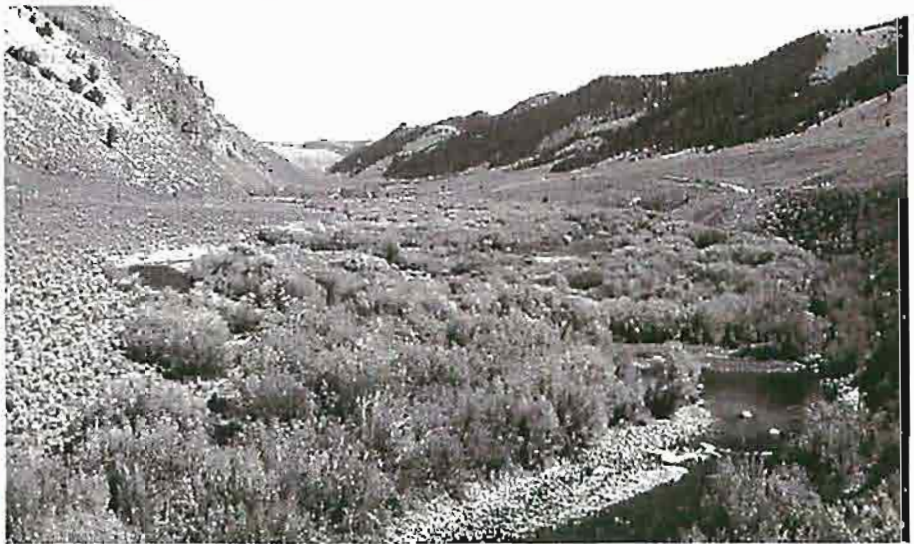


# BIG LOST RIVER MOUNTAIN WHITEFISH STATUS REPORT

BIG LOST  
RIVER WATERSHED,  
IDAHO



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## **Ecosystem Sciences Foundation Statement**

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This Status Report on the Big Lost River Whitefish was prepared by Ecosystem Sciences Foundation. Ecosystem Sciences Foundation supports finding balanced and lasting solutions to economic, logistical, and ecological challenges of water management and species protection. Ecosystem Sciences Foundation encourages and promotes integrated regional strategies to improve water management and species protection. It is the hope of the Board of Directors at the Ecosystem Sciences Foundation that resource managers in the Big Lost River Watershed and throughout Idaho will utilize the information presented in this document to enhance species protection by managing the ecologic resources needed for the species.

### **Scientific Professionals**

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The team of professionals at Ecosystem Sciences Foundation includes experts in aquatic ecology, biology, geography, hydrology, and agriculture and grazing management. The team worked together to produce this document using current scientific information on the subject matter and all available, locally specific information.

The lead scientist and principal investigator for this status report is Mark Hill. Mr. Hill has a Bachelor of Science Degree in Limnology and a Master of Science Degree in Fisheries Science from Michigan State University. He is a Fellow of the American Institute of Fisheries Research Biologists, and is Board Certified by the American Fisheries Society. Mr. Hill has published extensively on aquatic ecology research and topics. He has over 50 publications in professional scientific journals and investigative reports in the U.S. and internationally, numerous professional presentations and court testimony, and has served on the International Fisheries Committee of the American Fisheries Society in addition to many other professional activities.

Big Lost River Mountain Whitefish Status Report



**Big Lost River Watershed Regional Setting**

The Big Lost Basin encompasses approximately 485,000 hectares in South Central Idaho. The basin is bounded by the mountains of the Lost River Range to the northeast, the Boulder Mountains to the northwest, and the Pioneer Mountains to the southwest. The Big Lost River flows generally east and south, eventually sinking into the fractured basalts of the Snake River Plain.

**EXECUTIVE SUMMARY**

The mountain whitefish (*Prosopium williamsoni*) thrive only in cold streams, rivers and lakes of western North America. Isolated populations exist along the southern edge of this range, and the Big Lost River whitefish is one such example.

The mountain whitefish is widely thought to be native to the Big Lost River basin. Mountain whitefish were once found in about 348 kilometers of stream in the Big Lost River drainage. Based on recent fishery surveys they occupy only 76 kilometers or 22% of their historic range and only about 1.5% of their historic population numbers or abundance.

Studies by the USFS conclude that mountain whitefish are extirpated from many key tributaries. The decline in mountain whitefish in the Big Lost River and extirpation from primary tributaries has many causes. The overarching causes of whitefish decline stem from irrigation for agriculture purposes and the introduction of

non-native species. Mountain whitefish are not protected by national or state regulation.

In DNA analysis, of all the genetic information available, studies have concluded that Big Lost River whitefish are genetically different from all other whitefish and they are likely a unique species or sub-species of fish. Given the most recent genetic studies the Big Lost mountain whitefish must be managed as a separate species from all other mountain whitefish.

To prevent the complete extirpation of the Big Lost River whitefish, it is necessary to restore the natural hydrograph of the Big Lost River and its tributaries, implement watershed-wide riparian restoration, reduce non-native fish stocking, and establish sanctuary reaches.

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## **Abbreviations Used**

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AF- Acre Foot (of water)  
BMP- Best Management Practices  
CD- Critically Dry (water year)  
CFS- Cubic Feet (per second)  
CEQA- California Environmental Quality Act  
CWA- Clean Water Act  
DPS- Distinct Population Segment  
EIR- Environmental Impact Report  
EIS- Environmental Impact Statement  
ESA- Endangered Species Act  
FS- Forest Service (United States Department of Agriculture)  
FWS- Fish and Wildlife Service (United States Department of Interior)  
HCP- Habitat Conservation Plan/Natural Community Conservation Plan  
IDFG- Idaho Department of Fish and Game  
MOU- Memorandum of Understanding  
MYA- Million Years Ago  
PME- Protection, Mitigation & Enhancement  
USFS- United State Forest Service  
USFWS- United States Fish and Wildlife Service  
YOY- Young of the Year

## 1.0 INTRODUCTION

The mountain whitefish (*Prosopium williamsoni*), also commonly known as mountain herring, or simply whitefish, thrive only in cold streams, rivers and lakes of western North America. Isolated populations exist along the southern edge of this range, and the Big Lost River whitefish is one such example. In the past, during cooler and wetter times, whitefish from the Snake River system were able to migrate through the Big Lost River Basin, but now, due to the terminal nature of the Big Lost River, whitefish are isolated to the Big Lost River Basin. Millennia of isolation have allowed whitefish in the Big Lost River Basin to evolve features and adaptations that separate Big Lost River whitefish from other whitefish.

