ASSESSMENT OF FISHERIES LOSSES IN THE UPPER SNAKE RIVER BASIN IN IDAHO ATTRIBUTABLE TO CONSTRUCTION AND OPERATION OF DAMS WITH FEDERAL HYDROPOWER FACILITIES

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ABSTRACT

The Pacific Northwest Electric Power Planning and Conservation Act of 1980 established a process for protecting, mitigating, and enhancing fish and wildlife affected by the construction and operation of hydropower projects in the Columbia River basin, and formed what is now known as the Northwest Power and Conservation Council (NPCC). In 1982, the council introduced a fish and wildlife program, and an amendment in 1995 included a two-step process for resident fish mitigation, the first of which was to complete assessments of resident fish losses related to the construction and operation of hydropower facilities. This report (1) quantifies lotic habitat lost as a result of construction of Anderson Ranch Dam and Reservoir, Black Canyon Dam and Reservoir, Deadwood Dam and Reservoir, Boise River Diversion Dam and Reservoir, Minidoka Dam and Lake Walcott, and Palisades Dam and Reservoir; and (2) estimates the number of salmonids that likely would have inhabited the lotic habitat lost due to reservoir construction and dam operation. Although anadromous salmon and steelhead historically occurred throughout much of the study area and were extirpated by these facilities, this report deals only with resident salmonids. These include native species (bull trout *Salvelinus confluentus*, redband trout *Oncorhynchus mykiss gairdneri*, Yellowstone cutthroat trout *O. clarkii bouvieri*, and mountain whitefish *Prosopium williamsoni*) and nonnative species (rainbow trout *O. mykiss*, brook trout *Salvelinus fontinalis*, and brown trout *Salmo trutta*). Taken together, these reservoirs inundated a total of about 198 km of riverine habitat. Factoring in the kilometers of inundation, the average abundance of salmonids in neighboring riverine habitat (based on a total of 180 surveys of fish abundance), and the number of years these dams have been in operation, it is estimated that riverine habitat for an estimated 1.3 million Yellowstone cutthroat trout, 4.3 million redband/rainbow trout, 2.8 million brown trout, 84,000 brook trout, 95,000 bull trout, and 50.1 million mountain whitefish have been lost due to inundation by these reservoirs. These calculations assume that current densities of salmonids are typical of densities since the construction of each dam. Taking into account this and other assumptions, it is likely that these estimates are conservative in nature and represent a minimum number of fish lost.

INTRODUCTION

The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Public Law 96-501) established a process for protecting, mitigating, and enhancing fish and wildlife affected by the construction and operation of hydropower projects in the Columbia River basin. The act formed the Northwest Power Planning Council, now known as the Northwest Power and Conservation Council (NPCC). The council's purpose was to ensure the region a supply of inexpensive power and balance that goal with the needs of fish and wildlife. In 1982, the council introduced a fish and wildlife program. The council's program takes an adaptive approach to fish and wildlife mitigation and has been amended several times. In 1995, program amendments included a two-step process for resident fish mitigation (Section 10; NPPC 1995). The amendment requested that fish and wildlife managers complete assessments of resident fish losses related to the construction and operation of federal hydropower facilities. Secondly, the amendment called for the development of biological objectives for mitigation (e.g., escapement, harvest, and production goals).

The purpose of this report is to quantify lotic habitat lost as a result of construction of dams in the upper Snake River basin (i.e., the Snake River basin above Hell's Canyon Dam) that possess federal hydropower facilities, including Anderson Ranch Dam and Reservoir, Black Canyon Dam and Reservoir, Deadwood Dam and Reservoir, Boise River Diversion Dam and Reservoir, Minidoka Dam and Lake Walcott, and Palisades Dam and Reservoir. None of these structures have ever provided fish passage. A secondary purpose of this report is to estimate the number of salmonids (bull trout *Salvelinus confluentus*, redband trout *Oncorhynchus mykiss gairdneri*, Yellowstone cutthroat trout *O. clarkii bouvieri*, and mountain whitefish *Prosopium williamsoni*) that likely would have inhabited the lotic habitat lost due to reservoir construction. Because the operation of Deadwood Reservoir impacted losses below the reservoir (see methods), habitat lost due to operation of Deadwood Dam is also included.

Some would argue that reservoirs created behind dams create a net benefit to fish populations. They would argue that, after reservoir construction, fish populations expanded, and increased fisheries benefits resulted. That may be true in part, but benefits rarely accrue to native fish populations. At the present time, all native salmonids in the upper Snake River basin, except mountain whitefish, are or have been petitioned to be listed under the Endangered Species Act (USFWS 1995, 1998, 2001). Creation of migration barriers and reservoir construction and operation have been included as threats to species persistence in all listing petitions. In addition, fish management costs increase after reservoir construction, as reservoir fisheries typically require supplemental stocking with hatchery fish or new species introduction to support fisheries in altered habitat.

Losses of anadromous fish populations have been considered elsewhere and are not considered here. Losses to resident, native, non-game fish species will be reported later.

BACKGROUND AND DESCRIPTION OF STUDY AREAS

Anderson Ranch Dam and Reservoir

The South Fork of the Boise River has a diverse history. The earliest records show that salmon and steelhead were a crucial part of the subsistence for the Snake River and Shoshone Indian tribes. In addition to abundant fisheries resources, gold was discovered in the South Fork

Boise River in 1862. In the early 1900s, industrial and agricultural growth led to greater demands for water (Caldwell and Wells 1974). To meet those demands, the Federal government constructed the Deer Flat (1906), Boise River Diversion (1908), and Arrowrock (1915) dams. In 1941, Congress authorized the construction of Anderson Ranch Dam, which was completed in 1950. Anderson Ranch Dam was built for irrigation, hydroelectric energy, and flood control.

Anderson Ranch Dam is located in Elmore County, Idaho, near river km 60 on the South Fork Boise River (Figure 1). The dam is 47 km northeast of Mountain Home, Idaho. The earthen structure stands 138 m high with a crest length of 411 m. At maximum pool, the reservoir is 1,279 m above sea level and contains 609 x 10^6 m^3 of water. Maximum depth exceeds 107 m. The reservoir inundated approximately 58 km of total stream habitat. The drainage area of the South Fork Boise River is 3,377 km^2. Average annual inflow to the reservoir is 884 x 10^6 m^3/yr. The powerplant originally had a rated capacity of 27,000 kilowatts with two units installed. In 1981, both generators were rewound and modernized to an increased capacity of 20,000 kilowatts each. Net generation in fiscal year 2005 was 91,164,540 kilowatt hours.

Anderson Ranch Reservoir is situated in a steep, narrow, rugged canyon that in some places drops more than 305 m to the waters edge. Granitic and basaltic canyon walls range in slope from 20% to vertical cliffs. Vegetation on south-facing slopes includes sagebrush *Artemisia spp.*, cheatgrass *Bromus tectorum L.*, bluebunch wheatgrass *Pseudoroegneria spicata*, and bitterbrush *Purshia tridentata*. North-facing slopes are predominately quaking aspen *Populus tremuloides*, Douglas-fir *Pseudotsuga menziesii*, and Ponderosa pine *Pinus ponderosa*. Annual precipitation at the dam averages 53 cm. Most of the precipitation in the basin occurs at high elevation as snow from November to May (Water and Power Resource Service 1981).

Black Canyon Dam and Reservoir

Human development during the early 1800s brought significant change to the Payette River basin. Historically, the Payette River supported abundant salmon and steelhead populations (CBIAC 1956). The salmon runs were an important resource to the original inhabitors of the region. Black Canyon Reservoir resides within the ancestral fishing and hunting area of the Shoshone and Bannock Indian tribes (Martin and Mehrhoff 1985). In 1862, gold was discovered in the region and the population grew from about 3,000 to nearly 20,000 (Caldwell and Wells 1974). To support the mining communities, farmers increased agricultural production by irrigating more land (USFWS 1980). Water and power demands continued to grow, and the passage of the 1902 Reclamation Act provided the financial resources for large-scale irrigation and electrical power development (Quivik and Hess 1989). In 1905, the Secretary of the Interior authorized the Boise Valley Project, which included construction of three dams on the Boise River and two dams in the Payette Drainage.

Black Canyon Dam was part of the Payette Project. The initial plans for the Payette Project were to build a dam for diverting water, build a storage reservoir upstream to support the diversion dam, and build a canal system from the diversion dam to the Boise Valley (Quivik and Hess 1989). Black Canyon Dam served as the diversion location and Deadwood and Cascade reservoirs as storage reservoirs.

Black Canyon Dam was built in 1924 to divert water from the Payette River for irrigating land south and east of Emmett, Idaho (Quivik and Hess 1989). Black Canyon Dam is located 8 km northeast of Emmett, in Gem County, Idaho near river km 63 on the Payette River (BOR

1997; Figure 2). The concrete gravity-type structure stands 56 m high with a crest length of 317 m. At maximum pool, the reservoir is 761 m above sea level. The reservoir initially held 54 x 10^6 m^3 of water, but by the early 1970s sedimentation had reduced total storage to approximately 31 x 10^6 m'. The Payette River drainage area above Black Canyon Dam is 6,941 km^2 (BOR 1997). Average annual inflow to the reservoir is 2,659 x 10^6 m^3/yr. The reservoir inundated approximately 16 km of the Payette River and about 15 km of tributary streams.

The powerplant's originally capacity (in 1925) of 8,000 kilowatts was increased to 10,200 kilowatts by 1995 with the installation of forced air cooling and a stator rewind/upgrade. Net generation in fiscal year 2005 was 61,600,400 kilowatt hours. The Black Canyon control building (from which Black Canyon Dam and Powerplant, Anderson Ranch Dam and Powerplant, and Deadwood Dam are remotely operated) is located next to the powerplant.

