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SILVER CREEK PRESERVE
STREAM QUALITY MONITORING EXECUTIVE SUMMARY
1991 - 1995

Prepared by:

Rob Valli, Science Intern
Ed "Mud" Watters, Preserve Manager
Silver Creek Preserve
The Nature Conservancy
P.O. Box 624
Picabo, ID 83348
(208)788-2203

The Nature Conservancy of Idaho initiated water quality monitoring of Silver Creek and its tributaries in June 1991. The knowledge gained from this monitoring is being used to identify long term trends in stream flow, water quality, and sedimentation. The information is also used to help determine where restoration projects are needed to enhance stream and water quality.

Parameters monitored include: stream flow/discharge, water temperature, dissolved oxygen, turbidity, conductivity, total dissolved solids, nitrates as N, nitrites as N, total phosphorus as P, ammonia as N, orthophosphate, sediment depths, and aquatic plant composition and cover. Data is collected in the field and water samples are analyzed in a laboratory. The information is entered into a database and summarized annually.

Study Area

Silver Creek Preserve is located approximately 30 miles south of Sun Valley, three miles west of Picabo, ID. The property owned and managed by The Nature Conservancy of Idaho comprises 845 acres. Many of the land owners in the surrounding area have granted conservation easements on their properties, increasing the total area protected and cooperatively managed by TNC to 9,466 acres, including 30 miles of stream along Silver Creek and its tributaries.

Three spring creeks, Stalker, Grove and Loving, are the primary tributaries which flow into Silver Creek **(Figure 1)**. The land surrounding these tributaries is used foremost for ranching and farming (primarily barley, alfalfa, potatoes, and canola). Due to decades of intensive agriculture, much of the watershed has been heavily impacted by grazing, field run off, eroding banks and deteriorating riparian communities. Since 1975, cooperative work with area landowners, such as fencing projects, restrictions on aerial spraying, maintaining minimum setback from stream banks and dredging sections of streams for accumulated sediments, has restored a large portion of the riparian habitat.

Silver Creek's low gradient (less than one percent), alkaline chemistry (average pH = 8.3) and relatively cool, average constant temperature (40 - 60 degrees Fahrenheit) supports a diverse and unique spring creek ecosystem. Dense aquatic plant cover and high dissolved oxygen levels provide for an ideal trout stream with an abundance of food. In addition, the riparian zone includes excellent habitat for deer, elk, waterfowl, beaver, muskrat, otter and over one hundred species of birds.

Methods

Six stream monitoring sites were placed permanently in Silver Creek and its major tributaries in 1991. Each site contains two sets of steel t-posts (set perpendicular to the current and on opposing banks) and a permanent staff gauge. A tape measure is strung tautly across the transect. All measurements are made along this line.

In the past, all stream parameters were measured throughout the year at monthly intervals. November through April monitoring periods were subsequently dropped in 1993, as was pH in 1995. The Stalker Creek Bridge site transect was moved approximately twenty feet downstream as of June 29, 1994, (to avoid trampling a particularly sensitive area). Chaney Creek was dropped as a site in 1995 due to the depth of the sediment and the inability of the sampler to access the entire transect.

In 1995 the sampling schedule was substantially changed. Years of sampling pressure had degraded the old transect sites to the point where they no longer reflected an accurate portrait of the stream. These original transects, however, are still used for the monthly velocity measurements. The staff gauge, water and air temperature, dissolved oxygen, turbidity and discharge measurements are monitored once a month from May to October at each site. Sediment depth, macrophyte cover, conductivity, total dissolved solids are monitored once a year in September. These parameters are measured at new transects 10-20 feet upstream of the old transect posts.

Sampling for each site is conducted during the same time of day to decrease variances in parameter sampling (e.g., temperature and dissolved oxygen). Stream flow/discharge is measured using a Marsh-McBirney (Model 201) Portable Water Flow Meter. Water temperature and dissolved oxygen are measured in stream using a YSI 55 Portable Dissolved Oxygen Meter. Sediment depth is measured in the stream using a probe and aquatic plant cover is measured visually along the transect. Air temperature is measured with a glass thermometer.

