1. Subbasin Assessment – Watershed Characterization

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize waterbodies that are water quality limited (i.e., waterbodies that do not meet water quality standards). States and tribes must periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses the waterbodies in the Big Lost River Subbasin that have been placed on what is known as the "§303(d) list."

The overall purpose of this subbasin assessment and TMDL is to characterize and document pollutant loads within the Big Lost River Subbasin. The first portion of this document, the subbasin assessment, is partitioned into four major sections: watershed characterization, water quality concerns and status, pollutant source inventory, and a summary of past and present pollution control efforts (Chapters 1 – 4). This information will then be used to develop a TMDL for each pollutant of concern for the Big Lost River Subbasin (Chapter 5).

1.1 Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water Pollution Control Federation 1987). The act and the programs it has generated have changed over the years as experience and perceptions of water quality have changed. The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to insure "Swimable and fishable" conditions. This goal, along with a 1972 goal to restore and maintain chemical, physical, and biological integrity, relates water quality with more than just chemistry.

Background

The federal government, through the U.S. Environmental Protection Agency (EPA), assumed the dominant role in defining and directing water pollution control programs across the country. The Department of Environmental Quality (DEQ) implements the CWA in Idaho, while the EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Section 303 of the CWA requires DEQ to adopt, with EPA approval, water quality standards and to review those standards every three years. Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish TMDLs for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the waterbodies to meet their designated uses. These requirements result in a list of impaired waters, called the "§303(d) list." This list describes waterbodies not meeting water quality standards. Waters identified on this list require further analysis. A subbasin assessment and TMDL provide a summary of the water quality status and allowable TMDL for waterbodies on the §303(d) list. The *Big Lost River Subbasin Assessment and TMDL* provides this summary for the currently listed waters in the Big Lost River Subbasin.

The subbasin assessment section of this report (Chapters 1 – 4) includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in Big Lost River Subbasin to date. While this assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a waterbody and still allow that waterbody to meet water quality standards (Water quality planning and management, 40 CFR 130). Consequently, a TMDL is waterbody- and pollutant-specific. The TMDL also includes individual pollutant allocations among various sources discharging the pollutant. The EPA considers certain unnatural conditions, such as flow alteration, a lack of flow, or habitat alteration, that are not the result of the discharge of a specific pollutants as "pollution." TMDLs are not required for waterbodies impaired by pollution, but not specific pollutants. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several waterbodies and/or pollutants within a given watershed.

Idaho's Role

Idaho adopts water quality standards to protect public health and welfare, enhance the quality of water, and protect biological integrity. A water quality standard defines the goals of a waterbody by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

The state may assign or designate beneficial uses for particular Idaho waterbodies to support. These beneficial uses are identified in the Idaho water quality standards and include:

- Aquatic life support – cold water, seasonal cold water, warm water, salmonid spawning, modified
- Contact recreation – primary (swimming), secondary (boating)
- Water supply – domestic, agricultural, industrial
- Wildlife habitats, aesthetics

The Idaho legislature designates uses for waterbodies. Industrial water supply, wildlife habitat, and aesthetics are designated beneficial uses for all waterbodies in the state. If a waterbody is unclassified, then cold water and primary contact recreation are used as additional default designated uses when waterbodies are assessed.

A subbasin assessment entails analyzing and integrating multiple types of waterbody data, such as biological, physical/chemical, and landscape data to address several objectives:

- Determine the degree of designated beneficial use support of the waterbody (i.e., attaining or not attaining water quality standards).
- Determine the degree of achievement of biological integrity.
- Compile descriptive information about the waterbody, particularly the identity and location of pollutant sources.
- When waterbodies are not attaining water quality standards, determine the causes and extent of the impairment.

1.2 Physical and Biological Characteristics

Setting and Topography

The topography of southern Idaho is varied and dramatic. The fundamental reasons for this diversity are geological: the recency of volcanism and uplift of ranges along normal faults. This rough topography reflects a complex geologic past.

The Big Lost River Watershed is the western-most of the local Central Valleys watersheds that collectively make up the Sinks Drainages. The Little Lost River, Birch Creek, Medicine Lodge Creek, and Beaver-Camas respectively, are located to the east and make up the remaining watersheds of the Sinks Drainages. These watersheds are contained within the Basin and Range province, which occupies a small area of southern Idaho between the Middle Rocky Mountains and the Snake River Plain, west of the northern bound of the Central Rocky Mountains. These are the watersheds that disappear into valley fill material of the longitudinal valleys formed by the Pioneer Range, White Knob Mountains, Lost River Range, Lemhi Range, and the Beaverhead Range of the Basin and Range province.

The Big Lost River Watershed drains an area of 4835 km^2 (1867 mi^2) bounded by the Pioneer Mountains to the west and south, the Boulder Mountains in the northwest, and the Salmon River Mountains to the north. The White Knob Range in the central and south- central watershed and the Lost River Range to the East complete the mountainous enclosure.

The Big Lost River gets its name because it naturally sinks into the Snake River Plain before it has a confluence with any other river. During average hydrologic years it disappears north of Arco, Idaho, before it reaches the Snake River Plain. During high precipitation years it flows past Arco, Idaho onto the Idaho National Engineering and Environmental Laboratory (INEEL) where it sinks into what are locally known as The Playas, east of Arco.

The Big Lost River watershed lies on the northern edge of the Snake River Plain. The Snake River Plain was formed by the Yellowstone Hot Spot. This is an ancient system of volcanic formations resulting from the North American Plate moving southwest over a stationary-melting anomaly in the earth's mantle commonly referred to as the Yellowstone Hot Spot.

The Hot Spot is characterized by high topography, related to high subsurface heat flow and volcanic activity. The melting anomaly in the mantle results in the inflation, or elevation of the earth's crust, which produces the Continental Divide and also produces other features important to the surrounding hydrology such as active fault zones, earthquakes, and hot springs (Link 2003). In the wake of the Hot Spot is a path of subsided/deflated terrain that forms the Snake River Plain. This subsidence was due to cooling of the crust and the volcanic infusion of heavy material into the lower and middle crust, resulting in sinking of the Plain relative to the surrounding topography.

As the North American Plate migrated over the Hot Spot the surface hydrology radiated away from the area of the melting anomaly. This can be seen today in the present day location of the Hot Spot in the Yellowstone area. The location of the Hot Spot approximately 6.5 to 10 million years ago would have caused the waters of the Central Valleys, including the Big Lost River, to drain northward into the historic Salmon River drainage. This relationship may have caused the Big Lost to drain into the ancestral Salmon River drainage. The Little Lost would have flowed into the ancestral Pahsimeroi subwatershed, and Birch Creek would have flowed into the ancestral Lemhi watershed. In the wake of the Hot Spot the topography subsided, or deflated, changing the predominant valley slope aspect from north to south and the adjacent Central Valley drainages were captured. The flow from the captured drainages changed to the south, toward the Snake River Plain, isolating the drainages from the ancestral Salmon River creating what we know today as the Sinks Drainages (Link 2003).

