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Silver Creek Preserve

An Ecological Enhancement Strategy for Silver Creek, Idaho

Prepared by:

Ecosystem Sciences Foundation

Prepared for:

The Nature Conservancy

Protecting nature. Preserving life.

Acknowledgements

Document designed, researched and developed by Ecosystem Sciences Foundation, 2010. www.ecosystemsciences.com

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Forward

"Flowing at the base of the Picabo Hills, this high-desert spring-fed creek attracts an abundance of wildlife including eagles, hawks, songbirds, waterfowl, coyotes, bobcats, mountain lions, deer and elk. Silver Creek's globally unique aquatic ecosystem features one of the highest densities of stream insects in North America, which supports the world-class fishery.

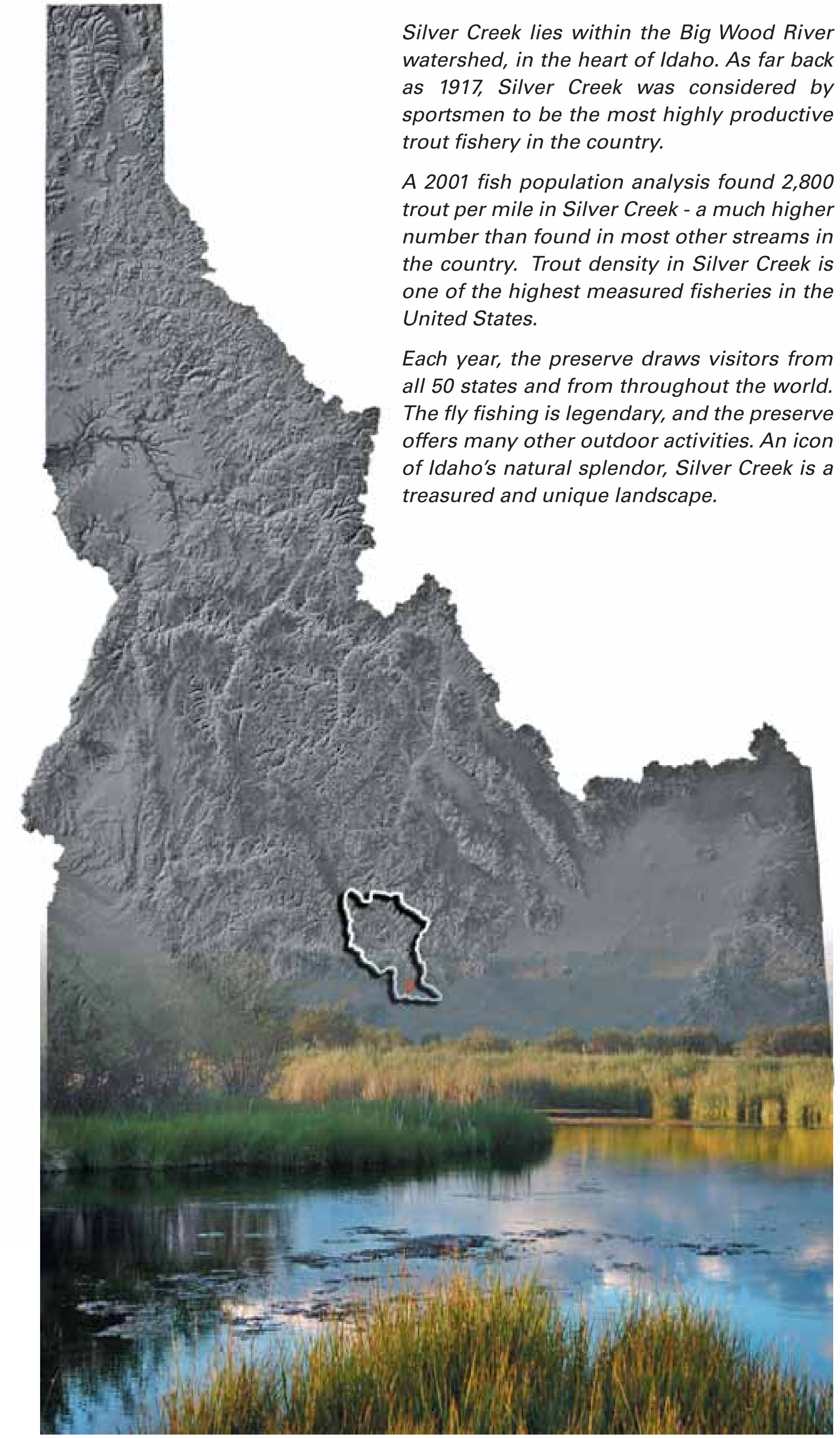
As many as 150 species of birds have been identified along the self-guided nature trail, which begins at the preserve visitor center. The Conservancy owns 883 acres along Silver Creek and has protected more than 9,500 acres through conservation easements, making this one of the most successful private stream conservation efforts ever undertaken for public benefit."

- The Nature Conservancy

This restoration and enhancement plan for the Silver Creek Preserve is the result of a partnership between The Nature Conservancy (TNC) and Ecosystem Sciences Foundation (ESF), and with valuable input from stakeholders. Funding from TNC was matched by ESF; scientists from both organizations collaborated on the development of the plan, and input from knowledgeable stakeholders was critical to understanding both current and historic land and water uses. It is hoped that this partnership will endure and continue to provide the focus and cooperation needed to implement a long-term restoration and enhancement plan.

The comprehensive plan was developed to identify areas or reaches of Silver Creek and its tributaries that most need help, and to use the restoration methods that will have the most conservation benefit. The effort will result in habitat objectives that benefit the fishery as well as many wildlife species, habitat and overall ecological health.

For the past 35 years, Silver Creek has been a successful conservation project due to community support. The enhancement plan is likewise driven by community involvement, with input from stakeholders. The public has been invited and encouraged to participate and voice their views and thoughts throughout the project.



Silver Creek lies within the Big Wood River watershed, in the heart of Idaho. As far back as 1917, Silver Creek was considered by sportsmen to be the most highly productive trout fishery in the country.

A 2001 fish population analysis found 2,800 trout per mile in Silver Creek - a much higher number than found in most other streams in the country. Trout density in Silver Creek is one of the highest measured fisheries in the United States.

Each year, the preserve draws visitors from all 50 states and from throughout the world. The fly fishing is legendary, and the preserve offers many other outdoor activities. An icon of Idaho's natural splendor, Silver Creek is a treasured and unique landscape.

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Executive Summary

The Nature Conservancy's (TNC) Silver Creek Preserve protects one of Idaho's premier streams that is renowned for its trout fishery. The preserve is a centerpiece of TNC's presence in Idaho. Under TNC's management, the preserve has recovered from a history of degradation ranging from intensive livestock grazing to overfishing. Still problems remain, and Silver Creek, Loving Creek and other streams in the watershed suffer from elevated water temperatures and heavy accumulations of sediments.

Numerous restoration actions have been undertaken in the past to ameliorate or remove some of the most pernicious conditions. Some of these interventions were more successful than others. TNC recognizes the need to address the enhancement and restoration of Silver and Loving creeks at a watershed scale rather than simply from within the preserve boundaries. Restoration planning must take upstream influences and downstream connections as well as greater ecosystem inputs into consideration. Currently, these streams are not at the threshold or tipping point at which fish kills occur or where other traumatic biological impacts will occur. Thus, there is time to allow for nature to do some of the heavy lifting, allowing for ecological processes to develop, and allowing self-organization to be the driving force.

Time is critical to any restoration project. Restoration goals are met on biological, not political, time scales. Measuring restoration success must take into account the time needed for natural processes to achieve goals. While streams are often "engineered", the measure of success comes in time and whether the restoration actions ultimately achieve the biological goals. The goals for the restoration and enhancement of Silver and Loving creeks are, ultimately, biological. Reducing temperature inputs and sediment loading, for example, has the end goal of improving habitat and water quality conditions for the trout fishery. How well the fishery responds to temperature and sediment restoration actions will not be instantaneous, but will be measured (monitored) over time.

What makes Silver Creek and its surrounding watershed so unique is that it is largely a spring driven ecosystem. Unlike most streams in the Intermountain West, Silver and Loving creeks, and all the other streams within the subbasin, are a consequence of springs emanating from the aquifer. Irrigation and precipitation do influence the ecosystem, but the streams were created by the interplay of geologic and climatic forces long before human development.

Silver Creek is decidedly unique, and as such, will require careful planning and cautious in-channel actions. This plan identifies priority sites for restoration and enhancement and provides a three-tiered approach to intervention, with the first tier representing the least cost and least disruptive methods, and each successive tier representing more cost and more in-channel actions. Most stream restoration is undertaken as a consequence of degradation in which the fishery has been decimated or extirpated. Silver Creek is quite different in that the fishery is not only present, but is also one of the highest quality trout streams in the West. Therefore, restoration must be performed so as to cause no harm or impact to a thriving, high quality fishery.

Silver Creek Preserve

Aerial Image Mosaic

Data:
Image: June 24, 2009 USDA Farm Service Agency
Image processing by Ecosystem Sciences

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THE NATURE CONSERVANCY
Silver Creek Preserve
Map 1

Mapping and analysis by:
Ecosystem Sciences Foundation

Section 1: Purpose

Overview and Background

Since 1976, The Nature Conservancy (TNC) has worked with individuals and partners to protect more than 10,000 acres of working farms, uplands, wetlands and riparian areas in south-central Idaho's rich Silver Creek watershed. The watershed includes the Conservancy's 880-acre Silver Creek Preserve, a world-class fishery located at the base of the Picabo Hills.

TNC's management efforts in the watershed have benefited habitat, improved water quality and increased land values due in part to improved recreational fishing opportunities. A recent study commissioned by the Conservancy, however, suggests that Silver Creek continues to be threatened by a wide range of stressors that include high summer water temperatures, decreased flows, and invasive species.

After years of studies, research and management lessons, TNC initiated this current planning effort to develop a comprehensive enhancement plan to guide restoration efforts. The purpose is to implement a holistic management approach at the watershed scale, so that causes of degradation or impacts are addressed rather than just treating symptoms at the stream level.

The map on page 4 shows the Silver Creek Preserve and its watershed. By virtue of its position within the watershed, the preserve is heavily influenced by land and water uses outside its boundaries. Silver Creek receives sediment and thermal loading through the numerous upstream tributaries in the watershed; up-gradient surface water diversion, groundwater pumping, and reduced spring flows also influence Silver Creek's ecological condition.

A watershed scale plan recognizes that Silver Creek, Loving Creek and other tributaries are not isolated, and the conditions of one stream or area of the watershed can influence others. Therefore, this enhancement and restoration plan is intended to look beyond the Conservancy's immediate preserve boundary and work cooperatively with adjacent landowners and other watershed stakeholders to benefit all ecosystem components.

The plan is also intended to be dynamic in that it will evolve over time in response to environmental changes. The climate and land and water uses throughout the watershed will change over time, which can present new challenges to ecosystem health as well as improve current conditions. The plan must be flexible and adaptable to meet these future challenges and conditions; as a result, the core of the plan will be a defined monitoring and adaptive management program.

Goals and Objectives

The fundamental goal is to implement a plan that will protect and enhance the Silver Creek Preserve and its greater ecosystem. Inherent in this goal is the obligation to maintain the high quality trout fishery of the preserve. Attaining this goal requires meeting immediate objectives of reducing the principal threats from sediment and thermal loading throughout the watershed, and engaging multiple stakeholders in developing a long-term vision for the management of the watershed.

Approach

The approach for Silver Creek is decidedly unique and different from other stream restoration projects, and requires very careful planning and cautious in-channel actions. Most stream restoration is undertaken as a consequence of degradation in which the fishery has been decimated or extirpated. Silver Creek is different in that the fishery is not only present, but it is one of the highest quality trout streams in the West. Therefore, restoration must be performed so as to cause no harm or impact to a thriving, high quality fishery. For example, planning and implementation must be cognizant of brown trout and rainbow trout timing. Brown trout spawn in the fall and incubation occurs overwinter with fry emergence in early spring. Rainbow trout, on the other hand, are early spring spawners with incubation into early summer (temperature dependent). This leaves a relatively narrow window in which to perform instream actions and avoid impacts to trout spawning and redd incubation. This is particularly important if the restoration action is upstream from critical spawning and early rearing habitat.

A second condition that makes Silver Creek different from other restoration projects is that it is a spring system. Silver Creek emerges as springs and inflows from Buhler Drain, Patton, Cain, Mud and Chaney creeks, which form Grove and Stalker Creeks and then Silver Creek, which is joined by Loving Creek (Brown 2000 & 2001). Silver Creek tends to rise and fall with Big Wood River flows, such that precipitation, groundwater inflow and, to some extent, irrigation, all influence the stream (Moreland 1977). Silver Creek flows begin to rise in June and peak in late summer. This reflects the lag time and influence from groundwater and overland irrigation inflow. However, the rise is minor (20 to 25% increase) when compared to Intermountain West streams in which freshet flows can be 200% higher than base flows. Nevertheless, this influence from groundwater and irrigation in late summer makes Silver Creek unique among spring systems, which generally have relatively steady year-round flows, or experience early spring highs associated with snow melt and precipitation.

