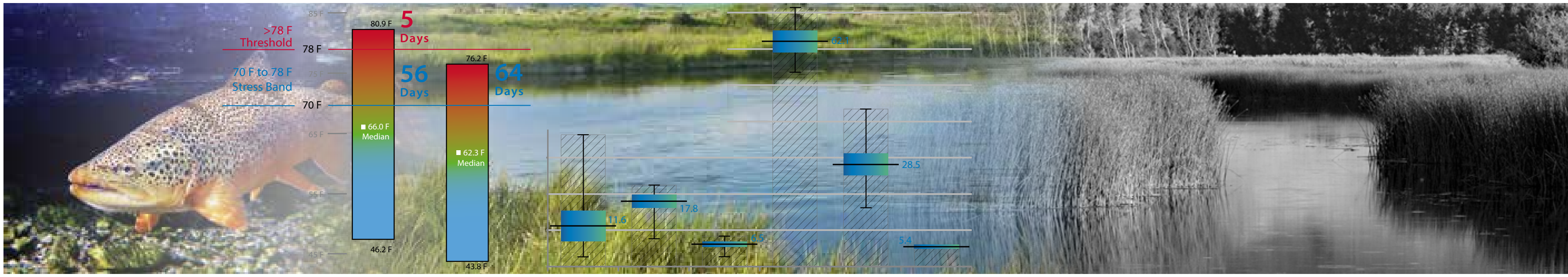
2017

Silver Creek Annual Report

Ecosystem Sciences Foundation



Ecosystem Sciences Foundation

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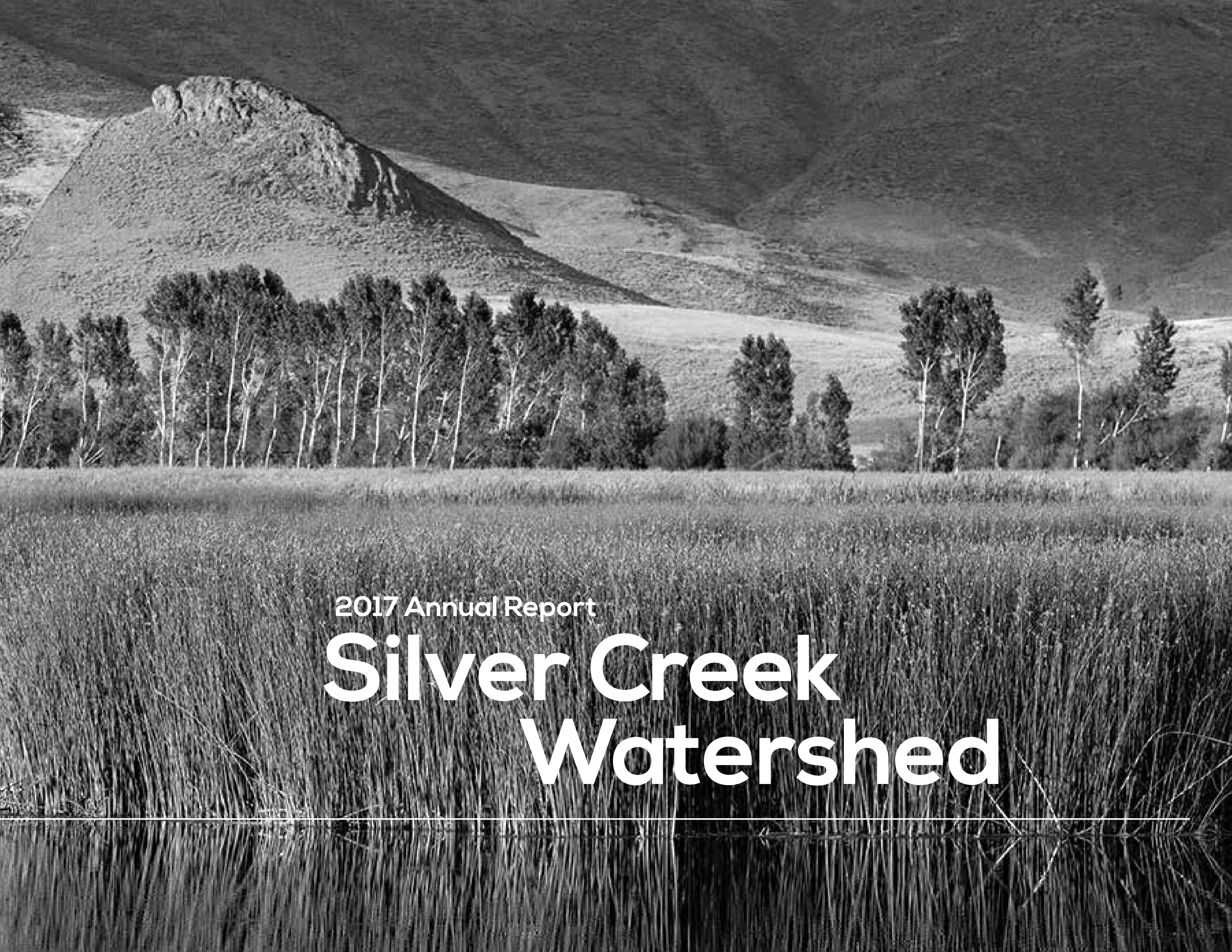

2017 Annual Report

Silver Creek Watershed

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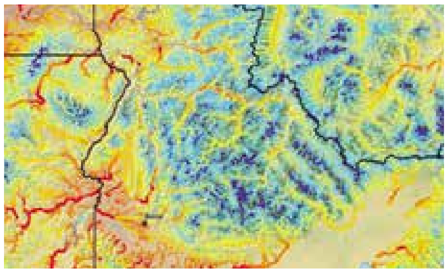
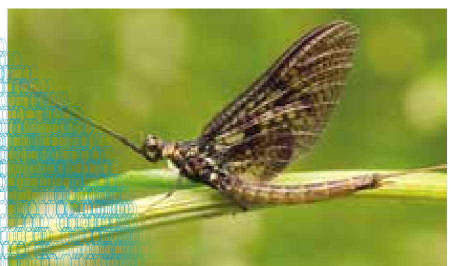
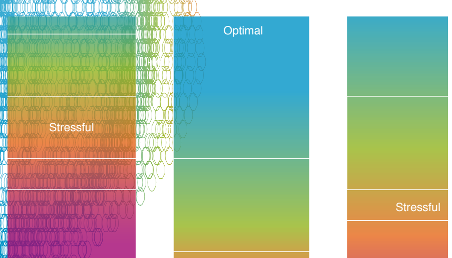
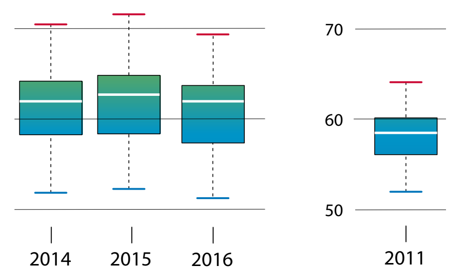








Silver Creek Watershed

Ecosystem Sciences Foundation (ESF) has been working in the Silver Creek watershed since 2009, when it partnered with The Nature Conservancy to develop a *Restoration and Enhancement Strategy* for the Silver Creek Watershed. The strategy identified numerous actions to be taken, including addressing data gaps on stream flow, temperature and sediment conditions. To address these data gaps, ESF began its monitoring program in 2010 to increase our understanding of the Silver Creek system. This past year, ESF and its partners continued to gather critical data on stream flows, temperature, and dissolved oxygen. In addition, ESF conducted statistical analyses of temperature monitoring results and prepared an in-depth review of recent water quality research performed by the U.S. Geological Survey.

To date, our Silver Creek program has enjoyed support from numerous stakeholders. Most of the land within the watershed is privately owned; consequently, landowners in the watershed recognize the need to protect the ecological health of the watershed, as well as their rights as landowners. Our partners and stakeholders have been integral in helping us achieve our vision of providing direction for stewardship of the Silver Creek Watershed and in designing and promoting appropriate stream restoration and enhancement actions.

The significant conclusions and findings from 2017 are:

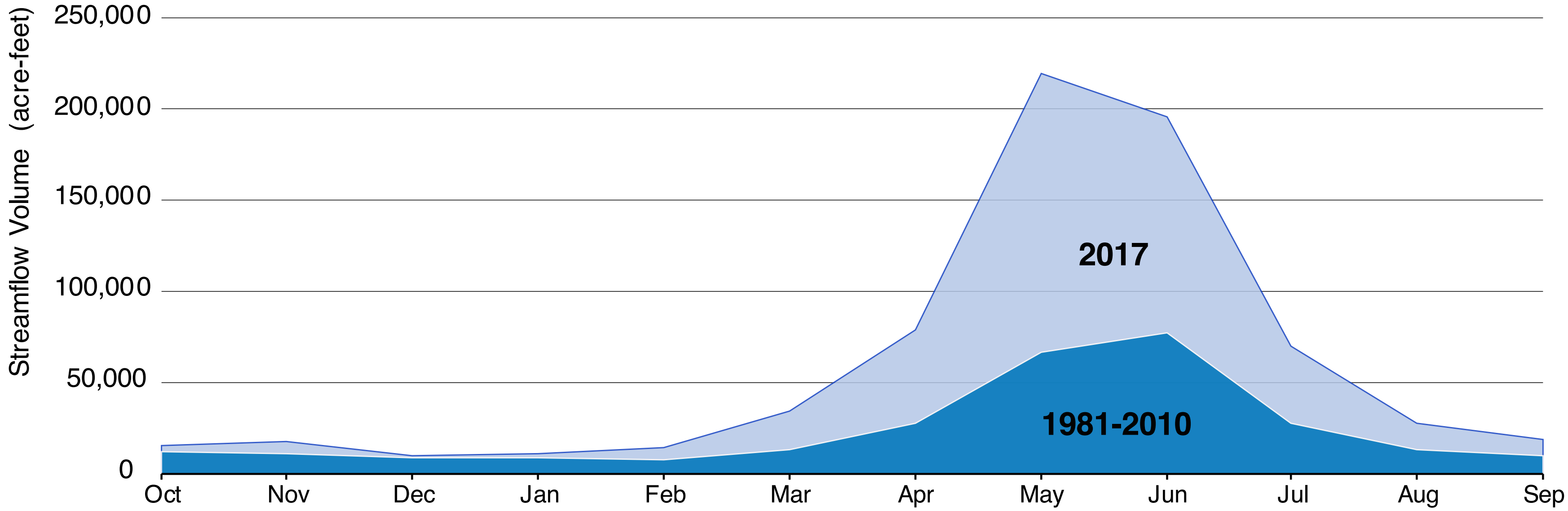
- The three-year period of below average discharge within the system ended with a historic snowpack and run-off year that reversed the trend.
- With some notable exceptions, temperatures in the Silver Creek system had lower average temperatures than 2016.
- Dissolved Oxygen monitoring indicated that in some areas of Silver Creek, Dissolved Oxygen concentrations become so low that they stress all life stages of trout, especially in Butte Creek and Lower Silver Creek. However, these conditions are generally limited to early morning hours. In the afternoon, Dissolved Oxygen levels rise rapidly. Cold tributary creeks like Grove, Chaney and Loving Creek maintained higher Dissolved Oxygen levels than Butte Creek and Lower Silver Creek.
- The USGS found that the Purdy Pond and Kilpatrick Dam restoration projects did not negatively affect stream macroinvertebrate communities.
- Cooperation between ESF and USFS on Silver Creek will result in better regional data sets and new sampling for fish on Silver Creek.