Approximately 6,000 years ago a wetter climate prevailed in this region and in conjunction with glacial melt off and higher average precipitation, lakes were present in troughs that resulted from the subsidence of the earth's crust. Lake Terreton formed in what is known as the Big Lost Trough. It received the flow of the Big and Little Lost Rivers. Mud Lake formed in the Mud Lake Basin and received flow from Birch, Medicine Lodge and Camas Creek. During flood years the lakes were likely connected with the headwaters of the ancestral Henry's Fork of the Snake River. These connections between the various surface waters of the region could have been the mechanism that inoculated the Sinks Drainages with fish as recently as 5,000 to 6,000 years ago. Today, due to dryer conditions, all that remains of these lakes are the ephemeral playa systems that can be seen from the air over the northern Snake River Plain. The Playas, or lakebeds, as they exist today have been essentially unchanged for approximately 1,000 years (Link 2003).

Volcanic Rift Zones developed when lava flowed down along the axis of the longitudinal valleys of the Big Lost and Little Lost Rivers into the basins in the Snake River Plain that eliminated the connectivity between the trough lakes. The Rift Zones are the linear features that are oriented north to south along the normal faults that form their respective valleys. To the south of the Volcanic Rift Zones are rhyolitic domes that form the buttes that are prominent in the Snake River Plain south of the Lost Rivers. These rhyolitic domes squeezed up through the basaltic lava flows along a feature called the axial volcanic high. The axial volcanic high is 1 million years old, and separates the Sinks drainages from the Snake River Plain and subsequently the Snake River.

The eastern watershed is bounded by the Lost River Range, which run north to south. Elevations of the Lost River Mountains range from 1944m (6260 ft) at the Thousand Springs Sinks to 3859 m (12662 ft) at the pinnacle of Mt Borah, the highest point in Idaho. Much of the Lost River Range is over 3352 m.

The northern watershed boundary is within the southern extreme of the Salmon River Mountains and the Boulder Mountains where the North Fork of the Big Lost River has its origin. Elevations range from 3570 m (11,714 ft) on Ryan Peak to 2088 m (6,850 ft) at the confluence with the East Fork of the Big Lost River. The Pioneer Mountains form the western watershed boundary. Elevation here ranges from 3660 m (12008 ft) on Hyndman Peak to 2088 m (6,850 ft) at the confluence with the East Fork of the Big Lost River.

Climate

The Valley bottom of the Big Lost River watershed can be characterized as a high desert. Average annual precipitation is less than 10” per year over much of the valley. Winters are long and cold while summers are brief and hot. Precipitation rises in the surrounding mountains to 25 inches or more, falling mostly as snow. Periodic heavy thunderstorms are not uncommon during June and July. Average annual temperature and precipitation is summarized in Table 1. Precipitation, temperature and accumulated precipitation are summarized for the Lost River Wood River watershed divide Snotel monitoring Site from 1996 through 2003 in Figure 1. A general decrease in precipitation is seen since 1996 in the Big Lost River watershed. The nearest high elevation climate monitoring is Galena, Idaho, and this station is assumed to be representative of the higher elevations in the watershed.

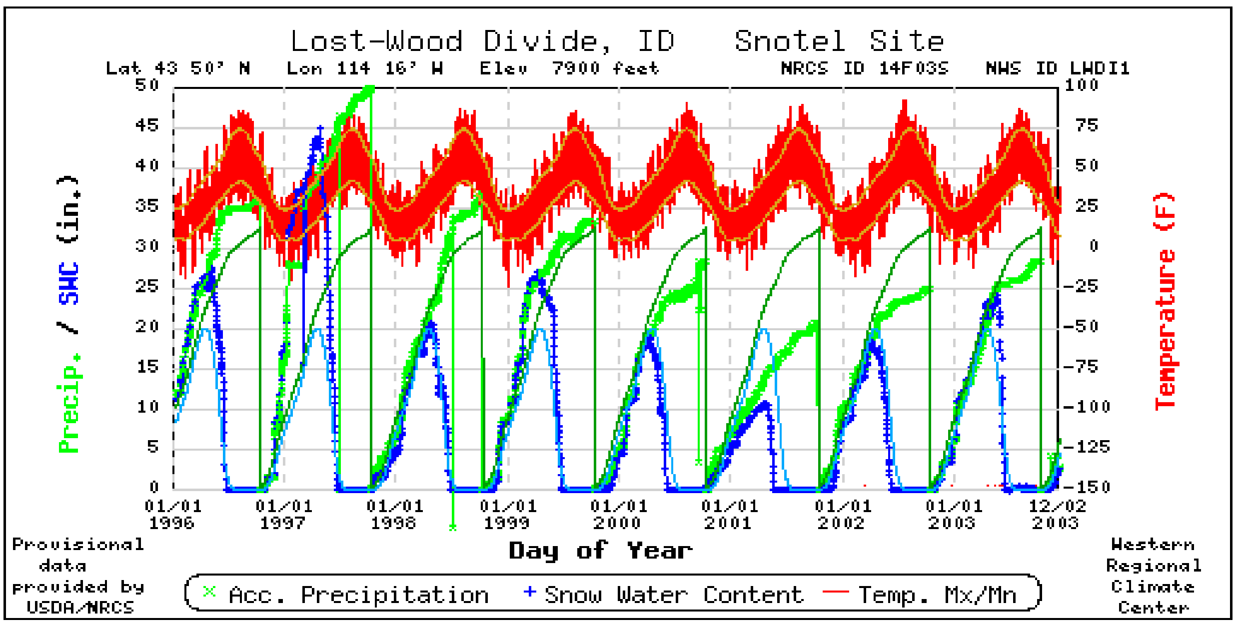

Figure 1. Precipitation summary for the Lost-Wood divide monitoring location

Table 1. Annual climate summary for stations in, or near the Big Lost River watershed with range of daily extremes.

Location (elevation)	Galena (7300 ft.)	Chilly (6200 ft.)	Grouse (6110 ft.)	Mackay (6,000 ft.)	Arco (5330 ft.)
Average Annual Maximum Temperature	51.3 F (Range 98º F to 38º F)	54.5 (Range 95º F to 40º F)	53.6 (Range 95º F to 38º F)	54.4 (Range 96º F to 35º F)	57.3 (Range 103º F to 40º F)
Average Annual Minimum Temperature	18.6 (Range 32º F to -40º F)	23.6 (Range 36º F to -42º F)	20.6 (Range 32º F to -42º F)	27.9 (Range 36º F to -35º F)	27.1 (Range 42º F to -45º F)
Average Annual Total Precipitation	24.74 Daily Range 0 to 2.75in.)	8.27 Daily Range 0 to 2.15in.)	12.75 Daily Range 0 to 1.9in.)	10.07 Daily Range 0 to 1.7in.)	9.76 Daily Range 0 to 2.4in.)
Average Annual Total Snowfall	182.8 Daily Range 0 to 25in.)	19.0 Daily Range 0 to 12 in.)	61.4 Daily Range 0 to 20in.)	32.9 Daily Range 0 to 14in.)	31.3 Daily Range 0 to 25in.)
Average Annual Snow Depth (in.)	17 Daily Range 0 to 122in.)	0 Daily Range 0 to 20 in.	4 Daily Range 0 to 42in.)	1 Daily Range 0 to 37in.)	1 Daily Range 0 to 37in.)