At one time, whitefish were the most common salmonid of the Big Lost River Basin. It is estimated that 500 whitefish per mile existed in pre-European settlement of North America. Population has been in decline, though, since the developments of a non-native sport fishery and irrigated agricultural in the watershed. Now, mountain whitefish only occupy 22% of their historic range in the Big Lost River Basin (Losinski 2004).

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## 2.0 BIG LOST RIVER BASIN

### *The Sinks Drainages*

The Sinks Drainages are a collection of closed surface drainage basins in southeastern Idaho consisting of five USGS hydrologic units: Beaver-Camas (17040214), Medicine Lodge (17040215), Birch (17040216), Little Lost (17040217), and Big Lost (17040218) ([Figure 2.1](#) Map of Sinks Drainages). These streams originate in the Pioneer, Boulder, White Cloud, Lost River, Lemhi, and Centennial mountain ranges and flow generally east and south, eventually sinking into the fractured basalts of the Snake River Plain. These five drainages differ from their adjacent drainages (Big and Little Wood, Salmon, and Henrys Fork) in that they do not presently have a surface connection to the Snake

River basin (Van Kirk et al. 2003) ([Figure 2.1](#) Map of Sinks Drainages).

The geologic history of the Sinks Drainages is varied and complex, but can be traced to the topographic uplift and subsidence of the northeast-migrating Yellowstone-Snake River Plain hotspot over the last 17 million years. This volcanic activity continued into the Pleistocene when the northeast-trending Axial Volcanic High with associated rhyolitic domes along the Snake River Plain was constructed (Van Kirk et al. 2003). Additionally, the construction of the northwest-trending basaltic volcanic rift zones parallel with Basin and Range mountains north of the Snake River Plain resulted in isolation of the northern drainages from the Snake River. The result of this geologic activity was the formation of the Big Lost Trough and Lake Terreton basins and the present day modern sinks drainage pattern.

During glacial periods throughout the Pleistocene era large lake systems formed in the Big Lost Trough area. The most extensive lake existed during the Olduvai normal magnetic polarity interval from 1.95 to 1.77 MYA (Van Kirk et al. 2003). Pleistocene to Holocene connections to the various Sinks Drainages occurred by common drainage into the lake system on the Snake River Plain. Species dispersal (e.g. Mountain White Fish) to all five drainages must have occurred via this lake system, specifically Lake Terreton, a body of water connecting all five drainages up to about 10,000 years ago. Recent volcanism on the Yellowstone Plateau to the northeast of the Sinks Drainages and desiccation of the Snake River Plain lake system produced the Snake River Plain topography and drainage system present today (Van Kirk et al. 2003).

### *Big Lost River*

The Big Lost Basin<sup>1</sup> encompasses 485,623.5 hectares in South Central Idaho including portions of Custer, Butte, and Jefferson Counties. The basin is bounded by the mountains of the Lost River Range to the northeast, the Boulder Mountains to the northwest, and the Pioneer Mountains to the southwest ([Figure 2.2](#) map of Big Lost Watershed). Tributaries of the Big Lost River flow from these mountains toward the main stem, which flows in a generally southeasterly

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<sup>1</sup> USGS unit #17040218

direction past the town of Arco. The Big Lost River then flows in a generally northeasterly direction, before sinking into the Snake River Plain and becoming part of the Snake River Plain Aquifer (Dreher 2000). This portion of the Big Lost Basin intersects the Idaho National Laboratory ("INL") reservation (Dreher 2000).

Precipitation provides the source of water for the Big Lost River and its tributaries, and fluctuates widely from year to year, often incurring water shortages (Crosthwaite et al. 1970). At lower elevations (less than about 1890 meters), specifically near Chilly-Barton Flats, Mackay and Arco, precipitation is relatively low, varying from 15 to 46 centimeters annually, of which more than 50% occurs in the spring and summer (Figure 2.2 map of Big Lost Watershed). At higher elevations precipitation increases considerably to about 86 centimeters annually, largely in the form of snow (Dreher 2000).

The majority of the Big Lost River Valley is comprised of unconsolidated alluvial deposits that extend upstream to the heads of the tributary streams. This alluvium creates the distinctive characteristic of the Big Lost River Basin, which is the large interchange of surface water to ground water and vice versa. At moderate and low flows the surface water in the main stem of the Big Lost River disappears and becomes ground water at the Chilly Sinks. Large quantities of water reappear as surface water in the vicinity of Mackay Reservoir, and disappear again at the Darlington Sinks, only to reappear near Moore, and again disappear downstream from Arco where it becomes ground water of the Snake River Plain (Dreher 2000) (Figure 2.2 map of Big Lost Watershed). Most of the tributaries also fail to consistently maintain surface water flows that reach the main stem of the Big Lost River (Dreher 2000). Thus, ground water and surface water are so closely related in the basin that neither can generally be considered separate. Throughout much of the Big Lost River valley, ground water levels are less than 15 meters below land surface. Near the Big Lost River, ground water levels are commonly less than 3 meters below land surface. However, following a series of dry years, water levels are typically 3 to 18 meters lower (Dreher 2000).

Water use in the basin is related to agriculture, municipal uses in the towns of Mackay, Moore, and Arco, and industrial use at the INL (Dreher 2000). Irrigation, the major water use in the basin, began in the 1880s and has grown substantially over time. In

1910 Mackay Dam and Reservoir was constructed and provided additional irrigation water to new lands (Dreher 2000). Ground water development began in the 1950s and 1960s, and has been used primarily for irrigation to supplement surface water and storage water supplies. As of 2000, ground and surface water supported approximately 27,114 hectares of irrigated land in the Big Lost River Basin (Dreher 2000).