Three water samples are collected in polyethylene bottles at each site and analyzed in the preserve lab. A LaMotte Turbidimeter (Model 2008) is used to determine turbidity in water samples. Total dissolved solids and conductivity are measured with a Hach Conductivity/TDS Meter (Model 44600). Nitrates as N, nitrites as N, total phosphorus as P, ammonia as N, orthophosphate levels are measured twice a year by sending a water sample to Alchem Laboratories Inc. in Boise.

A detailed description of the methods is available by contacting the Silver Creek Preserve at (208) 788-2203 or P.O. Box 624, Picabo ID 83348.

Results and Discussion

Stream Flow/Discharge Levels

Peak discharge in Silver Creek generally occurs in late March and early April as a result of local snow-melt **(Figure 2)**. However, the discharge of the springs that feed Silver Creek typically peak in October due to the time it takes spring-time flows from the Wood River to recharge Silver Creek's aquifer. Although local snow-melt and surface run-off cause the highest flows in Silver Creek, these peaks do not have the duration of the September - October peak. Silver Creek's seasonal low flows typically occur in early summer before significant aquifer recharge, and when high demands are made on local water for irrigation **(Figure 2)**.

Early this summer, while the Wood River was experiencing some of its highest flows in recent history; Silver Creek water levels appeared lower than normal. On June 12, 1995, the Silver Creek site gauge read the lowest level recorded (on our limited record) at .50'. This was caused by the lack of large macrophyte beds usually seen in the river at this time, which displace a significant amount of water and give the perception of higher water levels. A late, cold, rainy Spring with many cloudy days was responsible for this paucity. The actual discharge during this period, however, was somewhat higher than past years.

Later in the season, flows peaked in late August, just before that month's monitoring survey, and remained higher than normal into winter. All sites broke their previous discharge records for the May through October monitoring periods. The majority of past gauge height records were also broken during this monitoring year. By comparing discharge, gauge height and stream width, the magnitude of this year's record discharge could be appreciated when juxtaposed with the previous eight years of drought. Because Silver Creek's discharge is influenced by an aquifer recharged by the Big Wood River, and the Big Wood experienced an unusually high discharge year, Silver Creek's 1995 record flows represent a notable year in the history of this watershed.

Water year 1992 recorded the lowest annual average discharge in Silver Creek at 107 cfs according to the USGS gage at Martin Bridge. Water year 1994 was slightly higher at 127 cfs **(Figure 3)**. 1987-1994 witnessed the lowest flows since records were first taken in the 1920's. Although this decline in discharge is related to an extended drought, Silver Creek's discharge is possibly declining more than would be expected by drought alone. This subject is currently being analyzed by Dr. Charles Brockway who is the University of Idaho's Research Professor of the Dept. of Civil and Agricultural Engineering. Summaries of his research to date are available by contacting the Silver Creek Preserve.

Water Temperature

Dissolved oxygen levels fluctuate widely late night to early morning during periods of high temperature. Low D. O. levels cause concern for fish survival. Previous years of drought compounded these concerns. With exceptionally high water levels and unseasonably cold nights in August, water temperatures remained ideal and concerns of the past two years were quickly allayed.

Based on averages for this year, the following 3 morning sites are ranked in order of coolest to warmest: Silver Creek, Stalker Bridge, Loving Creek. This follows the general trend of the last few years. Of the afternoon sites, Grove Creek was colder than Stalker Frazier in 1995 by approximately 2 degrees C. This is a reversal from the average of the last few years that indicates that Stalker Fraizer is usually averages approximately 2 degrees *colder* than Grove Creek. Overall, however, Silver Creek's water temperatures are best viewed from the perspective that they remain relatively constant compared to the average temperature fluctuations of a freestone stream.

Dissolved Oxygen (D.O.)