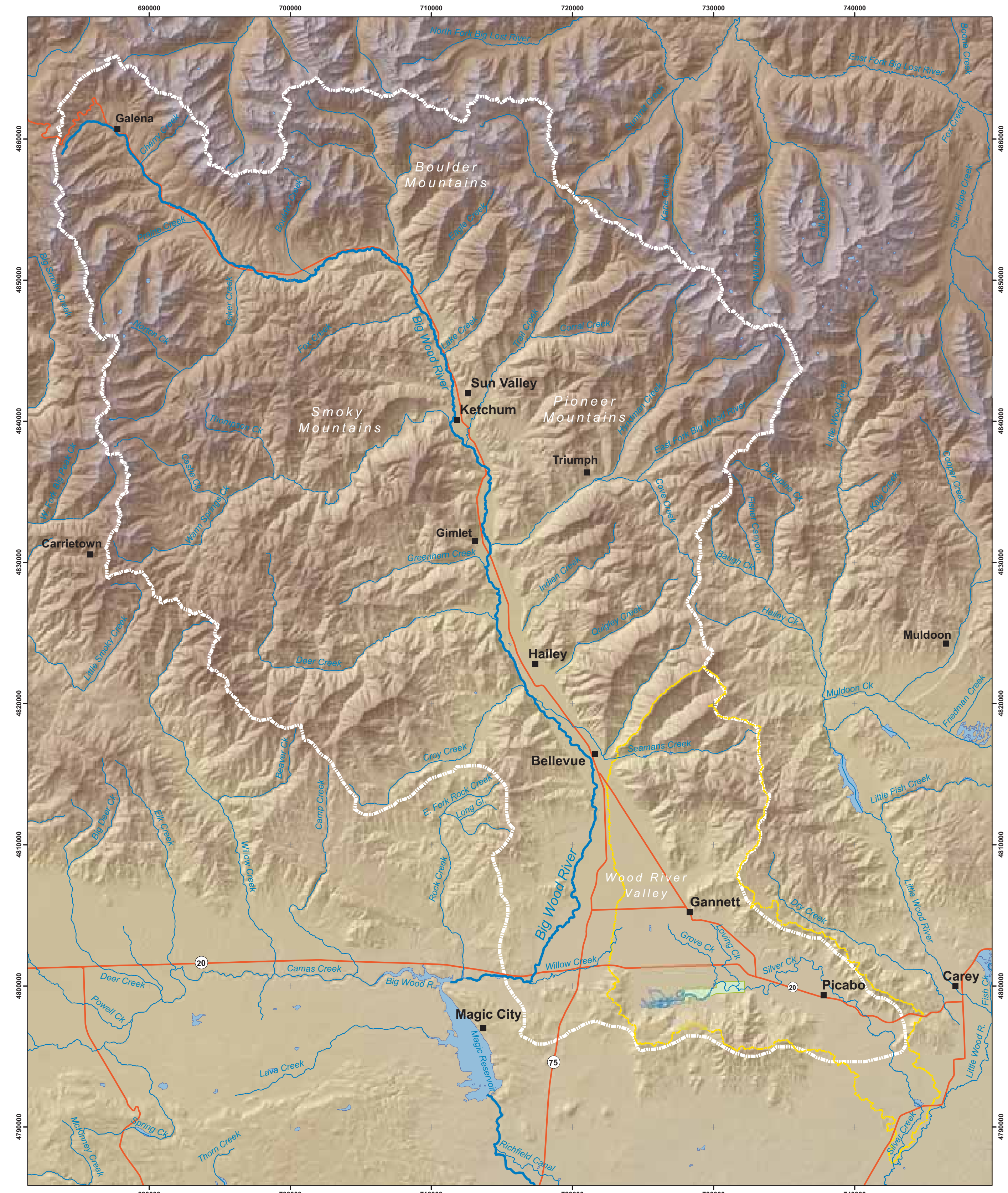
Except in extreme water years, high flows in Silver and Loving creeks lack the energy to modify geomorphic surfaces or cause excessive erosion or sloughing. In most water years, high flows rise to irrigate and promote germination of riparian vegetation on floodplain landforms. These are typical events on spring-flow streams, but because Silver Creek's natural flow pattern has been altered by external hydrological inputs, late summer high flows favor the growth of riparian species such as reed canary grass (RCG) (Phalaris arundinacea) rather than willow and cottonwood. Consequently, Silver and Loving creeks have experienced rapid expansion of RCG on floodplains and other landforms that would ordinarily support willow and cottonwood communities.

Restoration planning must take upstream influences, downstream connections, as well as greater ecosystem inputs, into consideration. Given the fact that Silver and Loving creeks are not isolated from the rest of the watershed, management must be done within a watershed perspective.

Stakeholders and Partners

The Conservancy has actively promoted developing strong ties with stakeholders throughout the watershed. Cooperation with adjacent landowners, along with the establishment of conservation easements, have been instrumental to the management of the preserve since its inception. The success of restoring and enhancing the watershed depends upon the continued goodwill and collaboration with stakeholders. Included in this effort are the various state and federal resource agencies that have provided assistance and advice over the years. Government agencies and universities have proven to be necessary and valued partners.

This plan incorporates stakeholder participation in a very meaningful and active way. It is anticipated that stakeholders will have the opportunity to provide input on recommended restoration actions as well as adaptive management decisions. The plan does not obligate any stakeholder or landowner to comply with any elements of it. Rather, it is hoped that stakeholders will recognize the value in coordinated actions that provide multiple or synergistic benefits.



Watershed Map

Big Wood River Watershed

0 1.5 3 6 9 12 Miles

Map Data:
Delineated by IDWR
Crosses divide into Little Wood River Watershed

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Legend

- City
- Rivers and Creeks
- Highway
- Silver Creek Preserve
- Big Wood Watershed
- Silver Creek Watershed

Oblique Aerial

Big Wood River Watershed

Watershed Statistics:

THE NATURE CONSERVANCY
Silver Creek Preserve
Map 2
Mapping and analysis by:
Ecosystem Sciences Foundation

Section 2: Environmental Setting and Resources

Watershed

Watersheds are bounded by a ridgeline, or elevation contour, that delimits a drainage basin, or catchment. Within each catchment ecological processes are complex and interdependent to create an ecosystem. Human intervention to divert water for agriculture, power production, flood control, etc. has altered the natural processes in many watersheds. This plus destructive land uses have degraded watersheds resulting in nonfunctioning ecosystems that increasingly are unable to provide basic and sustainable water resources.

Since water naturally flows down hill from the watershed boundary through the drainage basin, the watershed is the integrating influence for both natural and human uses and processes within each catchment. We therefore use the watershed as the natural ecosystem boundary, and the area of influence for interventions to restore ecological function and sustainable water supplies and resources. Planning and sustainable development is most effectively done at the watershed or catchment level.

Sound land use and water use management must include interventions at the watershed level, as well as at the government policy level to influence and foster improved management. Water policies must be adaptable to changing conditions and predicated on the recognition that functional watershed ecosystems are essential to sustainable development. The future of effective and sustainable water resource management demands cooperative ecosystem management by local stakeholders as well as state agencies.

The goal of sustainable watershed management is, therefore, to align human uses of resources (e.g., forestry, agriculture, water storage and diversion, hydropower, navigation) with the available water supply to sustain watershed ecological function and human activities.

Silver Creek Watershed

The Silver Creek watershed is located in south central Idaho in Blaine County. The watershed encompasses roughly 68,000 acres (USDA 1996), the majority of which supports some form of agriculture (alfalfa, barley, wheat and pasture). The Silver Creek watershed is surrounded by mountains rising 2,000 to 3,000 feet above a generally flat valley floor (USDA 1996). Elevations range from 7, 988 feet at Bell Mountain to 4,650 feet where Silver Creek confluences with the Little Wood River. Over 64% of the land in the watershed is privately-owned, while 30% is administered by the federal government (Bureau of Land Management [BLM]) and the remaining 6% lands are owned by the State of Idaho (USDA 1996).

Silver Creek is a spring driven system. The underground springs that supply the surface water in the watershed emerge primarily in the north near Gannet, Idaho, although spring vents occur throughout the watershed. Silver Creek is actually considered to be part of the Little Wood River watershed (USDA, 1996), although the waters of Silver Creek are supplied by groundwater flowing from the Big Wood River watershed. The major tributaries of Silver Creek, most notably, Loving, Grove, and Stalker creeks, merge to form Silver Creek, which then flows in a southeasterly direction towards its confluence with the Little Wood River south of Carey, Idaho.

Geology

The complex geology of the Silver Creek watershed has been influenced by volcanic eruptions, glacial activity and the Big Wood River. The watershed is located within the Big Wood River valley, which is a structural depression that has filled with sediment. More than 3 million years ago during the Pliocene Epoch the Big Wood River flowed southeast past the present town of Picabo, Idaho (USDA 1996). A basalt flow during the Pleistocene (less than 2.5 million years ago) epoch dammed the Big Wood River creating a large lake within the river valley. Over time, the lake rose in elevation, which allowed the Big Wood River to carve a new outlet to the southwest near Stanton Crossing, near its present location (USDA 1996). Subsequent basalt flows during the Pleistocene dammed the new outlet alternately causing the Big Wood River to flow to the southeast and then to the southwest. Concurrent with the basalt flows and lake formations were periods of alpine glaciation in the headwaters of the Big Wood River (USDA 1996). Glaciers advanced and retreated throughout the Pleistocene, often creating a lake in the Big Wood River Valley, and leaving coarse grained, poorly sorted materials over the valley. This sequence of events caused the deposition of alternate layers of coarse and fine grained sediments that comprise the current aquifer system (USDA 1996).

The primary soils in the Silver Creek watershed are the Little Wood – Balaam-Adamson complex, Picabo-Hapur-Bickett complex, and the Friedman-Elksel-Starhope complex (USDA 1996). The Little Wood-Balaam-Adamson complex is a very deep, well drained soil formed on alluvial slopes of 0 to 4%. This complex occurs within the northern portions of the watershed. The Picabo-Hapur-Bickett complex occurs in the southern third of the watershed and is a very deep, somewhat poorly drained soil that formed on alluvial slopes of 0 to 2%. The Friedman-Elksel-Starhope complex, found in the eastern and southern portions of the watershed, are a moderately deep soil formed in colluvium and residuum derived from volcanic rocks on slopes of 4 to 60%.

Climate

The climate in Idaho varies from west to east. Western Idaho's climate is heavily influenced by the Pacific Ocean and experiences wet winters and dry summers, while eastern Idaho experiences more Continental climatic influences, with heavier precipitation in summer than in winter (Climate of Idaho 2010). Elevation also has a major influence on Idaho's climate, with higher elevations receiving greater amounts of precipitation and lower overall temperatures.

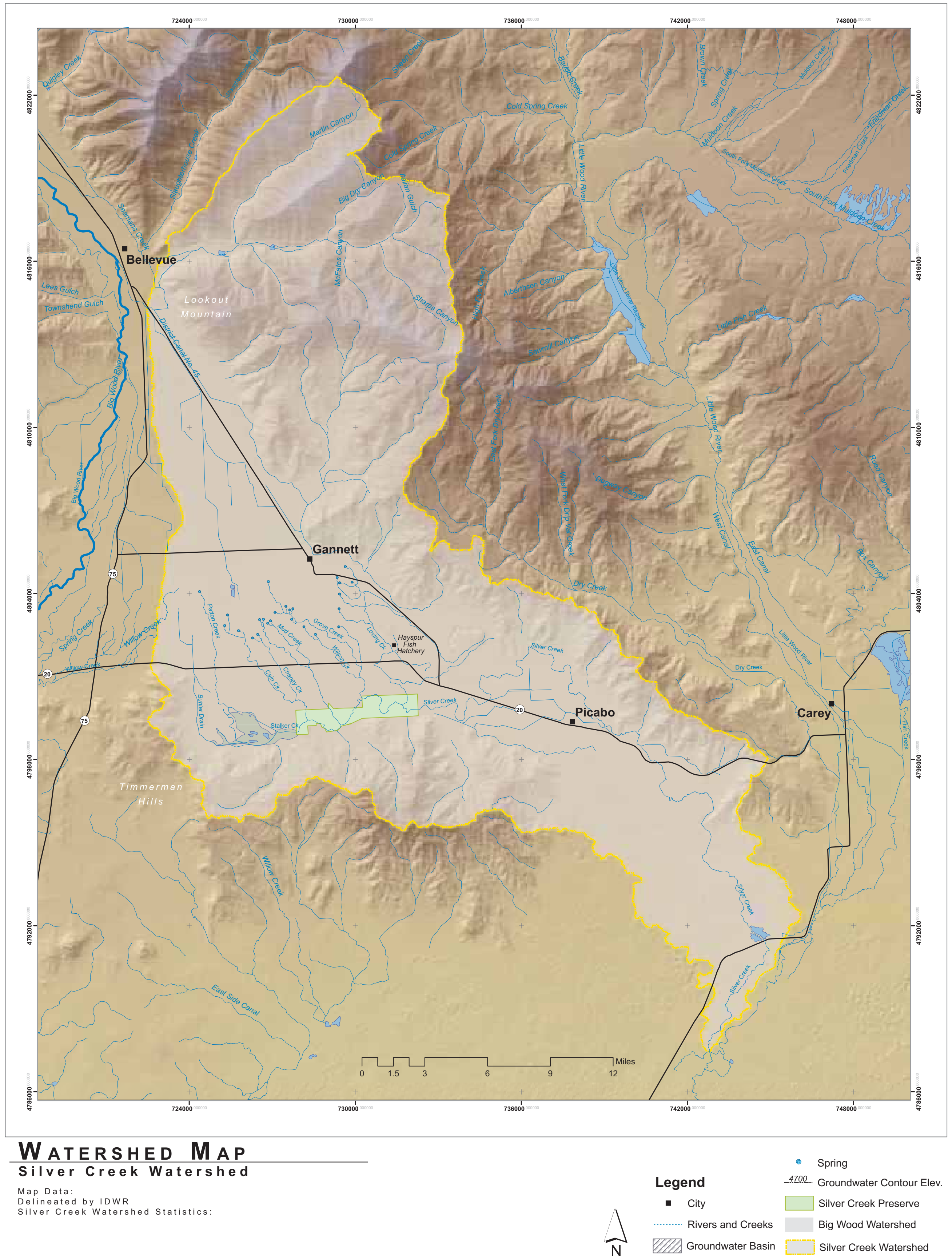
Given the Silver Creek watershed's central location in the state, it is influenced by both the Pacific Ocean and Continental climate patterns; its higher elevations also influence the climate in the watershed (a majority of the watershed occurs above 5,000 feet). The Silver Creek watershed generally experiences a 300F annual temperature variation, with an average low of 280F and an average high above 570F. Lowest temperatures occur in winter. January lows, for example, average below 100F. High temperatures occur in July with averages over 850F. Annually, the area receives 13 inches of precipitation, most of which falls from December to May—less than 20% of the total falls as snow during the winter months (PICABO, IDAHO station 107040).

Hydrology

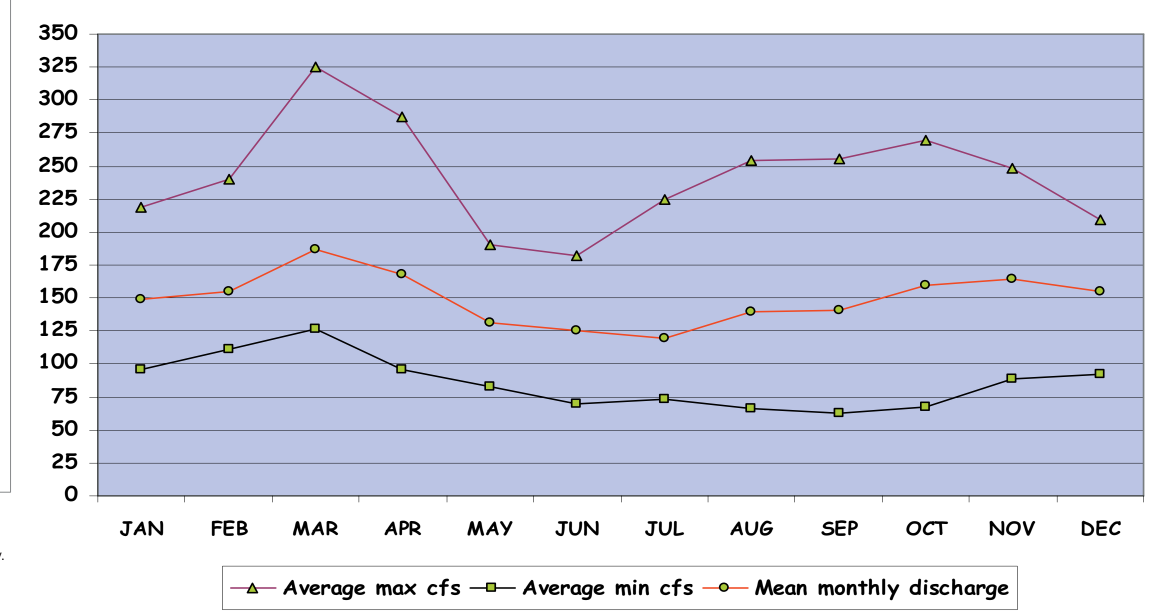
As mentioned above, Silver Creek is spring driven system. Groundwater emerges from springs and seeps throughout the watershed to form the main tributaries of Silver Creek. Groundwater within the system is recharged by subsurface flows from the Big Wood River, as well as snowmelt, precipitation and to a large extent by irrigation. Hydrographs of the Silver Creek tributaries show flows generally rising in June immediately after the irrigation season begins, and peaking in October towards the end of the irrigation season (USDA 1996). Generally, however, the flows in Silver Creek have been observed to rise and fall in proportion to the flows in the Big Wood River, which demonstrates the hydrologic link between these two systems (Brockway and Kahlown 1994; Brown 2001).