Prior to dam construction, the Payette River flowed through a riverine environment likely dominated by a black cottonwood *Populus trichocarpa* complex with an understory of various shrubs and grasses. The surrounding uplands were a shrub-steppe vegetation community (Martin and Mehrhoff 1985).

Deadwood Dam and Reservoir

Deadwood Dam was built in 1931 to store water for downstream diversion at Black Canyon Dam during the irrigation season (Quivik and Hess 1989). Deadwood Dam is located in Valley County, Idaho near river km 29 on the Deadwood River (Figure 3). The dam is located 24 km north of Lowman, Idaho. The concrete-arch structure stands 50 m high with a crest length of 228 m. At maximum pool, the reservoir is 1,624 m above sea level and contains 200 x 10 m^3 of water. The drainage area in the Deadwood River above Deadwood Reservoir is 290 km^2. Average inflow to the reservoir is 145 x 10^6 m^3/yr. Deadwood Dam has no powerplant, but instead is controlled to maximize power generation at Black Canyon Dam, and for downstream agricultural uses. The reservoir inundated a total of approximately 25 km of stream habitat.

Deadwood Dam is situated in a narrow canyon bordered by two granite outcrops. The dam is surrounded by coniferous forest. Climate consists of short warm summers and long cold winters. Annual precipitation averages about 142 cm (Meuleman and Martin 1986).

Boise River Diversion Dam and Reservoir

The Boise River Diversion Dam was built in 1908 to supply water to the New York Canal. The Boise River Diversion Dam is located in Ada County 6.4 km southeast of Boise, Idaho (Figure 4). The dam is a rubble concrete structure 21 m high, with a crest length of 152 m. The dam has a diversion capacity of 79.7 m^3/s. The dam is a run-of-the-river facility with storage of 4 x 10^6 m^3 of water. Average annual inflow is 2,713 x 10^6 m^3/yr. No fish bearing tributaries were inundated by the Boise River Diversion Dam. The reservoir inundated approximately 4.6 km of the Boise River.

In 1912, a powerplant and a 17-mile transmission line were constructed to supply construction power for Arrowrock Dam. The original plant has three vertical generators each with an original capacity of 500 kilowatts. Due to the deteriorated condition of the equipment and high operating costs resulting from full-attended operation, the powerplant was placed in ready reserve status in 1982. The plant was reconstructed in 2002 to 2004 and returned to service in June 2004. Net generation in fiscal year 2005 was 10,746,000 kilowatt hours.

The climate in the region is considered semi-arid. Annual precipitation is 36 cm. Summers are hot and dry and winters are cold and wet. At the rivers edge, black cottonwoods and willows *Salix spp.* are common. At higher elevation, sagebrush and grasslands dominate.

Minidoka Dam and Lake Walcott

In 1904, the Secretary of the Interior authorized the construction of Minidoka Dam for irrigation and power generation. Minidoka Dam is located 16 km northeast of Rupert, Idaho (Figure 5). The dam was completed in 1906, is a rock-fill structure with a concrete core, and stands 26 m high. The dam's crest length is 1,364 m. Elevation at full pool is 1,294 m, which is the optimal elevation for diverting water during the irrigation season. Water storage capacity is 259 x 10^6 m^3 (BOR 1997). Average annual inflow to the reservoir is 5,778 x 10^6 m^3/yr.

A power plant was added in 1909. The hydroelectric power plant was one of the first built by the federal government in the northwest (Martin and Meuleman 1989). The original powerplant was constructed upon the concrete buttress section of the dam, located at the right end of the rockfill section. The original generator Units 1-5 have been retired. Units 6 and 7 have been refurbished and continue to operate. At full head and flow, Unit 6 provides 3 megawatts, and Unit 7 provides 5.5 megawatts of power. In 1997, construction was completed at the Allen E. Inman Powerplant, which replaced the retired units (1-5) and houses two 10-megawatt horizontal shaft Kaplan Units. The combined generation capacity of all four units is 28.5 megawatts, with a combined flow of 245.5 m^3/s. Net generation in fiscal year 2005 was 79,173,000 kilowatt hours. The reservoir inundated approximately 62 km of the Snake River but almost no tributaries. Rock Creek and the Raft River are the two largest tributaries entering the Snake River within the boundaries of Walcott Reservoir.

The climate in the area of Minidoka Dam is considered semi-arid. Annual precipitation is 32 cm. Summers are hot and dry and winters are cold with a mean annual temperature of 9.4°C. Sagebrush/wheat grass steppe is the dominant vegetation with the occasional stand of junipers *Juniperus spp*. Riparian vegetation includes sedges and forbs with mixed willow, alders *Alnus spp.*, and cottonwoods (Lay 1999).

Palisades Dam and Reservoir

The initial use of irrigation in the South Fork Snake River region began in the early 1870s with the development of farming in the Rexburg and Blackfoot area. Prior to the presence of settlers from the eastern United States, the area was the traditional hunting and fishing grounds for the Shoshone and Bannock Indian tribes. By the early 1900s, over 202,350 ha of land were under irrigation, and the demand was increasing. Following the passage of the Reclamation Act of 1902, the United States Reclamation Service constructed four projects to meet the increasing eastern Idaho water demands. These projects, including Lake Walcott, Jackson Lake, American Falls and Island Park, failed to meet the increasing irrigation demand. A drought in the early 1930s combined with expanding industry and the human population increased the need for additional water storage. This need precipitated the development of the Palisades Project (Simonds 1995).

The area selected for the Palisades Project was a site known as “Grand Valley”, located 11.3 km southeast of Irwin, in Bonneville County, Idaho near river km 1,450 on the South Fork Snake River (BOR 1996; Figure 6). The valley floor in this area was wide (1.6-3.2 km) and sloped gently. Farming and grazing dominated the valley surrounding the riparian marshes. Common crops included dryland wheat and irrigated hay (Sather-Blair and Preston 1984). The valley was bordered on the south by the Caribou National Forest and the Targhee National Forest on the north. National Forest land surrounding the SFSR was comprised of a coniferous forest, aspen, and a shrub-steppe plant community (Sather-Blair and Preston 1984).

Palisades provides water for irrigation, flood control, recreation, and electrical power generation. The concrete gravity-type structure stands 82 m high with a crest length of 640 m. At maximum pool, the reservoir is 1,716 m above sea level. The dam impounds 1,481 x 10^6 m^3 of water at full pool. The South Fork Snake River drainage area above Palisades Dam is 13,468 km^2 (BOR 1996). Average annual inflow to the reservoir is 5,923 x 10^6 m^3/yr. The reservoir inundated approximately 38 km of the South Fork Snake River and about 79 km of tributary streams.

Palisades Dam and Powerplant were completed in 1957, with the last unit placed on line in 1958 and first reservoir spill in 1959. The dam was initially equipped with four power-generating units, which provided a total generating capacity of 118 megawatts. These were later upgraded (in the 1990s) to provide a continuous power output of 168 megawatts (Simonds 1995). From the start, the generators produced copious quantities of ozone, due to corona discharge, which deteriorated all metal parts and the winding. The original windings lasted less than 10 years. All the generators were rewound in the 1960s, using an epoxy-mica insulating system, instead of the original asphalt-mica insulating system. Corona was a problem, and ozone deterioration continued to the point that windings were seriously deteriorated by the late 1980s. Generators were rewound again in 1991-1995, increasing unit capacity to 44 megawatts. Station service switchgear was replaced in 2001, and penstock flow meters were installed in 2002. Net generation in fiscal year 2005 was 517,411,940 kilowatt hours.

FISH SPECIES

Historically, Shoshone Falls near Twin Falls, Idaho on the Snake River blocked upstream fish migration and created markedly different fish communities upstream and downstream of the falls. Upstream of the falls, salmonid communities were dominated by Yellowstone cutthroat trout and mountain whitefish. Other common native species included longnose dace *Rhinichthys cataractae,* speckled dace *Rhinichthys osculus*, Piute sculpin *Cottus beldingi,* mottled sculpin *Cottus bairdi,* redside shiner *Richardsonius balteatus,* Utah chub *Gila atraria*, and Utah sucker *Catostomus ardens.* Northern leatherside chub *Lepidomeda copei*, bluehead sucker *Catostomus discobolus*, and mountain sucker *Catostomus platyrhynchus* are also native but are uncommon.

Downstream from Shoshone Falls, salmonid communities were dominated by salmon and steelhead, as well as bull trout, redband trout, and mountain whitefish (Gilbert and Evermann 1894; Hubbs and Miller 1948; CBIAC 1956; USFWS 1980). At least three anadromous salmonids utilized the Boise and Payette rivers, including Chinook salmon *Oncorhynchus tshawytscha,* sockeye salmon *Oncorhynchus nerka,* and steelhead trout *Oncorhynchus mykiss* (Caldwell and Wells 1974).

Dam construction eliminated salmon and steelhead from areas upstream from dams. Following dam construction, salmonid communities downstream from Shoshone Falls were dominated by redband trout, bull trout, and mountain whitefish (Caldwell and Wells 1974;

USFWS 1980). Other common native species include white sturgeon *Acipenser transmontanus,* northern pikeminnow *Ptychocheilus oregonensis,* several sculpin species *Cottus spp.,* chiselmouth *Acrocheilus alutaceus,* longnose dace, speckled dace, peamouth *Mylocheilus caurinus,* redside shiner, and several sucker species *Catostomus spp.* Table 1 illustrates which fishes currently occur in or around the reservoirs included in this study.

Historically, bull trout, Yellowstone cutthroat trout, and redband trout populations in the upper Snake River basin contained resident and migratory life history forms (SBNFWAG 1998). Resident populations generally spend their entire lives in tributary and headwater streams, whereas migratory forms rear in tributary streams for several years and migrate to more productive downstream habitat in larger rivers (fluvial life forms) or lakes (adfluvial life forms). The coexistence of migratory and resident forms of trout can be important (Rieman and McIntyre 1995; Nelson et al. 2002). Migratory trout link resident populations to the species' gene pool. Barriers to migration isolate resident populations, which can cause isolated populations to become vulnerable to habitat degradation, loss of genetic diversity, and local extirpation (Novinger and Rahel 2003; Fausch et al. 2006).