Dissolved oxygen levels on Silver Creek typically reach their lowest daily point just before sunrise and then immediately begin to climb after sunrise **(Table 3)**. This daily cycle reflects the balance between photosynthesis and respiration.

Oxygen concentrations are closely dependent upon water temperature. As temperatures increase, the solubility of oxygen decreases. An organism's metabolic rate and oxygen use, however, increase with temperature and, with the decrease in solubility of oxygen, can lead to dissolved oxygen crashes. Due to the abundance of plants in our system, fluctuations can be dramatic, and it is important for managers to track dissolved oxygen levels throughout these periods. On June 23, 1992, a fish kill of over 50 large trout occurred when dissolved oxygen levels reached 2.5 ppm at the Point of Rocks Fish and Game access several miles downstream of the Preserve.

During the hot and dry summer of 1994, fish kills were a serious concern again and Silver Creek's water temperature and dissolved oxygen levels were monitored closely. Dissolved oxygen fluctuated the most on June 29, 1994- from 3.2 ppm at 6:00 AM to 15.7 ppm at 4:00 pm near the Stalker Creek Bridge.[1]

Management actions taken to minimize stress on the fish, included posting signs to warn anglers of weak fish, and asking anglers to postpone fishing until an hour or two after sunrise. Fortunately, most fishing occurs mid-morning during this time of year, when the water is cool and dissolved oxygen has risen to normal levels.

The 1995 daytime dissolved oxygen levels were similar to the general trend of the last few years despite that the previous years were associated with a drought. They major difference was that there were no observed D.O. crashes in the early mornings in the summer of 1995. This can be attributed to the higher quantity of water in the system, less radiant energy, favorable ambient temperatures and less macrophyte biomass. Stalker Creek's D.O. at Fraizer Cabin, however, was lower than the past four years average levels. This corresponds to the higher temperatures recorded in that stream this year.

pH

The pH values for Silver Creek and its tributaries range from 7.5 to 9.0. This parameter has been so predictable that it was dropped in 1995. Trout and many aquatic insects and plants need long-term pH values between 6.5 and 9.0 to thrive. Silver Creek seems to provide the optimum alkalinity for these species.

Conductivity and Total Dissolved Solids

[1]These high and low data were collected separately from the monthly water quality monitoring.

The electrolytic conductivity of a solution represents the ability of water to pass an electrical current. This ability is determined by the concentration of dissolved charged molecules such as nitrate, carbonate, chloride, sodium and calcium present in the water. Organic compounds generally do not contribute to this measurement.

In Silver Creek, conductivity is used to monitor fluctuations in dissolved ions. There is a background conductivity reading due to the origin of the spring water **(Table 1)**. As water moves through the carbonate aquifer underlying the area north of Silver Creek, it picks up calcium, magnesium, carbonates and other ions. Increases in conductivity in Silver Creek would most likely be seasonal, either from spring runoff or fertilizer input. The conductivity overall is at a healthy and consistent level in the Silver Creek system.

In 1995, both conductivity and total dissolved solids (TDS) readings for all sites exceeded or rivaled past records for both parameters. These findings could possibly reflect the rate at which water passed through the aquifer and its increased ability to pick up ions.

Turbidity

Turbidity is the level of observed cloudiness in a water sample. This perception of cloudiness is caused by light being scattered by suspended solids in the water. Spring and summer of 1992 and 1994 saw minimal fluctuations in turbidity because of the lack of winter precipitation and very little spring runoff into the streams. The winter of 1992-93 experienced very heavy snowfall, provided a large spring runoff and subsequently high turbidity levels well into July.

Because of the slow flows in Silver Creek and its tributaries, there is little ability to naturally flush suspended particulate out the streams. This, coupled with a history of farming and grazing practices that degraded the riparian zone, resulted in sediment loading and high turbidity in the Silver Creek system. Many area ranchers and farmers have become more conscious of the streams and utilize agricultural practices that have less impact on the streams. These practices include maintaining a buffer zone between their fields and the water, hardening stream banks at livestock watering areas, etc.