The tributaries of Silver Creek are spring-fed creeks that join to form greater Silver Creek. Stalker Creek and its tributaries Chaney and Mud creeks, emerge in the western part of the watershed and flow in a northwest-to-southeast direction. Stalker Creek encompasses roughly 52% of the overall watershed but comprises only 32% of the discharge (Perrigo 2006). Grove Creek emerges in the north part of the watershed southeast of Gannet, Idaho. Grove and its tributary Wilson Creek occupy only 26% of the Silver Creek watershed, but contribute nearly 50% of the overall flow (Perrigo 2006). Loving Creek's headwaters are located in the northern part of the watershed, where springs emerge to the east and south of Gannet. Loving Creek occupies only 22% of the watershed and contributes 27% of the overall flow in Silver Creek (Perrigo 2006).

Silver Creek and its tributaries are low gradient streams (<1%), generally dropping less than 15 feet per mile (Perrigo 2006). These low gradient streams meander through the flat Big Wood River valley at low velocities. Low gradient, low velocity streams are typical of spring driven systems in which discharge is generally constant, with only very slight seasonal changes.



Average maximum/minimum flows for Silver Creek at Sportsmans Access near Picabo (1974-2007)



Groundwater Basin Flow Contours Map
Big Wood River Watershed

Map Data:
Delineated by IDWR
Crosses divide into Little Wood River Watershed

Legend
- City
- Rivers and Creeks
- Groundwater Basin
- 4700 Groundwater Contour Elev.
- Silver Creek Preserve
- Big Wood Watershed
- Silver Creek Watershed

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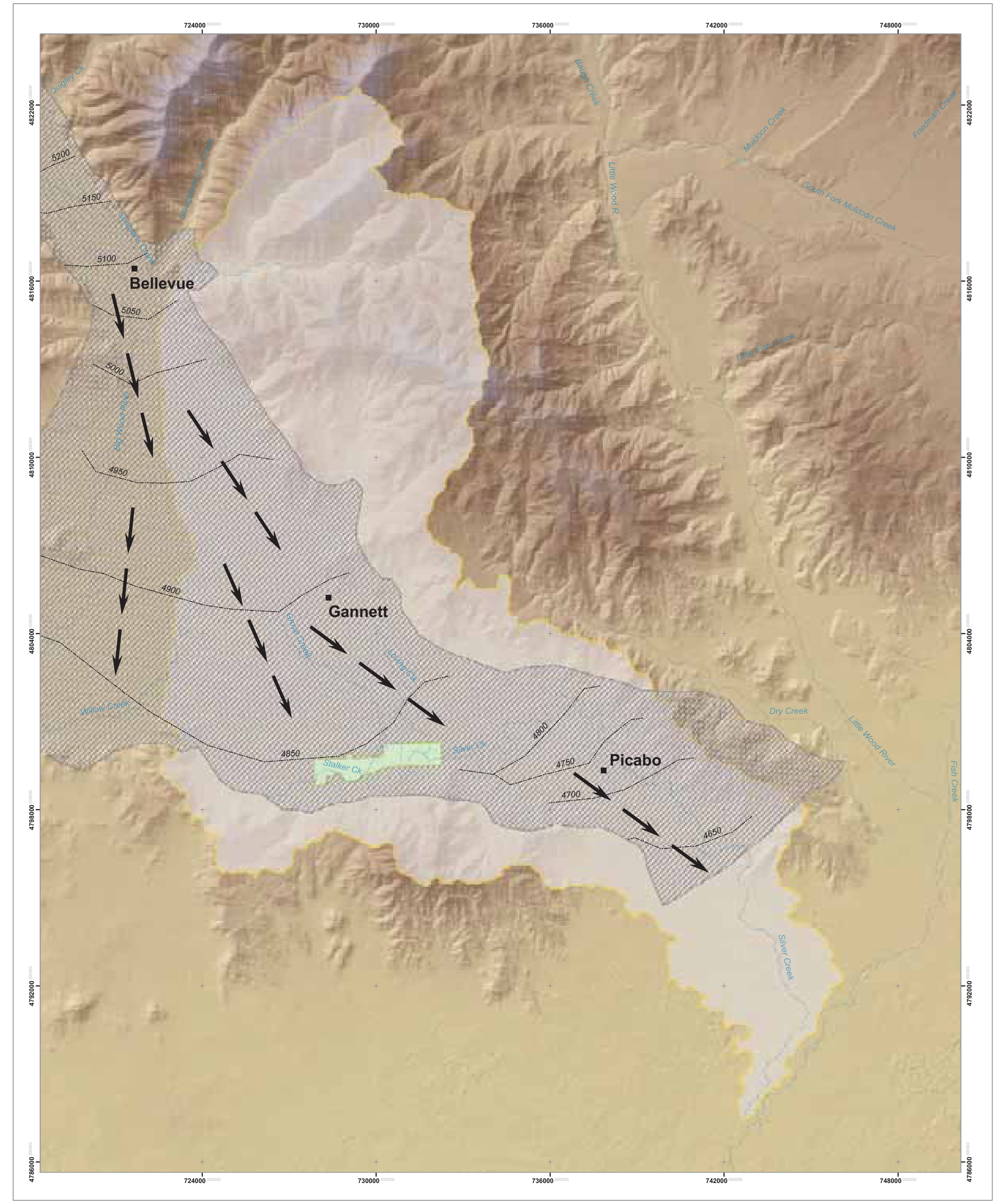


Groundwater Basin Flow Contours Map
Silver Creek Watershed

Data:

The Nature Conservancy
Silver Creek Preserve
Map 3
Mapping and analysis by:
Ecosystem Sciences Foundation

Groundwater

Groundwater is the major source of surface water within the watershed. The groundwater system that underlies the watershed is heavily influenced by conditions in the Big Wood River watershed. Generally, the source of all groundwater within the Silver Creek watershed is precipitation in the upper Big Wood River watershed (Smith 1959). This precipitation is carried off by streams, some is evaporated, and the remainder percolates into the ground. A portion of the water that enters the ground restores soil moisture, is used by plants or is returned to the atmosphere by evaporation. The water not held as moisture eventually reaches the zone of saturation and recharges the groundwater (Smith 1959). This large volume of groundwater follows the slope of the water table south underneath the Big Wood River valley towards the Silver Creek watershed.

In the northern part of the Silver Creek watershed, groundwater moves in a southerly direction, where it follows the surface drainage (USDA 1996). In the southern section of the watershed, groundwater moves in a more easterly-southeasterly direction as it moves down slope at the base of the Picabo Hills.

Groundwater levels fluctuate seasonally and rise and fall in response to recharge of and discharge from the underlying aquifer. In general, water levels rise in the late spring in response to recharge from snow melt and flood flows in the Big Wood River and continue to rise through early summer as irrigation water recharges the aquifer. Groundwater levels begin to decline in July and continue to decline into fall (USDA 1996). The maximum groundwater level fluctuations occur near the Poverty Flat and Picabo areas, where 36 and 18 feet fluctuations occur, respectively. Smaller seasonal fluctuations of less than 10 feet occur throughout the southern part of the watershed.

Landcover 1946

Pre-Settlement Period

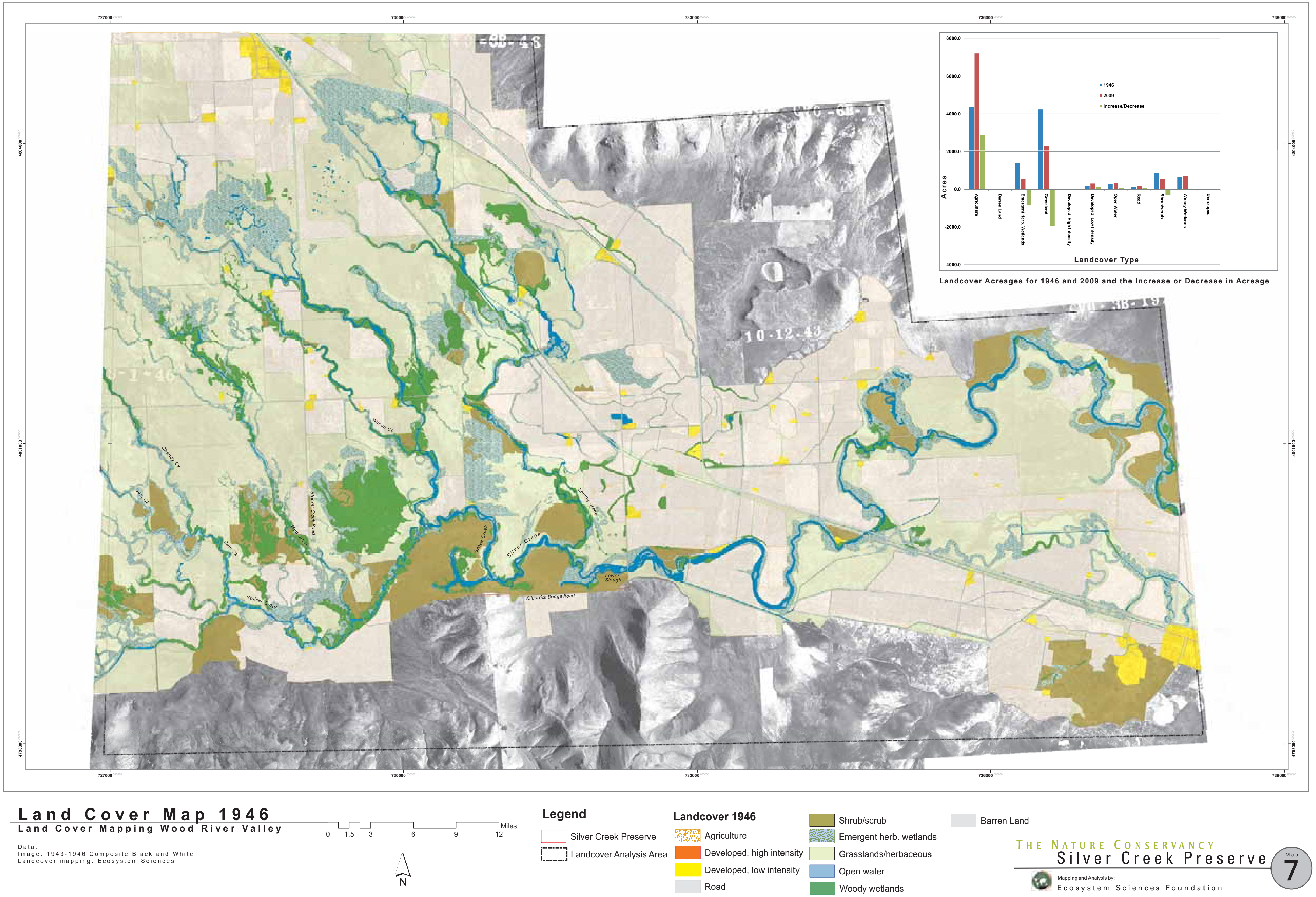
Prior to the arrival of European settlers in the latter part of the 19th century, the Silver Creek watershed is believed to have been only slightly modified by humans. Native Americans likely used the area for hunting, and utilized fire to improve habitat for their target species (Anderson et al. 1996 and Perrigo 2006). The area was likely covered in many of the same plant communities found there today (See section below), but with a higher cover and density of native species and communities (Anderson et al. 1996 and Todd 1997).

European Settlement and the Introduction of Agriculture

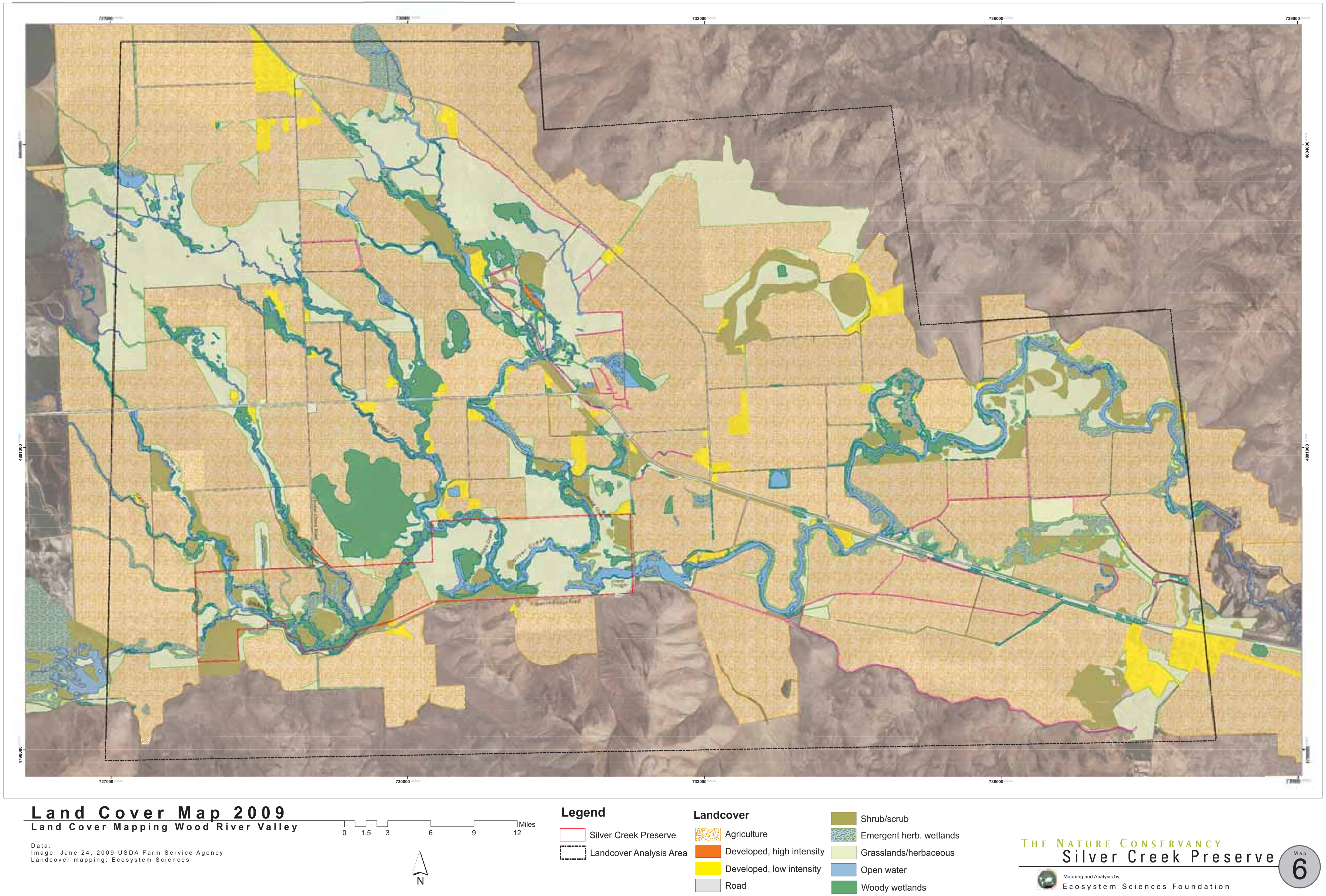
Due to investments by state and federal governments, irrigated agriculture and livestock grazing were introduced to the watershed in the 1880's (Perrigo 2006) forever changing the landscape of Silver Creek. Sheep and other livestock devastated native communities and trampled and destabilized stream banks (Anderson et al. 1996). Natural riparian communities were converted to agriculture fields, and many ditches and canals were dug across the valley. Flood irrigation was the dominant form of irrigation utilized (Brockway and Kahlown 1994). Many of the current impacts on Silver Creek and its tributaries are a legacy of these early post-European settlement land use practices (NRCS 1996).