The completion of these dams blocked fluvial salmonids from reaching headwater or tributary populations. Anderson Ranch Dam blocked 75% (2,543 km^2) of the South Fork Boise River drainage and 24% of the entire Boise River drainage (BOR 1997); Black Canyon Dam blocked 81% (7,033 km^2) of the Payette River drainage (BOR 1997); Deadwood Dam blocked 14% (288 km^2) of the South Fork Payette River drainage and 3% of the entire Payette River drainage (BOR 1997); Boise River Diversion Dam blocked 65% (6,954 km^2) of the Boise River drainage (BOR 1997); Palisades Dam blocked 90% (13,668 km^2) of the South Fork Snake River drainage (BOR 1997). Minidoka Dam had little impact on fish movement because Shoshone Falls is only about 100 km downstream of the dam, and no major river drainages exist between Minidoka Dam and Shoshone Falls. Estimating fish loss from dam blockage is problematic without data from unaltered systems in the region. Surrounding watersheds have similar barriers to migrant fish populations. Thus, we did not attempt to directly quantify losses of large fluvial stocks attributable to migration barriers (i.e., the dams).

Anderson Ranch Dam and Reservoir

Prior to dam construction, salmon and steelhead dominated the fish community of the South Fork Boise River (CBIAC 1956; USFWS 1980). Despite the loss of anadromous populations, the South Fork Boise River continued to support a native fish community.

Prior to the completion of Anderson Ranch Dam, the resident native fish community was composed of bull trout, redband trout, mountain whitefish, northern pikeminnow, shorthead sculpin *Cottus confusus,* chiselmouth, and several sucker species (Caldwell and Wells 1974; USFWS 1980). Brook trout *Salvelinus fontinalis,* cutthroat trout O. *clarkii,* kokanee, rainbow trout, Redside shiner, smallmouth bass *Micropterus dolomieui,* and yellow perch *Perca flavescens* have been introduced (Table 1). Kokanee populations in the reservoir fluctuate significantly due in part to extreme high and low water conditions, which affects the quality of the fishery. The rainbow trout fishery in the reservoir is maintained by stocking catchable sized sterile rainbow trout.

Fish responses to the inundation of the South Fork Boise River were varied. Gebhards (1963) reported that, after impoundment, northern pikeminnow and sucker populations increased. Conversely, mountain whitefish, bull trout, and redband trout exhibited precipitous declines. The declines were assumed to be caused by competition and predation from expanding pikeminnow and sucker populations, which flourished in the reservoir environment (CBIAC 1956; Gebhards 1963).

Black Canyon Dam and Reservoir

Prior to dam construction, salmon and steelhead dominated the fish community of the Payette River drainage (CBIAC 1956). At least three species of anadromous fish utilized the Payette River, including Chinook salmon, sockeye salmon, and steelhead trout (Caldwell and Wells 1974). Pacific lamprey *Lampetra tridentata* may have also been present. Black Canyon Dam was the first barrier to salmon migration up the Payette River. Shortly after the dam was completed in 1924, few if any salmon remained in the Payette River (CBIAC 1956). Despite the loss of anadromous populations, the Payette River continued to support a diverse native fish community.

Historically, the resident native fish community of the Payette River supported migratory and resident forms of bull trout and redband trout (SBNFWAG 1998). Mountain whitefish, largescale sucker *Catostomus macrocheilus* and bridgelip sucker *Catostomus columbianus,* northern pikeminnow, chiselmouth, redside shiner, longnose and speckled dace, mottled sculpin, shorthead sculpin, peamouth, and white sturgeon were also present. Black Canyon Reservoir provides only marginal fish habitat. Sand from upstream land disturbances has covered most habitats.

Deadwood Dam and Reservoir

Historically, the resident native fish community in the Deadwood River drainage was similar to but more simplistic than for the areas lower in the Payette River drainage. The reservoir is currently managed for bull trout, kokanee, redband trout, and cutthroat trout. Yearly intensive tributary management is required to prevent overpopulation and stunting of kokanee. Stocking of sterile hatchery rainbow trout also occurs annually. Cutthroat trout have been introduced and have established a marginal fishery. The Deadwood River below the dam has almost no fishery due to hypolimnetic coldwater releases throughout the growing season that inhibits fish growth and survival. In addition, from the 1930s to 1993, minimum winter stream flow below Deadwood Dam was typically 0-0.06 m^3/s. Currently, minimum winter flow is about 1.42 m^3/s. Historically, winter flow was likely greater since winter inflow is usually greater than 1.42 m^3/s.

Boise River Diversion Dam and Reservoir

Barber and the Boise River Diversion dams were the first fish barriers (1908) to salmon migration on the Boise River, and effectively blocked all salmon migration (Caldwell and Wells 1974). Historically, the Boise River supported migratory and resident forms of bull trout and redband trout (SBNFWAG 1998). Also represented in the resident native fish community were white sturgeon, mountain whitefish, northern pikeminnow, shorthead sculpin, chiselmouth, several sucker species, and possibly Pacific lamprey (Table 1) (Caldwell and Wells 1974; USFWS 1980). Barber Dam does not create a reservoir and therefore this reach was not included in total length of river inundated for this study. There is virtually no fishery in the 4.6-km section of the Boise River above the Boise River Diversion Dam, as it is nearly entirely silt bottomed and is annually reduced to 2-6 m^3/s or less in the winter, providing little habitat for salmonids.

Minidoka Dam and Lake Walcott

Yellowstone cutthroat trout and mountain whitefish were the dominant native salmonids in the reach above Minidoka Dam. Utah sucker, Utah chub, and mottled sculpin are other fishes commonly found in the Snake River above Shoshone Falls (Simpson and Wallace 1982). The fishery in Lake Walcott consists largely of a hatchery rainbow trout put-and-take operation, as well as an introduced smallmouth bass fishery.

Palisades Dam and Reservoir

Prior to the construction of Palisades Dam, the impounded reach of the South Fork Snake River supported a quality Yellowstone cutthroat trout fishery. Catch rates were estimated at 0.68 fish/h in the river above the dam site, similar to the river downstream (Miller and Roby 1957). Fishing in the river was somewhat seasonal due to the heavy spring flows and fluctuations from Jackson Lake. Historically the South Fork Snake River was known for its large cutthroat trout, and it was not uncommon to harvest trout up to 2.3 kg (Moore et al. 1981). Local anglers reported that these large fish became scarce within three to five years following the completion of Palisades Dam (Miller and Roby 1957). Large numbers of trout were reported in the afterbay of the dam in 1957. These fish were thought to be remnants of fish that spawned in tributaries above the dam (Miller and Roby 1957). Today the reservoir fishery is supported largely by stocking catchable and sub-catchable cutthroat trout from Jackson National Fish Hatchery. The fishery below the dam is impacted by low water flows during late fall and winter from Palisades Reservoir and Dam. Alteration of the spring hydrograph is thought to have favored spawning of rainbow trout, endangering the world-class cutthroat trout fishing (R. Van Kirk, Idaho State University, personal communication).

METHODS

Estimating native sport fish losses is exceptionally difficult, especially when pre-impoundment data are nonexistent or qualitative in nature. However, attempts have been made using post-impoundment fisheries information (Zubik and Fraley 1987; Marotz et al. 1998). In both studies, the authors estimated native fish losses by averaging population data from tributary and river reaches in the same geographical area, and applying those values to the amount of inundated habitat. A similar approach was used here to estimate the losses of salmonid fisheries (native and nonnative) resulting from the construction and operation of Anderson Ranch, Black Canyon, Boise River Diversion, Deadwood, Minidoka, and Palisades dams and reservoirs. In addition, the operation of Deadwood Reservoir has greatly impacted the fishery in Deadwood River from the dam to the confluence with the South Fork Payette River. Losses of redband trout, bull trout, and mountain whitefish in this 35.4-km section of river were also estimated. Estimates were made separately for each location.

An extensive literature search provided some information on pre- and post-reservoir conditions, including fish assemblages, available/lost habitat, environmental impacts, and fish densities. The most extensive quantitative data available stems from Idaho Department of Fish and Game's (IDFG) Native Salmonid Assessment project, funded by BPA. Over 2,500 surveys of fish abundance have been made on this project from 1998 to 2006, many of which were adjacent to the water bodies in question. Previous studies have shown that, for the most part, native salmonids have experienced obvious declines in abundance from historical levels, but have not experienced significant changes in the upper Snake River basin in the last 10-20 years (e.g., Meyer et al. 2003; Zoellick et al. 2006). Because data from this BPA-funded project was more quantitative in nature and more broadly distributed than previous data from the last 10-20 years, we used data from this project exclusively, and assumed this data would produce conservative approximations of historical abundance.

Fish sampling is described in detail in Meyer et al. (2006). In short, at each study site, fish were captured using electrofishing or snorkeling gear. When electrofishing, fish were identified, enumerated, measured to the nearest millimeter (total length, TL) and gram, and eventually released. The few hatchery rainbow trout (which in Idaho are sterilized before release) that were encountered were easy to differentiate from wild rainbow trout based on fin condition, and were not included in this study. Sampling in small streams was conducted by depletion electrofishing, using one or more backpack electrofishers (Smith-Root Model 15-D) with pulsed DC. Block nets were installed at the upper and lower ends of the sites to meet the population estimate modeling assumption that the fish populations were closed. Maximum-likelihood abundance and variance estimates were calculated with the MicroFish software package (Van Deventer and Platts 1989). At sites too large to perform backpack electrofishing, mark-recapture electrofishing was conducted with a canoe- or boat-mounted unit (Coffelt Model Mark-XXII) and DC (if possible) or pulsed DC. Recapture runs were made two to seven days after marking fish. Log-likelihood or modified Peterson estimates of trout abundance were made using the Mark Recapture for Windows software package (Montana Fish, Wildlife and Parks 1997). We could not estimate trout <100 mm at the mark-recapture sites due to low capture efficiencies of small fish. Where electrofishing was not possible due to access constraints or other logistical difficulties, snorkeling was conducted following the protocol of Thurow (1994). We counted all salmonids ≥100 mm, and total counts were used as minimal abundance estimates with no correction for any sightability bias.