Subbasin Characteristics

Hydrography/Hydrology

The Big Lost River, the largest stream in the subbasin, flows toward the northeast from the confluence of the two largest tributaries: the East Fork and North Fork Big Lost Rivers (known as The Forks). Thus the Big Lost River begins at the confluence of the East Fork and North Fork Big Lost Rivers, about 11 miles southwest of Chilly Buttes.

At the base of the Lost River Range, about 2 miles east of Chilly Buttes, the River flows to the southeast within the longitudinal valley formed between the Lost River Range and the White Knob Range. The River course continues southeast until it reaches the axial volcanic high described above, where it arcs to the east and then northeast to where it sinks into the northern edge of the Snake River Plain about 6 miles east of Howe, Idaho.

The headwaters of the East Fork Big Lost River are located in the southwest corner of the subbasin in Copper Basin. Copper Basin lies between the Pioneer Range and the White Knob Range. The East Fork Big Lost River flows northwestward to its confluence with the North Fork Big Lost River. Major tributaries to the East Fork of the Big Lost River include Star Hope Creek, and Wild Horse Creek.

The Headwaters of the North Fork Big Lost River are located in the northwest corner of the subbasin along the watershed divide with the East Fork Salmon River. The headwaters of the North Fork form in the southern bound of the Boulder Mountains and Salmon River Mountains and the northern bound of the Pioneer Mountains. The flow is predominantly eastward to its confluence with its major tributary, Summit Creek, and subsequently the East Fork of the Big Lost River.

As the Big Lost River passes the Chilly Buttes it looses its flow to irrigation diversions and infiltration into the substrate. After spring snowmelt the river is often dry between Chilly Buttes and Mackay Reservoir except for isolated pools and scant inflow from Thousand Springs.

Recent work has determined that the Big Lost River flooded one or more times, carrying boulders from the Copper Basin area all the way to the Snake River Plain at Box Canyon south of Arco (Rathburn, 1993). The last of these floods occurred about 16,000 years ago, at the same time as the Lake Missoula floods in northern Idaho and over two thousand years before the Lake Bonneville Flood in southern Idaho (O'Connor, 1992, 1993). Such Pleistocene floods are part of the mythology of cultures from around the world.

Geology

The Pioneer Mountain Range is situated in the southeastern quadrant of the watershed. This is a roughly circular mountain range consisting of many low foothills and a rugged high core of peaks built of hard igneous and metamorphic rocks. The highest peak in the Pioneers is 12,009-foot Hyndman Peak. There are many other summits well over 11,000 feet in elevation including Old Hyndman, Cobb, and the Devil's Bedstead.

The Pioneer Mountain foothills rise directly out of the vast basalt-covered Snake River Plain to the south. The Pioneers lie between the Big Wood River Valley to their west (Hailey, Ketchum), the headwaters of the Big Lost River on their east, and Summit Creek/Trail Creek on their north. Despite the heavy snow and great variations in elevation, there is very little timber in these mountains.

The Pioneer Mountains are the oldest mountains of the watershed. The core of the Pioneers is Paleoproterozoic gneiss west of Copper Basin. Above the gneiss are Proterozoic and Paleozoic metasedimentary rocks, all intruded by an Eocene pluton. The core complex is uplifted on the Wildhorse detachment fault, which forms a domal pattern and which moved from Eocene until Oligocene time. There is thick Lower Paleozoic black shales, such as the Devonian Milligen formation, which occupies much of the low country east and west of the Wood River Valley (Link, 1989).

At the same time as the Challis volcanic rocks were erupted, the Pioneer Mountains metamorphic core complex was rising. Low-angle extensional and strike-slip faults formed in the Boulder and Pioneer Mountains northeast of Ketchum. The general sequence of events was: 1) Cretaceous intrusion ending by 70 million years ago; 2) formation of northwest-striking high angle faults as well as low-angle oblique-slip faults, ending about 45(?) million years ago; this faulting stripped sedimentary cover from the Pioneer Mountains; 3) volcanic activity of the Challis volcanic episode and faulting of the northeast-striking Trans Challis fault system; intrusion of the Summit Creek stock in the core of the Pioneer Mountains at about 48 million years ago; 4) intrusion of late-stage granite plutons (Sawtooth, Boulder, Pioneer and Smoky Mountains) and related rhyolite volcanism about 44 million years ago, 5) final uplift and unroofing of Pioneer Mountains core complex (37 to 34 million years ago); the Summit Creek stock was beheaded by this faulting and its upper portion moved northwestward by as much as 23 km (Link, 1996).

The Lost River Range forms the eastern boundary of the watershed. The highest peak in the Lost River Range is 12,668 ft. Borah Peak, also Idaho's highest elevation. There are other summits near 12,000 feet in elevation including Leatherman and Breitenbach.

The Lost River Range contains one of the best continuous exposures of Paleozoic sedimentary rocks in Idaho. The rocks of the range are tilted eastward, and the range is bounded on the west by the segmented Lost River normal fault, which was last active in October, 1983, at Borah Peak. The interior of the range is rugged and forbidding. There are few roads and fewer perennial streams, since the porous limestone generally soaks up the snow melt and any summer rain (Link, 1996).

The range is made up of folded Proterozoic and Paleozoic sedimentary rocks. The Lost River normal fault runs along the base of the mountains, and has been active over the last few million years. Huge alluvial fans radiate from the steep canyons and spread out over the valley. The Range is underlain by the Silurian Laketown Dolomite and Devonian Jefferson Formation (Link 1989).

The Boulder Mountains exhibit a normal fault that runs through the low hills along the western range that has uplifted the mountains above the Wood River Valley. The white rocks in the cliffs at the base of the range are Eocene granite. The dark rocks on the summits are Devonian Milligen Formation and Pennsylvanian and Permian Wood River Formation. The Boulder Mountains occur in the northeast quadrant of the watershed. This portion of the Boulder Mountain Range extends far to the east, to the Herd Peak Highlands. It is composed of high, nearly treeless mountains. The Boulder Mountains rise at the head of North Fork of the Big Lost River in the southeastern portion of that range.

The White Knob Mountains are a compact group of sedimentary peaks located west of Mackay. The range's west to east trending crest is about 30 miles in length and 10 miles in width. The East Fork Big Lost River and the Big Lost River almost completely encircle the White Knob Mountains, forming the range's southern, western, northern and eastern boundaries. Antelope Creek completes the circle along the range's southern boundary as it flows east from Antelope Pass to the Big Lost River.

