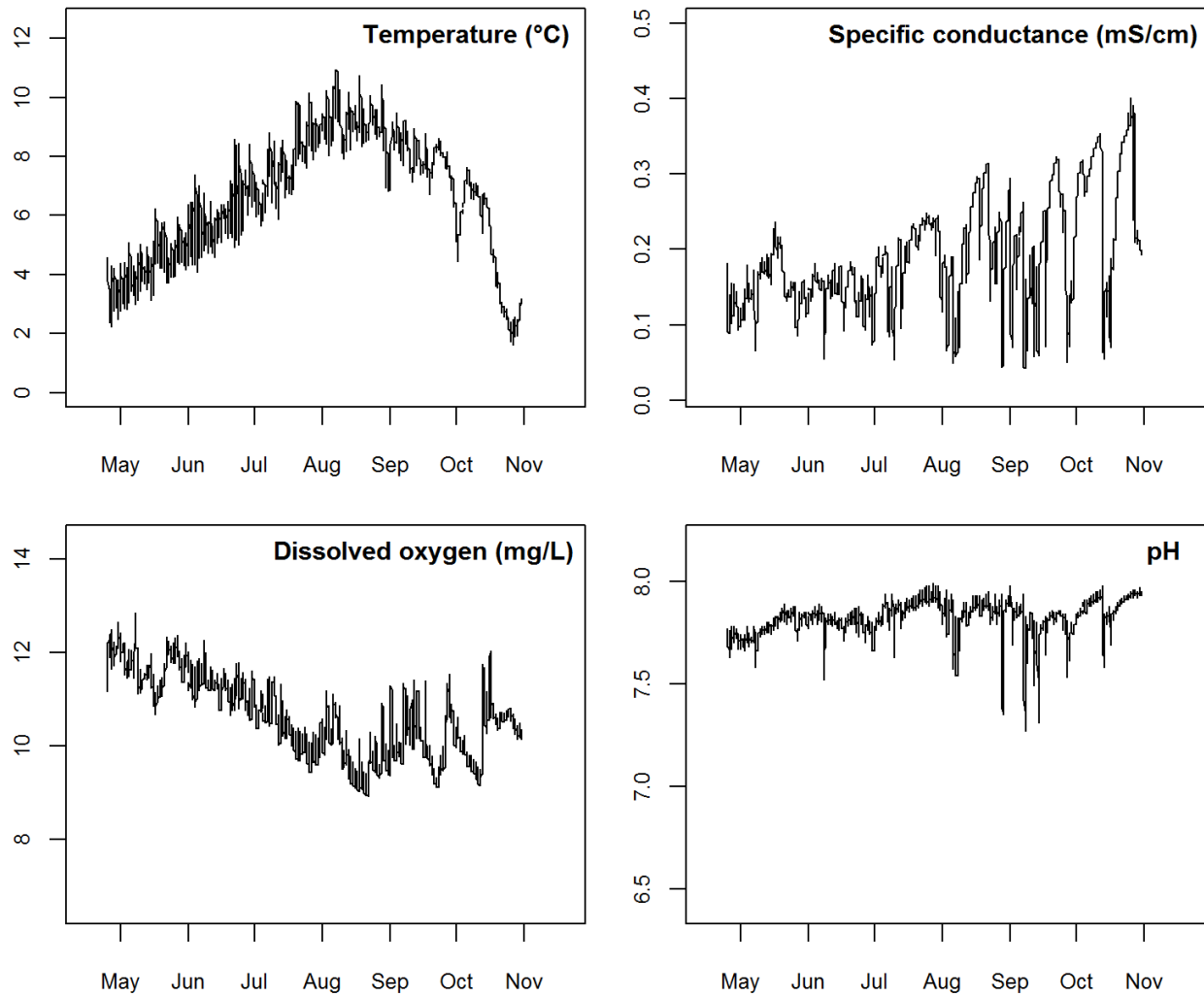


Figure 10. Hourly water quality data for the Salmon River in 2012.