Redband/rainbow trout were lumped with hybrids (Rainbow x cutthroat or redband x rainbow) for population estimates. Because electrofishing is known to be size selective (Reynolds 1996), trout were separated into two length categories, <100 mm TL and ≥100 mm TL; abundance estimates were made separately for these two size groups and pooled for an estimate of total abundance at each site. Raw data used for this study can be found in Appendix A.

River kilometers (km) and tributary length lost to inundation were measured using a geographic information system (ArcGIS) and were summed by stream order (Strahler 1964). Since pre-inundation sinuosity and channel trajectory was unknown, we calculated the number of kms of inundated stream by tracing the stream length for non-inundated streams adjacent to the reservoirs, and divided by the straight distance measurements for those streams. This correction on average was about 35%, so we multiplied straight distance measurements for inundated streams by 1.35.

We estimated total fish loss due to inundation using the stratified random sampling formulas from Scheaffer et al. (1996). For each location, we first summed the total length of stream inundated for each stream order, or stratum, and divided this total by 100 meters of stream (the typical length of most study sites on which abundance was based) to calculate the number of sampling units (N_i) in each stratum (L). Abundance of various sportfish from adjacent fish survey sites was standardized to density per 100 linear meters of stream. We calculated a mean abundance ($\bar{y}_i$) within each stream order (stratum), and an associated variance. For total population size (N_{census}), we used the formula:

$$N_{census} = \sum_{i=1}^{L} N_i \overline{y_i}$$

and for variance of N_{census} we used the formula:

$$\widehat{V}(N_{census}) = \sum_{i=1}^{L} N_i^2 \left(\frac{N_i - n_i}{N_i} \right) \left(\frac{s_i^2}{n_i} \right)$$

where s_i^2 is the variance of the observations in stratum i, and n_i is the sample size within stratum i. All sample sites, including dry and fishless sites, were included in these estimates. We estimated losses for each dam from the time of inundation to the year 2007. For Deadwood Dam and Reservoir, separate estimates were produced for above the dam (1931-2007) and below the dam (1931-1993, the year when winter flows were no longer 0.06 m^3/s).

Our analysis assumes that there are currently no wild salmonids occupying the inundated reaches of river for each study location. This assumption is not far from the truth. Except for a few mountain whitefish, bull trout, cutthroat trout, and redband trout in Deadwood Reservoir, a few mountain whitefish, bull trout, and redband trout in Anderson Ranch Reservoir, and a few mountain whitefish and Yellowstone cutthroat trout in Palisades Reservoir, the small number of salmonids that may be encountered in these water bodies are mostly of hatchery origin. We also assumed our abundance estimates were not positively or negatively biased, although studies have shown that depletion estimates, which were the vast majority of our estimates, can drastically underestimate true abundance (Peterson et al. 2004; Rosenberger and Dunham 2005). Snorkeling counts also underestimate true abundance (Mullner et al. 1998). In addition, our big-river electrofishing and snorkeling estimates did not include fish < 100 mm, creating another source of negative bias. We also assumed that, in calculating total loss, all trout were equal, regardless of species. In other words, we assumed that niche overlap was complete for all trout, and simply summed loss estimates for each species of trout for an overall loss estimate at each facility. Finally, we assumed that current abundance is reflective of abundance since the time of construction of these dams, which is unlikely to be true. Taken together, it is likely that this assessment of loss drastically underestimates true losses.

RESULTS AND DISCUSSION

Anderson Ranch Dam and Reservoir

Anderson Ranch Reservoir inundated a total of about 58.1 km of stream, most of which was fifth- and sixth-order stream reaches (Table 2). Thirty-three estimates of fish abundance were available from the South Fork Boise River drainage near the reservoir. No data was available for fourth-order streams, so data were pooled for third- and fifth-order streams to extrapolate abundance for fourth-order reaches. Average linear density for bull trout, redband trout, and mountain whitefish among all nearby study sites was 0.05, 0.43, and 0.19 fish/m, respectively (Appendix A). Habitat for an estimated 1,533 bull trout, 37,725 redband trout, and 42,137 mountain whitefish have been lost annually since 1950 due to inundation of the South Fork Boise River and tributaries in Anderson Ranch Reservoir (Table 3), for a total of 81,405 salmonids lost annually, or a total of about 4.72 million salmonids through 2007.

Black Canyon Dam and Reservoir

Black Canyon Dam and Reservoir inundated a total of about 31 km of stream in the Payette River drainage, most of which was first-order and sixth-order in nature (Table 2). A total of 43 estimates of fish abundance were available from the Payette River drainage near the reservoir. Average linear density for brook trout, redband trout, and mountain whitefish among all study sites was 0.02, 0.14, and 0.24 fish/m, respectively (Appendix A). Habitat for an estimated 769 brook trout, 1,461 redband trout, and 75,715 mountain whitefish have been lost annually since 1924 due to inundation of the Payette River and tributaries in Black Canyon Reservoir (Table 3), for a total of 77,945 salmonids lost annually, or a total of about 6.55 million salmonids through 2007.

Deadwood Dam and Reservoir

Deadwood Reservoir inundated a total of about 25.2 km of riverine habitat in the Deadwood River drainage (Table 2). In addition, 35.4 km of river below Deadwood Dam contains almost no fishery due to historical dewatering of this section of river during the winter, and continued hypolimnetic cold-water releases from Deadwood Dam in the summer that prevent a fishery from developing. A total of 49 estimates of fish abundance were available from the Payette River drainage near Deadwood Reservoir. Average linear density for bull trout, brook trout, redband trout, and mountain whitefish among all study sites was 0.01, 0.01, 0.12, and 0.10 fish/m, respectively (Appendix A). Habitat for an estimated 98 bull trout, 265 brook trout, 2,751 redband trout, and 566 mountain whitefish have been lost annually since 1931 due to inundation of the Deadwood River and tributaries to the Deadwood River (Table 3). In addition, the operation of Deadwood Dam below the reservoir results in the annual loss of an estimated 6,647 mountain whitefish and 6,087 redband trout. These estimates result in a total of about 1.26 million salmonids through 2007.

Boise River Diversion Dam and Reservoir

Boise River Diversion Reservoir inundated a total of about 4.6 km of the Boise River (Table 2). Three estimates of fish abundance were available from the Boise River directly downstream of the reservoir. Average linear density for redband trout, brown trout, and mountain whitefish among all study sites was 1.12, 0.15, and 1.92 fish/m, respectively (Appendix A). Habitat for an estimated 5,168 redband trout, 699 brown trout, and 8,892 mountain whitefish have been lost annually since 1908 due to inundation of the Boise River by the Boise Diversion Dam (Table 3), for a total of 14,759 salmonids lost annually, or a total of about 1.48 million salmonids through 2007.

Minidoka Dam and Lake Walcott

Minidoka Dam inundated about 61.7 km of the Snake River (Table 2). No fish bearing tributaries are inundated by Lake Walcott. The only quantitative estimate of fish abundance in the vicinity of Lake Walcott is from the Snake River near Blackfoot, about 100 km upstream. Linear densities at this location for Yellowstone cutthroat trout, rainbow trout, brown trout, and mountain whitefish were estimated to be 0.01, 0.03, 0.16, and 3.48 fish/m, respectively (Appendix A). Habitat for an estimated 858 Yellowstone cutthroat trout, 1,738 rainbow trout, 9,976 brown trout, and 215,092 mountain whitefish have been lost annually since 1906 due to inundation of the Snake River by Minidoka Dam (Table 3), for a total of 227,664 salmonids lost annually, or a total of about 23.22 million salmonids through 2007.

Palisades Dam and Reservoir

Palisades Reservoir inundated a total of about 117 km of the South Fork Snake River and tributary streams (Table 2). A total of 51 estimates of fish abundance were available from the South Fork Snake River drainage near Palisades Reservoir. No data were available for mountain whitefish in fifth-order streams, so data were pooled for fourth- and sixth-order streams to extrapolate whitefish abundance for fifth-order reaches. Average linear density for Yellowstone cutthroat trout, rainbow trout, brown trout, and mountain whitefish among all study sites in the area was 0.39, 0.02, 0.07, and 0.39 fish/m, respectively (Appendix A). Habitat for an estimated 24,995 Yellowstone cutthroat trout, 15,477 rainbow trout, 34,543 brown trout, and 372,000 mountain whitefish have been lost annually since 1958 due to inundation of the South Fork Snake River and tributaries to Palisades Reservoir (Table 3), for a total of 447,015 salmonids lost annually, or a total of about 22.35 million salmonids through 2007.

CONCLUSION

Factoring in the number of years these dams have been in operation, it is estimated that riverine habitat has been lost for an estimated 1.34 million Yellowstone cutthroat trout, 4.46 million redband/rainbow trout, 2.81 million brown trout, 85,000 brook trout, and 96,000 bull trout, for a grand total of 8.71 million trout. In addition, an estimated 50.79 million mountain whitefish have been lost due to inundation by the above-mentioned reservoirs. Based on the above-mentioned assumptions, it is likely that these estimates are conservative in nature and represent a minimum number of fish lost.

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Table 1. Fish species found in and around individual water bodies in Idaho. Nat refers to native fish, Non refers to non-native fish, and blanks indicate fish that are absent from the area.