The White Knob Mountains are located to the west of the Lost River Range and have some summits over 11,000 feet. The White Knob mountains have a core of limestone through which there are intrusions of granite. The north and the south ends of the range are overlain by Challis volcanics, primarily rhyolite, that erupted out of vents now plugged by the granite dikes.

This geology is known for mineral deposits, and the eastern slope of the White Knob Mountains have many old mines and shafts. There is copper ore here that provided the nearby town of Mackay an important source of income. There is a small roadless area in the core of the range. Although steep, the mountains are open with little timber and long fields of talus and scree.

The Salmon River Mountains are located along the north central part of the North Fork Big Lost River watershed. They comprise a small portion of the watershed though this range extends far to the north into the Salmon River Watershed, and are primarily considered Eocene Challis Volcanics. The Salmon River Mountains are the second largest of the Idaho Batholith mountain groups. These mountains are named for the Salmon River, which encircles nearly the entire range, forming its boundary from Riggins, ID in the northwest, to Salmon in the northeast, to Challis in the southeast and Stanley to the southwest. Within the North Fork Big Lost River watershed The highest point within the Salmon River Mountains is Meridian Peak at 10,285 ft.

Glacial History

The Pleistocene (the last 2 million years) has been a time of climatic conditions alternating between glacial and non-glacial, with a periodicity of about 100,000 years. There are also smaller cycles with periodicity of a few thousand years. In conjunction with a lowering of the earth's temperature by a few degrees, snow fields have built up, and reflectivity and cloudiness have increased.

During the cooler and wetter parts of the cycles, glaciers formed in the higher mountains of Idaho. The Yellowstone Plateau and Jackson Hole areas were extensively glaciated, as were the Sawtooths, Pioneers, the high Lost River, Lemhi, and Beaverhead Ranges to the east and the Albion Range south of the Snake River Plain. In the Copper Basin area the last two glacial advances are termed "Copper Basin" and "Potholes" (Figures 2 and 3).

During glacial advances, ice builds up and flows down valleys. At the terminus and sides of valley glaciers, poorly sorted sediment is deposited in moraines. In front of the glaciers, abundant meltwater flows downstream. This sediment-charged water deposited the high-level river terraces present today in the valleys of the Big Lost

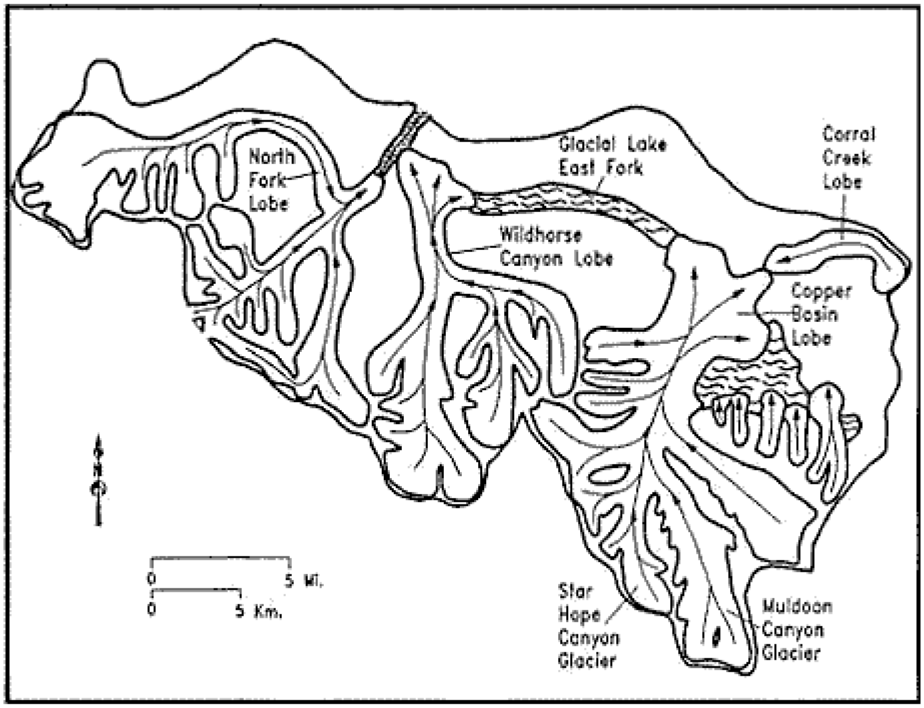

Figure 2. Reconstruction of ice margins and fluvial systems at the latest and smallest of the glacial advances of the Potholes glaciation, about 20,000 years ago in the Big Lost River subbasin (redrawn from Evenson and others, 1982).

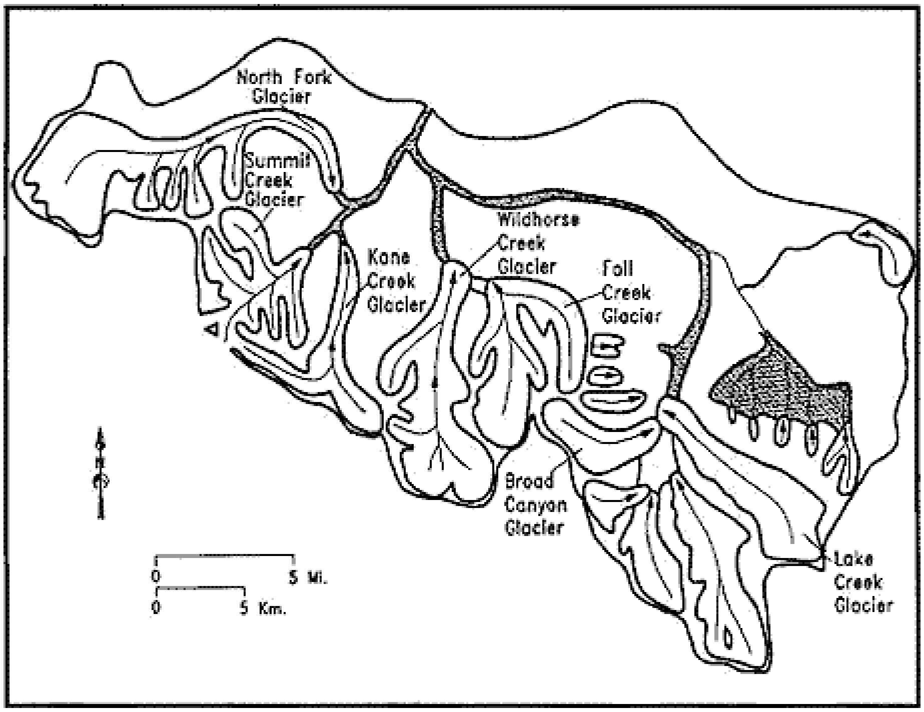

Figure 3. Reconstruction of ice margins, fluvial, and lacustrine systems at the maximum of Copper Basin glaciation, probably about 120,000 years ago (redrawn from Evenson and others, 1982).