1943-46 Conditions

As part of this watershed planning effort, land cover types were mapped using a mosaic of 1943-1946 aerial photographs based on several broad cover classes (Figure on right). Aerial photographs were not available for the entire watershed, but 12,000 acres were mapped, including the Silver Creek from its formation upstream of the TNC preserve until just north of the town of Picabo. All but the uppermost headwaters of Loving, Grove, Wilson, Mud, Chaney and Cain creeks were also mapped.



Most of Stocker Creek was not within the image area, therefore is not included in this analysis. By 1943-46, approximately one-third of the valley floor had been converted to irrigated agriculture (4351 acres). A vast network of small canals diverted water from Silver Creek's tributaries to flood irrigate these lands. Another one-third of the valley was grasslands, many of which were utilized as pasture. Springs and areas of natural vegetation had already been heavily modified from a natural condition. Human development had converted 171 acres to low-intensity urbanized areas and another 135 acres to roads. Open water covered 290 acres and the associated woody and emergent herbaceous wetlands covered 658 and 1393 acres respectively.



Landcover 2009

In order to determine the current land use patterns within the watershed, land cover types were mapped using 2009 aerial photographs (NAIP 2009, Figure to left). The same land cover types were used for this effort as were used in the 1946 effort for ease of comparison. Unlike the 1043-46 photographs, 2009 imagery was available for the entire watershed. For comparative purposes, the 12,000 acre area covered by the 1943-46 photographs was mapped first (Figure page 6). The mapping of the rest of the watershed is ongoing, and will be completed for the final draft of this document. Within the 1943-1946 image area, 7205 acres (59%) were irrigated agriculture, an increase of 2854 acres from 1943-46 conditions. Although a large network of canals still exists, the number of small canals has decreased with the conversion from flood to sprinkler irrigation. Groundwater wells and pivot irrigation systems have contributed to the increase in irrigated lands. The main crops grown on these lands are wheat, barley, alfalfa and oats (Brockway and Kahlown 1994 and Wolter et al. 1994). These new agricultural areas were converted from emergent herbaceous wetlands (838 acre decrease from 1943-46 conditions) grasslands (1966 acre decrease) and shrub/scrub areas (327 acre decrease, Graph page 6). Developed areas have also increased from 171 acres in 1943-46 to 307 acres in 2009. An additional 49 miles of roads have also been built. Open water areas increased between 1043-46 and 2009 by 51 acres to 342 acres. Several impoundments and water diversions have widened the stream channel and created several ponds. Because of conservation steps taken by farmers, the Nature Conservancy and other land owners in the watershed, livestock grazing within the stream channel has decreased dramatically. Many stream-side areas are fenced to prevent livestock from grazing on sensitive riparian vegetation and trampling stream banks.

Several stream and riparian restoration efforts have also been undertaken. Likely due to these conservation efforts, woody wetlands have increased by 29 acres from 1943-46 conditions to 688 acres, demonstrating the effectiveness of better land-use practices.

Vegetation Communities

Due to current and historic land uses, the vegetation of the Silver Creek watershed has been heavily modified from its natural state. The dominant vegetation type is agricultural fields composed primarily of wheat, barley, alfalfa and oats (Brockway and Kahlown 1994 and Wolter et al. 1994). Grasslands and emergent and woody wetland areas are a mixture of native and introduced species as a consequence of past land use. Common exotic species known to occur in the drainage include Kentuky bluegrass (Poa pratensis), orchardgrass (Dactylis glomerata), common timothy (Phleum pretense), smooth brome (Bromus inermis), fowl bluegrass (Poa palustris), Canada thistle (Cirsium arvense) and tansy ragwort (Sencio jacobaea) (Jankovsky-Jones 1997 and Gillian Associates 2007). Reed canary grass (Phalaris arundinacaeae) is common along stream banks. The origin of reed canary grass is one of debate among scientists, but its ecological impacts are not disputed: it stabilizes stream banks but forms dense monocultures decreasing species diversity. Other common grass and herb species include sedges (Carex spp.), rushes (Scirpus spp., Eleocharis spp. and Juncus spp.), bentgrass (Calamagrostis spp.), and cattail (Typha latifolia), among many others. Trees are generally found only in wetlands or at sites where humans have planted and maintain them. Common trees and shrubs found in riparian woodlands include black cottonwood (Populus trichocarpa), narrow leaf cottonwood (Populus angustifolia), willow species (Salix spp.), water birch (Betula occidentalis), dogwood (Cornus stolonifera), currants (Ribes sp.), shrubby chokecherry (Prunus virginiana), and wild rose (Rosa woodsii). Aspen (Populus tremuloides) is associated with spring wetland sites. Shrubby cinquefoil (Potentilla fruticosa) is common on wetter scrub/shrub sites while drier shrub sites are dominated by sagebrush (Artemisia spp.) associations (Brockway and Kahlown 1994 and Wolter et al. 1994).

Fisheries

Pre-Settlement Period

Silver Creek in its natural condition was one of the outstanding trout fisheries in the world. In 1854, travelers and settlers reported that Silver Creek was about 25 feet wide, 2 feet deep, and so full of trout they could hardly swim (Gillian 2007). Prior to human settlement all trout in the Silver Creek watershed were native redband trout, a variety of rainbow. When all the large marshes were functioning and the watershed was covered with native vegetation, its wildlife and fisheries were highly sought after by Native Americans. No data or information documents Silver Creek conditions in its natural state. There is little doubt the stream was much different than the condition in which it is found today.

1875 to 1947

With the advent of large numbers of livestock moving into the basin and the soon to follow agricultural practices, Silver Creek and its fishery soon become impacted. Heavy livestock impacts were evident as early as 1903. Hauk (1947) reported a much wider Silver Creek with heavily silted tributaries; however, he noted that the trout population was still high compared to other trout streams in the country. He expressed concerns that the trout fishery was in decline. To try to protect this declining fishery all the Silver Creek tributaries were closed to fishing from 1934 to 1946. Hauk (1947) reported that as far back as 1917, Silver Creek was considered by sportsmen to be the most highly productive trout fishery in the country. Even in its more degraded state, Silver Creek and its tributaries (as it is today) supports valuable productive trout fishery.

Brook trout were stocked by government agencies in the Silver Creek watershed probably by the 1920's. In 1947, brook trout were reported to be abundant in the tributaries of Silver Creek. Their numbers made up the highest percentage of trout species found. Rainbow trout were still quite abundant in Grove Creek. IDFG heavily stocked the McCloud River rainbow trout in Silver Creek from the 1920s to 1930s. In later periods the agency stocked other varieties of rainbow trout. These stocking practices are the main reason that native redband trout no longer survive in the watershed in their pure form.

1947 to 1980

Efforts were made again in 1953 to close Silver Creek to fishing because it was believed that over-fishing was causing the declining trout population. By the early 1960s, other sources were reporting a slow decline in trout populations; however this declining fishery was still unparalleled (Wiley 1977). Fishing on Stocker and Loving Creeks was reported to be good. Gebhards (1963) and Bell (1966) also pointed out declines in trout populations during the late 1950s and early 1960s. In later years, Megarale (2007) was suggesting that catch rates and size declined in 2003 and 2004.

By the early 1950s, agricultural reclamation was eliminating the huge marshes in the tributaries of Silver Creek. No data are available to determine the impacts to the trout population from these land conversions.

1980 to Date

In the 1980s, government agencies stocked brown trout in waters with direct access to the Silver Creek watershed. By 1986, brown trout made up 19 percent of the trout population in Silver Creek; this figure increased to 30 percent in 1992, 35 percent in 1993, and 60 percent in 2004—it leveled off in 2007 at 55 percent (chart bottom right). Due to this indiscriminate stocking, brown trout are here to stay in Silver Creek and are now one of the important trout species in sport fishery.

A 2001 fish population analysis found 2,800 trout per mile in Silver Creek. This is a much higher number than found in most other streams in the country. Trout density (1,573 rainbow/hectare) in Silver Creek was the highest measured for a mixed species salmonid fishery in the United States (Wilkinson 1996). Wiley (1977) reported 3 to 6 pound trout were regularly taken by fishermen.

Jack Hemmingway (personal communication) stated in 2000 that Silver Creek was now better fishing than it was in the 1930s. Brook trout, however, have fewer numbers now than when they were originally stocked over a half century before. Reports from 1952, 1953, 1970, and 1997 indicated that fishermen were averaging a catch rate of about 1 trout per hour. From 2001 to 2007, Gillian (2007) reported a decline in the trout population. It is doubtful that fishing success, per unit of time, in Silver Creek has decreased much over the past 75 years. Trout populations naturally have wide variations in year to year population size and could be the cause of the consistent reports of fish population declines.

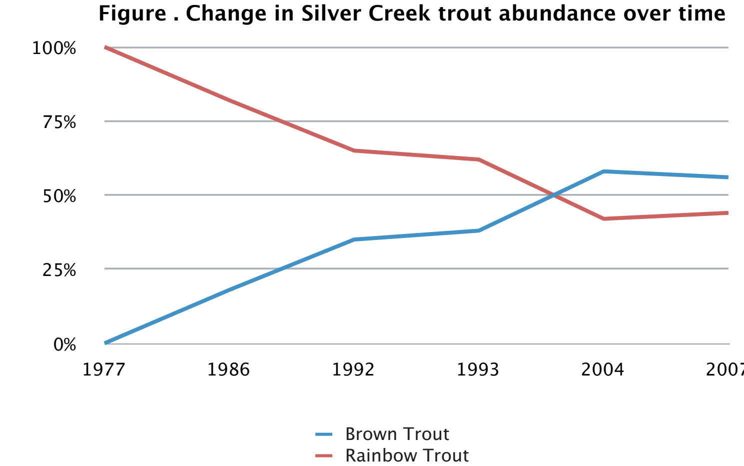
In June 1992, the first recorded trout kill occurred at "Point of Rocks" on Silver Creek. This could have been caused by low dissolved oxygen (2.5ppm), high stream temperatures, toxic inputs, a combination of these factors or unknown factors. In June 1994 a second trout kill was reported when dissolved oxygen was 3.2 ppm, but dissolved oxygen soon rose to 6 ppm. Reported fish kills in the Silver Creek watershed are quite rare to date. These small and isolated kills should not have a significant effect on population size at this time.

Wildlife

Silver Creek Preserve protects one of the last near-intact examples of a high desert cold-spring ecosystem. The Silver Creek watershed contains and supports a large variety of wildlife from hummingbirds to moose. Even though important wildlife populations thrive in the watershed and especially on the preserve, there is very little ecological information to date that describes their status or life cycle requirements.

Harsh winter conditions result in many wildlife species only seasonally using the area. Many species are transitory to the watershed and the habitat available is very valuable in providing the requirements needed for a successful life cycle. Many wildlife species like beaver, muskrats and moose are year-around residents. The large waterfowl populations have always been significant. Ducks and trout are the principal reasons the preserve is available to recreational users today. Wildlife appear to be doing well in the Silver Creek watershed today though more information on the status and requirements of the wildlife species is needed and should be prioritized by the TNC in the future.

Figure . Change in Silver Creek trout abundance over time



Section 3: Environmental Issues and Challenges

Silver Creek is located in the lower end of the watershed, and as a consequence, it is heavily influenced by up-gradient land and water uses. Silver Creek's condition on the preserve is a product of tributary inputs, which include sediments from runoff, thermal loading, nutrients, and volume (discharge). Loving Creek, a tributary of Silver Creek, is also influenced by land and water uses within its drainage area. Because Silver Creek was placed into a preserve nearly 35 years ago, the stream itself is influenced by deleterious conditions; that is to say, ecological issues in Silver Creek do not originate from within the preserve, but from the entire watershed.

This plan was developed using the available data on the tributaries, Silver and Loving creeks and other areas and ecological components throughout the watershed. While the available data is sparse and somewhat out of date, there is sufficient information (when combined with detailed analysis of current aerial imagery and mapping) to identify the sources and causes of degradation, and develop requisite restoration and enhancement interventions. The monitoring program in this plan will generate a substantial amount of data from which adaptive management decisions can be made to effectively manage the preserve into the future.

Database Summary

The database for Silver and Loving creeks was compiled by Save Silver Creek (references are provided at the end of the document). Studies have been performed in the watershed for many years and for a variety of purposes. Most studies are snapshots of conditions at a point in time; rarely were uniform studies conducted over time to provide cohesive data sets. The exception is the discharge measurements and temperature on Silver Creek, for which there are time series data.

Discharge measurements were recorded by the United States Geological Survey (USGS) at two gauging stations: Station 13150430 at the sportsman's access near Picabo from 1974 to 2002; and Station 13150500 at Highway 20 near Picabo from 1920 to 1962. The USGS has adjusted flow measurements to provide a reliable hydrologic data set since 1974. Other discharge measurements have been made by TNC at various staff gauges along Silver Creek within the preserve.