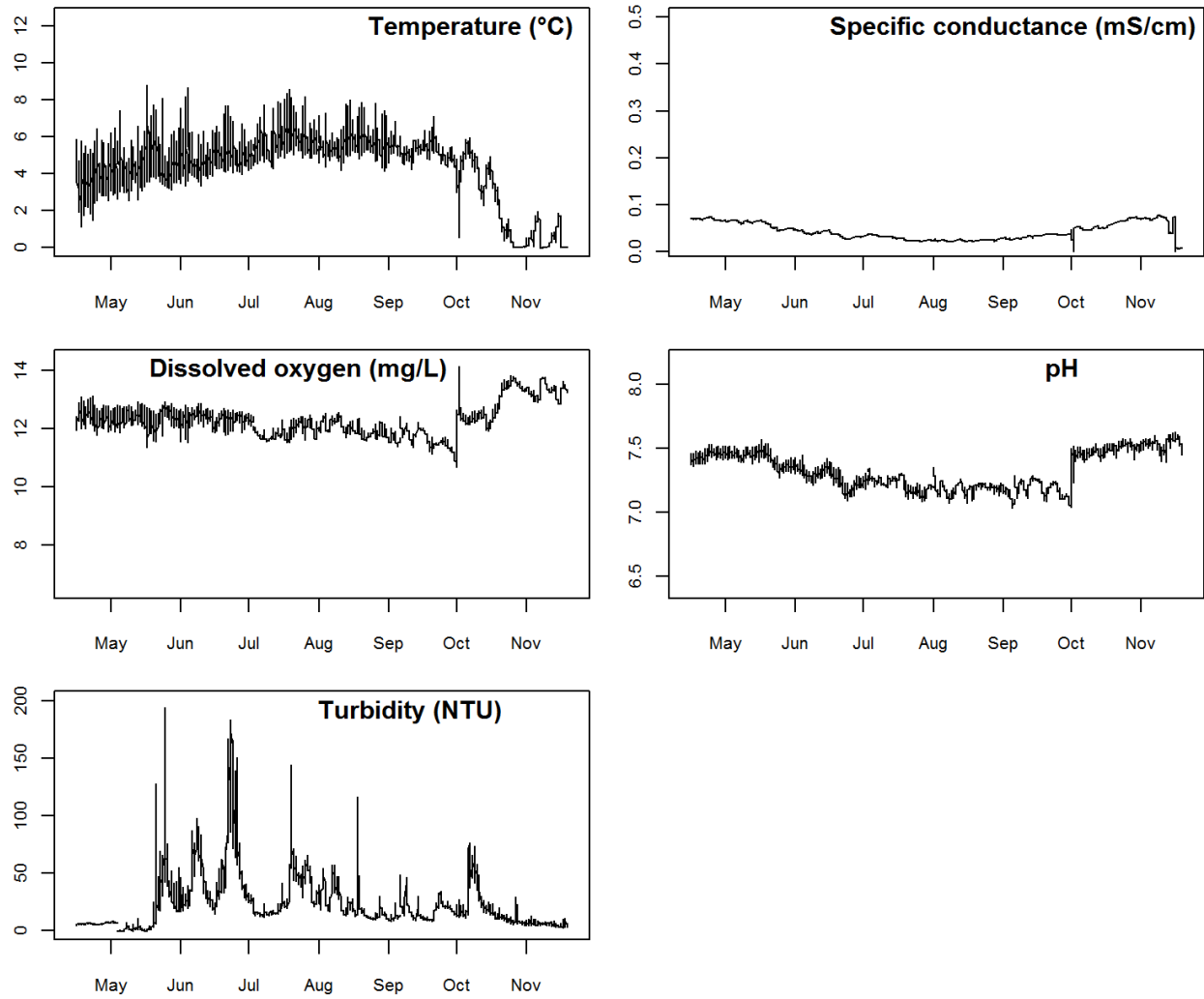


Figure 11. Hourly water quality data for the Taiya River in 2012.