Soils

In the Big Lost River Subbasin, the surface soil is predominately gravelly loam. There is some loam, stony sand, stony loam, gravelly sand, silt, and unweathered bedrock in the subbasin. The Pioneer and Whiteknob mountain ranges contain unweathered bedrock and fragmented material with gravelly loam covering the slopes and gravelly silt in the river valleys. In the Lost River Range there is unweathered bedrock and fragmented material on its peaks and stony loam on its slopes to the valley floor where there is more gravelly loam. The southeast corner is predominately very stony silt along with some loam in the northern edge.

The soil depths range from 35 to 60 feet deep. The shallowest layer sits in the south west corner of the subbasin with an average depth of 35 feet. Several soils are about 60 feet deep.

The K-factor is the soil Erodibility factor in the Universal Soil Loss equation. The factor is comprised of four soil properties: texture, organic matter content, soil structure, and permeability. The K-factor values range from 1.0 (most erodible) to 0 (least-erodible). The K-factors for this subbasin range from 0- .49. The majority of the basin ranges from .1-.15 which are low K-factors for an arid climate. The highest K-factors are found in the southeast portion of the basin as well as along the Big Lost River near Chilly and the area between Antelope Creek and Arco. The lowest values are found in the areas containing unweathered bedrock and fragmented material in and closest to the mountain ranges

The average soil slope provides a measurement of potential soil erosion, or Erodibility risks. Soil slope, a calculation of slope length and rise, was averaged for the various soil units. The average slopes of the subbasin range from 1 to 52.4. The lowest slope of .57 is found at the very tip of the most eastern border. Most of the low slopes are found along the river corridor and in the valley bottom. Obviously, the highest slopes are found in and along the mountain ranges.

Vegetation

Vegetation in the Big Lost River watershed varies by altitude and moisture regime. Valley bottoms include sagebrush and grassland ecotype in valley uplands. Riparian areas include mature cottonwood, alder, willow and shrubs. Sagebrush and grasslands extend into higher elevations and include aspen and juniper stands where soil moisture permits. Higher subalpine elevations feature lodgepole pine, Douglas Fir, whitebark pine, subalpine fir, and spruce. The highest elevations tend to be scree and barren rock with only lichen and shallow-rooted short grasses. An important function of vegetation is land cover to reduce erosion. This is very important on highly erodable soils such as lakebed deposits and stratified glacial soils found in Copper Basin and the North Fork Big Lost watershed and the associated alpine elevations (Figure 4). Higher density land cover can be riparian vegetation such as willow, crops such as alfalfa, wheat, or potatoes as well. Cropland is associated with valley bottoms and generally displaces riparian vegetation and upland sagebrush/grassland vegetation.

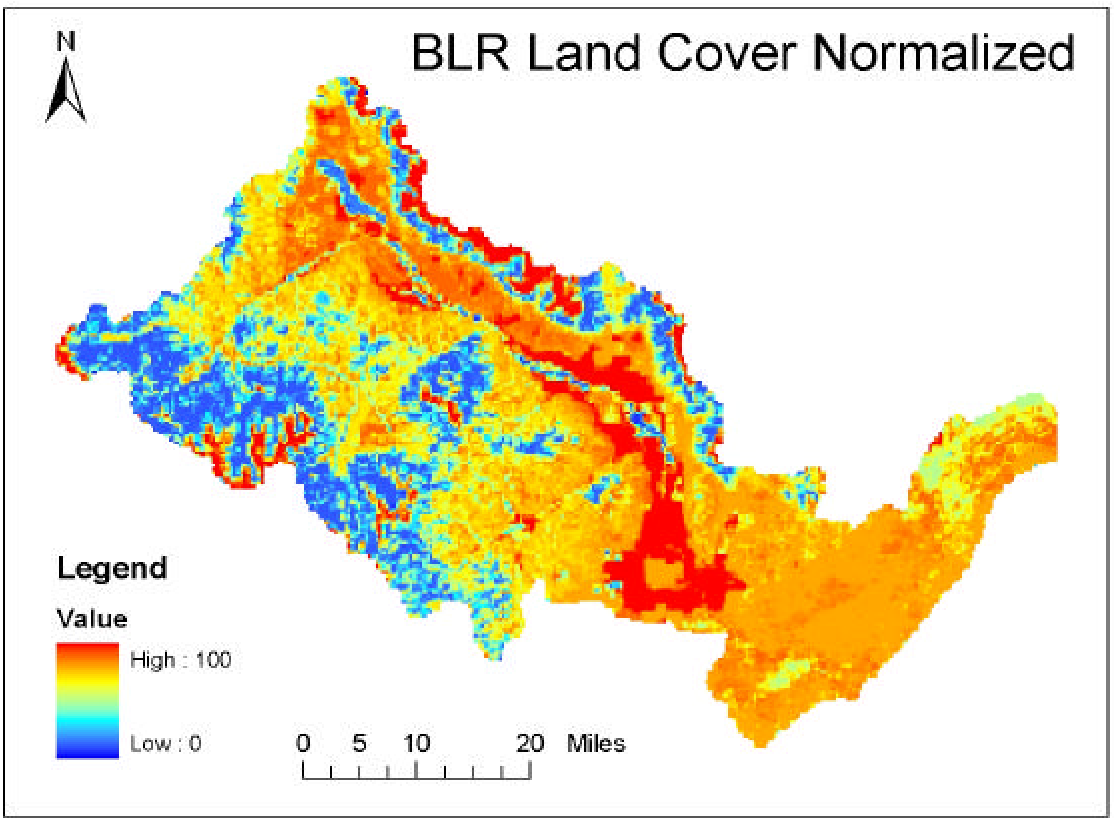

Figure 4. Big Lost River subbasin land cover.

Fisheries

In 1944 Hubbs and Miller (1948) described three species of fish that were described as indigenous to the Lost Rivers watersheds of south-central Idaho: cutthroat trout (Oncorhynchus mykiss), dolly varden char (also known as bull trout) (Salvelinus malma), and the mottled sculpin (Cottus Bairdi Girard). In 1963 nomenclature for the genus Cottus was revised by Bailey and Bond (1963), and the common name mottled sculpin was changed to shorthead sculpin. The mountain whitefish (Prosopium williamsoni) is also found in the watershed, and was reported by Overton (1977), along with cutthroat trout, bull trout, and the shorthead sculpin, to be the four native fish of the Big Lost River watershed.