For more details please visit: www.savesilvercreek.com

The information that is presented in this report reflects summarized analysis of all data. We are presenting the most important aspects of the past season's work in a way that tells a story of the stream system and watershed. The information presented here is a result of detailed, scientifically rigorous analysis, and reflects a considerable amount of field work to collect. The website has additional information on programs in the watershed, including raw and tabulated data.

Winter Snow + Water Year 2017

The water year for 2016-17 set records after robust snow pack levels accumulated over the winter. In 2017, snow water equivalent (SWE) levels within the Big Wood Basin were measured at 319% of median from those measured from 1981-2010. We calculate the total streamflow volume for the Big Wood River at Hailey (USGS gauge#13139510) to be 249% above median from streamflow measured 1981-2010. This has been great news for the Silver Creek system, which relies heavily on groundwater levels within the Wood River Valley Aquifer, a system in which three-quarters of inflow is received directly from tributaries and streamflow losses. As a spring-fed system, Silver Creek's water comes from groundwater upwelling at springheads and streambed groundwater inputs to maintain a stream flows. In 2017, monitoring within Silver Creek's tributaries showed a significant increase in spring and stream flows. Additionally, none of the springs dried up mid-summer, which has been documented in previous low water years. Well water monitoring within the South Valley Groundwater District found that groundwater depth and artesian pressure was sustained at most wells throughout the June to November 2017 timeframe. The consistent, cool groundwater inputs that continued throughout the summer months led to a reduction in average and maximum stream temperatures at most locations when compared to the previous four monitoring years (see pages 4-7 for more details). These benefits underscore the importance of groundwater as the ecological driver of the Silver Creek ecosystem.



Big Wood River stream flows (measured in acre-feet) for 2017 as compared to the most recent 30 year mean (1981-2010).

June 1, 2017

Idaho Water Supply Outlook Report

Big Wood Basin **319%** of median snowpack

Big Wood Basin **165%** of average precipitation

Streamflows up to **250%** of average

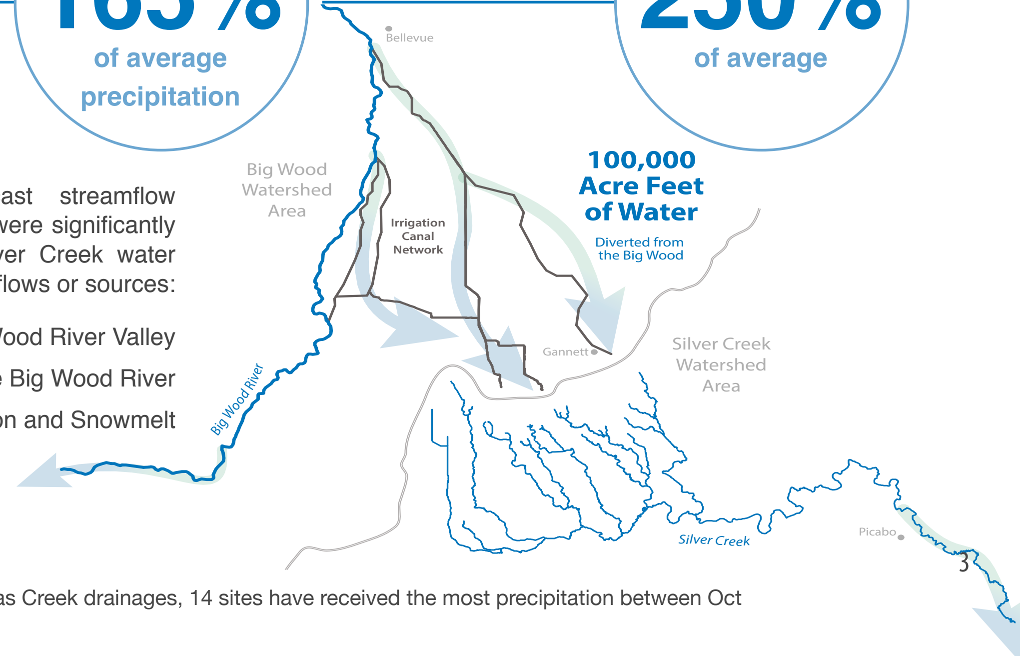
In 2017, the Big Wood basin received the most precipitation between Oct 1 and April 1 on record.

Snowpack conditions, forecast streamflow runoff and groundwater flows were significantly increased in 2017. Major Silver Creek water inflows or sources:

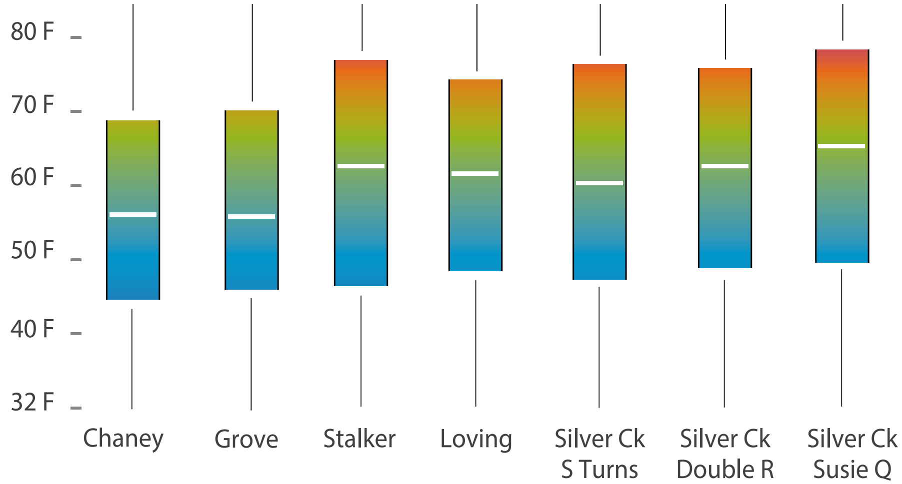
1) Groundwater inflows, Wood River Valley

2) Irrigation diversions from the Big Wood River

3) Precipitation and Snowmelt



Of the 15 SNOTEL sites in or near the Little Lost, Big Lost, Little Wood, Big Wood, and Camas Creek drainages, 14 sites have received the most precipitation between Oct 1 and April 1 on record. (NRCS, June 2017)



Summer Stream Temperatures: The graph above indicates the maximum, average and minimum summer water temperatures on selected areas of Silver Creek over a four year period (2011-2017). This year, 43 stream temperature loggers and 13 springhead loggers were monitored throughout Silver Creek and on each tributary to record critical information and track changes in the system.