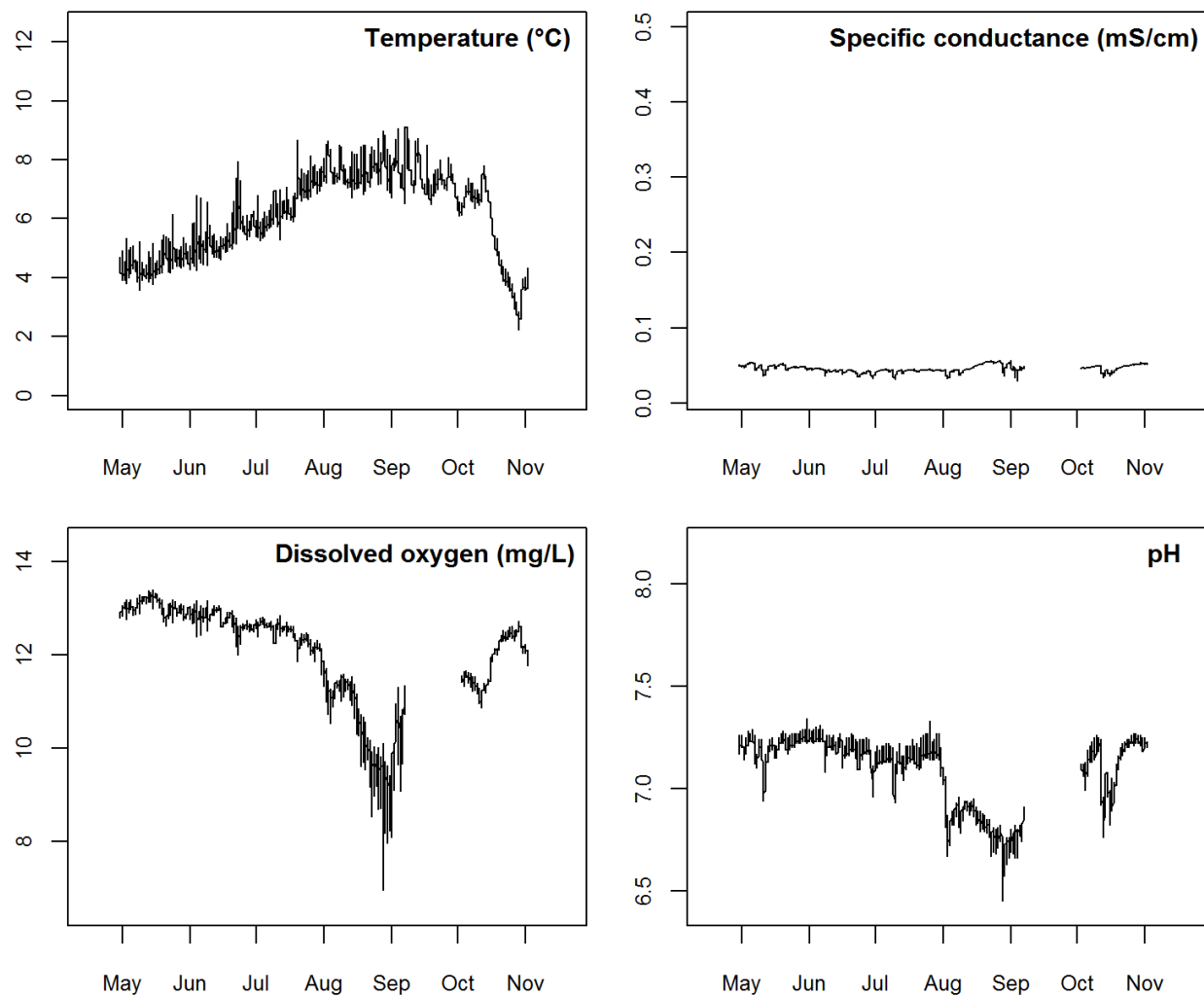


Figure 12. Hourly water quality data for the Indian River in 2012.