Temperature monitoring at numerous sites throughout the basin were initiated in 2006 and continued through 2009. The database was compiled from continuous data loggers at 16 locations on Wilson, Chaney, Grove, Stalker, Loving, and Silver creeks. Temperature data analysis is presented below later in this document.

While sediment data are limited, sufficient work has been performed to verify the sediment budget for Silver Creek. Other data include numerous but unrelated fisheries studies conducted since 1947. The most complete fisheries data set comes from Idaho Department of Fish and Game (IDFG) surveys. Although this database is insufficient to establish trends, it does provide insight into speciation and relative abundance and distribution.

Water resources studies include occasional water quality, sediment, and groundwater evaluations and reviews. Several restoration reports are included in the database with useful transect and sediment transport data related to Kilpatrick Pond. Invasive species studies also provide valuable information on baseline conditions for New Zealand mud snail and reed canary grass.

Data Gaps

Studies for TNC on and off the preserve have frequently been done as part of graduate school research. Other studies have been done to address specific research questions. TNC will continue to cooperate with independent research projects and studies but with encouragement to fill data gaps necessary for the management of the preserve. There are numerous gaps in the database that will not necessarily be addressed with the monitoring program, because monitoring will be focused on evaluating interventions. The most important data gaps are described below.

Tributary Hydrology and Temperature

The USGS gauging sites provide the only long-term flow measurements available. Flows in the tributaries have been estimated in a variety of ways, but there are few direct, sustained measurements of discharge in most of the streams supplying Silver and Loving creeks. Staff gauges should be installed and calibrated for the upper and lower reaches of the main tributaries and read frequently each month. Without this type of data an accurate hydrologic budget of the watershed cannot be developed. Because tributaries dictate conditions in the receiving streams (Silver and Loving), knowledge of how tributary temperatures vary is also critical. Thermal data recorders are needed in all the tributaries to monitor existing conditions and the effectiveness of interventions to reduce temperatures.

Spring Hydrology and Temperature

There has been a substantial loss of springs over time from ponding and diversion; therefore the remaining springs play a critical role in stream discharge and temperature. Also, spring flow is an indicator of groundwater conditions—increasing groundwater extraction could reduce spring discharge throughout the watershed. Spring temperatures will change as a function of change in discharge—thermal recorders are needed on the major spring locations not only to measure these changes over time, but also to provide advance warning on any sudden temperature changes or spikes.

Pond Temperatures

The available data on water heating in ponded water are very sparse, and do not indicate that water temperatures in ponds are an issue. However, it is reasonable to suspect that ponded water does heat-up; especially those ponds open to solar heating for long periods during the day. Thermal data recordings for at least one summer in representative ponds would provide the necessary insight into how significant temperature loading is in ponds throughout the watershed.

Groundwater Balance

Numerous groundwater studies have been performed in the watershed; however, these studies were performed on a coarse scale relative to Silver and Loving creek's area of influence. Consequently, TNC, in cooperation with the University of Idaho and the Technical University of Denmark, has initiated a more detailed analysis of groundwater dynamics and how it influences Silver Creek and the preserve. This study is expected to be completed in 2011. The results will also indicate the rate at which groundwater change occurs (e.g. extraction versus recharge and depth to groundwater changes).

Fish Habitat Inventory

Even though there have been many years of fish survey work on Silver Creek, the last attempt at describing fish habitat in the creek was over 25 years ago. Before any instream work is performed on Silver and Loving creeks, it is essential to perform a detailed inventory (qualitative and quantitative) of fish habitat if restoration interventions are to be effective. Without detailed knowledge of where spawning, early rearing and other critical fish habitat features are, any instream work could adversely affect fish distribution, recruitment or growth. A habitat inventory should also include identification of food sources.

Redd Survey

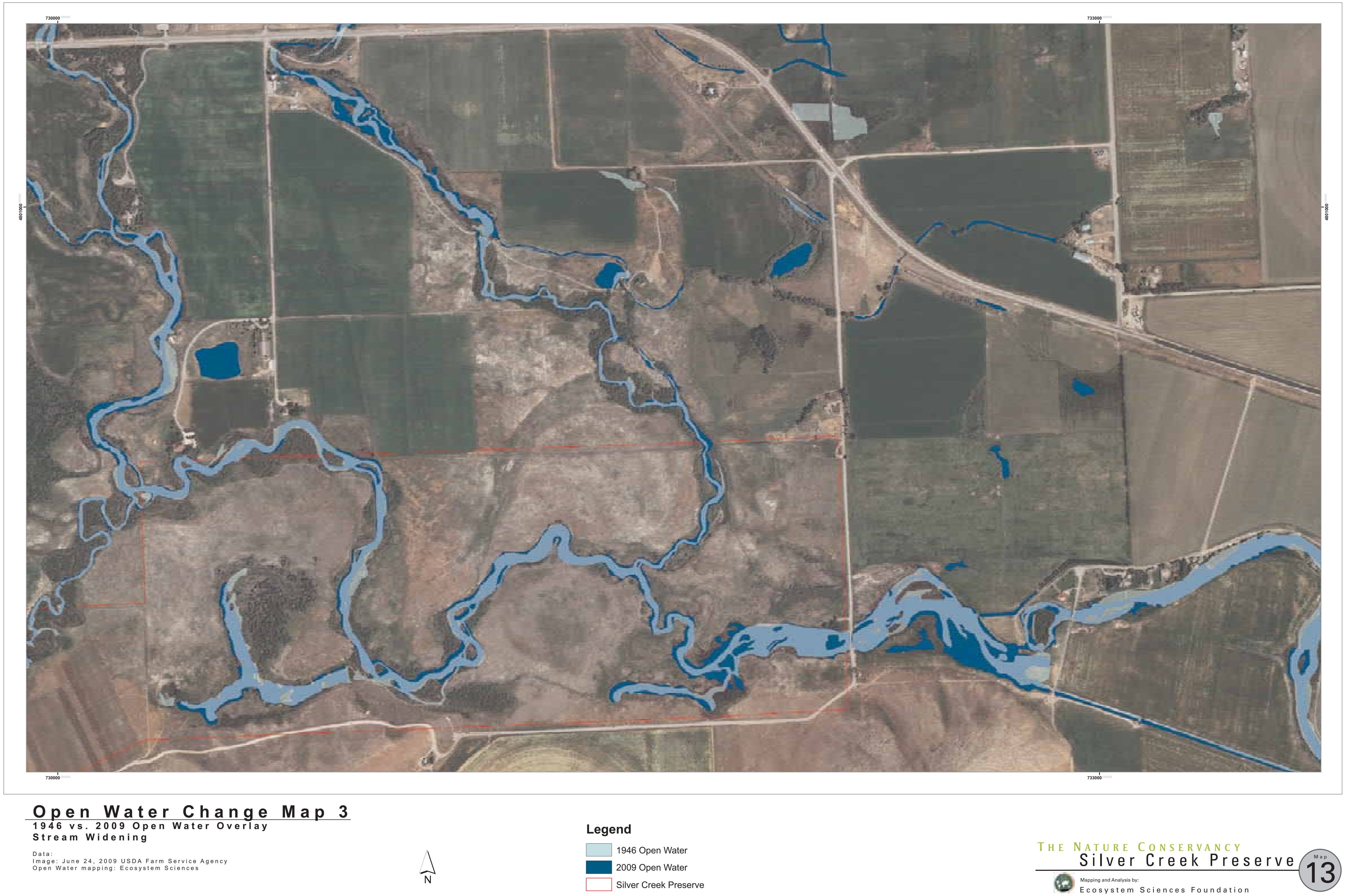
Trout appear to spawn throughout Silver Creek, using the available gravel sites. Redd surveys have not been conducted in the stream since 1988, and substrate conditions have undoubtedly changed since then because of sediment movement. Redd surveys should be conducted annually in the spring for rainbow trout and in the fall for brown trout to identify the most used and most valuable spawning sites. Redd surveys also reveal overlapping use by the different salmonid species, which is an indication of competition and the potential effect on incubation survival.

Muskrat/Beaver Habitat Inventory

Freshwater mammals like muskrats and beavers can have a profound influence on stream dynamics that includes impacts from dam building, bank erosion and loss of riparian vegetation. Both beaver and muskrat occur in the watershed. Some stakeholders have voiced concerns that muskrats in particular are responsible for bank erosion, potential sources of sediments. While mapping has not indicated significant bank erosion in the watershed, it cannot be concluded that increasing muskrat populations will not be a future issue. These animals should be surveyed every few years to track population change. The inventory should also include changes in bank conditions and in riparian habitat attributable to beaver and muskrat.

Channel Geometry

There are a few existing cross-section transects on Silver Creek and a few tributaries. However, these are too few to provide a reliable database for stream modeling. TNC has initiated a project to collect cross channel data on 100 transects on Silver and Loving creeks and tributaries. The data will include riparian zone width, channel width, average depth, thalweg, and substrate measurements. These data will be essential for future monitoring of vegetation, channel, and substrate changes.



Channel Widening Comparison: 1946 to 2009

Past land use practices have had a significant impact on the current condition of Silver Creek and its tributaries. Grazing, agricultural development, and water management practices have affected the width of the stream channels within the Silver Creek Watershed for at least the last 60 years. Current land cover mapping (based on 2009 aerial images) juxtaposed with historical land cover mapping (based on 1946 georectified aerial images) identified areas within the Silver Creek watershed where stream widening has occurred.

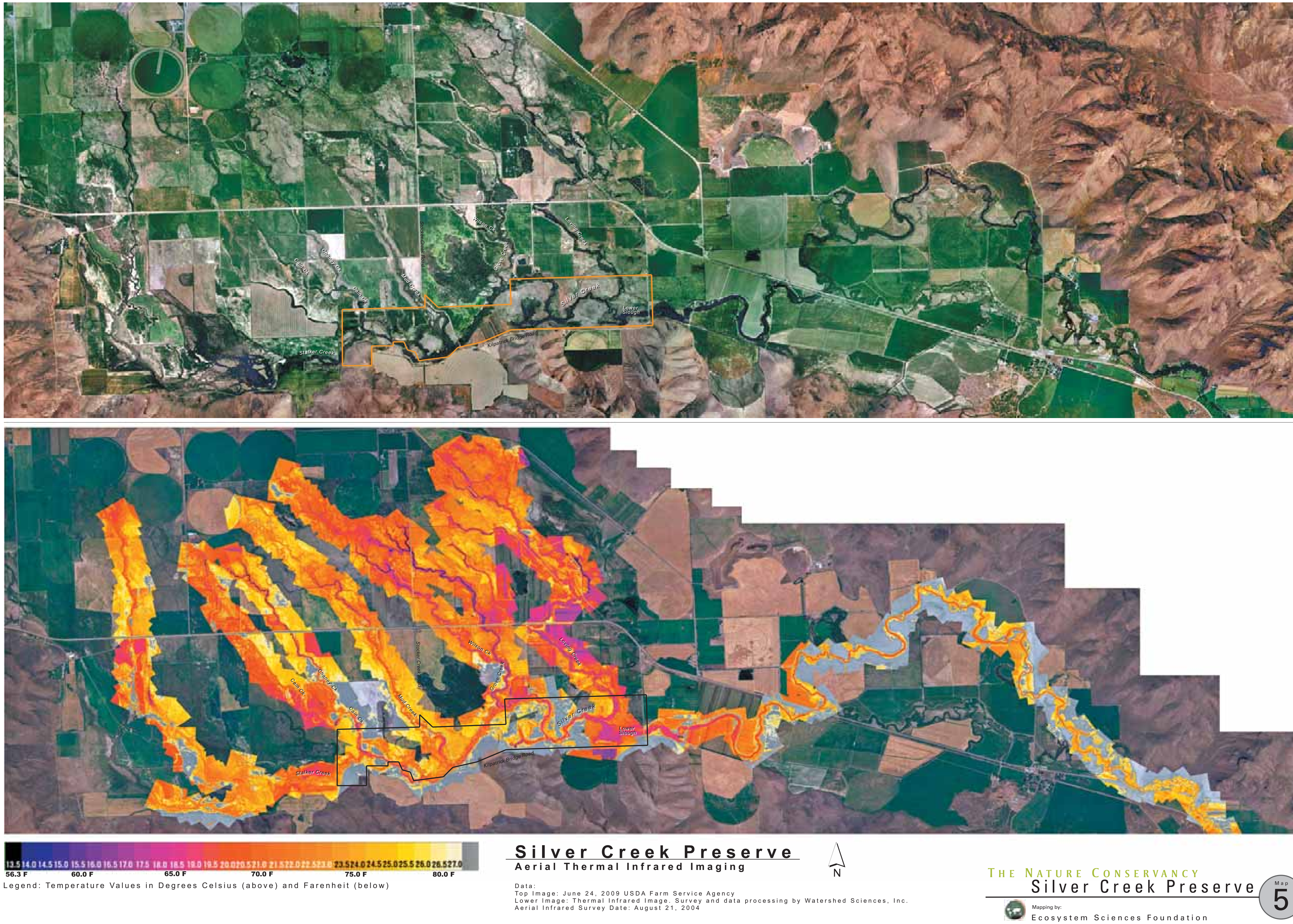
Channel widening can have deleterious effects on water quality, most notably on temperature and fish habitat (Gillian 2007). Wide channels often have little riparian vegetation and are thus subject to significant solar inputs, much like ponds mentioned above. These areas then become warmer than the surrounding stream channels that are narrower and support a more robust riparian canopy. Additionally, areas where channels have widened often have diminished flow velocities and therefore become depositional areas. Significant sediment deposits can hinder trout reproduction by covering gravel areas (redds) where salmonids reproduce (Grunder 1985).

Areas of the Silver Creek Watershed where widening was evident based on a comparison of the 1946 and the 2009 aerial images include: Loving Creek downstream of Highway 20; Grove Creek between Highway 20 and its confluence with Silver Creek; and Chaney Creek between Highway 20 and its confluence with Cain Creek.

Thermal Loading

Sediment loading also increases stream temperatures, because soil is an effective heat sink (Colby 1963). The more sediment there is in a stream, the higher the temperatures can go. The figure to the left shows the difference in temperatures between soil (land surfaces) and water—agricultural agriculture lands absorb the greatest amount of heat. However, sediments are only a contributory factor to thermal loading in streams throughout the watershed, and direct solar heating is the primary cause of temperature issues in Silver and Loving creeks. Land cover mapping illustrates the fundamental watershed challenge to stream temperature, which is lack of shading due to a lack of riparian vegetation on tributaries. A secondary cause of elevated stream temperatures throughout the watershed is the loss of springs and ponding (Perrigo 2006). Grazing at the turn of the 20th century was the primary cause of riparian vegetation loss (Grunder and Griffith 1983). Land use practices since then have inhibited recruitment of riparian vegetation and altered springs (for irrigation purposes).