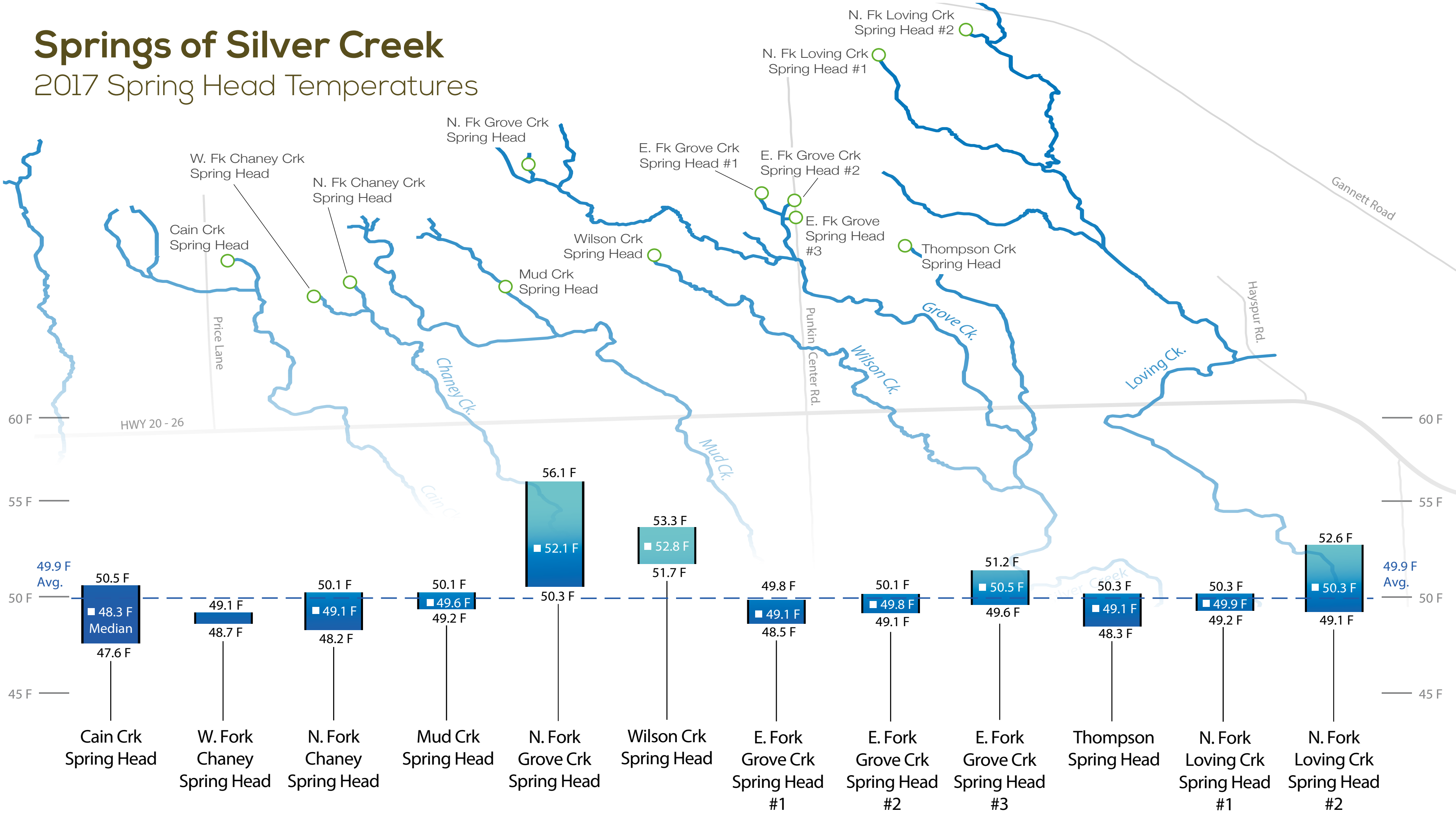
Stream Temperature

In 2017, we deployed 13 springhead and 43 stream temperature loggers in key locations throughout the Silver Creek Watershed. It is important to monitor the springs that feed Silver Creek because they are the primary source of water to the system and these springs provide consistent, cool water to Silver Creek's tributaries that can mitigate against changes in air temperature and climatic conditions. For the 13 spring head loggers, median temperatures stayed near 49.9°F throughout the summer of 2017. As opposed to the past four monitoring years,no springheads dried up mid-summer. The record 2016-17 water year increased groundwater levels and allowed for both a longer duration of high springhead flows and reduced extraction of groundwater for agricultural use, therefore maintaining higher spring flows year-round. As a spring-driven system, these springs are critical to the health and persistence of Silver Creek.

Temperature monitoring within Silver Creek and its tributaries found average and maximum stream temperatures had decreased at most locations, as compared to temperatures measured from 2013-2016. This illustrates the connection between the very high water-year, which led to an increase in the duration and quantity of groundwater, and lower overall

Springs of Silver Creek

2017 Spring Head Temperatures

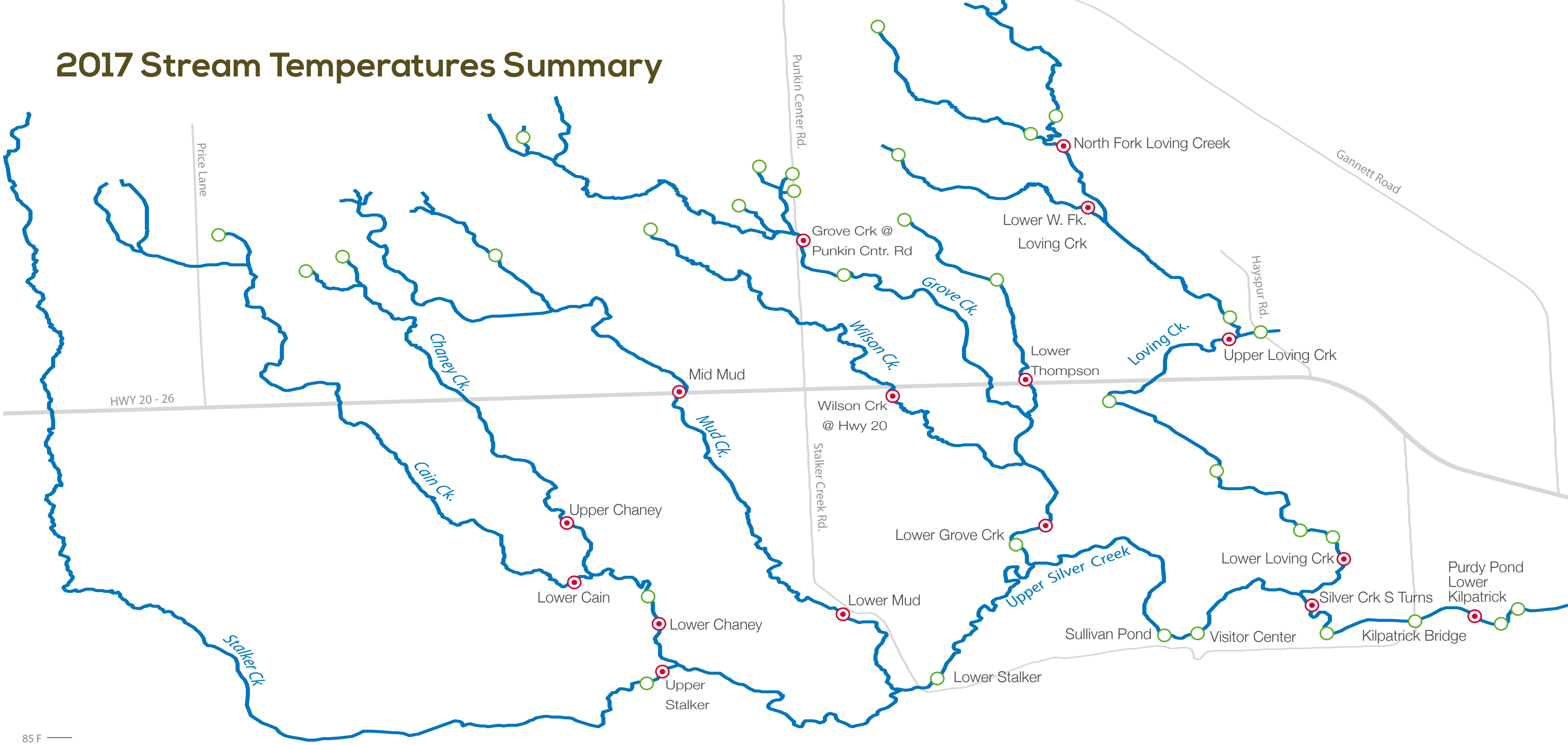


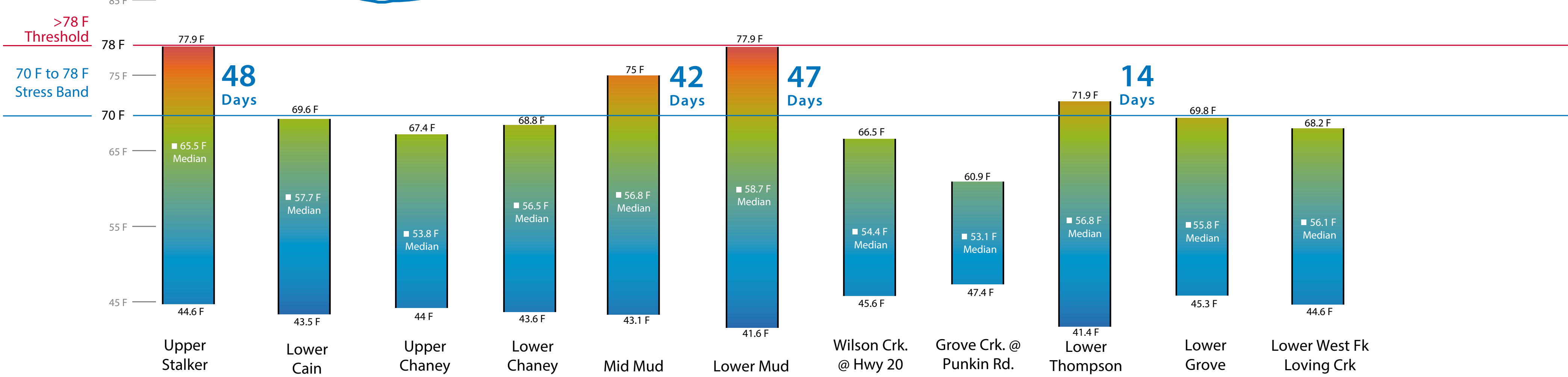
Stream temperature bands The above graphic depicts the summarized spring head temperature data for the entire summer season. The data were analyzed for the summer season to illustrate the spring temperatures that occurred for the period of June through September 2017. Each graph displays the total temperature range from June 1 to September 30; the absolute high and low temperatures are given, and the median water temperature is shown for that particular spring.

temperatures. The most notable decrease in temperature was measured in Cain Creek, which for the first time since 2012 remained below the stress band (70°F) for trout throughout the monitoring period in 2017; average temperatures decreased by 2-4°F and maximum temperatures decreased by 4-10°F from those measured in 2013-2016. In contrast, water temperatures in both Stalker and Grove Creek increased, by about 3°F and 1°F respectively, as compared to the 2014-2016 monitoring years.

A possible explanation for this increase in stream temp is that in lower run-off years a larger percentage of the creek water is coming from springs that bring deep, confined aquifer water to the surface. In 2017, there was more shallow groundwater (warmer) entering the stream leading to higher temperatures.

2017 Stream Temperatures Summary





Stream temperature bands The above graphic depicts the summarized stream temperature data for the entire summer season for a selected group of data loggers and locations. The data were analyzed for the summer season to illustrate the high temperatures that occurred throughout the stream system for the period of June through the end of September 2017. Each graph displays the total temperature range for the period of record; the absolute high and low temperatures are given, and the median stream temperature is shown for that particular stream.