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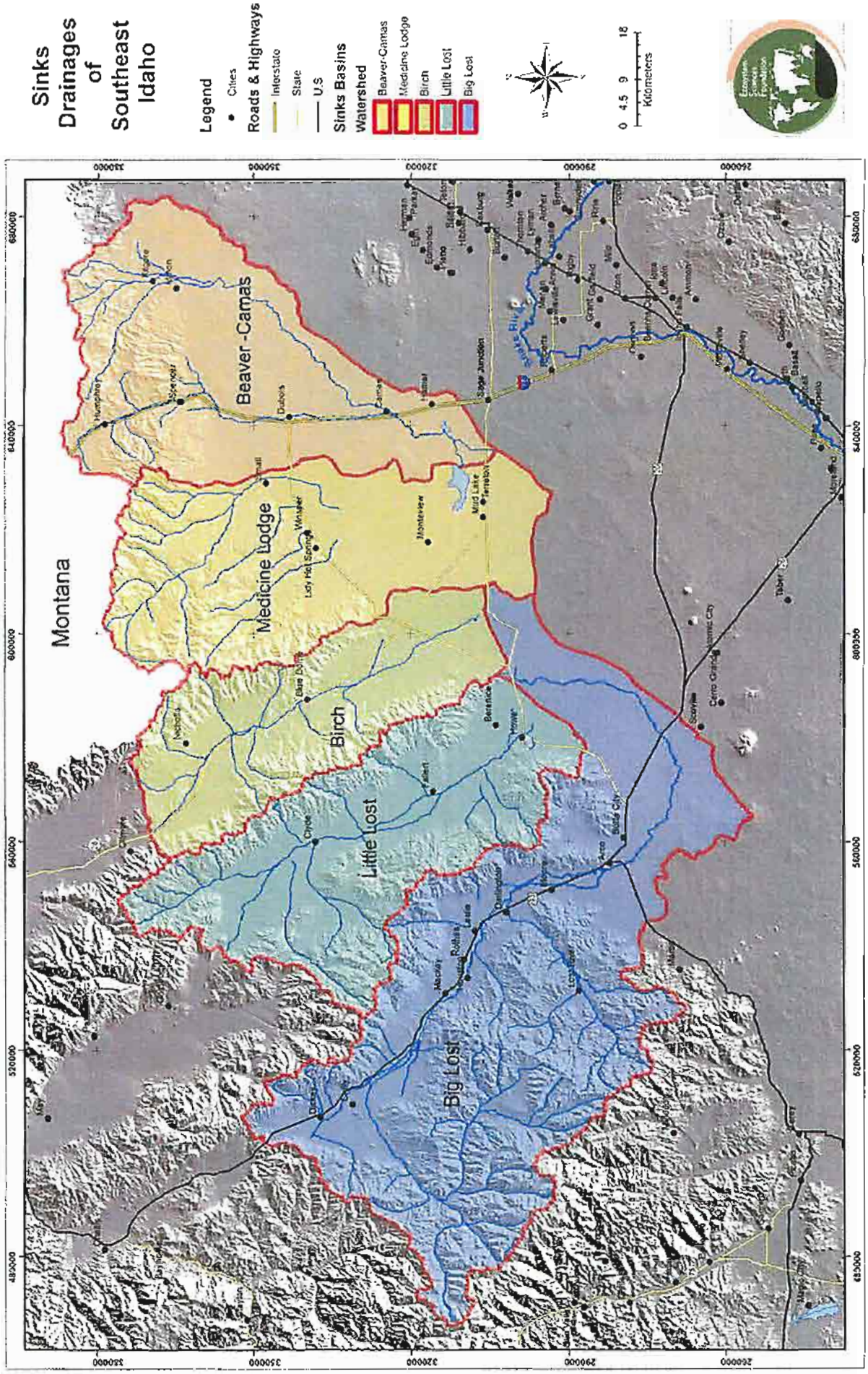


Figure 2.1 Sink Drainages of Southeast Idaho



Big Lost River Mountain Whitefish Status Report



Figure 2.3. Geographical distribution of the mountain whitefish, *Prosopium williamsoni*

### 3.0 CLASSIFICATION AND NOMENCLATURE

The mountain whitefish is a member of the family Salmonidae, subfamily Coregoninae. It was first described (originally as *Coregonus williamsoni*), by C.F. Girard (1856) from a specimen in Deschutes River, Oregon. Recent genetic and phenotypic studies suggest that designation of multiple species and subspecies is warranted (Whitely 2002). The genetic distance observed between Big Lost whitefish and surrounding populations is at least as large as that seen between other subspecies or even species (Whitely and Gammett 2002).

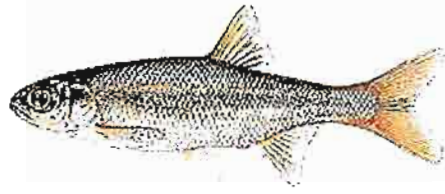


Photo. © Joseph R. Tomelleri

#### Figure 5.1. Mountain whitefish

Body slender, round cross section, and moderately compressed laterally; scales cycloid, 70 to 90 in the lateral line. Head short and somewhat pointed; snout more or less pointed; eye moderate; single flap between each pair of nostrils; mouth small, slightly inferior and without teeth; gill rakers short, 19-26; a distinct pelvic axillary process present. Strong tubercles developed on scales of sides of spawning males. Color light grayish blue on the back, silvery on the side, and dull whitish on the belly. Adults without black markings; young with several parr marks on each side.<sup>2</sup>

### 4.0 PRESENT LEGAL STATUS

Mountain whitefish are not protected by national or state regulation. Idaho Fish and Game regulates sport fishing in the Big Lost River Basin and the whitefish fishery is currently open from late-May to 31 March for catch-and-release fishing (IDFG 2006).