Overton (1977) reported six species of fish in the lower Big Lost River (downstream of Arco): rainbow trout (Oncorhynchus mykiss), brook trout (Salvelinus fontinalis), dolly varden char (bull trout), kokanee salmon (Oncorhynchus nerka), mountain whitefish, and the shorthead sculpin. Cutthroat trout were not observed in the reported sampling, though evidence of their hybridization with rainbow trout was described as apparent. It was speculated by Overton (1977) that the absence of cutthroat in the lower river reflected their "disappearance" as the result of introduction of brook and rainbow trout combined with degraded water quality. Overton states that no "other families of fishes have been observed or reported in the Big Lost River". Introduced species identified by Overton (1977) included rainbow trout, brook trout, and kokanee Salmon. Abundance of fishes, in Overton (1977), is identified as being dependent upon waterflow.

The federal Fish and Wildlife Service has not included the Big Lost River watershed in its recovery plan for bull trout restoration because the species is not currently present in the watershed. A number of people feel that bull trout were never present in the watershed. Introduction of exotic salmonid species and non-game species has made it difficult to determine definitively which fish are native to the collective watersheds known as the Sinks Drainages (Behnke, 2002) which includes the Big Lost River watershed.

The distribution of fishes in the Big Lost River watershed is related to habitat. Kokanee salmon require a pelagic habitat for rearing adjacent to accessible spawning habitat. This combination is found in Mackay Reservoir with the lower reaches of Warm Springs Creek providing adequate spawning habitat. The Big Lost River from Chilly Buttes to Mackay Reservoir is primarily dry channel with the exception of the limited inflow from Thousand Springs Creek, just below the Chilly Buttes. This makes Warm Springs Creek extremely important to the fishery below Chilly Buttes and above the reservoir. It is essentially the only viable fishery resource in this reach other than the reservoir. Below Mackay Reservoir rainbow trout and whitefish are the predominant species. Rainbow trout are stocked into the reservoir and when the reservoir is drawn down they entrained to the river fishery between Mackay Reservoir and the Moore Diversion. Below the Moore Diversion the channel is primarily dry and provides no sustainable fishery resource.

Above Chilly Buttes, where the Big Lost River and its major tributaries flow perennially, rainbow trout are the primary species. Brook trout and cutthroat trout are found in larger tributaries such as Wildhorse Creek and Starhope Creek and in the upper East Fork, above

Starhope Creek, and North Fork of the Big Lost River. The Idaho Department of Fish and Game began stocking cutthroat trout into the upper Starhope Creek watershed in 2000. Rainbow trout are still stocked into the East Fork of the Big Lost River and North Fork of the Big Lost River.

Subwatershed Characteristics

Subbasin Characteristics

Big Lost River Subbasins that comprise the watershed are grouped by subwatersheds that are comprised of administrative subunits called Assessment Units devised by the Environmental Protection Agency for accounting of water quality issues. Subbasins are grouped by major tributaries that include the East Fork of the Big Lost River, the North Fork of the Big Lost River, the Upper Big Lost River, Antelope Creek, and the Lower Big Lost River (Figure 5). The East Fork and North Fork of the Big Lost River form the headwaters of the Big Lost River. The form of the watershed is similar to the shape of a question mark. The East Fork of the Big Lost flows north to northwest then picks up the flow from Summit Creek and the North Fork to form the Big Lost River mainstem which wraps around the White Knob Mountains into the valley formed with the Lost River Range to flow south. A significant feature in the watershed is Mackay Reservoir, an irrigation impoundment that is the keystone to fisheries in the mainstem and Warm Springs Creek.

Subbasins will be discussed from the headwaters of the East Fork and North Fork Big Lost River downstream and within the subbasins streams will be grouped by Assessment Units for further discussion of important features related to water quality. The lower Big Lost River assessment units do not have streams that regularly flow to the Big Lost River except under extreme hydrologic events. There are limited BURP sites over the lower subbasin assessment units. BURP data is shown in Appendix F.

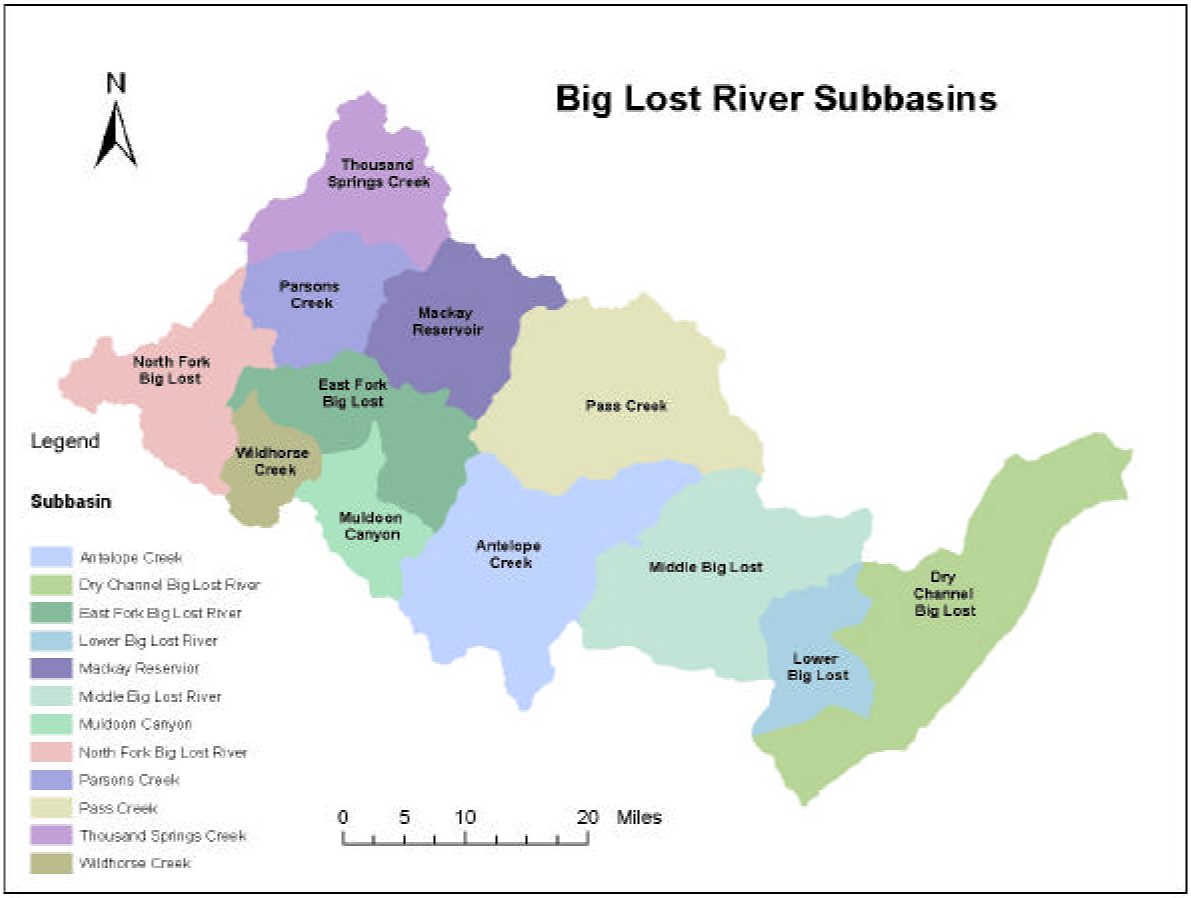

Figure 5. Subbasin names and locations in the Big Lost River watershed.