Locations of Stream Temperature Logger Array

This map illustrates the Silver Creek stream and tributary system along with the locations of the stream temperature loggers. The temperature loggers are expressed in two categories for discussion and analysis purposes:

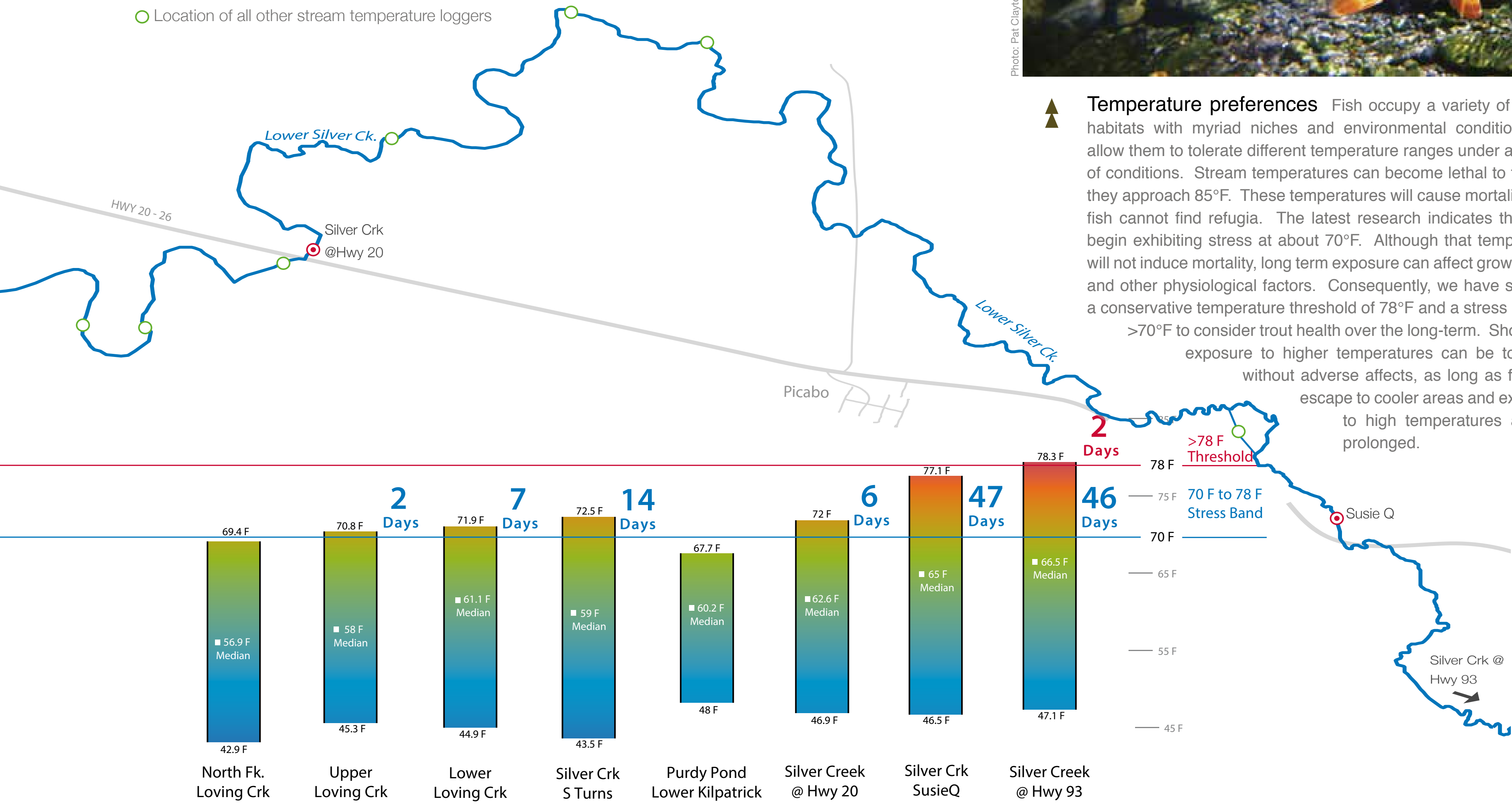
⦿ Location of stream temperature loggers illustrated in bottom graphic of seasonal temperatures

○ Location of all other stream temperature loggers

Stream temperatures are logged at one-hour intervals over a twenty-four-hour period for as long as the logger is left in place. The array of stream temperature loggers in the Silver Creek system is designed to capture temperature differences for each stream and tributary segment, from the spring source to Lower Silver Creek at the Highway 93 crossing.

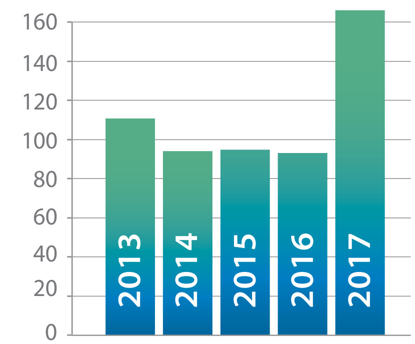
Photo: Pat Clayton

Temperature preferences Fish occupy a variety of stream habitats with myriad niches and environmental conditions that allow them to tolerate different temperature ranges under a variety of conditions. Stream temperatures can become lethal to trout as they approach 85°F. These temperatures will cause mortality if the fish cannot find refugia. The latest research indicates that trout begin exhibiting stress at about 70°F. Although that temperature will not induce mortality, long term exposure can affect growth rates and other physiological factors. Consequently, we have selected a conservative temperature threshold of 78°F and a stress band of >70°F to consider trout health over the long-term. Short-term exposure to higher temperatures can be tolerated without adverse affects, as long as fish can escape to cooler areas and exposure to high temperatures are not prolonged.

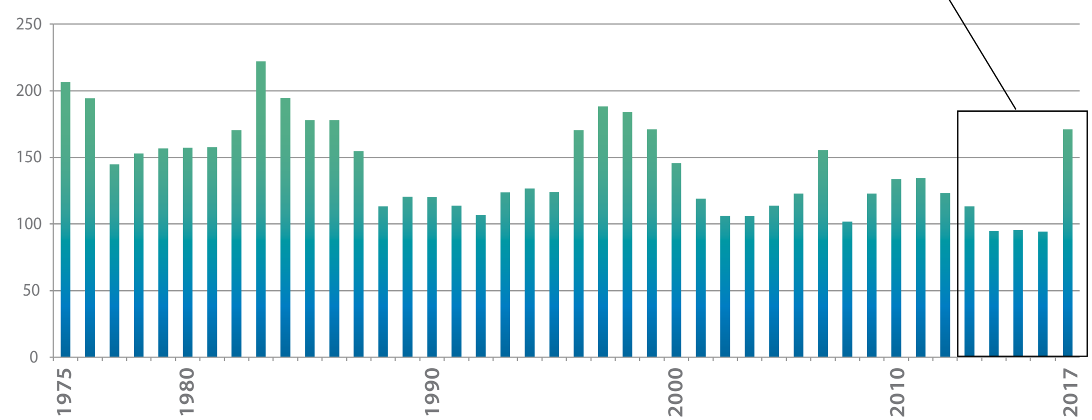


The overall median temperatures throughout the summer were within the preference range for trout (around 55-60 degrees) in Cain, Chaney, Mud, Wilson, Grove, Thompson, and the upper reaches of Loving Creek. Stalker Creek, Lower Loving Creek and Silver Creek all had median temperatures above 60°F. However, the number of days that temperatures were within the stress band for trout (70°F-78°F) decreased significantly compared to measurements taken in 2013-2016. In 2017, Silver Creek at Highway 93 was the only site where temperatures exceeded the upper stress threshold (78°F) for trout.

Stream Hydrology



Annual average streamflows (cfs) at USGS gage (Sportsmans Access) 1975 - 2017.



Silver Creek annual average streamflows (cfs) at USGS gage (Sportsmans Access) 1975 - 2017.

Monitoring streamflows is important, as it helps build our understanding of the volume and origin of water entering Silver Creek's tributaries and its potential influence on water temperature, dissolved oxygen and other water quality parameters.

Total annual discharge at Sportsman's Access in 2017 was historically high and flows were well above the 30-year average. Silver Creek's tributaries had more flow than at any point since monitoring began in 2011. It was a significant water year for Silver Creek and it's tributaries. Similarly, the Big Wood River had a large increase in annual discharge in 2017.

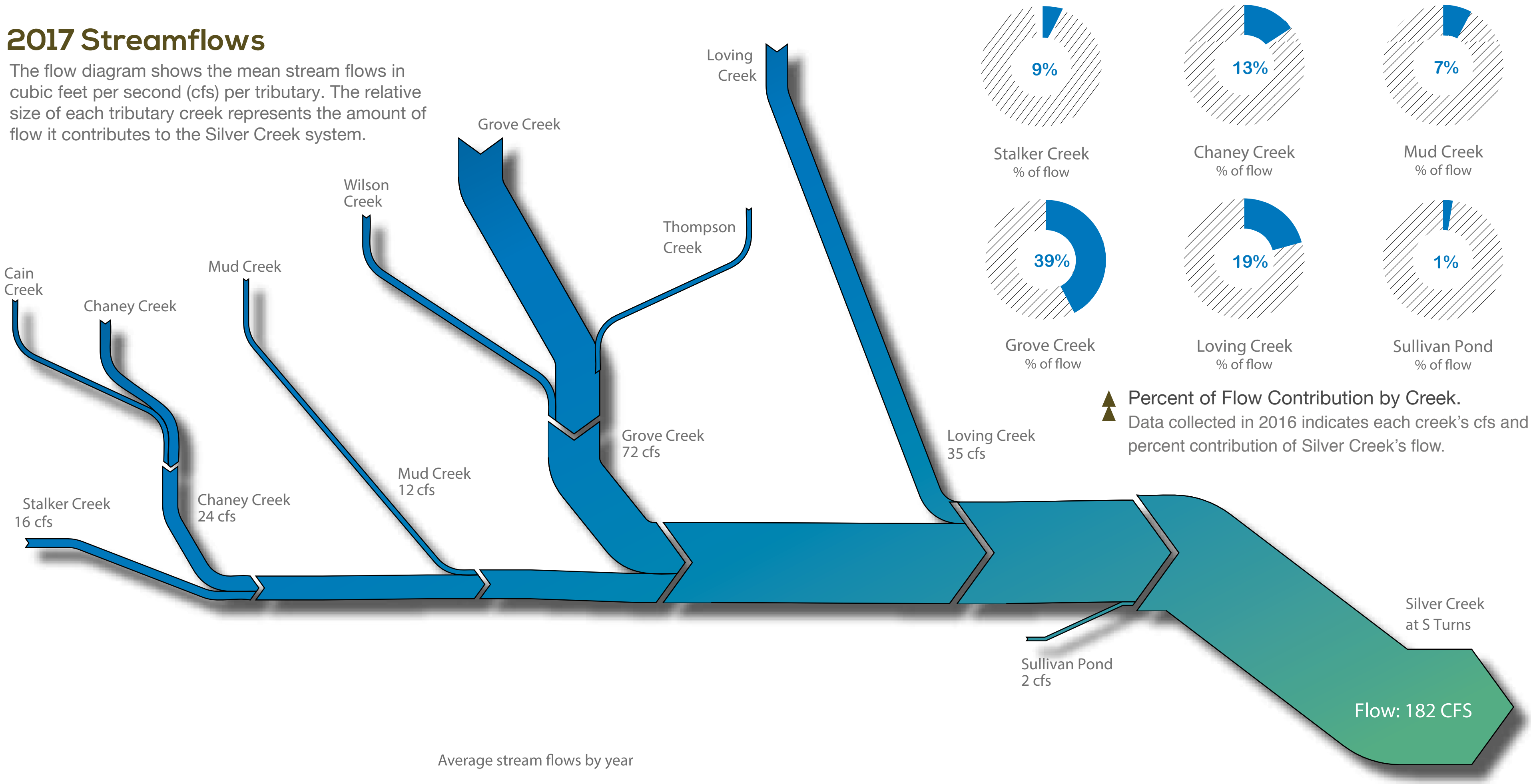
Big Wood River Average Annual Discharge (cfs):