#### Spawning and Egg Development

Mountain whitefish are autumn, generally nocturnal, spawners, usually from September to November, but spawning has been observed as late as February (R.L. & L. Environmental Services 1996, Northcote and Ennis 1994). Wydoski (2001) estimated spawning season for the Blacks Fork River, Utah to be mid-October to mid-November. In Idaho, spawning generally occurs in late October or early November when water temperatures are between 4-7°C (Simpson and Wallace 1982). They do not make nests, or redds. Although some fish move upstream to spawn in the tributaries in the fall, spawning is known to occur in the main stem as well. Stream populations spawn in rubble and gravel areas with a particle size between coarse rubble and fine gravel with a depth range of 0.13 - 1.22 m (Northcote and Ennis 1994). Mountain whitefish produced 772 to 4,860 eggs in the Blacks Fork River (Wydoski 2001), while the average female in Idaho is reported to produce about 5,000 eggs (Simpson and Wallace 1982).

### 5.0 LIFE HISTORY

Mountain Whitefish (*Prosopium williamsoni*) are found in cold streams and lakes in the mountainous areas of western North America, from the northern Lahontan Basin in Nevada to the Yukon-British Columbia border in Canada (Simpson and Wallace 1982; Lee et al. 1980; Scott and Crossman 1973); see [Figure 2.3](#). Over most of the mountain whitefish range, including Idaho, it is a riverine species. In British Columbia, three life history patterns exist: a lacustrine pattern in which the entire life cycle occurs within a lake, a riverine pattern where the life cycle is entirely contained within the river, and an adfluvial pattern where the life cycle involves movements between lakes and rivers.

#### Growth and Age

When the fry emerge in the spring make their way downstream until backwater areas or shallow pools are found. They may then form schools, and use

<sup>2</sup> Simpson and Wallace 1982

protected side pools. Later in the summer the young fish move into the riffles and deeper parts of the stream (Nothcote and Ennis 1994). Mountain whitefish reach sexual maturity in their 3<sup>rd</sup> or 4<sup>th</sup> year (Simpson and Wallace 1982; Wydoski 2001). Fish can live 12-15 years and a sex ratio of 1.6 males to 1 female has been reported (Wydoski 2001). (Figure 5.1 and Figure 6.1)

Adult mountain whitefish move from their overwintering areas in deep pools in the lower reaches of the river to feeding sites in creeks and tributaries each spring. Later in the year, when the waters warm and the flows attenuate, they move to summer feeding grounds in the larger reaches (Westworth 1992). Mountain whitefish diet mainly consists of terrestrial and aquatic insects, but they often eat fish eggs, including their own.

## 6.0 HABITAT REQUIREMENTS

The habitat requirements for the mountain whitefish throughout the geographic range of the species are presented in Table 6.1. Habitat requirements for the Big Lost River Whitefish will be more specific. For example, spawning temperatures range from 0-7°C throughout North America, but have been reported between 4-7°C in Idaho (Simpson and Wallace 1982).



Figure 6.1. *Prosopium williamsoni*.

Picture by Keeley, E.R.

<http://fileman.ifm-geomar.de/Photos/ThumbnailsSummary.php?ID=2685>

## Big Lost River Mountain Whitefish Status Report

**Table 6.1. Habitat requirements for mountain whitefish**Mountain Whitefish (*Prosopium williamsoni*) habitat throughout the geographic range of the species.

Requisite Life Function	Habitat Component	Habitat Requirement
Spawning	Preferred temperature	0-8°C <sup>3</sup>
	Preferred Depth	0.1-1.0 m <sup>4</sup>
	Preferred Substrate	Rubble/gravel/rocks; 50-100 mm in diameter <sup>5</sup>
	Preferred velocity	0.89-1.02 m/s <sup>7</sup>
Egg Development	Temperature tolerance	0.0 – 12.0°C <sup>7</sup>
	Upper limit of optimum incubation temperature	6.0°C <sup>7</sup>
	Range of incubation time	36-127 days <sup>5</sup> ; 444 degree days <sup>6</sup>
	Minimum oxygen concentration	8 mg/L <sup>5</sup> ; moderate reduction in embryo survival below 35% saturation at 4°C <sup>6</sup>
Rearing	Temperature tolerance	0.0-20.6°C <sup>7</sup>
	Optimum temperature for growth	9.0 – 12.0°C <sup>7</sup>
	Recommended oxygen concentration	>5.63 mg/L <sup>7</sup>
	Oxygen concentration lethal below	3.98 mg/L <sup>7</sup>
	Habitat type preference	Lakes, rivers, and tributaries <sup>7</sup> ; fringe or tails of pools over rock or rubble bottom; backwater areas <sup>6</sup>
	Depth preference	<3.0 m <sup>7</sup>
	Microhabitat	Areas with slow to moderate stream velocities; low velocity areas along river margins <sup>7</sup> ; young-of-the-year will use protected side pools of small tributaries <sup>6</sup>
	Cover	Cutbanks/woody debris/ aquatic vegetation <sup>7</sup>
Adult holding and feeding	Turbidity tolerance	<10.0 mg/L <sup>7</sup>
	Gradient	0.59 to 1.46% <sup>5</sup>
	Temperature tolerance	0.0 – 20.6°C <sup>7</sup>
	Optimum temperature for growth	9.0 – 12.0°C <sup>7</sup>
	Recommended oxygen concentration	7.75 mg/L <sup>7</sup>
	Short term minimum oxygen concentration	4.25 mg/L <sup>7</sup>
	Depth preference	<3.0 m
	Substrate	Gravel, cobble <sup>7</sup>
	Cover	Cutbanks/woody debris/ aquatic vegetation <sup>7</sup>
Overwintering	Turbidity tolerance	<10.0 mg/L <sup>7</sup>
	Habitat preference	Shallow backwaters and shallows along margins; deep pools
	Preferred depth	No data
	Substrate	No data

<sup>3</sup> Northcote and Ennis 1994.<sup>4</sup> Ford et al. 1995.<sup>5</sup> Stewart et al. 1982.