East Fork of the Big Lost River

The East Fork of the Big Lost River has a watershed area of 687 km^2 with major tributaries consisting of Wild Horse Creek, Pole Creek, Deer Creek, Rider Creek, Little Boone Creek, Willow Creek, Boone Creek, Fox Creek, Road Creek, Star Hope Creek, Corral Creek, Coal Creek, Steve Creek and Anderson Canyon Creek. The East Fork of the Big Lost River is on the 303(d) list of impaired water bodies for major pollutants that include sediment, temperature and habitat alteration. Much of the sub-watershed is located in Copper Basin, shown in brown in Figure 6. Copper Basin is a large glaciated basin on the watershed divide that separates the East Fork from Antelope Creek, to the south, in the Pioneer Mountains. The majority of flow in the sub-basin is derived from Star Hope Creek and Wild Horse Creek.

The upper 303(d) listed reach extends from the headwaters to the confluence of Star Hope Creek (West Fork of the Big Lost River). This reach is listed for sediment and temperature. The lower listed reach, listed for habitat alteration, extends from the confluence of Star Hope Creek to the confluence with the North Fork of the Big Lost River, where the main Big Lost River begins. The only other 303(d) listed stream in this sub-watershed is Little Boone Creek, an ephemeral stream that sporadically drains a wetland for only brief periods during snowmelt.

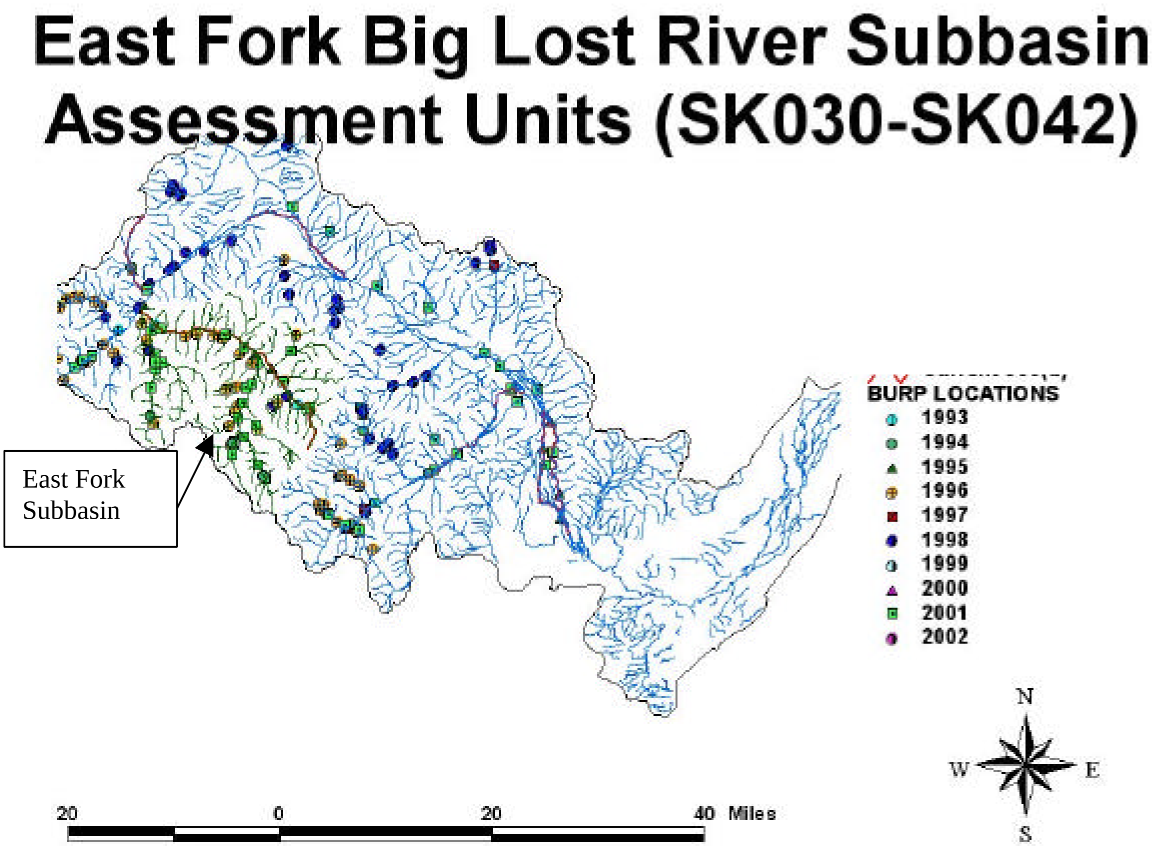

Figure 6. Location of the East Fork subbasin within the Big Lost River watershed.

Springs, snowmelt runoff, and storm events drive flow in the upper East Fork. The source of the East Fork is a complex of springs with beaver dams in the upper watershed within Copper Basin known as The Swamps (Figure 7). It becomes 2^{nd} order at the confluence of Coal Creek and 3^{rd} order at the confluence of Corral Creek just below the Burma Road Bridge. Anderson Canyon is an ephemeral stream that flows as a second order stream during peak runoff and remains dry for the remainder of the year. The upper reach from the swamps to the Copper Basin Guard Station, several miles downstream, is said to be undisturbed. Flow is perennial throughout the course of the East Fork of the Big Lost.