2013	**299.0**
2014	**309.7**
2015	**311.5**
2016	**406.4**
2017	**1,003.0**

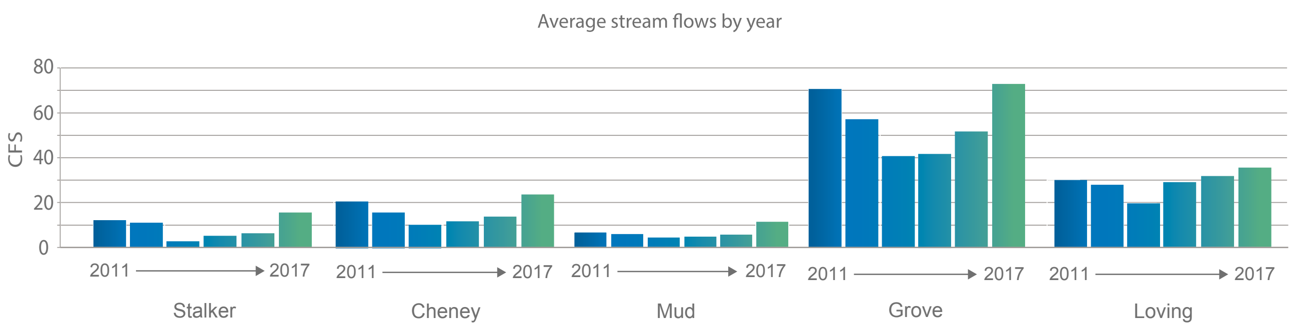
The 2017 water year resulted in above-average flows in the Wood River, Silver Creek, and its tributaries. These systems are connected by a common groundwater system that is dynamic and complex. However, in 2017 the connection is clearly evident; all of these systems had above-average flows.

2017 Streamflows

The flow diagram shows the mean stream flows in cubic feet per second (cfs) per tributary. The relative size of each tributary creek represents the amount of flow it contributes to the Silver Creek system.



Percent of Flow Contribution by Creek. Data collected in 2016 indicates each creek's cfs and percent contribution of Silver Creek's flow.



Annual average streamflows by creek for 2011-2017. Data collected from 2011 - 2017 shows each creek's average flow. The overall increase in streamflows (2017) affects many critical components of the aquatic ecosystem. Measurements were not continuous, but were distributed throughout the spring, summer and fall.

Water Quality

Dissolved Oxygen

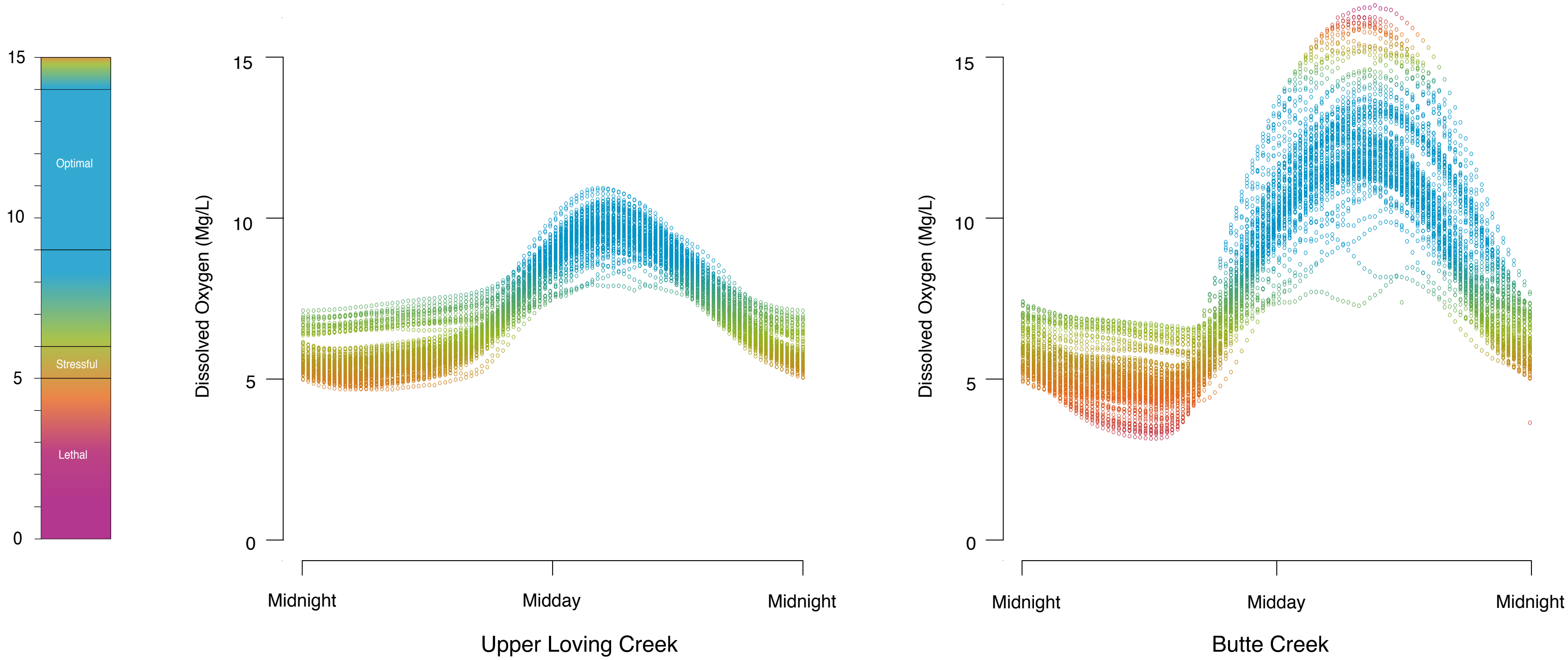
During the summer of 2016 dissolved oxygen (DO) was measured continuously from June through October at 6 sites. In 2017, an additional sensor was placed in Upper Loving Creek. These data were recorded using optical DO sensors that record the DO and temperature value every 15 min.

Similar to last year's results, the data indicated that not all of Silver Creek's waterways exhibit the same pattern of DO values and that DO levels stress fish in certain locations at certain times of the day. Seasonal fluctuations also occur, as changes in sunlight, temperature, flow and aquatic plant growth vary throughout the year.

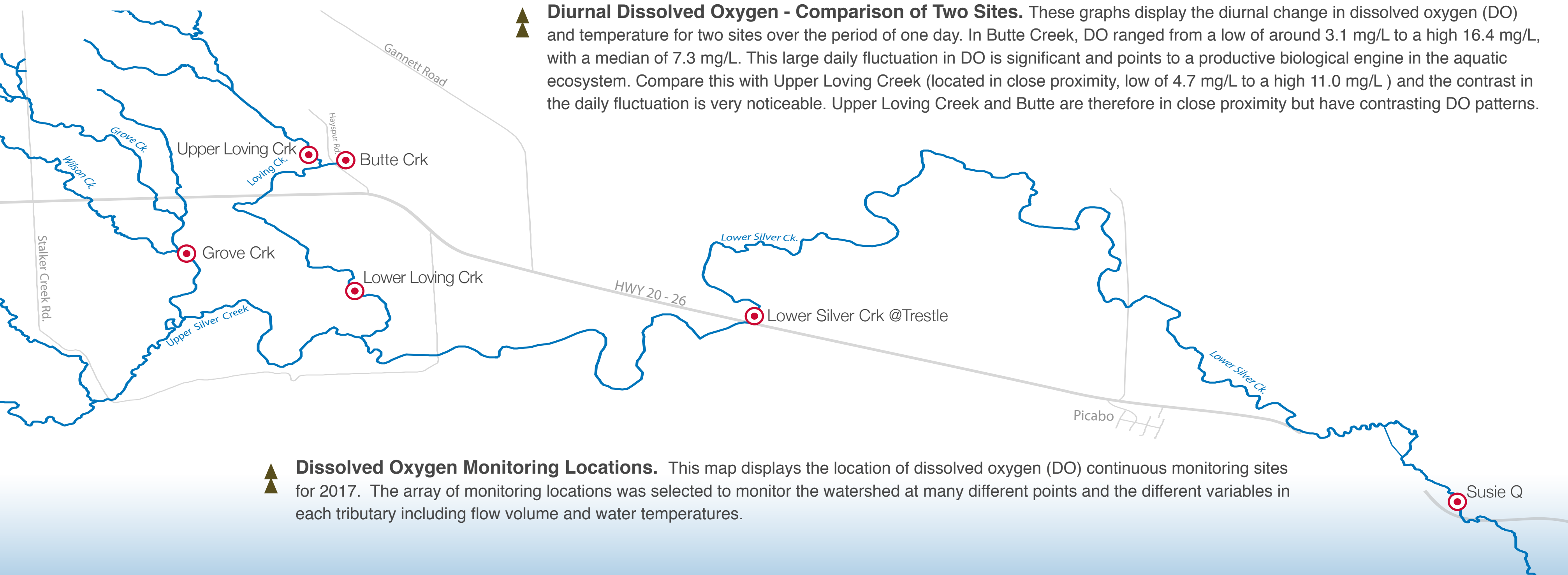
In many areas of the Silver Creek system the daily fluctuations in DO are significant, which points to a productive biological engine in the aquatic ecosystem. As aquatic plant life within the stream utilizes photosynthesis to create energy, they produce oxygen. This raises DO levels, which peak in the afternoon.