## 7.0 HISTORICAL DISTRIBUTION

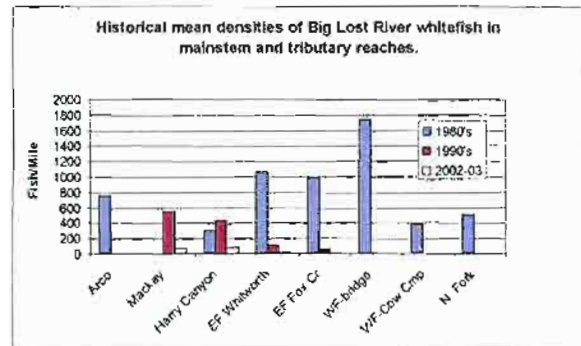
The mountain whitefish is widely thought to be native to the Big Lost River basin. Both scientific literature and historical accounts (Gamett et al. 2004) support this assertion. Mountain whitefish have been present in the Big Lost River as far back as the late 1800s when the first permanent settlers moved into the area. Early miners' records indicated that whitefish, sometimes referred to as mountain herring at that time, were present in Warm Spring creek in the 1860s (Gamett et al. 2004).

It is not clear how the mountain whitefish became established in the Big Lost River drainage. Although the Big Lost River is currently isolated from other stream networks, fish could have moved into the Big Lost River through historical stream connections (with the Salmon or Snake rivers) or stream capture. Gamett et al. (2004) believe the Mountain Whitefish entered the Big Lost River from the Snake River between 10,000 and several million years ago when higher stream flows formed a pluvial lake connecting all the lost streams with the Snake river. The Big Lost River is the only lost stream to have sufficient habitat for Mountain Whitefish (Gamett et al. 2004). A genetic investigation revealed that the Big Lost Whitefish are most closely related to Snake River Whitefish, with the exception of one locus that appears to be more closely related to Salmon River whitefish (Whitely and Gamett 2002)

There is very little historical data prior to the 1980s, making estimates of historical populations difficult. Gamett et al. (2004) used museum records, published reports, agency files and personal interviews to reconstruct pre-settlement (circa 1870) population and geographic distribution estimates. They estimated 173,500 (see [Table 8.1](#) for more detailed distribution numbers) whitefish occupied approximately 216 stream miles, including all the larger reaches of the river (see [Figure 8.2](#) map of historical distribution).

## 8.0 POPULATION STATUS AND DECLINE

Estimates of current and past distribution come from fishery surveys (Corsi and Elle, 1989; Corsi, 1989; Corsi and Elle, 1994; Elle and Gambin, 1993; Elle, 1997), and oral histories (Gamett 2004) collected by the USFS and IDFG. As shown in [Figure 8.1](#) and [Figure 8.2](#) mountain whitefish were once found in about 216 miles of stream in the Big Lost River drainage. Based on recent fishery surveys (Gamett et al., 2004), they occupy only 76 kilometers or 22% of their historic range ([Figure 8.3](#)).



**Figure 8.1**  
Historic mean densities of Big Lost River Whitefish. Adapted from Gamett et al 2004.

Studies by the USFS conclude that mountain whitefish are extirpated from many of the key tributaries. [Table 8.1](#) summarizes population estimates from the referenced USFS and IDFG studies. Antelope Creek, Wildhorse Creek, Star Hope Creek, and the North Fork. Overall, mountain whitefish numbers have declined from an estimated 310 fish/kilometer in pre-European settlement to about 11 fish/kilometer currently in the East Fork (Losinski 2004). Although USFS and IDFG population research is ongoing, the low density combined with the current distribution suggests the overall population is a small fraction of the historical number, and the species has been lost from virtually all of the principle tributaries to the Big Lost River. Remnant populations of the species are found in the East Fork and the Blaine to Mackay Dam reach, but the only place where mountain whitefish maintain a significant population within the overall fishery is in the Chilly Diversion to the East Fork reach.

## Big Lost River Mountain Whitefish Status Report

Table 8.1 Population trends (Gamett et al., 2004).

Reach	Historic Fish #	Current Fish #	Status % of Historic #
Arco to Blaine Diversion	32,500	0	0
Blaine to Mackay Dam	16,000	608	4
Chilly Diversion to East Fork	13,500	1,674	12
East Fork of Big Lost River	13,000	286	2
Antelope Creek	22,000	0	0
Star Hope Creek	8,000	0	0
Wildhorse Creek	6,500	0	0
North Fork of Big Lost River	14,500	0	0
<b>SUMMARY</b>	<b>173,500</b>	<b>2,680</b>	<b>1.5</b>

The decline in mountain whitefish in the Big Lost River and extirpation from primary tributaries has many causes as shown in [Table 8.2](#). The precipitous decline in recent years is not entirely understood, though drought and the demand for available water have clearly played a role. Much of the riverine area occupied by mountain whitefish is now dry due to agriculture water demand. For example, the Big Lost River supported a healthy whitefish population from the Blaine Diversion out onto the desert below Arco, and now this area is completely dry for most of the year.

Table 8.2.