Long term monitoring of stream temperatures provides reliable data for temperature profiles (Save Silver Creek, 2006-2009). The temperature charts illustrate the summer temperatures for tributary creeks and for Silver Creek from Stalker Creek to the Susie Q Ranch. As would be expected from a spring system, minimum temperatures remain relatively constant. Average temperatures in Silver and Loving creeks and their tributaries are well below the upper threshold for brown and rainbow trout and are within the preferred temperature range for all trout life stages (Bell 1990). Only the maximum temperatures, which occur for very short time periods in the evening hours, approach trout thresholds. To date, these temperatures have not had an adverse affect on the trout population, which has remained robust and healthy. However, the concern is that stream temperatures may increase in the long-term, exceeding upper thresholds for these trout species.



Ecological Tipping Points

The only recorded fish kills in Silver Creek occurred in June 1992 and June 1994 (IDFG personal communication, 2010). While the exact cause of the trout kills is unknown (extreme temperatures, low dissolved oxygen, nitrogen or sulfate saturation, runoff from agriculture lands), the events raised alarms about the health and condition of Silver Creek. Long term observations of sediment loading and temperature increases added to the concern that the Silver Creek ecosystem and its high value fishery might be in danger.

Analysis of the available data does not indicate that Silver or Loving creeks are in eminent danger of environmental collapse or that fish kills will become commonplace or that the fishery itself is adversely affected. However, it is clear that the ecosystem and Silver Creek in particular is under severe stress from watershed influences, primarily sediment and temperature loading.

The streams are approaching what can be described as "tipping points", or reaching the level at which additional stressors, such as extended drought periods, could cause rapid deterioration and have severe impacts on the fishery. Nevertheless, the ecosystem is currently far enough from the tipping points that there is sufficient time to address the causes and implement actions to move the ecosystem away from these thresholds. The actions included in this plan will not only remove the threat of Silver and Loving creeks from reaching the tipping points, but future management will ensure the long term health and sustainability of the fishery and its ecosystem.

The first priority to step the ecosystem back from tipping points is the attenuation of sediments inputs. Creating and enhancing buffer strips between agriculture fields and streams will reduce the overall sediment loading. Since it has been shown that the nexuses between fields and streams and overland runoff are the principal sources of sediment, resources and effort can be focused to interdict sediments at the source. It is not reasonable that all such priority sites identified in this plan can be remediated. It is to be expected that there will always be sediment inputs to the streams from overland runoff. However, it is reasonable that with enough site remediation work the total annual sediment loading will be reduced to the extent that output exceeds input throughout the ecosystem allowing annual export of legacy sediments.

The other priority is to improve shading on key tributaries. Those tributaries to Silver Creek identified as sources if thermal loading can be planted with riparian vegetation, which can begin shading stream areas within three years with significant thermal reduction as early as five years. This period of time for development of significant riparian vegetation is well within the time frame to step the system back from the thermal tipping point.

Section 4: Watershed and Landscape Influences

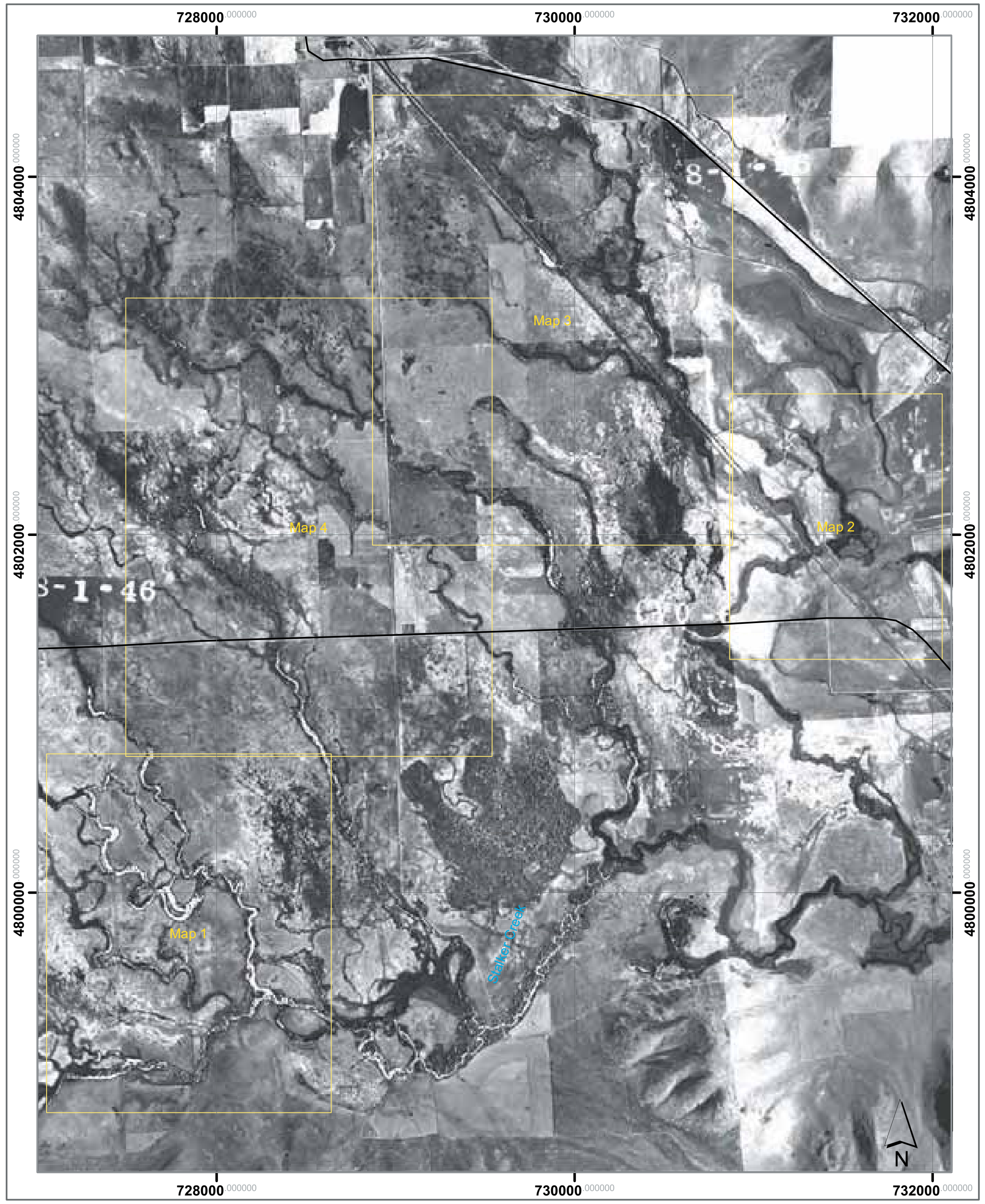
Activities within the watershed influence stream health and processes. For example, Silver Creek's bucolic setting and world class fishery make it a popular recreation destination; however, heavy fisherman traffic can reduce bank stability, mobilize instream sediments, and trample riparian vegetation. Land use patterns, especially agricultural practices, shape the landscape of the Silver Creek watershed. The conversion of lands formerly containing natural vegetation types to agricultural landscapes, influences instream temperature, sediment and nutrient levels. The method of irrigation, such as the conversion from flood to sprinkler irrigation, also influences these inputs and alters water use. Natural vegetation such as woody wetlands adjacent to streams provide shading and reduce nutrient and sediment inputs.

Stream conditions are a function of many ecological processes and are heavily influenced by activities within the watershed. This section identifies several watershed and landscape scale influences on the Silver Creek ecosystem. These influences should shape restoration and management priorities. Although many restoration efforts are focused on one reach or a small site within a reach, activities operating on the landscape scale influence ecosystem function. This section examines some of the land cover changes between 1943-46 and 2009 and addresses some major near term and long term threats, including exotic species, recreation, whirling disease, groundwater mining, urbanization and development, land use conversions and herbicide/pesticide accumulation. These selected influences will change through time, and management priorities and responses should adjust accordingly.

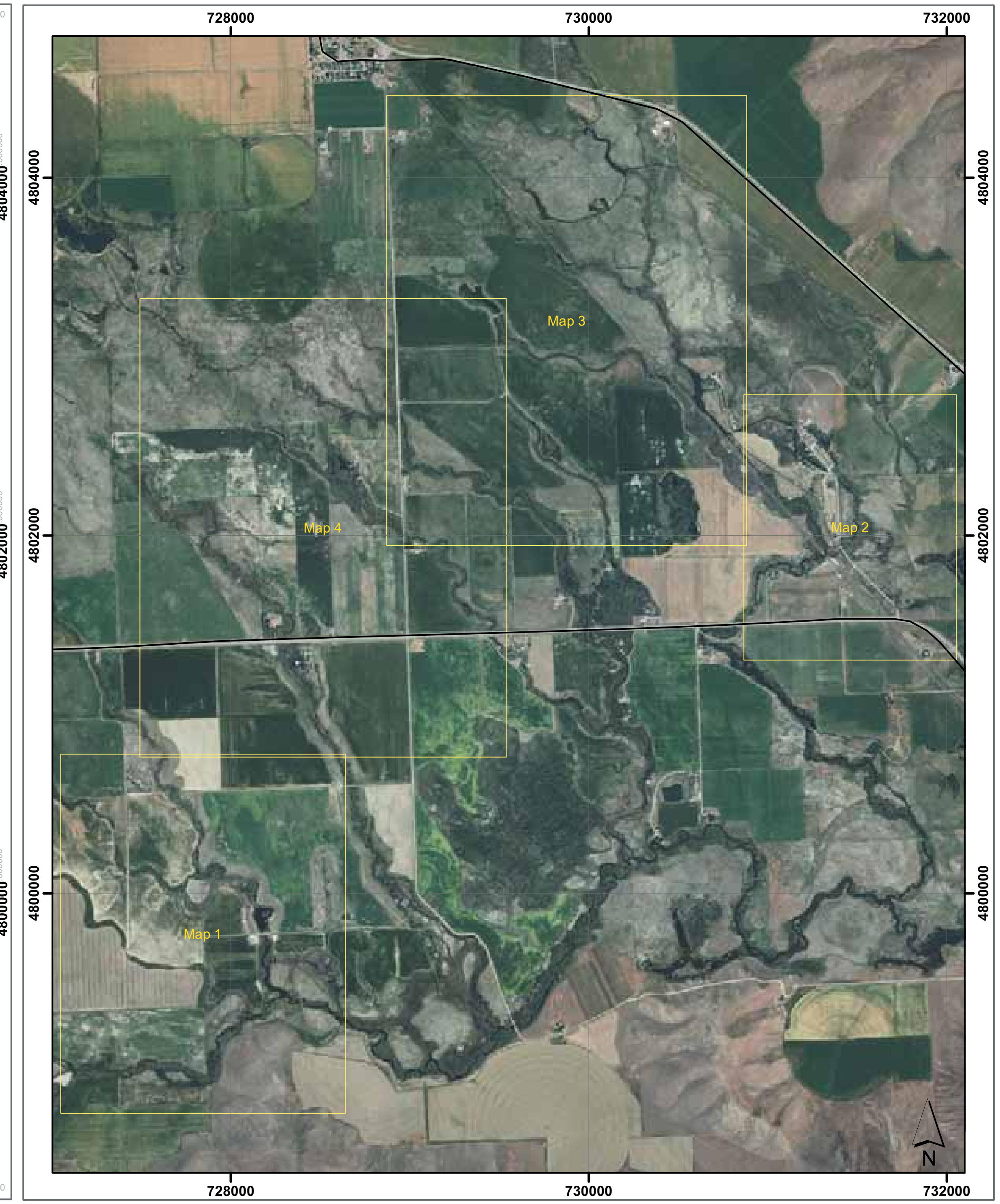
Landscape Change 1946 to 2009

The landscape of Silver Creek has changed dramatically through time. Because of a lack of information about the pre-European settlement and early agricultural period (prior to the 1943-46 photographs) only qualitative analyses may be made. However, land cover types can be mapped from aerial photographs and a quantitative analysis of land cover changes can be made over time (see Section 2 for a more detailed discussion). In general, over the past 50 years there has been an increase in irrigated agriculture areas, developed areas, roads, open water and woody wetlands, and a decrease in grasslands, emergent herbaceous wetlands, and shrub/scrub areas in the watershed. In its natural condition, woody wetlands, emergent herbaceous wetlands, grasslands and shrub/scrub areas were likely much higher than the 1943-46 or 2009 conditions. In this natural condition, open water was likely lower, and agriculture, developed areas, and roads did not exist.

Although mapping provides data which may be used to monitor trends and evaluate changes, a qualitative evaluation of side by side images illustrates a few of the changes the watershed has undergone that are not easily measured. The images to the right show Silver Creek and its main tributaries in black and white (1943-46) and color (2009). The conversion from grassland and emergent wetland to agriculture is clearly visible in this change pair. Examination of the two images shows a loss of overall habitat complexity and diversity. Many headwater emergent wetlands were drained for conversion to agricultural uses. Streams were impounded to create ponds or other water reservoirs for multiple uses. This loss of complexity affects habitat quality for species on a landscape scale, and influences ecosystem function. Many of the natural spring wetlands and tributary streams have been straightened or compartmentalized, reducing the connectivity of the system.