Overnight, plants continue to respire without photosynthesis, which requires oxygen (this demand is called biological oxygen demand) which they take from the water. This daily process causes DO levels to be lowest just before dawn and highest in the afternoon exhibiting a distinct diurnal cycle. As shown by the diurnal graphs presented, not all cycles are the same. The new sensor placed at Upper Loving Creek is in close proximity to the Butte Creek sensor location. Despite their close proximity in geographic space, their DO levels vary significantly (see diurnal plots on the facing page). This is due to a combination of factors, including volume, temperature, nutrient concentrations, and aquatic plant life, among others.

When DO readings fall into the stressful range for fish they will seek refuge in areas that have higher DO concentrations. Fish eggs are buried in gravels and lack the mobility to escape these conditions. At selected sites, 25% of all measurements made were at stressful to lethal levels for fish and their eggs (1st quartile at Suzie Q and Butte: 5.3mg/L; Lower SC at the Trestle: 6.5mg/L). The seasonal graphs present all data points taken during the 2017 season.

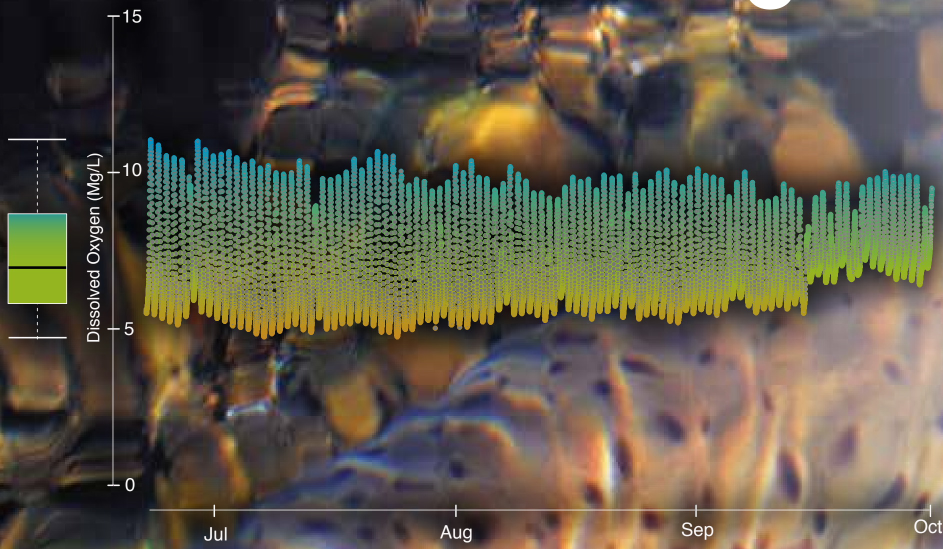


Diurnal Dissolved Oxygen - Comparison of Two Sites. These graphs display the diurnal change in dissolved oxygen (DO) and temperature for two sites over the period of one day. In Butte Creek, DO ranged from a low of around 3.1 mg/L to a high 16.4 mg/L, with a median of 7.3 mg/L. This large daily fluctuation in DO is significant and points to a productive biological engine in the aquatic ecosystem. Compare this with Upper Loving Creek (located in close proximity, low of 4.7 mg/L to a high 11.0 mg/L) and the contrast in the daily fluctuation is very noticeable. Upper Loving Creek and Butte are therefore in close proximity but have contrasting DO patterns.

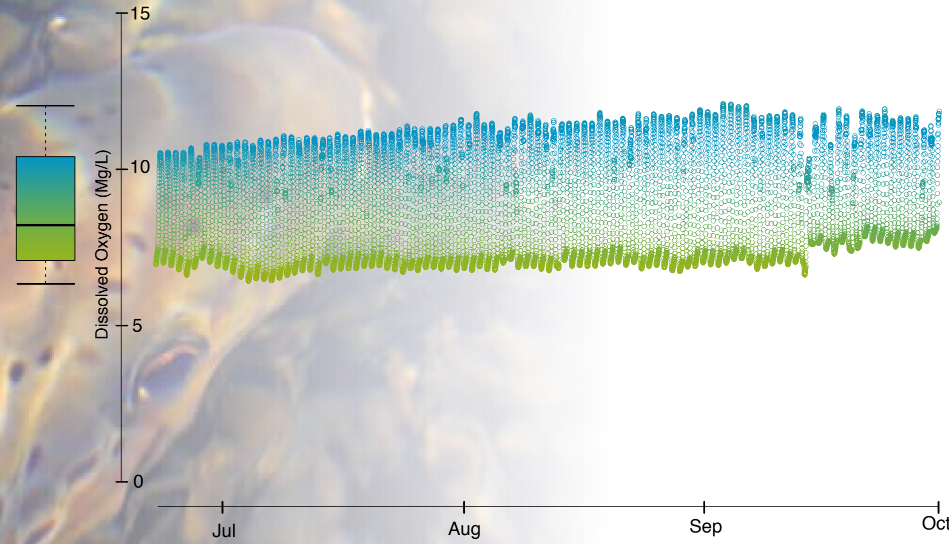


Dissolved Oxygen Monitoring Locations. This map displays the location of dissolved oxygen (DO) continuous monitoring sites for 2017. The array of monitoring locations was selected to monitor the watershed at many different points and the different variables in each tributary including flow volume and water temperatures.