Potential causes of mountain whitefish decline in reaches of the Big Lost River maintaining year around flow (from Fredericks et al., 2004)

Mountain Whitefish Life Stage	Potential Cause of Mortality
Incubation	Predation by non-native fish Flow alterations (reduced wetted widths) Whirling Disease Water Quality Temperature Change Icing
YOY Summer Rearing	Predation by non-native fish Dewatering Entrainment Temperature Habitat Limitations Water Quality Intra-inter species competition Whirling Disease
YOY Winter Rearing	Predation by non-native fish Temperature Icing Habitat Limitations Intra-inter species competition Whirling Disease
Juvenile/Adult Summer Rearing	Predation by non-native fish Angling Old Age Dewatering Entrainment Temperature Habitat Limitations Intra-inter species competition Whirling Disease
Juvenile/Adult Winter Rearing	Predation by non-native fish Angling Old Age Dewatering Entrainment Temperature Habitat Limitations Intra-inter species competition Whirling Disease
Migration	Dewatering Entrainment Angling Physical Barriers
Spawning	Dewatering Entrainment Predation by non-native fish Temperature Water Quality Whirling Disease

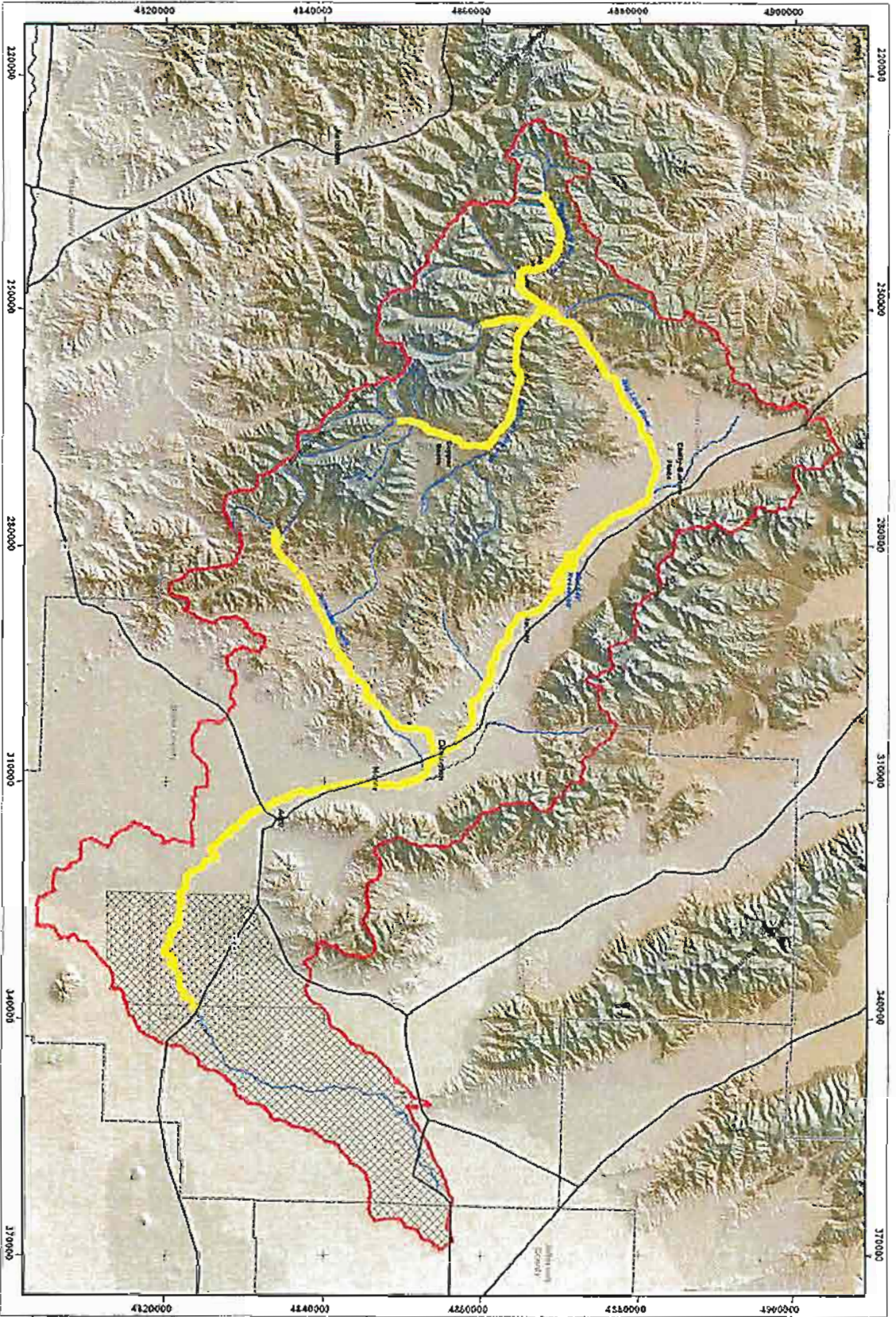
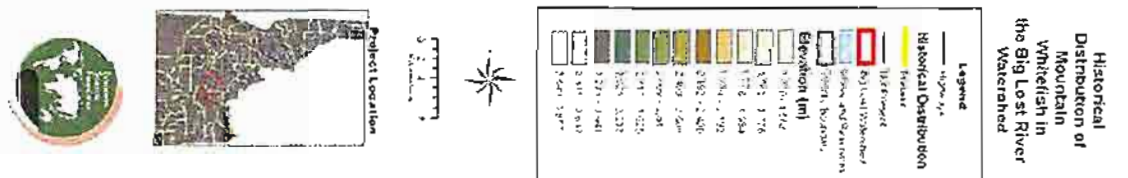


Figure 8.2. Historical Distribution of the Mountain Whitefish within the Big Lost River Watershed.