Species	Black Canyon Reservoir	Palisades Reservoir	Anderson Ranch Reservoir	Boise River diversion reservoir	Deadwood Reservoir	Lake Walcott
Bull trout *Salvelinus confluentus*	Nat		Nat	Nat	Nat	
Brook trout *Salvelinus fontinalis*		Non	Non			
Lake trout *Salvelinus namaycush*		Non				
Brown trout *Salmo trutta*	Non	Non		Non		Non
Redband/rainbow trout *Oncorhynchus mykiss*	Nat	Non	Nat	Nat	Nat	Non
Cutthroat trout *Oncorhynchus clarkii*	Non	Nat	Non	Non	Non	Nat
Chinook salmon *Oncorhynchus tshawytscha*	Nat[a]		Nat[a]	Nat[a]	Nat[a]	
Coho salmon *Oncorhynchus kisutch*						Non
Kokanee *Oncorhynchus nerka*			Non	Non	Non	Non
Mountain whitefish *Prosopium williamsoni*	Nat	Nat	Nat	Nat	Nat	Nat
White sturgeon *Acipenser transmontanus*	Nat			Nat		Non
Largescale sucker *Catostomus macrocheilus*	Nat		Nat	Nat		
Bridgelip sucker *Catostomus columbianus*	Nat		Nat	Nat		
Utah sucker *Catostomus ardens*		Nat				Nat
Bluehead sucker *Catostomus discobolus*		Nat				
Mountain sucker *Catostomus platyrhynchus*		Nat				
Northern pikeminnow *Ptychocheilus oregonenis*	Nat		Nat	Nat		
Chiselmouth chub *Acrocheilus alutaceus*	Nat		Nat	Nat		
Peamouth *Mylocheilus caurinus*	Nat		Nat	Nat		
Nonrthern leatherside chub *Lepidomeda copei*						Nat
Utah chub *Gila atraria*		Non				Nat
Mottled sculpin *Cottus bairdi*	Nat	Nat	Nat	Nat	Nat	Nat
Piute sculpin *Cottus beldingi*		Nat				Nat
Shorthead sculpin *Cottus confusus*	Nat		Nat	Nat	Nat	
Redside shiner *Richardsonius balteatus*	Nat	Nat	Nat	Nat		Nat
Longnose dace *Rhinichthys cataractae*	Nat	Nat	Nat	Nat	Nat	
Speckled dace *Rhinichthys osculus*	Nat	Nat	Nat	Nat	Nat	
Carp *Cyprinus carpio*	Non			Non		Non
Brown bullhead *Ameiurus natalis*	Non			Non		Non
Channel catfish *Ictalurus punctatus*	Non			Non		Non
Largemouth bass *Micropterus salmoides*						Non
Smallmouth bass *Micropterus dolomieui*	Non		Non	Non		Non
Black crappie *Pomoxis nigromaculatus*	Non					Non
White crappie *Pomoxis annularis*						Non
Bluegill *Lepomis macrochirus*	Non			Non		
Yellow perch *Perca flavescens*	Non		Non	Non		Non

[a]Currently maintained by stocking Non-migratory fish.

Table 2. Estimated kilometers of stream inundation by stream order for various water bodies in the upper Snake River basin in Idaho. Dashes indicate no streams of that stream order for that water body.

Water body	Stream order 1	2	3	4	5	6	7	Total
Palisades Reservoir	34.1	20.1	1.8	11.1	12.0	37.6	-	116.7
Lake Walcott	4.5	-	-	-	-	-	61.7	66.2
Black Canyon Reservoir	12.2	0.4	-	-	2.1	15.9	-	30.6
Deadwood Reservoir	4.3	8.8	9.1	38.5[a]	-	-	-	60.6
Anderson Ranch Reservoir	6.0	8.4	7.4	4.1	12.6	19.7	-	58.2
Boise irrigation diversion Reservoir	-	-	-	-	-	-	4.6	4.6
Total	61.1	37.7	18.3	53.7	26.7	73.2	66.3	337.0

[a]Includes 35.4 km of the Deadwood River below Deadwood Dam.

Table 3. Estimates of annual fish lost due to inundation of riverine habitat and operation of dams in various water bodies in the upper Snake River basin, Idaho. For each water body, *n* is the number of study sites for which fish abundance data was available and from which annual fish losses were estimated.

			Yellowstone cutthroat trout		Redband/ rainbow trout		Brown trout		Brook trout		Bull trout		Mountain whitefish	
Water body	*n*	Years of impact	N_{census}	90% CI	N_{census}	90% CI	N_{census}	90% CI	N_{census}	90% CI	N_{census}	90% CI	N_{census}	90% CI
Anderson Ranch Reservoir	33	58			37,725	5,557					1,533	1,191	42,137	26,440
Black Canyon Reservoir	43	84			1,461	1,761			769	77			75,715	83,726
Deadwood Reservoir, above dam	49	77			2,751	1,096			265	228	98	85	566	82
Deadwood Reservoir, below dam	24	77			6,087	2,114							6,647	2,237
Boise River Diversion Reservoir	3	100			5,168	1,459	699	385					8,892	735
Lake Walcott	1	102	858	NA	1,738	NA	9,976	NA					215,092	NA
Palisades Reservoir	51	50	24,995	8,081	15,477	23,923	34,543	44,623	10	13			372,000	215,523

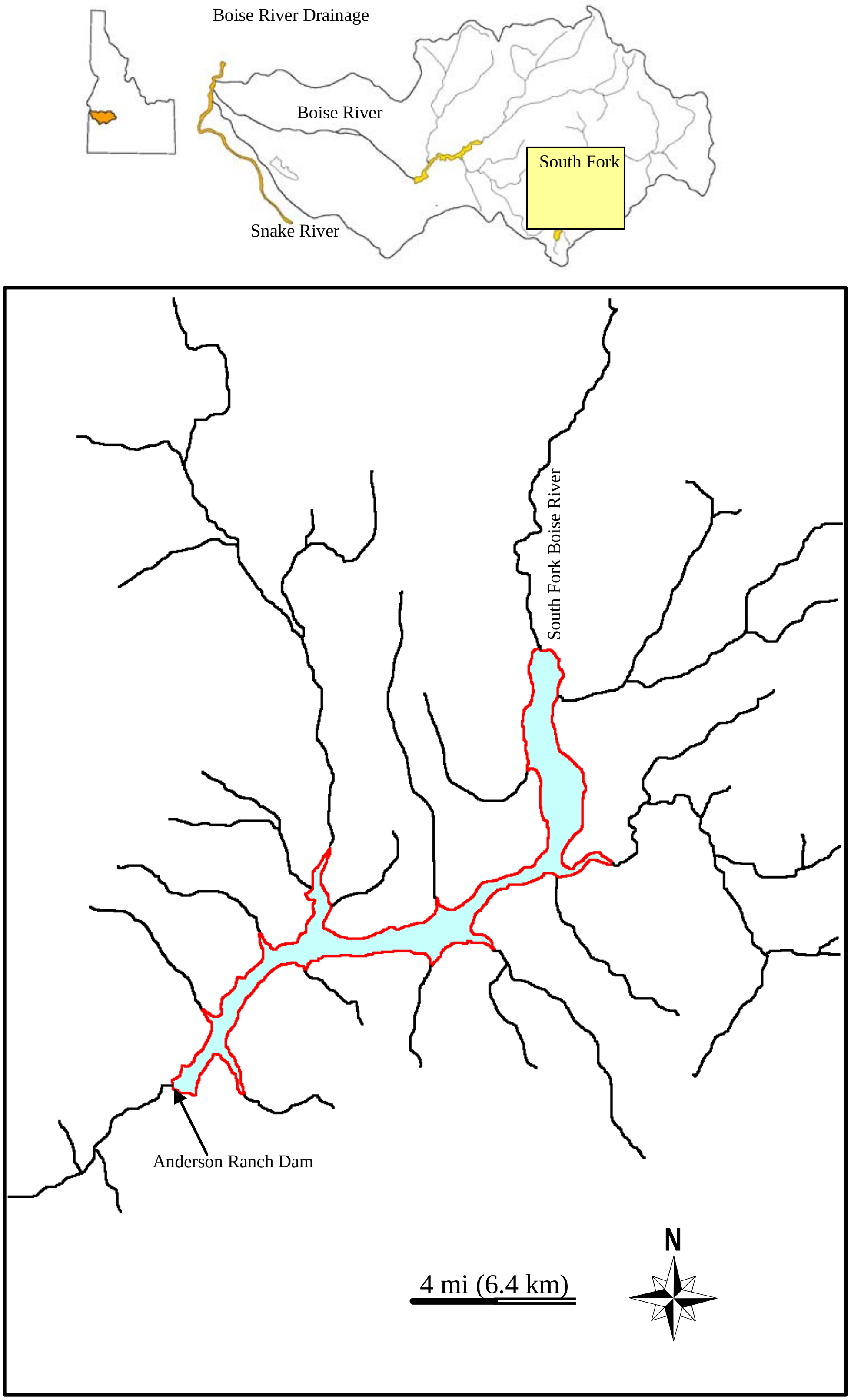


Figure 1. Anderson Ranch Reservoir and tributaries.