Silver Creek 1946 Conditions

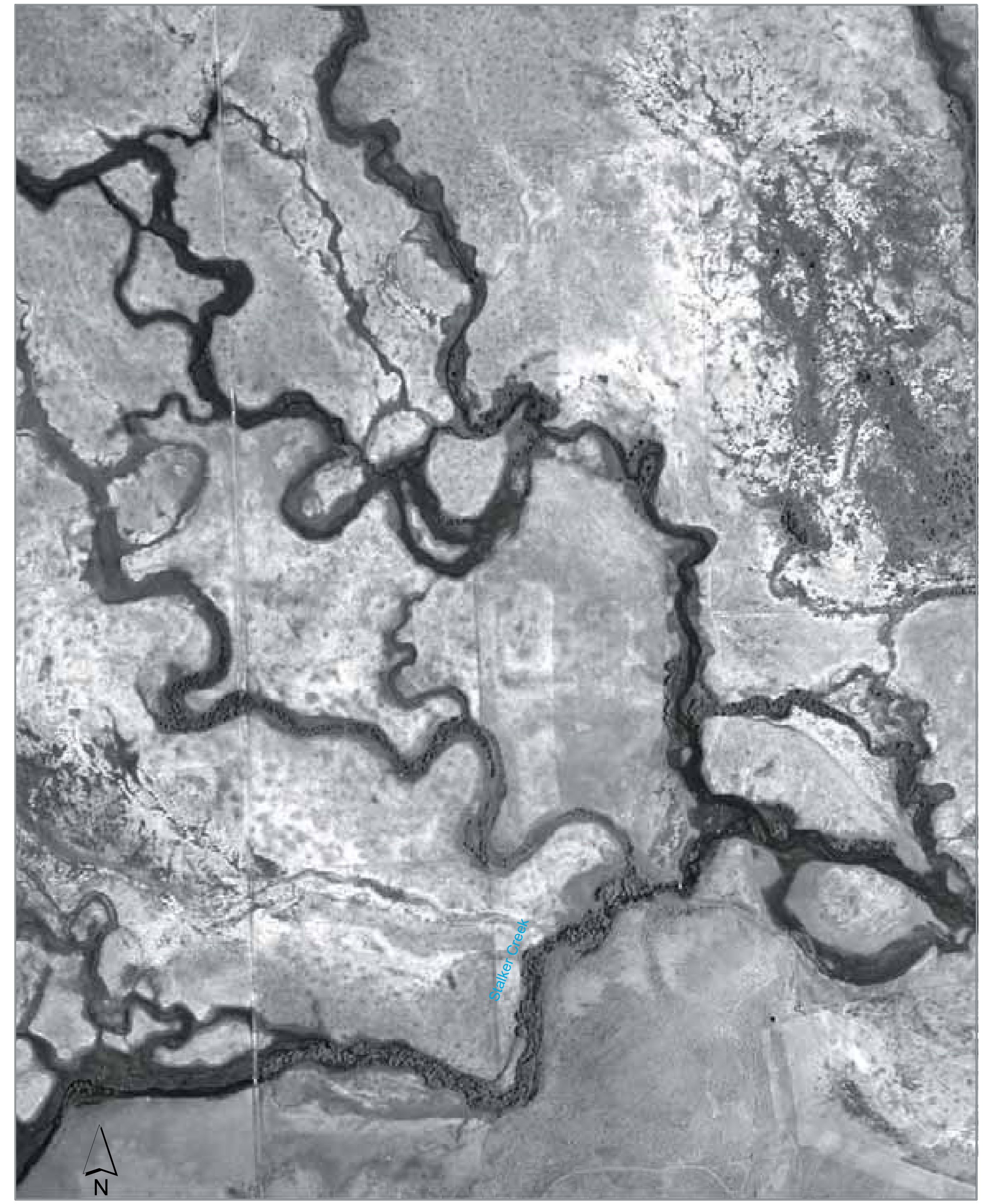


Silver Creek 2009 Conditions

Though the effects of connectivity loss are difficult to directly observe, connectivity is an important watershed component that operates on a landscape scale and is vital to the overall function and value of the watershed.

Landscape Change 1946 to 2009

Silver Creek 2009 Conditions



Silver Creek 1946 Conditions

The images to the left show portions of Stocker Creek , Chaney Creek, Cain Creek , and a small part of Mud Creek (in the upper right hand corner of each frame) in a mosaic of 1943-46 black and white images and a color 2009 image. The increase in irrigated agricultural lands is clearly visible in these finer scale images when compared to those in the figure on the opposite page (change pair 1). An increase in agricultural lands within the watershed results in accumulations of nutrients and pesticides, increased stream temperatures and sediment inputs. Also visible at this scale are areas where the channel has been straightened and has lost complexity. Areas covered by natural vegetation communities in the 1943-46 image were removed, and low-lying areas drained and filled to expand agriculture. This can clearly be seen on the right side of both images—a natural mosaic of shrub and grassland vegetation in a spring wetland area, visible in 1943-46, was converted to a straightened ditch with sparse wood vegetation along its edges, which is evident in the 2009 image. Road construction is also a clearly visible change between the two images, with the east-west road crossing Cain Creek; a wetland drain also resulted in a new pond north of the road. Finally, in the lower right hand corner of the 2009 image a new pivot irrigated field can clearly be seen.

Threats and Constraints

Near-Term / Long-Term Threats

Restoration and enhancement planning must consider not only the current ecological conditions and issues and challenges, but also recognize future threats to the health of the ecosystem and anticipate how to respond. TNC's preserve is already experiencing some chronic as well as new environmental threats. These threats either have not reached a level of significant impacts, or are still too remote to evaluate qualitatively or quantitatively. Threats are categorized as short-term or long-term depending upon how immediate the impact or risk. While there may be innumerable possibilities in the future, planning must focus on the most likely and foreseeable threats. Identifiable short-term threats to the Silver Creek watershed include non-native species invasions, whirling disease, and recreation impacts. Long-term threats include groundwater extraction, urbanization and development, land use conversions, and the accumulation of herbicides and pesticides.

Exotic Species Invasions

The most immediate exotic species threat to Silver Creek comes from the New Zealand mudsnail, which is present and spreading in some reaches (Richards and Lester 2003). While the infestation is relatively confined due to cold winter water temperatures (James 2007), the distribution and abundance of mudsnails throughout Silver Creek should be periodically monitored. At high densities, mudsnails can take over invertebrate production and eliminate the trout food source. Reed canary grass (RCG) was originally introduced to the Silver Creek watershed to stabilize streambanks (August et al., 2006). This same study shows that RCG growth has been aggressive and is now affecting streamside and instream habitat in Silver Creek, and especially in Wilson Creek. So far, interventions to remove or contain RCG have not been successful. Ultimately, the best intervention for RCG in the watershed is shading. Light attenuation is a key method in reducing RCG growth (Hitchcock 1950). There are a variety of non-native, weedy plants in Idaho that include: spotted knapweed, rush skeletonweed, leafy spurge, Canada thistle, cheatgrass, meadow and orange hawkweeds and yellow starthistle. Some of these plants have probably established and spread in the Silver Creek watershed. While these plant species are ecological and economic pests, not all non-native species are undesirable. For example, brown trout are a highly prized sport fish in Silver Creek, even though the species was introduced. Rainbow trout are also non-native (Williams and Powell 2000), yet both species fill desirable ecological and recreational roles.

Recreation

Silver Creek is an exceedingly popular recreation destination, with over 7,000 visitors a year, most of them anglers who walk the streambanks and wade in the stream. Overuse of the streambanks has caused trampling of riparian vegetation and in some places prevented recruitment of new vegetation. Intensive wading in deeper water and gravel areas where redds are less visible can damage redds and interrupt trout egg incubation; wading can also destroy aquatic invertebrates (Griffith 1988). Since the stream fishing regulation is catch-and-release, the fishery has been able to withstand intense angling pressure. However, a catch and release fishery can have high mortality and produce negative effects on growth and recruitment (Chapman 1990). Periodic fish surveys by the IDFG evaluate the fish population and age-size distribution, which guide adjustments to catch regulations. Other recreation activities such as bird watching, canoeing, and hiking have far less impact on Silver Creek's riparian system. Nevertheless, management should be aware of increased recreational uses and activities on the stream ecosystem.

Whirling Disease

Whirling disease was first detected at the Hayspur Hatchery in 1988 and in wild rainbow trout in Loving Creek in 1995. The disease is a waterborne pathogen that is deadly to trout. It is assumed that the Silver Creek trout population is infected with the disease; however, the trout population appears to be asymptomatic at this time (Wilkison 1996 and IDFG personal communication 2010).

Groundwater Mining

Groundwater pumping is a critical long term threat to the watershed and Silver Creek in particular. As the depth to groundwater increases, springs are in danger of being dried-up. A recent study by the USGS (Bartolino 2009) evaluated groundwater budgets for three periods. The study concluded that although groundwater storage is replenished in wet years, such replenishment is not complete and over the long term more water is removed from storage than is replaced. Changes have occurred in the watershed to cause a decline in groundwater storage. Causative agents include lining or abandoning canals and ditches, converting from surface water irrigation to groundwater irrigation, relocating diversion points and altering irrigation methods and efficiency.

Urbanization and Development

As the communities in the watershed grow so does water demand. Well permits have steadily climbed in relation to housing development and urbanization. Bartonlino (2009) identified increased groundwater pumping to meet urban and development demands as a contributing factor to the groundwater decline. Urbanization or growth of cities and towns in the watershed is expected to continue. While TNC's conservation easements protect the Silver Creek preserve from development, the preserve is still at risk from development throughout the watershed with its concommitment groundwater demand.

Land Use Conversions

Over time, land uses within the watershed have converted from intense livestock grazing to agriculture. Agricultural land uses have changed as well with different crops and cropping patterns. In general, the conversion of grazing to agriculture has been beneficial to the streams throughout the watershed. Nevertheless, as described in Section 5, agricultural practices in some areas of the watershed can be improved to provide greater stream protection and reduce sediment inputs and temperature loading. Land and water uses outside of the preserve have an overriding influence on conditions within Silver Creek. Consequently, land use changes throughout the watershed that involve modifications in water requirements, types of crops, or development are all important to the long term management of the preserve.

Herbicide/Pesticide Accumulation

Although there are no data to support concerns about the accumulation of herbicides and pesticides in streams throughout the watershed, both urban and agriculture runoff are recognized sources of these contaminants. Periodic monitoring of these constituents in water quality sampling would be prudent for long term management.

Section 5: Restoration and Enhancement Strategies


Aerial image mosaic and illustration by ESF. Landscape Photo credit: Flickr.com, Sam Beebe

This section describes the actions or interventions necessary to restore and enhance Silver and Loving creeks. The critical point in achieving this restoration is time. Nature restores ecosystems in biological time, not on human schedules. Regardless of whether the intervention is active or passive, time is required to ensure natural ecological processes are established.

Restoration Concepts

To achieve success in the restoration and enhancement of the streams, there are four basic requirements: (1) to understand ecosystem function; (2) to give the system time; (3) to appreciate self-design; and (4) address the causes of degradation.

Though there is currently little scientific research on the rebuilding and restoring of whole ecosystems, what works and does not work in different types of ecosystems is evident every time we rehabilitate nature's processes. Subtle ecosystem interactions are better understood when we allow nature the time to respond to the reintroduction of natural resources. Through careful monitoring of the effects of macro-scale interventions, we can then adaptively manage with confidence and use more subtle interventions at micro-scales to influence the direction of restoration efforts toward a functional and sustainable ecosystem.

Restoration and enhancement of the Silver Creek ecosystem will emphasize the "self-designing" or "self-organizing" capacity of nature to recruit species and to make choices from those species. Self-design emphasizes the development of natural habitat. Scientific knowledge in the field of ecology verifies that natural forces do ultimately self-design around habitat by choosing the most appropriate species to fill niches and establish rates of recruitment, production and growth.

Restoration Concepts, continued

Self-design allows the natural colonization of plant and animal species to attain balance and optimum biodiversity with minimal human manipulation of materials or processes. In other words, sustainable ecological restoration should not rely upon a human-built and artificially maintained ecosystem. We emphasize instead, to the greatest extent possible within the constraints of continued multiple uses, to give nature back what it needs to function and then take a hands-off approach that adapts management interventions to what nature is teaching us about what it needs to achieve a healthy balance.

Critical to any restoration project is time. Restoration goals are met on biological not political time scales. Measuring restoration success must take into account the time needed for natural processes to achieve some goals. While streams are often "engineered", the measure of success comes in time and whether the restoration actions ultimately achieve the biological goals. The goals for the restoration and enhancement of Silver and Loving creeks are ultimately biological. Reducing temperature inputs and sediment loading, for example, will meet the goal of improving habitat and water quality conditions for the trout fishery. How well the fishery responds to temperature and sediment restoration actions will not be instantaneous, but will be measured (monitored) over time.

Fortunately, Silver and Loving creeks are not at the threshold or tipping point at which fish kills or other traumatic biological impacts will occur. Thus, there is time to allow for nature to do some of the heavy lifting, allow for ecological processes to develop, and allow self-organization to occur before expensive and risky instream alternatives are proposed.

Restoration and enhancement work starts with identifying the problem(s). Too often, projects are implemented with only a focus on the symptoms, not the disease. Unless the problems that cause the degradation are addressed, restoration will have little chance of long term success. Restoration plans and actions should emphasize letting nature do the heavy lifting using as much "passive" intervention as possible. In many cases, sound water and land management actions can achieve far more benefits at considerably less cost and far less risk of doing harm than heavy in-stream construction. However, in some situations, such as incised channels or degraded steam banks, mechanical or "active" interventions may be needed. Nevertheless, these actions should be limited to the highest priority sites and designed to achieve the maximum benefit at the least cost and with minimal risk to stream biota and habitat.

Priority Sites

The principle causes of degradation in Silver and Loving creeks are from sediment and thermal loading. Other issues, as described in Sections 3 and 4, are the consequence of these causes (i.e., deposition and channel widening). Based on the available data, basin assessment and Total Maximum Daily Load (TMDL) studies, the only water quality issue at this time, is temperature. Therefore, restoration and enhancement efforts need to be focused on reducing the impacts of sediments and temperature before addressing deposition areas and channel widening.

Sediment Priority Sites

The source of sediments is overland runoff during snowmelt and precipitation events. Runoff is expected to be highest at those junctures between agriculture lands (crops and grazing) and streams that have inadequate buffering. Buffering refers to the distance and extent of vegetation between the stream bank and agricultural field, which prevents sediments from entering the stream during runoff events. While buffer widths vary depending upon site conditions, the preferred distance with dense riparian vegetation is 60 meters (200 feet) or more. The map to the right show three different levels of buffering conditions on Silver and Loving creeks and their tributaries. The highest priority sites are those with 10 meters or less buffering; the second priority are those sites with 10 to 30-meter buffers; and the lowest priority sites are sites with 30 to 60-meter buffers. Increasing the buffer widths at these sites will require TNC to work with stakeholders to set back agricultural practices from the steam banks to the extent practicable, restrict tilling, if necessary, and/or build additional fences.

Deposition Priority Sites

Sediment deposits occur throughout Silver and Loving creeks. While some of these deposits can be identified and mapped using aerial imagery, not all sites can be located and their depths and extent of sediment identified. The map in the upper right (to be completed for final draft) shows sediment deposits identified during the mapping work. These sites are intended to illustrate the general areas of deposition and the overall condition. Restoration interventions to transport or hold sediments in the ecosystem will depend upon the success of actions taken to attenuate or eliminate sediments at their source. Consequently, deposition zones will undoubtedly change in location and extent during efforts to control sources. Thus more detailed mapping and implementation of interventions should be delayed until monitoring indicates additional action is required.

Channel Priority Sites

Over-widening of the streams within the watershed has occurred, but Figure X shows that since 1946, channel widths have not increased dramatically. In addition, channel widening has not occurred uniformly throughout the streams. Widening of the channel most likely began with the introduction of livestock and slowed or ended with the conversion of land uses to more agriculture. The fundamental process of channel widening includes bank trampling by livestock as well as sediment inputs, which continuously raises steam bottoms, causing flows to push out stream banks. Even though these forces have been eliminated, the Silver Creek channel will not return to its original widths.

Artificially narrowing channel widths will have the salutary effect of decreasing cross-sectional area thereby increasing velocities and sediment transport and reducing temperatures. However, this is an extremely invasive technique with great risks to stream ecology. One alternative to channel narrowing is to reverse the process of rising stream beds by eliminating sediment inputs and allowing time for significant sediment exports, such that stream bottoms decline (deepen), causing stream banks to begin narrowing.

In the event other interventions are not effective and stream narrowing is necessary, further mapping will be needed to isolate specific channel priorities. Identification of these sites will be the first step in the development of site plans to perform such in-channel work.