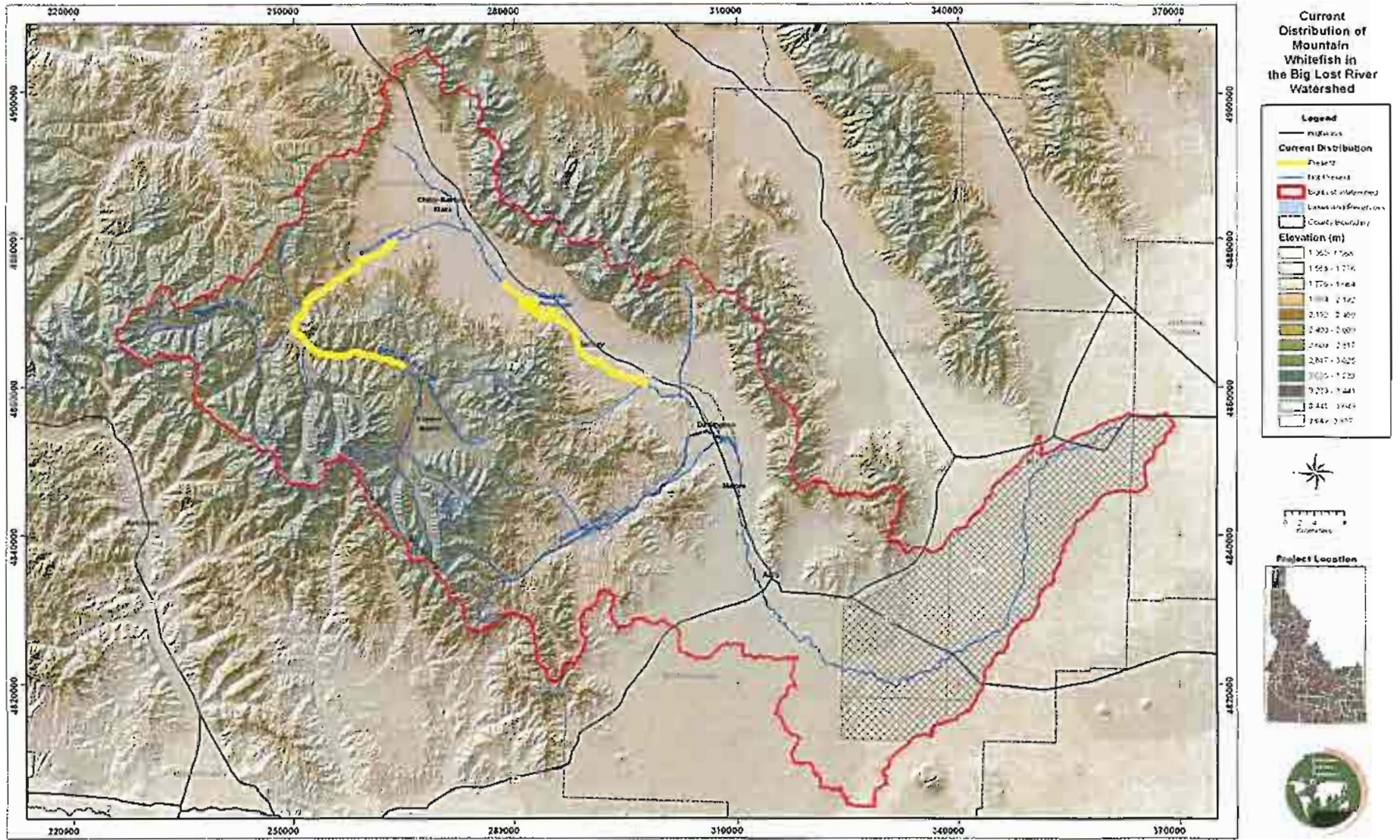


Figure 8.3. Current Distribution of the Mountain Whitefish within the Big Lost River Watershed.

The overarching causes of whitefish decline stem from irrigation for agriculture purposes and the introduction of non-native species.

- *Irrigation*

The Big Lost River drainage is riddled with water diversions on the mainstem and principle tributaries. The irrigation diversions, during operation, entrain fry, YOY, and juvenile whitefish. Water withdrawals also cause a reduction in key habitat features (wetted width, depth, and velocity) and minimizes the extent of riparian habitat (reduced water tables and out of-channel flows); induce temperature changes (warmer in the summer colder in the winter); and dewater spawning areas and exposes incubating eggs. Diversion structures block or hinder migration between spawning areas and rearing habitat; reduce stream connectivity; and inhibit genetic exchange between isolated metapopulations.

- *Introduced, non-native species*

It has long been known in fishery science that the displacement, decline, and extirpation of native fish species is a predictable outcome of introducing exotic fish into a natural system. The scientific literature is replete with studies describing the effect of sport fish introductions throughout North America. A recent, comprehensive analysis of non-native: native fish species interactions by Clarkson et al. (2005) resulted in the following conclusions:

*"The ubiquitous presence of non-native fishes, both sport and nongame, within waters of the southwestern United States is the foremost factor preventing immediate conservation and recovery of imperiled native species. We present evidence that the two fishery types cannot be co-managed in sympatry if natives are to persist. A dual responsibility of federal and state fish and wildlife agencies to manage both fishery types creates internal conflicts that typically are resolved in favor of non-native sport fisheries, despite existence of the Endangered Species Act. We advocate designation of watersheds to be managed exclusively for one fishery type or the other, and implementation of an aggressive program to eliminate non-natives in native-designated waters and protect against their reinvasions. To mitigate institutional conflicts, agency*

*infrastructures should be segregated to promote independent management of native fisheries and introduced sport fisheries. This approach can fulfill mandates of both the Endangered Species Act and the 1996 Fish and Wildlife Service policy on recreational fishing."*

The IDFG has stocked non-native sport fish (trout species) throughout the Big Lost River drainage since the 1920s. Today the river and tributaries are dominated by non-native sport fish. [Table 8.3](#) shows the Big Lost River drainage streams and the last IDFG stocking. Stream surveys indicate non-native fish are established and reproducing in all of the stocked streams (Corsi and Elle, 1989; Corsi, 1989; Corsi and Elle, 1994; Elle and Gambin, 1993; Elle, 1997). Augmentation stocking of hatchery produced, non-native species is routinely conducted by IDFG throughout the drainages as part of their fishery management program.