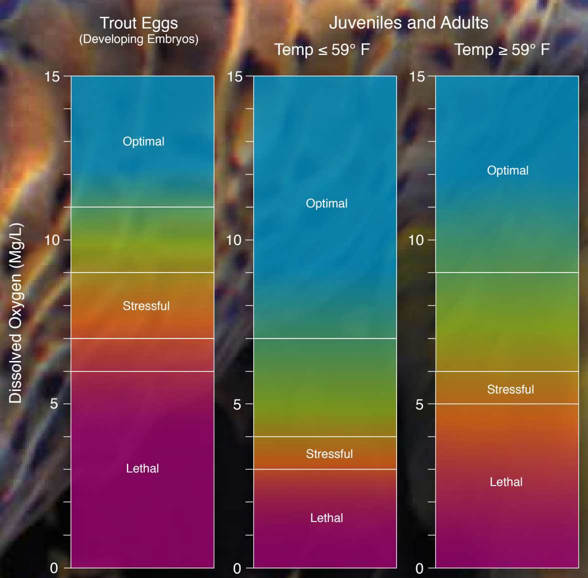
Dissolved Oxygen Results

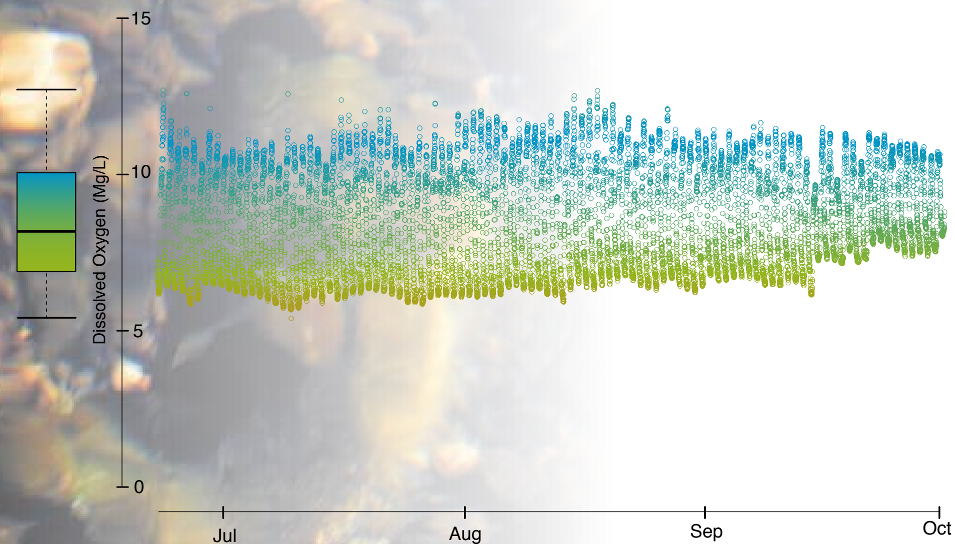


Upper Loving Creek



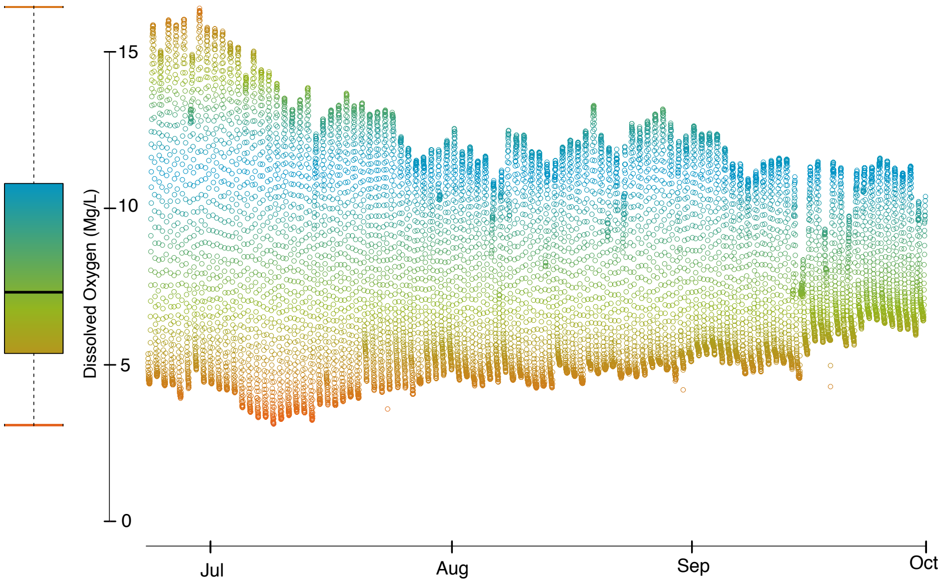
Grove Creek



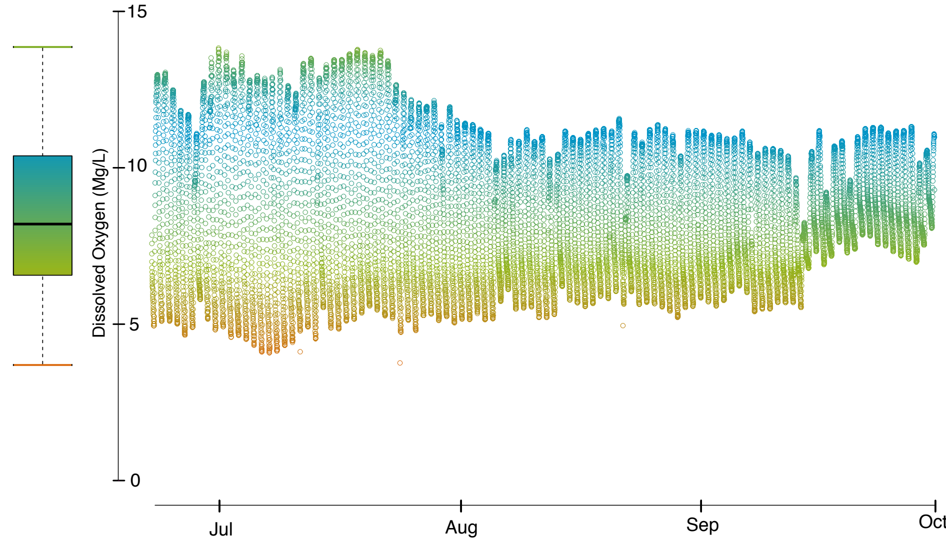


Chaney Creek Pond

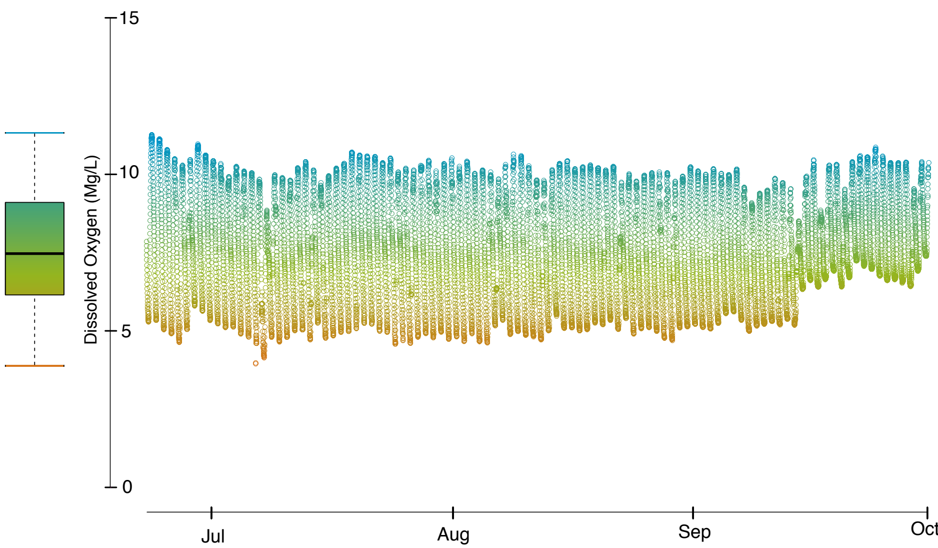
▲▲ **Average Dissolved Oxygen Requirements for Salmonids.** Trout, depending on thier particular life stage (egg, Juvenile, Adult), have differing requirements and thresholds for dissolved oxygen levels. Water temperature also plays a major role in dissolved oxygen levels. (Adapted from EPA's Chapman, 1986, and USFWS's Raleigh et al 1984, and Raleigh et al 1996).



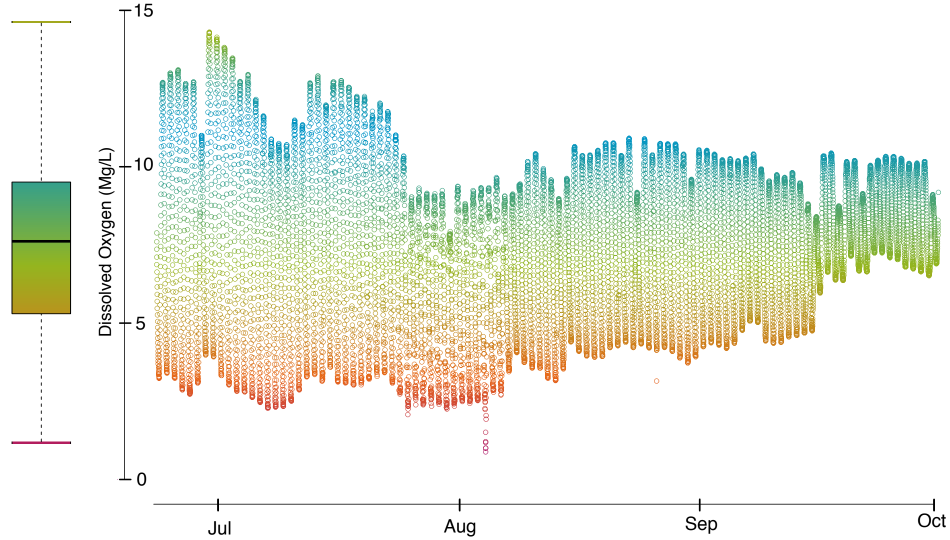
Butte Creek



Lower Silver Creek at Trestle



Lower Loving Creek



Susie Q

Macroinvertebrate Communities

Silver Creek supports a wide diversity of aquatic life and is a world-renowned trout fishery. To protect this resource, Ecosystem Sciences Foundation worked with The Nature Conservancy and local stakeholders to develop the Restoration and Enhancement Strategy for the Silver Creek Watershed in 2011. The Enhancement Strategy identified the impounded reach upstream of Purdy Dam as a top enhancement priority due to increased sediment accumulation and elevated water temperatures. The dam itself also blocked fish passage.

Following the publication of the Enhancement Strategy, The Nature Conservancy worked with multiple partners to develop a plan to replace Purdy Dam and dredge portions of Purdy Pond (upstream) to improve habitat conditions. Many stakeholders were concerned about how the restoration project might affect local macroinvertebrate communities. Healthy macroinvertebrate communities serve as an indicator of good water quality and general stream health.

Macroinvertebrates are also an important food source for trout and other resident fish species. To address these concerns, the U.S. Geological Survey (USGS) developed a study to evaluate macroinvertebrate communities before and after the channel restoration project (MacCoy and Short 2017).

Two trend sites were established in 2001 to provide base-line monitoring data. These two sites were located at the Silver Creek Nature Preserve and at Silver Creek at Sportsman Access, which is also the location of USGS Gage#13150430 - a gage that provides continuous discharge and temperature data. Five synoptic sites were also established upstream of Purdy Dam: one upstream of Kilpatrick

1 MacCoy, D.E., and Short, T.M., 2017, Macroinvertebrate communities evaluated prior to and following a channel restoration project in Silver Creek, Blaine County, Idaho 2001–16: U.S. Geological Survey Scientific Investigations Report 2017–5126, 25 p., https://doi.org/10.3133/sir20175126.

Pond in a free-flowing stretch of Silver Creek, three within Kilpatrick Pond and, one within Purdy Pond. The two trend sites also serve as synoptic sites. At all sites, macroinvertebrate samples were taken along with measurements of water depth, velocity, temperature, pH, specific conductance, and dissolved oxygen. The methods to obtain these data differed between trend and synoptic sites. For example, macroinvertebrate samples were collected from naturally occurring stream-bottom substrates at trend sites, while artificial substrates were used at synoptic sites. Trend sites were sampled once every 3 years (2001–16) in early to mid-June. Synoptic sites were sampled seasonally (spring, summer, and autumn) at all site locations in 2013, 2015, and 2016.

The following metrics were evaluated: total taxonomic richness (taxa richness); total macroinvertebrate abundance (total abundance); Ephemeroptera, Plecoptera, and Trichoptera (EPT) richness; EPT abundance; Simpson's diversity and; Simpson's evenness. A statistically significant decrease in one or more metric values following the project implementation in 2014 would indicate impairment of macroinvertebrate populations.

After establishing temporal patterns to identify impairment thresholds in macroinvertebrate communities in the years preceding restoration, trend site results found no significant decrease in any metric parameter for communities sampled in 2016 as compared to previous years. At synoptic sites, there was no significant change in total macroinvertebrate abundance from prior to restoration (2013) and post-restoration (2015 and 2016). There was also no statistically significant difference in EPT abundance, Simpson's diversity or Simpson's evenness among pre- and post-restoration sampling years. However, there was a statistically significant increase in EPT richness.

The study results indicate that the channel restoration project, which included the removal of Purdy Dam and dredging within Purdy Pond, did not negatively affect macroinvertebrate communities in Silver Creek. Additional post-project macroinvertebrate monitoring is planned by the USGS to assess long-term effects.

Mayflys (Ephemeroptera) were abundant at all monitoring sites pre- and post-restoration.

Working in Cooperation

USFS Rocky Mountain Research Station Boise Aquatic Sciences Lab

An important objective of our Silver Creek Program is to make our monitoring data easily accessible and available to anyone who would like to learn more about Silver Creek, and to add to the body of knowledge and aid in future research of Silver Creek. For that reason, the majority of our monitoring data and all of our annual reports are available online at the savesilvercreek.org website.

In early 2018, the U.S. Forest Service contacted Ecosystem Sciences Foundation about adding the continuous temperature data from Silver Creek to their extensive temperature database and interactive map, which includes over 5,400 sites across the United States. While some of our temperature data is collected seasonally (summer), many of the sites contain full year stream temperature data. All these data were provided to the U.S. Forest Service to add to their monitoring network.