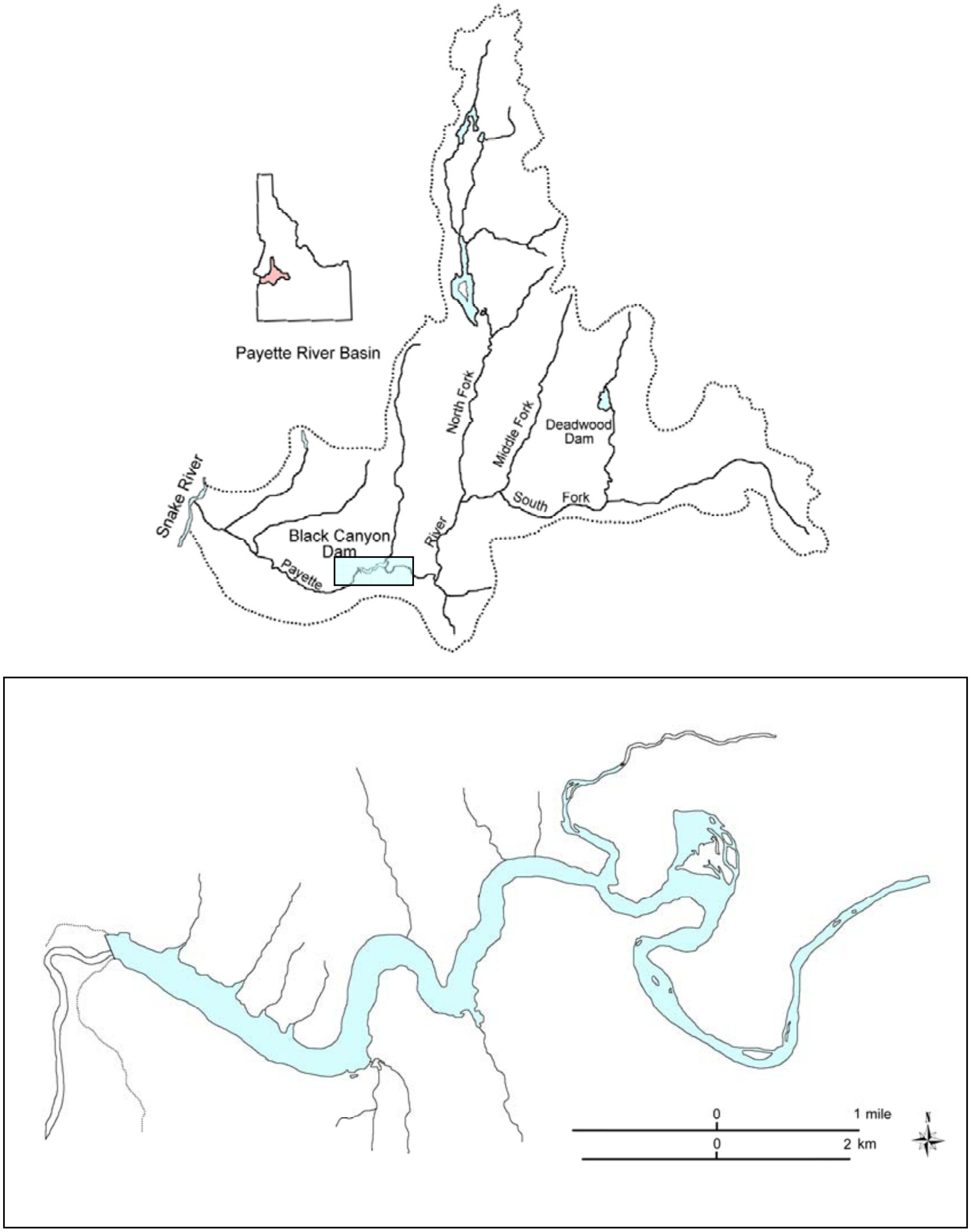
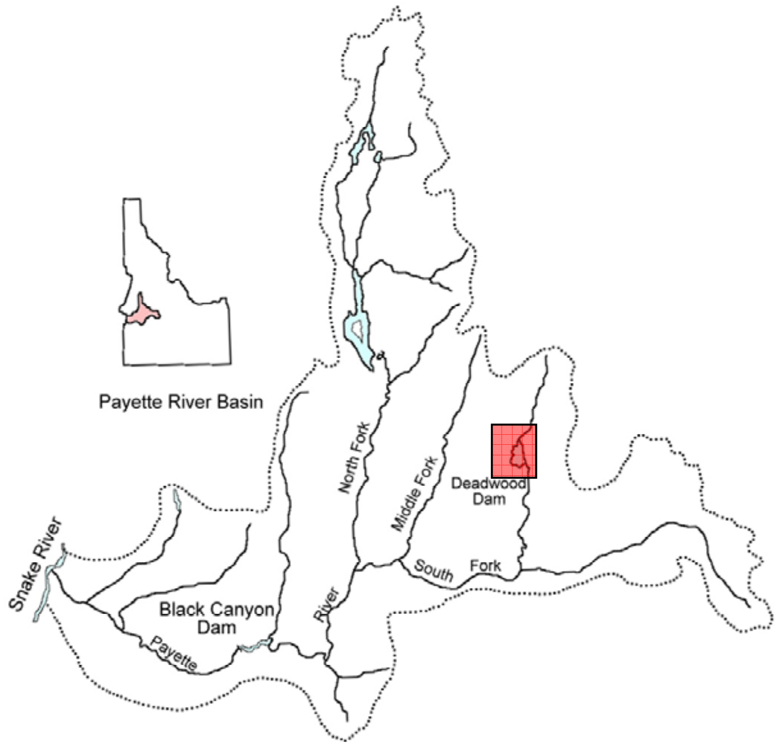


Figure 2. Black Canyon Dam and reservoir and tributaries.



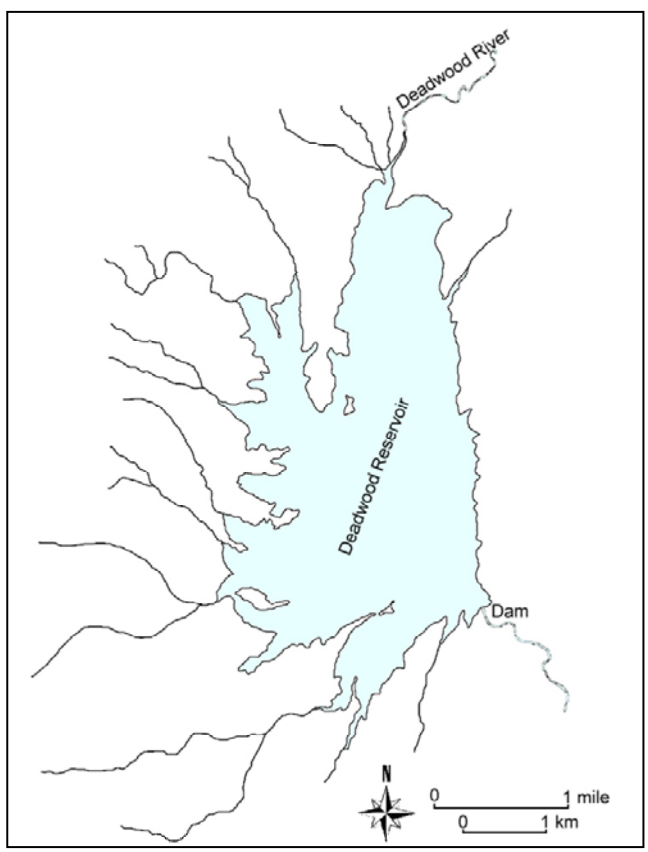


Figure 3. Deadwood Reservoir and tributaries.

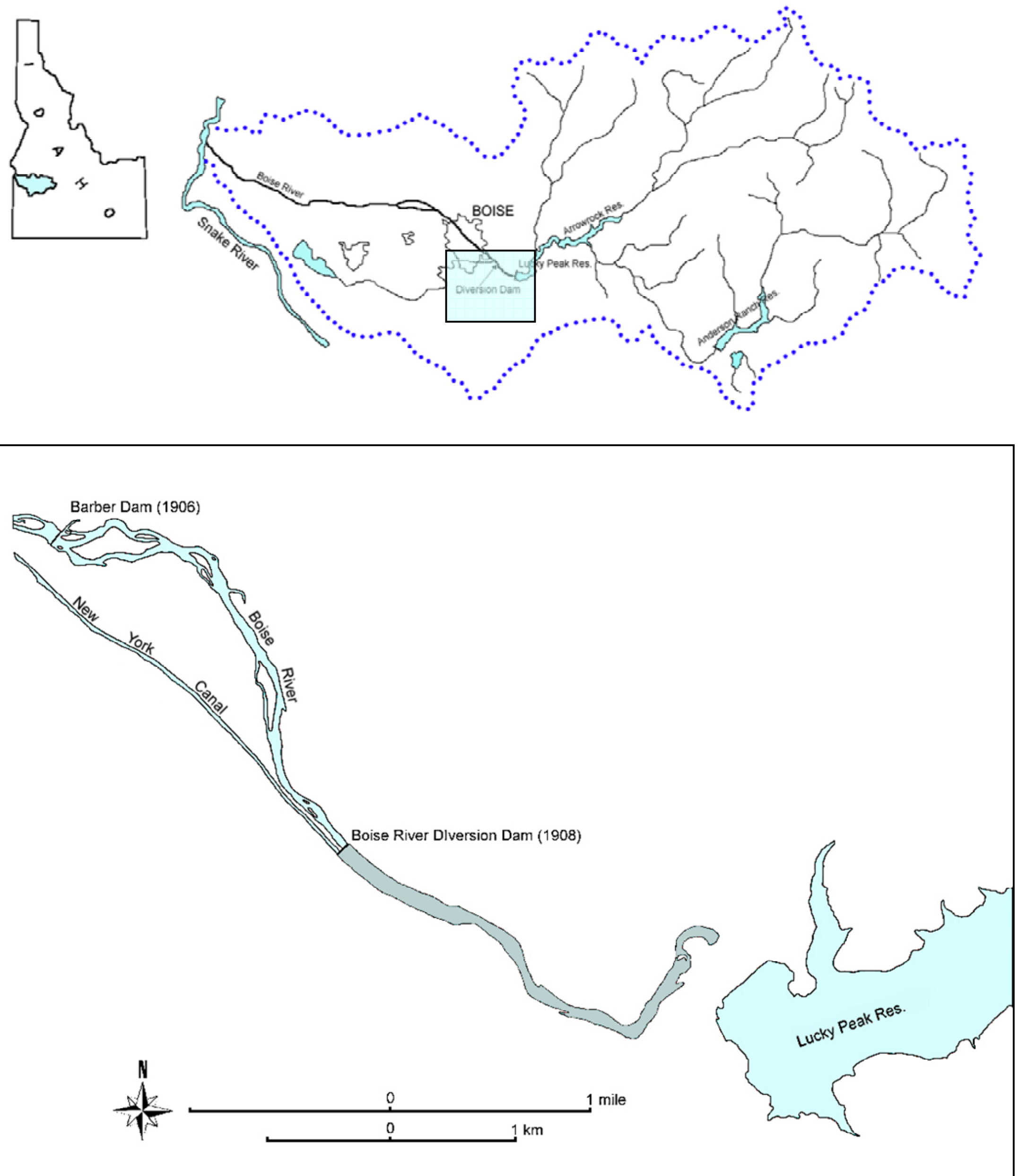


Figure 4. Boise River Diversion Dam and Reservoir.