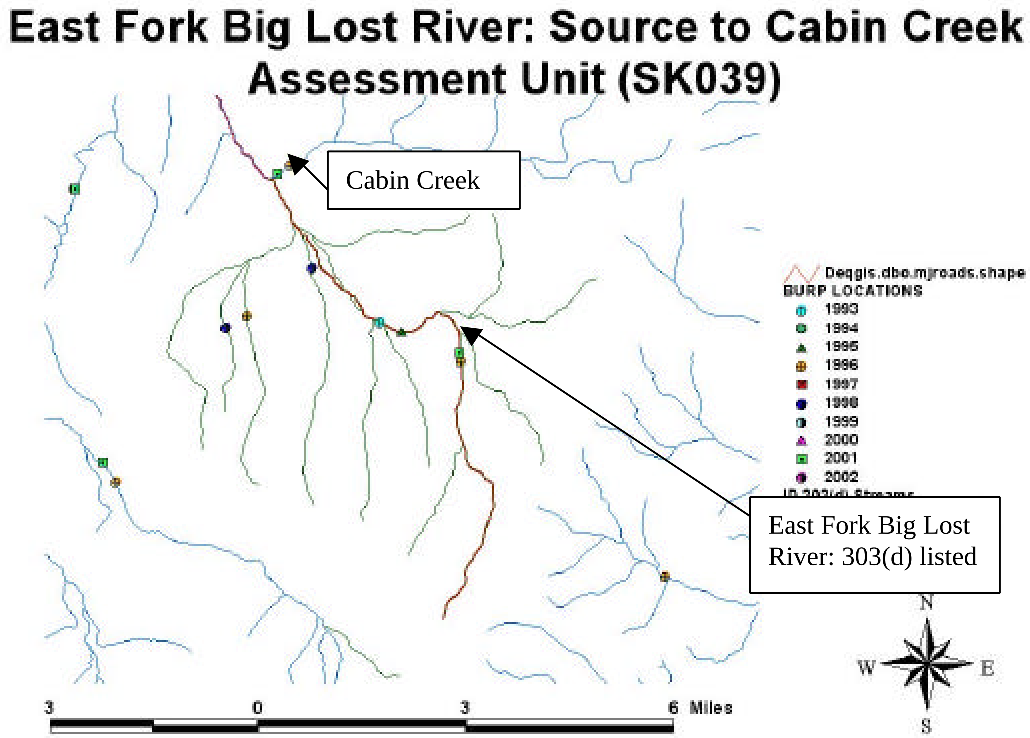

Figure 7. Upper East Fork assessment unit.

Property ownership over the upper listed reach is primarily public land managed by the USDA Forest Service. There are several private in-holdings along the stream above the confluence with Star Hope Creek, primarily recreational homes. Management emphasis of public lands on this reach is livestock grazing. There is a riparian management demonstration project below Corral Creek, which creates a 1200-acre riparian pasture that has been in place since the early 1980s. Over utilization of this demonstration project on shallow glacial soils stratified over cobble and boulder layers, however, has negated the potential improvement in riparian condition and streambank integrity and stability. Riparian fencing has not been implemented elsewhere within the watershed. Recreation use consists of dispersed camping and fishing access. Road density is less than 1 mile per square mile in the watershed though the density of roads within riparian areas is greater than 1 mile per square mile. There are several road crossings within this reach, primarily affiliated with grazing management and fishing access. There is an emergency aircraft landing strip associated with the Copper Basin Guard Station.

The upper watershed, above Star Hope Creek is characterized by a Rosgen B channel in valley type VIII (Rosgen 1996), with multiple alluvial and glacial river terraces laterally along the broad valley with gentle, down-valley elevation relief. Copper Basin has been extensively sculpted by Holocene glaciating. Eventually, below the Copper Basin Guard Station, the stream transitions to a C channel to the confluence of Cabin and Corral Creek. This segment exhibits a marked reduction in riparian vegetation, density and vigor. However, due to the hydrologic regime of a spring creek, it has maintained some of its streambank integrity. This may be due to past implementation of in-stream grade control structures. Many of these structures are failing resulting in side cutting and accelerated lateral migration of the stream channel. Once the channel is exposed to the snow melt driven peak flow regime of Corral Creek streambank integrity diminishes. The combined effect of increased sediment supply from Corral Creek and beaver activity in depositional areas, channel integrity further degrades due to streambank erosion. The channel progressively degrades to an F channel to the confluence of Star Hope Creek, where the lower assessment unit begins. The lower East Fork Assessment unit is shown in Figure 8.

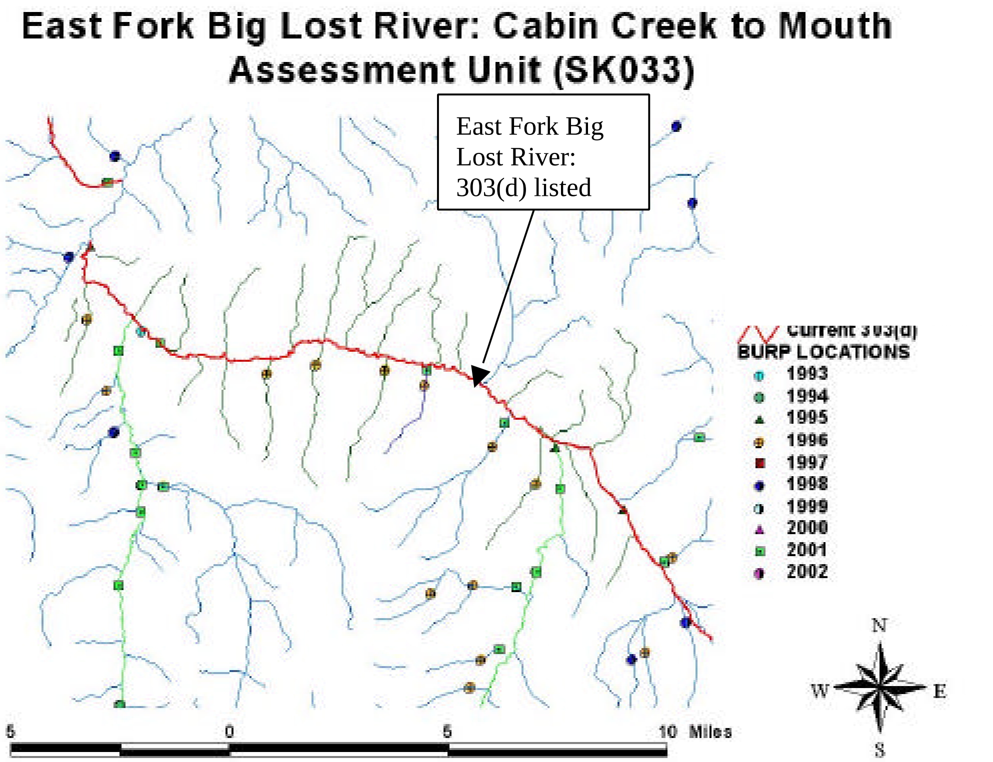

Figure 8. Lower East Fork assessment unit.

Star Hope Creek emerges from its upper type II valley in an A channel. It quickly picks up the flow of Bear Canyon Creek, a 2nd order stream which transitions from an A to a G channel when it enters the type VIII valley from its type II upper valley. The G channel is deeply incised into depositional material comprised of an unconsolidated and heterogeneous mixture of gravel, small cobble and sand. It has moderate channel gradient and low width to depth ratio and low sinuosity. They have high sediment supply and are typically unstable (Rosgen 1996).

Star Hope Creek flows in a C channel after entering the main type VIII valley. Riparian vegetation is primarily willow with some alder. Soils are glacially derived and are shallow and sandy overlying gravel and cobble with some boulder size material, which increases the potential for erosion. These soils are fragile and depend upon riparian vegetation to help anchor them in place. With good riparian vegetation the stream channel can withstand peak flow that results during snowmelt or concentrated thunderstorms. Channel stability is fair in Star Hope Creek until it picks up flow from Muldoon Canyon, approximately 1.25 miles below Bear Canyon Creek where the stream widens, substrate particle size increases, bank erosion increases with