Appendix B: Taiya River streamflow time series versus all water quality parameters

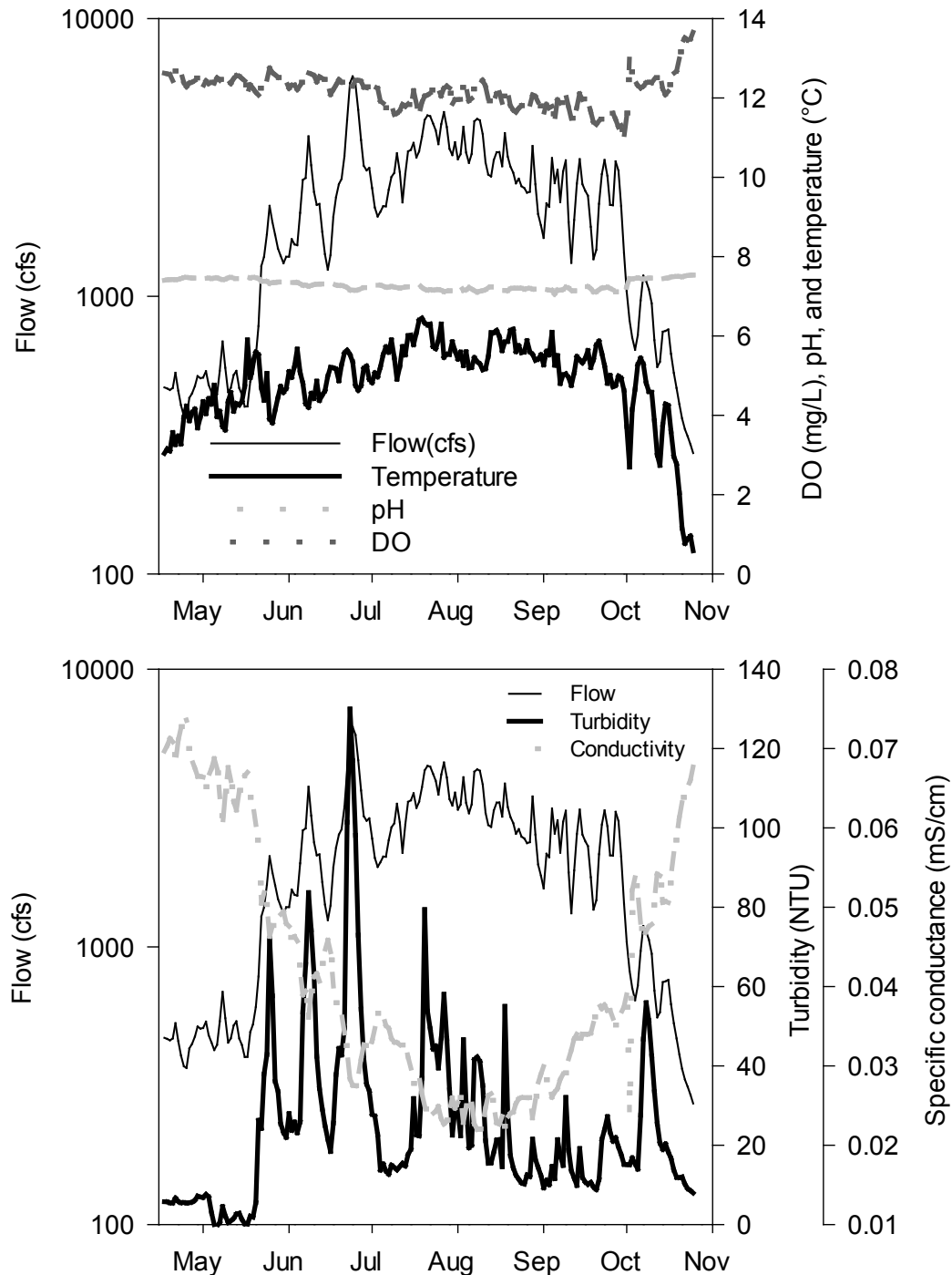


Figure 13. Daily average streamflow (log scale) versus daily averages for all water quality parameters in the Taiya River in 2012. Note the additional Y-axes on each panel. Streamflow data collected in the same location as water quality data and downloaded from the Taiya River USGS gage #1505621 website (http://waterdata.usgs.gov/ak/nwis/uv/?site_no=15056210&PARAMeter_cd=00065,00060). Data beyond October 25 not reported due to river ice conditions inhibiting flow measurement.