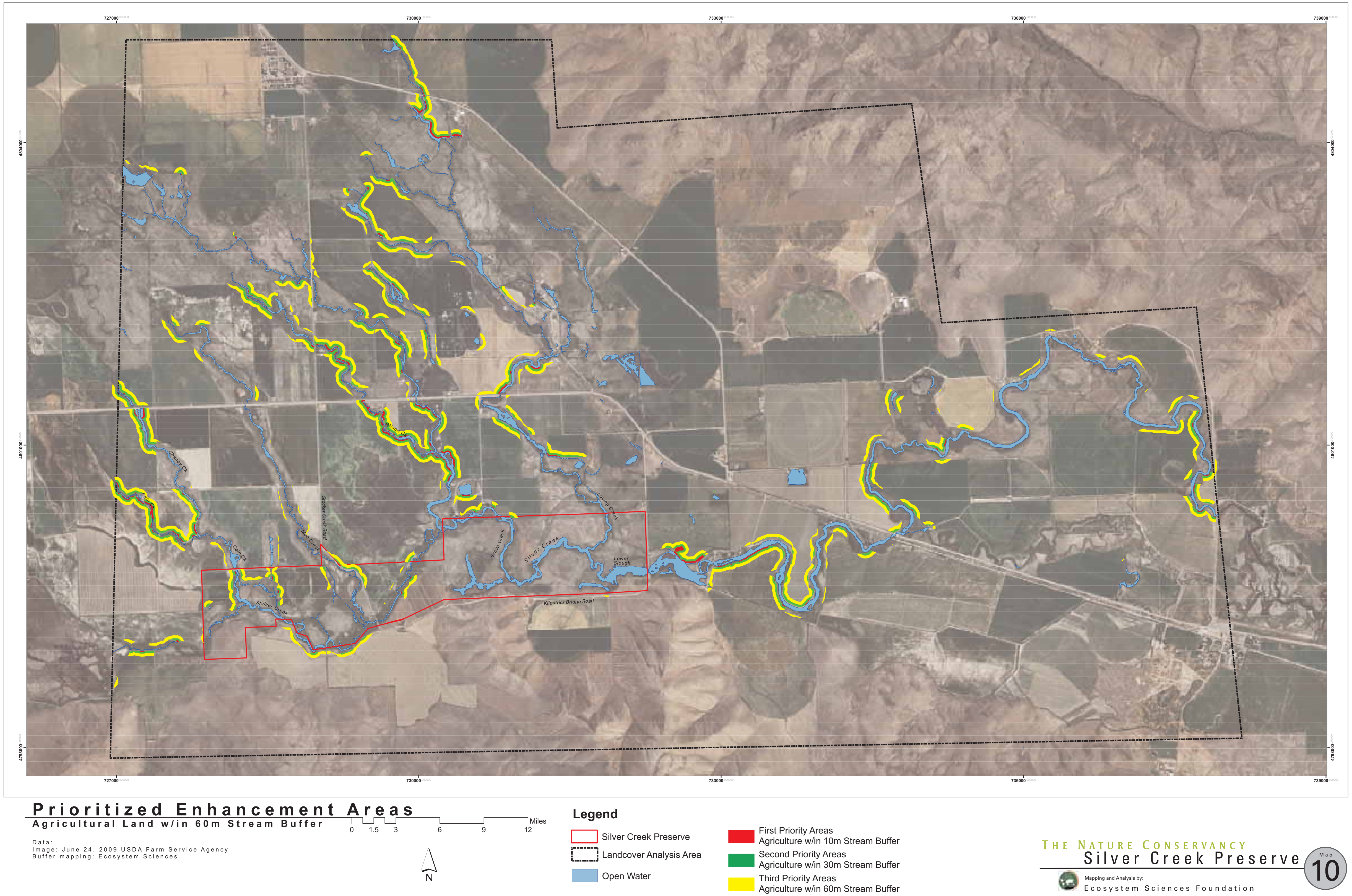
Temperature Priority Sites

The basin assessment and TMDL study performed by the Idaho Department of Environmental Quality (IDEQ) resulted in the listing of Loving Creek as impaired (due to temperatures). Loving Creek exhibits the greatest thermal loading and thus is the highest priority for restoration actions. The table displays the thresholds for canopy cover by stream reach for Loving Creek, which are necessary to reduce temperatures.

Segment	Bankfull Width (meters)	Vegetation Type	Existing Canopy Cover (%)	Target Canopy Cover (%)
Headwater to Stanfield ditch	30	Grasses, willows	0	20
Stanfield ditch to highway	20	Willow, grasses, Cattails	10-40	45
Highway to ditch	65	Grasses, willows	0	10
Ditch to mouth	48	Willows, alders, Grasses	10-40	28

IDEQ utilized the Alvord Lake TMDL to aid in selecting canopy cover targets that were based on similarities in bankfull width and vegetation type. Presumably this approach will also be suitable to define canopy cover goals for the other tributaries to Silver Creek.

The thermal map in section 3 shows the thermal profiles for the tributaries and Silver Creek. Determining which streams, in addition to Loving Creek, are the highest priorities for reducing temperatures is based upon the ratio of discharge to temperature. Using the best available data, the priority tributaries for increasing canopy cover are Stalker, Cain, Mud and Grove creeks.



Sediment Priority Areas

As mentioned above, past land use practices have had a significant impact on the current condition of Silver Creek and its tributaries. Grazing, agricultural development, and water management practices have affected the width of the stream channels within the Silver Creek Watershed for at least the last 60 years. Current land cover mapping (based on 2009 aerial images) juxtaposed with historical land cover mapping (based on 1946 georectified aerial images) identified areas within the Silver Creek watershed where stream widening has occurred.

Channel widening can have deleterious effects on water quality, most notably on temperature and fish habitat (Gillian 2007). Wide channels often have little riparian vegetation and are thus subject to significant solar inputs, much like ponds mentioned above. These areas then become warmer than the surrounding stream channels that are narrower and support a more robust riparian canopy. Additionally, areas where channels have widened often have diminished flow velocities and therefore become depositional areas. Significant sediment deposits can hinder trout reproduction by covering gravel areas (redds) where salmonids reproduce (Grunder 1985).

Areas of the Silver Creek Watershed where widening was evident based on a comparison of the 1946 and the 2009 aerial images include: Loving Creek downstream of Highway 20; Grove Creek between Highway 20 and its confluence with Silver Creek; and Chaney Creek between Highway 20 and its confluence with Cain Creek.

Section 6: Monitoring and Adaptive Management

Adaptive management is widely recognized as an intelligent, if not essential, approach to the management of natural resources under uncertainty. Adaptive management is a common element in large-scale, watershed-level, restoration projects. It can be defined as the systematic acquisition and application of reliable information to improve management over time. Thus, adaptive management depends upon monitoring to inform decision-making. How monitoring and adaptive management works is shown in the generalized model ito the right. Monitoring is implemented to evaluate trends toward a specified goal. Data is collected and analyzed to identify problems, then adaptive management options are weighed and recommendations made to implement new management actions.

Monitoring and adaptive management will be critical to the on-going management of the Silver Creek Preserve because this plan is only a conceptual beginning. Too little data are available to be certain about all watershed conditions – this is the uncertainty element. Many data gaps need to be filled, baseline conditions established, and monitoring programs implemented before more extensive or detailed plans can be developed.

It is important to remember that the preserve is not in an emergency state. The ecosystem is not in danger of exceeding tipping points in terms of sediment and temperature impacts, and there is time to allow first tier interventions to show results before more active and expensive interventions are considered and implemented.

Field Verification of Mapping

The first task when monitoring is implemented is the ground-truthing or field verification of the mapping work that has been completed. This element, while not an extensive amount of work, will result in corrections to vegetation and channel mapping that will provide greater accuracy.

Monitoring and Feedback

As shown in the figure on the right, monitoring and adaptive management is a continuous system in which information and knowledge gained is continuously fed-back into decision-making, so that over time an informed, dynamic ecosystem management program is built. Once adaptive management actions show desired results, it is usually possible to reduce monitoring effort. Once goals have been met and/or sustainable ecological conditions are established, fewer interventions will be required and, thus, less monitoring is needed.

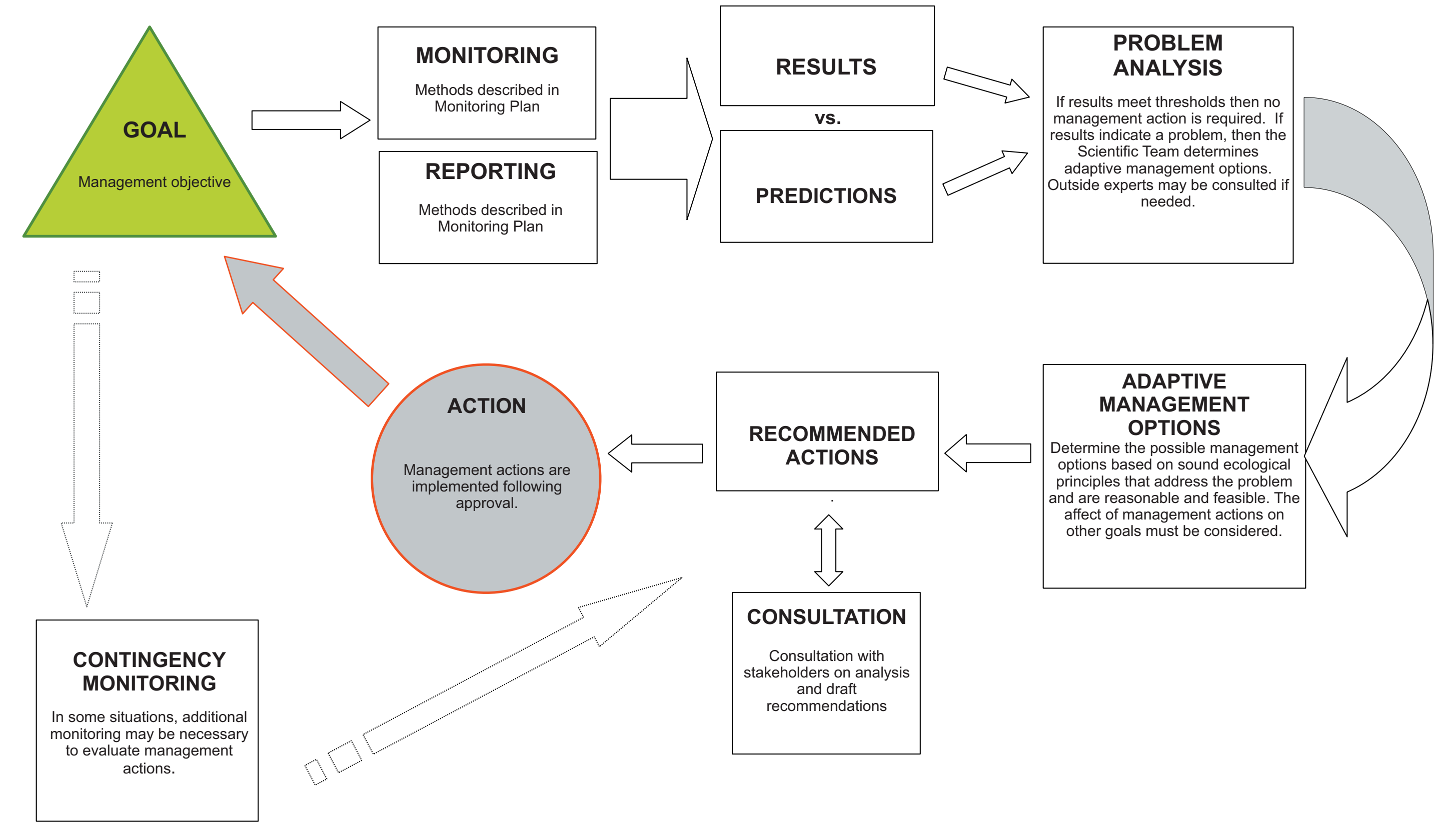
Baseline conditions will be established during the first year or two of monitoring. These will be the qualitative and quantitative metrics against which trends are measured. For example, some 100 transects are currently being monitored: riparian zones, channel depths, widths, sediment depth, and sediment distribution are being measured on all of the tributaries and throughout Upper and Lower Silver Creek and Loving Creek. In addition, TNC has initiated a cooperative groundwater monitoring and evaluation study. This element of the restoration and enhancement effort has completed all the mapping needed for establishing baseline conditions for land cover, land use, channel widths, vegetation, and other physical features. In short, TNC is well on its way to developing a robust monitoring program.

A detailed monitoring program will be described as part of a future task in conjunction with this plan. This monitoring program will evaluate and expand upon a previous study to develop methodologies to monitor spring-driven ecosystems.

Stakeholder Input

A critical part of monitoring and adaptive management is inclusion of stakeholders in the decision-making process. Stakeholders need the same information as scientists to form ideas and suggestions; however, the information must be relevant and understandable so that all participants are clear about the situations and conditions. Stakeholders often provide insight and common sense suggestions that improve adaptive management and project success. Stakeholders also usually have a vested interest in outcomes, especially if interventions directly involve their property or operations. The obvious outcome of the analysis for this plan is that the issues most affecting the preserve are outside of its boundaries. Silver Creek Preserve cannot be enhanced without the active and willing cooperation of landowners throughout the watershed.

Monitoring and Adaptive Management Pathways: Generalized Model



General Model for Adaptive Management Pathways, Feedback and Consultation.

Adaptive Management Actions

Section 5 describes the potential management actions as a tiered process. As each intervention is implemented, it must be accompanied by a monitoring program to measure whether the intervention is working and whether it is a success or failure in the long-term. As shown in the figure above, contingency monitoring is always an option to evaluate adaptive management actions or to acquire more definitive data regarding an issue. The decision to implement an intervention must be supported by the monitoring data as necessary and the best action to take. Stakeholder input is critical and success often depends upon the willingness of stakeholders to participate, including allowing access to private lands for collecting monitoring data.

Funding

The limiting factor for monitoring and adaptive management is the availability of funds. Resources are always in short supply and there is stiff competition for funds and manpower between projects. Consequently, monitoring must be highly focused and the emphasis be placed on collecting only pertinent data. Monitoring must be commensurate with management; it is not fiscally sound to collect data which cannot directly inform adaptive management. For example, using limited funds to monitor water quality constituents that are not a clear threat to the ecosystem when temperature monitoring is clearly needed and management intervention can make a difference. Also, teaming with resource agencies such as the IDFG for periodic fishery surveys, the USGS to augment flow data, or the IDEQ to assist with water quality monitoring as TNC has done in the past, is a good way to stretch limited funds. In the end, funding for monitoring and adaptive management will vary from year to year and with each funding cycle. TNC management must determine the priorities and allocate funds each year as a joint effort between stakeholders and managers.

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Silver Creek Preserve

An Ecological Enhancement Strategy for Silver Creek, Idaho

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