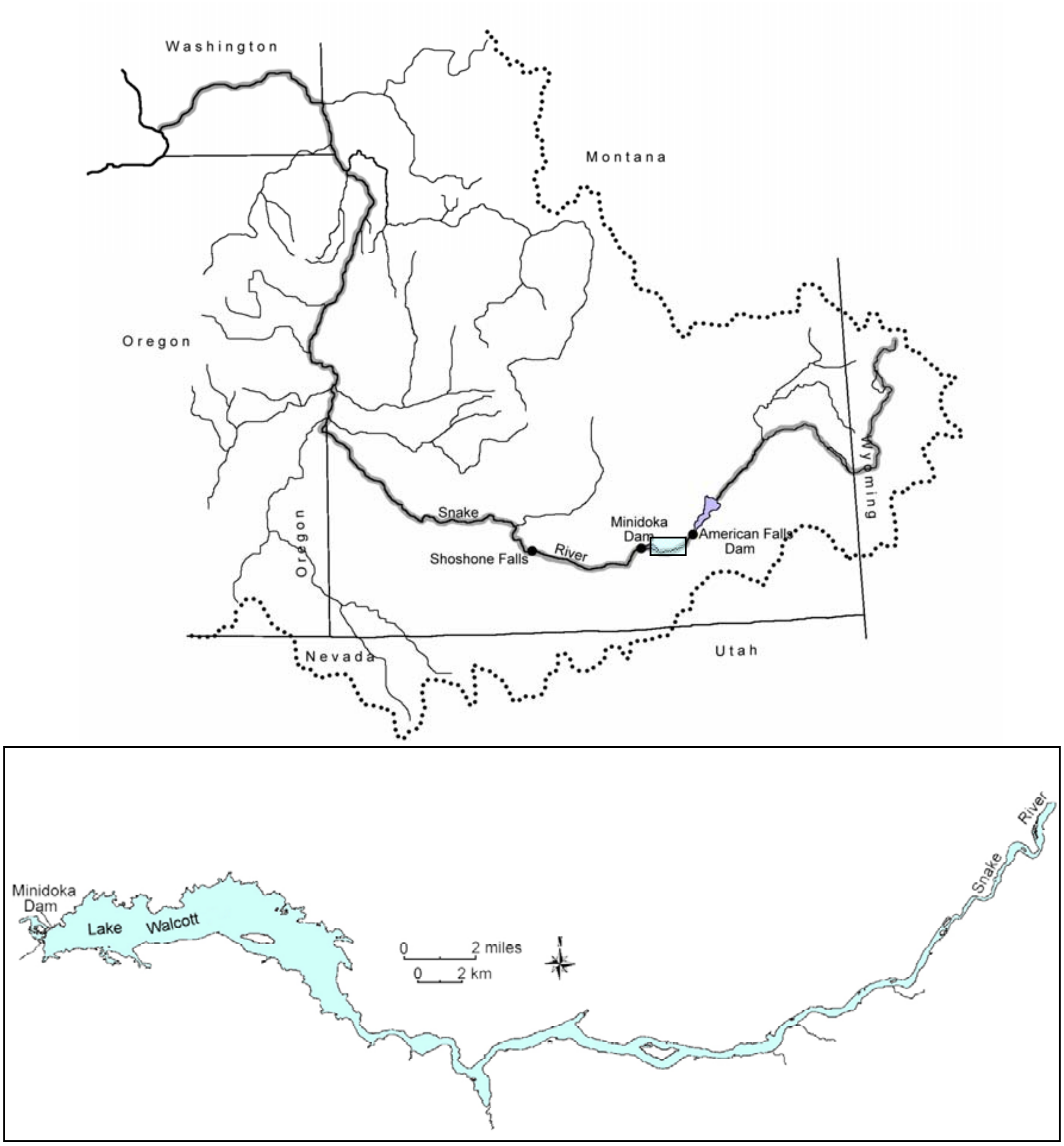


Figure 5. Minidoka Dam and Lake Walcott.

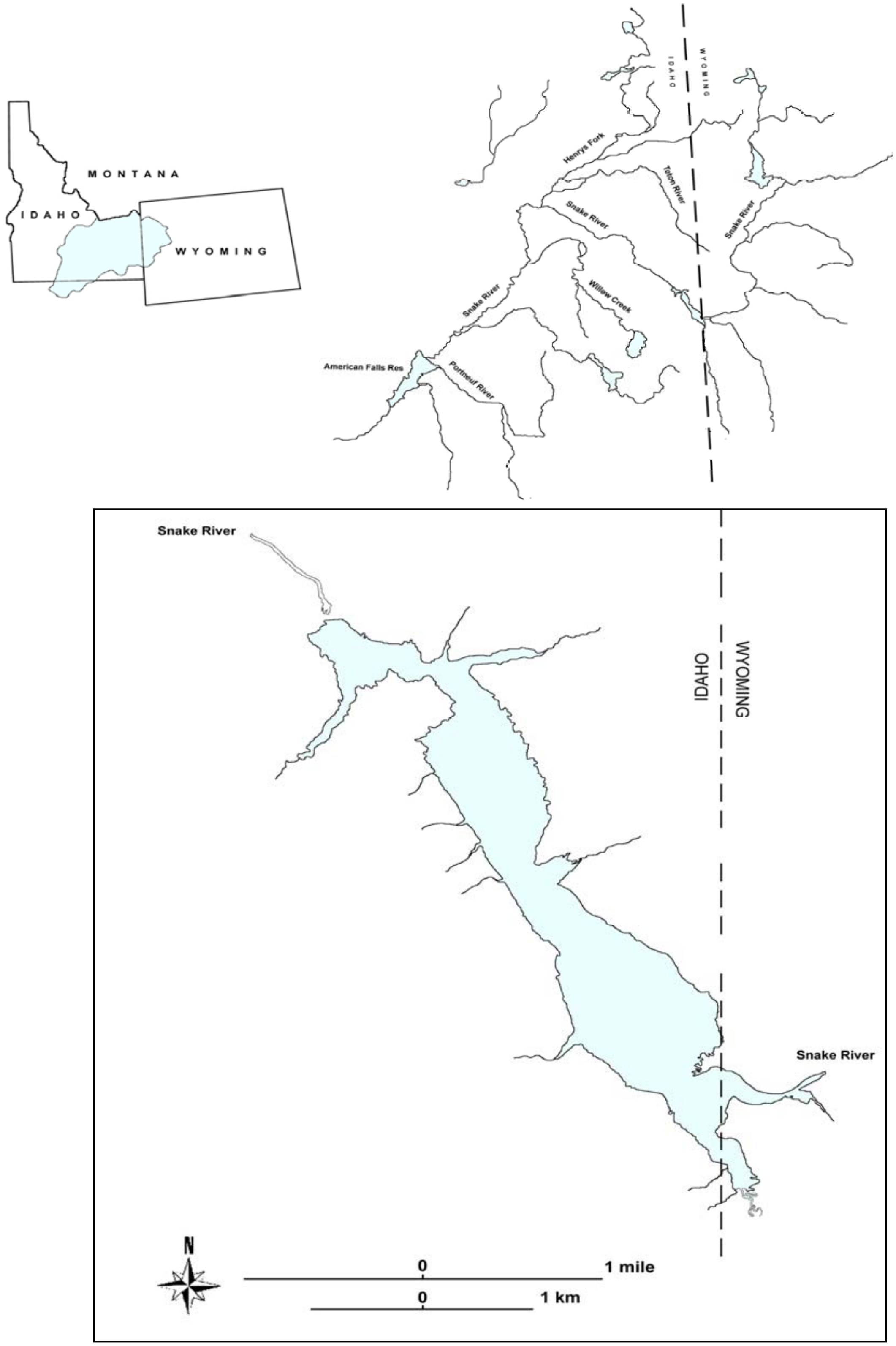


Figure 6. Palisades Dam and Reservoir.

Appendix A. Raw data used in fish abundance calculations.