The collection and mapping of this comprehensive temperature monitoring network has widespread research applications. For example, the temperature database was used to develop and update the U.S. Forest Service's Climate Shield website, which provides geospatial data that can 1) identify current locations of cold

Full Year Stream Temperature Monitoring Sites; USFS Rocky Mountain Research Station Boise Aquatic Sciences Lab

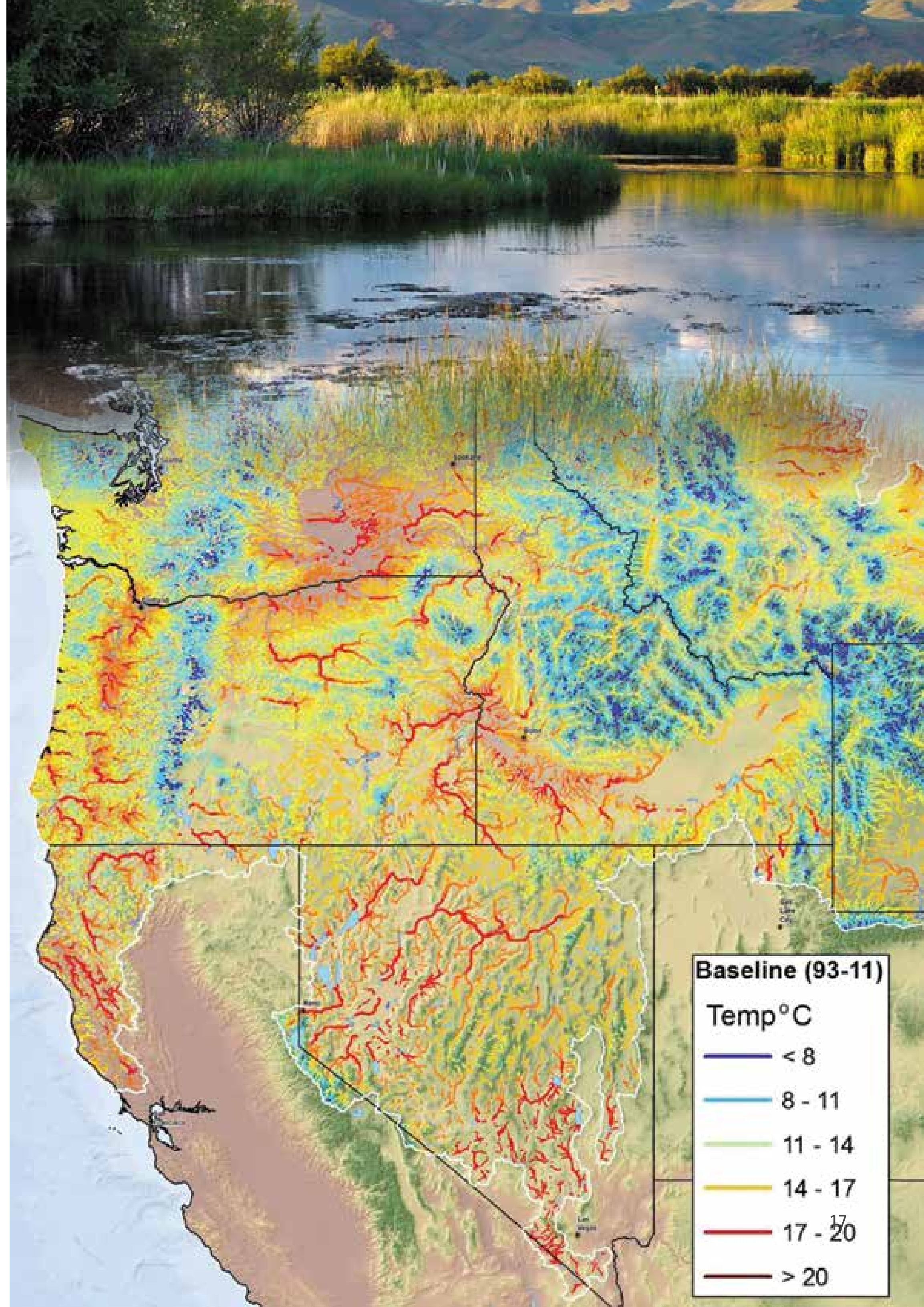
The Dynamic Mapping Tool provides a spatial index to over 5,500 sites on streams and rivers in the U.S. and Canada where full year stream temperatures are currently being monitored by numerous agencies. The primary goal is to portray a comprehensive set of sites across all agencies to facilitate data sharing and avoid redundancies, as new monitoring sites are added to the regional network. Raw temperature data are not downloadable through this site, but typically reside with the local data stewards, whose contact information is displayed by clicking on a point in the map. The map is updated once each winter to maintain an accurate description of current monitoring locations.

United States stream temperature and climate map

A Northwest United States temperature and climate map developed from data at more than 16,000 sites that was used to highlight climate refugia for mountain stream species. Credit: Dan Isaak, U.S. Forest Service

water refuge streams for native cutthroat trout and bull trout, and 2) forecast locations under varying climate scenarios that can aid in the protection of species and the prioritization of restoration activities, among other applications.

In response to this data request, ESF is considering deploying some of it's temperature monitoring loggers year-round at set locations to aid in the long-term collection of year-round stream temperature information in this area.



Next Steps

eDNA Monitoring

In partnership with the National Genomics Center for Wildlife and Fisheries Conservation, Ecosystem Sciences Foundation would like to conduct Environmental DNA (eDNA) sampling in Silver Creek and its tributaries in 2018. The collection of eDNA has become a common tool among researchers to detect the presence of macrobial species (i.e. fishes, amphibians, mollusks, crustaceans, and insects) based on the presence of their DNA in air, water and soil. The use of eDNA sampling has been found to be a simple and efficient tool for determining a species' presence in an ecosystem and is often as effective as traditional sampling techniques. Of interest, eDNA can be used to detect species that are rare, difficult to find, or are in low densities within the ecosystem. For streams, conducting eDNA sampling is non-invasive and generally involves filtering several liters of water from the area of interest and then testing for DNA signatures. This permits rapid collection of large numbers of samples, each with a high probability of species detection. In the Silver Creek watershed, eDNA sampling would be used to estimate the abundance and distribution of rainbow trout, brown trout and other fish species. This study will provide important information about Silver Creek's fish species for both conservation and recreational purposes. Please consider a donation to support this innovative project!

Fish Habitat Analysis and Mapping

Fish habitat features and redd counts were surveyed on nearly all the tributaries in Silver Creek in fall 2015 and spring 2016. However, due to lack of funding, the mainstem of Silver Creek has not been surveyed yet. ESF is seeking funds to conduct redd counts in the mainstem Silver Creek during the spring season and fall seasons in 2018. Our goal is to create a database of redd locations for brown and rainbow trout, as well as a map that identifies redd locations and delineates habitat such as: spawning areas, early rearing and nursery areas, side channels, pools, undercut banks, resting and feeding zones, and an evaluation of streambank conditions.

Monitoring and Maintenance

Over the past 7 years, the Silver Creek Program has monitored stream hydrology, water temperature, sedimentation and most recently dissolved oxygen. Combined, these parameters are indicators of ecosystem health, much like checking our own body temperature and circulatory system. Monitoring is paramount to understanding ecological processes and relationships, identifying trends and establishing effective strategies for enhancement. However, monitoring is a long term scientific tool that must be done consistently over time; the more data collected, the more meaningful the results. As our monitoring program continues, it is necessary to periodically replace temperature sensors and redeploy DO sensors, which comes at a capital cost. We are seeking additional funding to maintain our monitoring equipment and to continue these important programs.

Funding

To continue our ongoing monitoring work and perform new analyses, as described above, our Silver Creek Program needs additional funding. Our program is heavily based on monitoring and data analysis; we have found that these activities alone are rarely funded through traditional grant programs. Please consider a donation to continue this important work. A substantial volunteer effort goes into the Silver Creek program each year and your donations directly support the Program. Thank you for your support!

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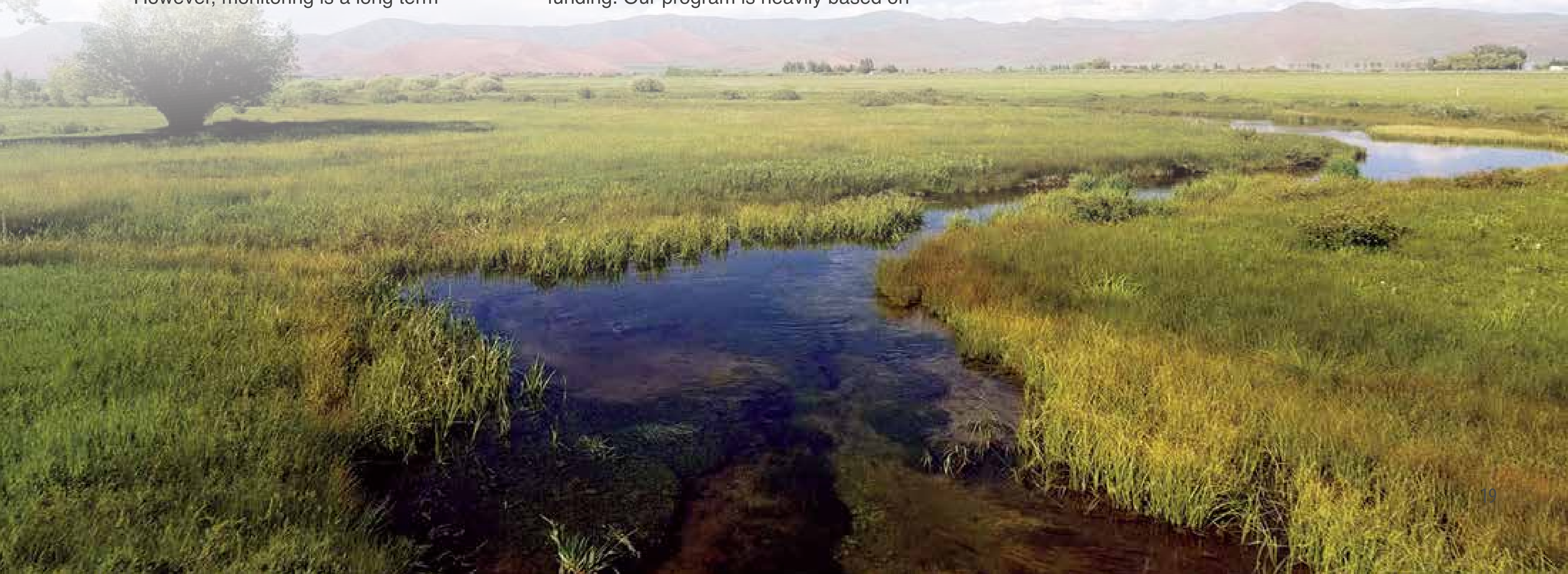

2017

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