Appendix C: Indian River streamflow time series versus all water quality parameters

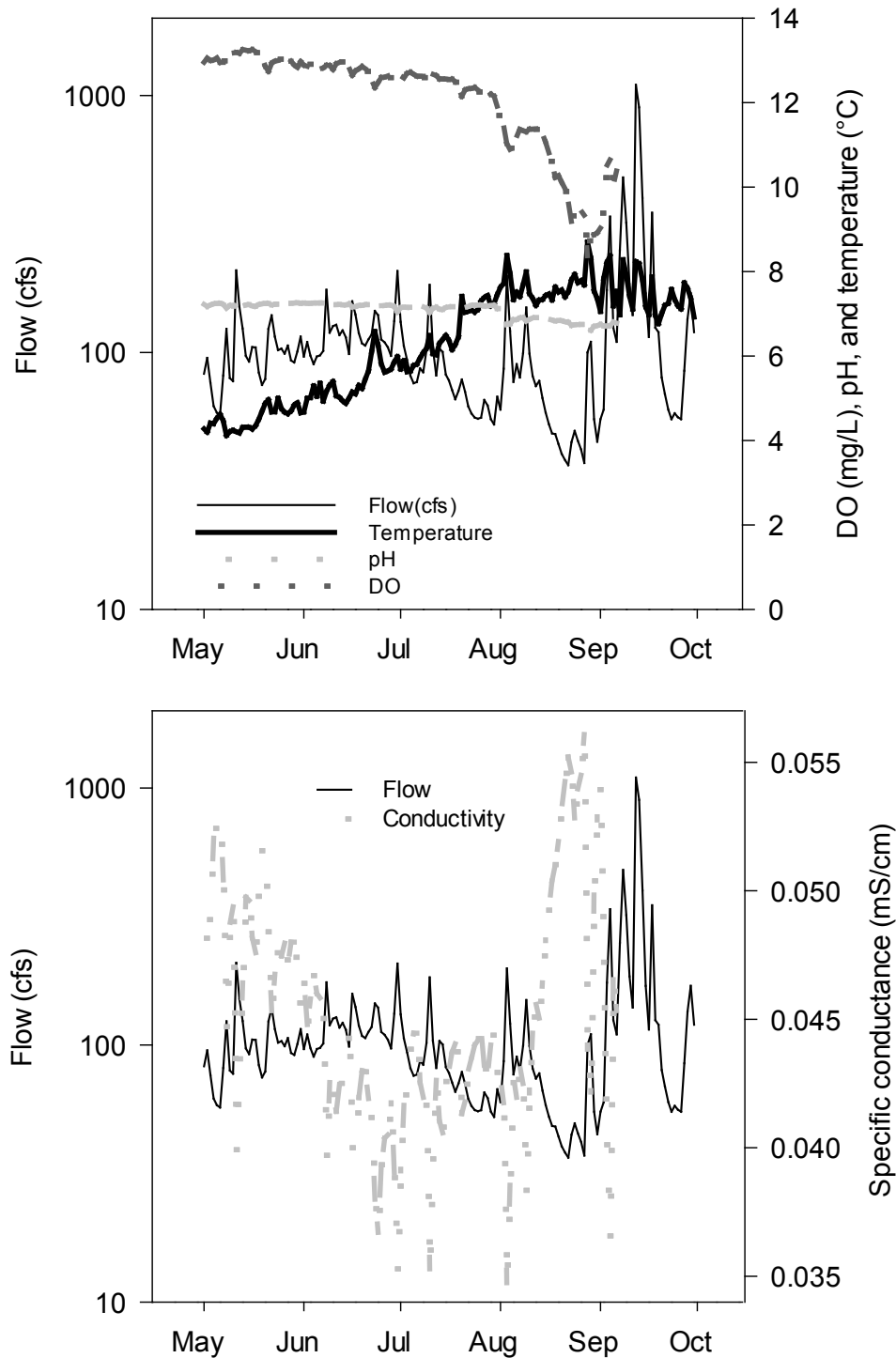


Figure 14. Daily average streamflow (log scale) versus daily averages for all water quality parameters in the Indian River in 2012. Note the additional Y-axes on each panel. Streamflow data collected in the same location as water quality data (NPS and WaterWalkers, unpublished data).

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
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