**Table 8.3.**

Most recent IDFG non-native fish stocking in the Big Lost River drainage

STREAM	YEAR	FISH STOCKED
Big Lost River	2002	Rainbow trout catchables
East Fork	2002	Rainbow trout catchables
North Fork	2002	Rainbow trout catchables
Antelope Creek	2002	Rainbow trout catchables
West Fork	2002	Rainbow trout catchables
Mackay Reservoir	2002	Rainbow trout catchables
Kane Creek	1986	Rainbow trout
Summit Creek	1982	Rainbow trout
Alder Creek	1973	Rainbow trout
Iron Bog Creek	1991	Rainbow trout
Cherry Creek	1982	Rainbow trout
Bear Creek	1984	Rainbow trout
Pass Creek	1986	Rainbow trout
Warm Springs Creek	1988	Rainbow trout
Parsons Creek	1977	Rainbow trout
Cabin Creek	1982	Rainbow trout
Fall Creek	1992	Rainbow trout
Twin Bridges Creek	1975	Rainbow trout

The effects of non-native fishes on natives result from interactions among life histories, behaviors, and habitat use. As shown in stocking records, non-natives introduction into the Big Lost River drainage are piscivores species which typically prey upon the

native assemblage including whitefish fry and YOY. Native fish typically fail to recruit young in the presence of non-natives (Marsh and Minckley 1989; Pacey and Marsh 1998; Dudley and Matter 2000). Predation on natives by introduced forms during early life stages is the most likely mechanism resulting in failure of natives, but other mortality factors contribute (Tyus and Saunders 2000).

Introduced fishes typically are phylogenetically advanced taxa that possess sophisticated life history and behavioral traits that allow them to persist within intensely competitive, saturated communities (Minckley and Rinne 1991; Douglas et al. 1994).

Non-natives may be released from much of their co-evolved parasite and disease load due to over-dispersion of parasite communities and small founding populations of introduced fishes (Torchin et al. 2001; Stockwell and Leberg 2002). At the same time, novel introduced parasites and diseases that are not co-evolved may differentially affect native fishes (Stockwell and Leberg 2002). While whirling disease is suspected to be a significant whitefish mortality factor in the Big Lost drainage, there have not been adequate studies to verify the frequency of disease. Typically, whirling disease is introduced with hatchery stocking.

Drought exhibits a short-term impact on fish populations, and in desert ecotypes drought is a natural climatic pattern which most native fish, to one degree or another, are adapted to. Drought may be a causative agent for precipitous declines over a recent, short time period, but it is unlikely the cause of the continuous decline in Big Lost River whitefish since European settlement in the drainage. Only in rare instances have natives persisted among introduced predator forms over a long history, i.e., several decades (Stefferdud and Stefferud 1995; Bryan et al. 2000); thus, predation by and competition with non-native fish is more responsible for the whitefish decline over time than drought.

The near-ubiquity of non-native fishes ensures that the impacts of predation, competition, or parasitism are ever-present factors, limiting successful completion of native fish life cycles (Clarkson et al. 2005).

## 9.0 GENETIC STATUS

Miller et al. (2005) collected 17 populations of whitefish from the upper Missouri River, lower Columbia River Colorado River, upper and lower Snake River, and Bonneville basins. The endemic whitefish from Bear Lake (Utah-Idaho) were also examined. The cytochrome b mitochondrial gene was sequenced, and phylogenies were generated assuming parsimony and maximum likelihood. Two distinct whitefish clades were found. The Colorado River, Snake River, and Bonneville basins comprise one clade and the Missouri River and Columbia River basins the second. Within these two clades, individual populations mainly clustered by drainage basin. The endemic Bear Lake whitefish complex, consisting of three recognized species, forms a separate clade interior to the Colorado River, upper Snake River, and Bonneville Basin whitefish group. Miller et al. (2005) conclude that the mountain whitefish is composed of as many as four separate species, in addition to the Bear Lake complex and that:

- The Big Lost River mountain whitefish is paraphyletic and comprised of two or three separate lineages.
- Lineages are embedded in mountain whitefish clades.
- Big Lost River mountain whitefish are isolated.

Campbell et al. (2005) also used nucleotide sequences of the cytochrome b gene of mitochondrial DNA to assess the phylogeography of mountain whitefish from Idaho, Montana, and Utah. Initial results support previous allozyme and microsatellite studies that found evidence for three well-defined genetic assemblages corresponding geographically to the (1) upper Snake River drainage (upstream of Shoshone Falls) and the Bonneville Basin, (2) the Snake River drainage (downstream to Shoshone Falls) including the Pahsimeroi and Salmon Rivers, and (3) the upper Missouri River. Levels of sequence divergence between these three genetic assemblages were equal to or greater than published levels of divergence found in salmonid subspecies occupying these drainages.

Whiteley (2002) also analyzed the three populations of mountain whitefish and reported the amount of genetic variation found among these three major groups with microsatellites was 35.2 %. The amount of variation partitioned among groups is high and

suggests that these three groups are genetically differentiated and evolving independently of one another. Whiteley (2002) writes "...the Big Lost should be considered a separate group. This group is highly genetically differentiated from all other populations analyzed to date. It is most genetically similar to populations from the upper Snake River (above Shoshone Falls). These fish should receive separate management consideration on the grounds that whitefish in the Big Lost have not had contact with other mountain whitefish populations for a long period of time and have evolved independently from other populations of mountain whitefish. These fish also have coloration and morphological differences, which provides additional evidence that they are highly differentiated from other mountain whitefish populations."

Whiteley and Gamett (2002) concluded that:

- Big Lost River whitefish are isolated and evolving separately.
- Morphologically Big Lost River whitefish are distinct from all other mountain whitefish.
- Whitefish in the Big Lost are fixed for microsatellite alleles that are rare or not present in the surrounding rivers.
- If a few fish were captured in another river and introduced into the Big Lost, the probability that these fish carried these rare alleles is extremely low.
- Biologically, they are an evolutionarily independent unit because they are isolated from surrounding populations and have been for some time.
- The genetic distance observed between Big Lost whitefish and surrounding populations is at least as large as that seen between other subspecies or even species.

In analysis of all the genetic information available at that time, Gamett et al. (2004) concluded that Big Lost River whitefish are genetically different from all other whitefish and they are likely a unique species or sub-species of fish.

Given the most recent genetic studies of Miller et al. 2005, and Campbell et al. 2005, all of which confirms past studies and conclusions – the Big Lost mountain whitefish must be managed as a separate species from all other mountain whitefish.

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