The intense angling pressure this year also contributed to increased observed turbidity earlier in 1995. This was due to the record number of anglers wading through the silt beds. A stream etiquette sign was posted at the major stream accesses asking anglers not to wade needlessly and to use trails, and not the stream, to move about the preserve. While it is doubtful that this significantly effected sampling, it was visibly noticeable on days with heavy angling pressure and was a reoccurring complaint among anglers.

The levels of turbidity at all sites in 1995 were very similar to the averages of all turbidity data for these streams. Improved riparian management upstream of the Preserve has most likely resulted in less turbid water overall in the upper Silver Creek system, but our data does not cover enough time to depict these changes.

Sediment Depth

Sediment depth in Silver Creek and its tributaries tends to be the higher in the slower moving tributaries. Fast moving streams have a better ability to flush out sediment, whereas slow streams leave more suspended particulates on the bottom. The transects at Grove Creek and Silver Creek have the least amount of sediment depth and the fastest moving currents of our six monitoring sites. In contrast, Stalker, Chaney and Loving Creeks all have slower currents and deeper sediments **(Figure 4)**.

Significant changes in sediment depths occurred in 1993 when the stream system experienced high snow melt levels. Grove Creek underwent the most dramatic change - from 27% gravel cover in 1992 (at the transect), to 75% in 1993 **(Figure 5)**. The flush of snow melt ant the rise in discharge exposed gravel beds and improved spawning habitat by pushing plants and sediments out of Grove Creek. Other sections of stream in the Silver Creek system experienced similar changes, and several major lateral and point bars were formed and altered on the Preserve by the settling of sediments.

Aquatic Plant Cover

The greatest changes observed in bottom cover occurred in 1993 and 1995 when spring-time snow melt flushed the system **(Figure 5)**. In general, the faster moving streams (Grove, Silver and Stalker at bridge) tend to have an abundant growth of Chara, an alga that flourishes in cold, alkaline streams. Chara, which anchors itself to the substrate and is prone to rolling out during periods of high flows, influences the local distribution of sediment in the stream on a yearly basis. The slower moving portions of the system tend to be dominated by Potamogeton and other plants (Figure 6). Unlike Chara, Potomogeton is rooted to its substrate and is less likely to be swept out of the streams with lower gradients that it is associated with.

Nitrates, Phosphates, and Ammonia

Sampling for nutrients in Silver Creek began in July 1993. Water samples were analyzed for ammonia, nitrate, nitrite, ortho phosphate, and total phosphorous.

Although there is no legal water quality standard for nitrates in Idaho, the levels have been more than double the EPA guidelines of .3 and should be monitored closely in Silver Creek (Table 2). The nitrate results in July 1995, for example, were lower than the four previous monitorings, but still twice the EPA guidelines.

Total Phosphorous detected in Silver Creek has been quite variable. The first two samples taken in 1993 were below detection thresholds of 0.05 mg/L. The third sample taken on September 27, 1993, was 0.2 mg/L, or twice the EPA standard of 0.1 mg/L. The July 26, 1995 sample was .02 mg/L.

Ammonia as N was below detection levels in 1995, down from .06 last June. Ammonia is highly pH and temperature dependent and should readily convert to nitrate where sufficient oxygen is present. Nitrite as N was also below detection levels for the third year (and fifth monitoring) in a row. Orthophosphate which had been below detection thresholds at <.05, was detected at .01 in 1995 after Alchem lowered their detection threshold levels this year.

Sediment Removal Monitoring

A sediment removal project was undertaken in 1990 with the use of a suction dredge to remove accumulated sediments in the lower Chaney Creek area. The sediment, resulting from unstable banks, accumulates upstream of a human made dam. (Dams slow stream flows causing sediments to settle and accumulate instead of flushing out of the system.)

The dredging process removed approximately 60% of the sediments in 1990. By 1992, about 5% of the sediments had filled back in. Since the fall of 1992, approximately 5% has filled back in (Figure 5a). By 1995, however, site 2 on Chaney Creek had accumulated so much sediment that it was impossible to wade through the transect and the site was abandoned for the year. A control site, which was established just downstream of the dam, has essentially remained unchanged since 1990 (Figure 5b). It seems that while the dredging 5 years ago was a temporary success, the site will undoubtedly need to be dredged on a continual basis if a pond is desired and nothing is done to prevent the upstream erosion.

Additional Notes

1. Silver Creek Preserve is considering yearly bio-assays as a way to monitoring the stream in the future.

2. Adding an additional discharge site at Kilpatrick Bridge is being considered for the following reasons and may have significant ramifications on data collection in the future explained in the latter half of the following paragraphs.

All discharge measurements should be considered only a rough estimate of actual flows because lush macrophyte beds at all sites (except the Grove Creek) hinders collection of accurate data. The two main macrophyte beds found in Silver Creek are Chara and Potomogeton, and each taints results in different ways. Chara beds tend to act as current breaks and divert water around and over them, causing great variances in flows within very small distances, as the water flows through small channels between the beds. Accurate readings are best attained where there is uniform substrate and corresponding low variance between flows.

Unlike streams associated with Chara, inaccuracies in discharge estimates of streams dominated by Potomogeton stem from different reasons. At the Loving Creek transect, for example, where the entire transect was dominated by Potomogeton, the sampler felt he could not get an accurate discharge estimate because readings across the entire transect for the bottom few feet fluctuated between positive and negative numbers.[2] Protocol dictates that the sampler moves the probe up from the stream bottom until a *stable* flow reading of zero is attained. Even though it was the sampler's opinion that there was positive flow at this depth, albeit a slow one, the readings for this depth were questionable and therefore had to be discarded.

For these reasons, it would be in the Preserve's best interest to add another discharge site at the Kilpatrick bridge to corroborate the other measurements. This site could easily be monitored from the bridge, would tell how much water is passing through the most downstream boundary of the preserve, and could be used to double check the other readings (e.g., Stalker Creek + Grove Creek + Sullivan's Sluice + Loving Creek = Kilpatrick Bridge). Also Silver Creek is necked down at the bridge, has a uniform substrate, and very little vegetation below it to interfere

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[2]Velocity measurements in streams dominated by Potomogeton tend to be slower, or even negative within a foot or more from the bottom, then increase at an increasing rate progressing up the water column. Because water flows through the vegetation, and not around or over it, discharge is undoubtedly underestimated. Moreover, Potomogeton tends to cover the probe in the thick beds. If the plant material is moved away, a channel is formed and more water flows through than if no such channel was created, further tainting results.

with readings, making it one of the most accurate discharge sites on the upper Silver Creek system.

A Kilpatrick site would also make estimating the flows at other sites possible.[3] The Preserve has collected enough data to create a ratio (in cfs) relating all the sites to one another. For example, if a reading of 125 cfs was taken at Kilpatrick Bridge we could estimate (in cfs) that Stalker Creek was flowing 7 at the Fraizer Cabin site, 17 at Chaney site, 34 at the Stalker Bridge site, 55 at the Grove Creek site, 104 at the Silver Creek site, and 26 at Loving Creek site. Such a project would increase efficiency in the future by not spending time measuring discharge at each site and entering data on the computer.

All the sites should be monitored occasionally throughout the season to re calibrate the readings and to make sure that one tributary is not flowing at an abnormal rate, etc. Even if this estimating technique was used every other month, it could save a significant amount of time without compromising accuracy. This technique could also be used during the winter months to estimate flows and would only take only two hours instead of two days.

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[3]Until this time there had been no way to accurately extrapolate flows given discharge at one point. Usually discharge can be estimated based on a gauge reading. This is not possible on the Silver Creek system because fluctuations in water level are not only associated with changes in discharge, but with changes in the vegetation and sediment beds as well. The ratio technique sidesteps these past pitfalls and could provide accurate estimates for all sites in the future.