SLIN	Used for:	Subbasin	Stream name	Site name	Sample date	UTM East	UTM North	GPS zone	Stream 1:100,000	Width (m)	Reach length (m)	Sampling technique	Linear densities (fish/m) MWF	YCT	BNT	RBT/ HYB	BUT	BKT
706	Anderson Ranch	SF Boise River	Dog Creek	Upper	8/28/1999	633103	4824980	11	1	2.67	70	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
703	Anderson Ranch	SF Boise River	Green Creek	Upper	8/28/1999	633272	4826150	11	1	2.05	81.5	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
702	Anderson Ranch	SF Boise River	Green Creek	Middle	8/28/1999	633775	4826375	11	1	1.34	50	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
705	Anderson Ranch	SF Boise River	Dog Creek	Middle	8/28/1999	634234	4823102	11	1	2.78	50	electrofish	0.0000	0.0000	0.0000	0.1400	0.0000	0.0000
700	Anderson Ranch	SF Boise River	Spring Creek	Upper	8/28/1999	635200	4835100	11	1	0.95	55	electrofish	0.0000	0.0000	0.0000	0.6182	0.0000	0.0000
715	Anderson Ranch	SF Boise River	Elk Creek	Upper	8/31/1999	639689	4842500	11	1	3.63	100	electrofish	0.0000	0.0000	0.0000	0.5233	0.9167	0.0000
714	Anderson Ranch	SF Boise River	EF Kelley Creek	Middle	9/9/1999	652975	4826599	11	1	2.70	90	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
712	Anderson Ranch	SF Boise River	EF Kelley Creek	Upper	8/31/1999	654500	4824000	11	1	0.83	97.7	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
711	Anderson Ranch	SF Boise River	Whiskey Jack Creek	Upper	8/30/1999	632088	4834303	11	2	2.91	50	electrofish	0.0000	0.0000	0.0000	0.3400	0.0000	0.0000
710	Anderson Ranch	SF Boise River	Whiskey Jack Creek	Middle	8/30/1999	632319	4834209	11	2	4.08	100	electrofish	0.0000	0.0000	0.0000	0.2300	0.0000	0.0000
709	Anderson Ranch	SF Boise River	Whiskey Jack Creek	Lower	8/28/1999	634500	4832700	11	2	3.31	100	electrofish	0.0000	0.0000	0.0000	0.3300	0.0000	0.0000
699	Anderson Ranch	SF Boise River	Spring Creek	Middle	8/27/1999	635463	4833720	11	2	3.85	85	electrofish	0.0000	0.0000	0.0000	0.2706	0.0000	0.0000
698	Anderson Ranch	SF Boise River	Spring Creek	Lower	8/27/1999	635522	4833481	11	2	2.30	100	electrofish	0.0000	0.0000	0.0000	0.4700	0.0000	0.0000
704	Anderson Ranch	SF Boise River	Dog Creek	Lower	8/26/1999	636881	4820915	11	2	3.34	100	electrofish	0.0000	0.0000	0.0000	0.8100	0.0200	0.0000
701	Anderson Ranch	SF Boise River	Green Creek	Lower	8/26/1999	638054	4822808	11	2	2.67	100	electrofish	0.0000	0.0000	0.0000	0.2200	0.0000	0.0000
693	Anderson Ranch	SF Boise River	Wagontown Creek	Lower	8/26/1999	639101	4824907	11	2	2.62	50	electrofish	0.0000	0.0000	0.0000	0.3600	0.0000	0.0000
690	Anderson Ranch	SF Boise River	Grouse Creek	Lower	8/26/1999	641795	4823078	11	2	2.89	100	electrofish	0.0000	0.0000	0.0000	0.3200	0.0000	0.0000
695	Anderson Ranch	SF Boise River	Cayuse Creek	Lower	8/27/1999	642700	4834200	11	2	2.75	101.1	electrofish	0.0000	0.0000	0.0000	0.4055	0.0000	0.0000
691	Anderson Ranch	SF Boise River	Grouse Creek	Middle	8/26/1999	643026	4823173	11	2	2.82	91	electrofish	0.0000	0.0000	0.0000	0.8901	0.0000	0.0000
697	Anderson Ranch	SF Boise River	Three Forks Creek (Cayuse Cr)	Upper	8/27/1999	646156	4837850	11	2	2.61	68	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
696	Anderson Ranch	SF Boise River	Three Forks Creek	Middle	8/27/1999	646223	4837665	11	2	2.56	90	electrofish	0.0000	0.0000	0.0000	0.5222	0.0000	0.0000
713	Anderson Ranch	SF Boise River	EF Kelley Creek	Lower	8/31/1999	652680	4828414	11	2	2.55	100	electrofish	0.0000	0.0000	0.0000	0.5700	0.0000	0.0000
724	Anderson Ranch	SF Boise River	Boardman Creek	Upper	9/10/1999	664859	4823404	11	2	3.50	75	electrofish	0.0000	0.0000	0.0000	0.0800	0.2267	0.0000
725	Anderson Ranch	SF Boise River	Boardman Creek	Middle	9/10/1999	665000	4823490	11	2	3.71	75	electrofish	0.0000	0.0000	0.0000	0.1067	0.3333	0.0000
716	Anderson Ranch	SF Boise River	Elk Creek	Middle	9/10/1999	641000	4840700	11	3	5.99	112	electrofish	0.0000	0.0000	0.0000	0.2768	0.0179	0.0000
717	Anderson Ranch	SF Boise River	Elk Creek	Lower	9/10/1999	641200	4840200	11	3	4.75	93	electrofish	0.0000	0.0000	0.0000	0.7634	0.0000	0.0000
727	Anderson Ranch	SF Boise River	Skeleton Creek	Lower	9/11/1999	660100	4828500	11	3	6.10	70	electrofish	0.0000	0.0000	0.0000	1.3714	0.0286	0.0000
726	Anderson Ranch	SF Boise River	Boardman Creek	Lower	9/11/1999	666300	4826300	11	3	5.20	86.7	electrofish	0.0000	0.0000	0.0000	0.4268	0.0692	0.0000
31855	Anderson Ranch	SF Boise River	SF Boise River	upper Brett	9/1/2006	665159	4828902	11	5	23.80	1015	electrofish	0.4709	0.0000	0.0000	0.3232	0.0000	0.0000
40482	Anderson Ranch	SF Boise River	SF Boise River	other Brett site	8/31/2006	662301	4827323	11	5	25.60	1479	electrofish	0.2306	0.0000	0.0000	0.3076	0.0352	0.0000
40093	Anderson Ranch	SF Boise River	SF Boise River	2006 Middle	10/19/2006	618232	4801725	11	6	31.8	1046	electrofish	1.0402	0.0000	0.0000	0.9082	0.0000	0.0000
40067	Anderson Ranch	SF Boise River	SF Boise River	2006 Upper	10/19/2006	621632	4798571	11	6	NA	1039	electrofish	1.1328	0.0000	0.0000	1.3763	0.0000	0.0000
40098	Anderson Ranch	SF Boise River	SF Boise River	2006 Lower	10/20/2006	617340	4802506	11	6	53.5	1030	electrofish	3.5078	0.0000	0.0000	1.0825	0.0000	0.0000
1912	Black Canyon	PAYETTE RIVER	Sucker Creek	513	6/30/2004	541158	4876057	11	1	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1961	Black Canyon	PAYETTE RIVER	Squaw Creek	XO2	7/13/2004	566088	4925416	11	1	5.58	50	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1963	Black Canyon	PAYETTE RIVER	Squaw Creek	SQ1	7/13/2004	567652	4921183	11	1	1.62	100	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1965	Black Canyon	PAYETTE RIVER	Third Fork Squaw Creek	TSQ1	7/13/2004	567087	4922191	11	1	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1966	Black Canyon	PAYETTE RIVER	Third Fork Squaw Creek	TSQ2	7/13/2004	565410	4921797	11	1	3.12	100	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1967	Black Canyon	PAYETTE RIVER	Squaw Creek	X01	7/13/2004	567036	4924778	11	1	6.58	100	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.2600
1972	Black Canyon	PAYETTE RIVER	Unnamed to 3rd fork Squaw	overdraw	7/14/2004	565823	4920349	11	1	2.62	70	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1991	Black Canyon	PAYETTE RIVER	MF Scriver Creek	1069	7/21/2004	576450	4894205	11	1	2.09	50	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1997	Black Canyon	PAYETTE RIVER	Poison Creek	X03	7/14/2004	564648	4925147	11	1	2.80	74	electrofish	0.0000	0.0000	0.0000	0.1892	0.0000	0.0000
2147	Black Canyon	PAYETTE RIVER	UNNAMED	1068	9/30/2004	553982	4863861	11	1	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2148	Black Canyon	PAYETTE RIVER	UNNAMED	1080	9/30/2004	521524	4871108	11	1	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2150	Black Canyon	PAYETTE RIVER	UNNAMED	1049	9/30/2004	510689	4878286	11	1	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2155	Black Canyon	PAYETTE RIVER	Unnamed trib to Cottonwood Creek	1034	9/30/2004	561005	4854259	11	1	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2196	Black Canyon	PAYETTE RIVER	UNNAMED	trib to Arling Trail creek	9/2/1998	568262	4941667	11	1	2.38	40	electrofish	0.0000	0.0000	0.0000	0.1500	0.0000	0.1500
2223	Black Canyon	PAYETTE RIVER	Landing Creek		7/29/1998	571888	4983942	11	1	2.91	50	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.6600
2340	Black Canyon	PAYETTE RIVER	Tributary to Sage Hen Reservoir	Reg 3, LWRSG2	7/14/2004	565008	4907413	11	1	1.28	35	electrofish	0.0000	0.0000	0.0000	0.0857	0.0000	0.0000
2363	Black Canyon	PAYETTE RIVER	Big Willow Creek	Reg. 3, Gauge Station	6/13/2001	541097	4879978	11	1	6.08	94.4	electrofish	0.0000	0.0000	0.0000	1.5890	0.0000	0.0000
1913	Black Canyon	PAYETTE RIVER	Sucker Creek	614	6/30/2004	535751	4877230	11	2	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1916	Black Canyon	PAYETTE RIVER	Bissel Creek	595	6/30/2004	540194	4873318	11	2	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1962	Black Canyon	PAYETTE RIVER	Sage Hen Creek	132	7/12/2004	563714	4910357	11	2	5.88	95.8	electrofish	0.0000	0.0000	0.0000	0.0418	0.0000	0.0000
1969	Black Canyon	PAYETTE RIVER	Renwick Creek	Renwick #1	7/13/2004	565389	4913814	11	2	2.75	110	electrofish	0.0000	0.0000	0.0000	0.0909	0.0091	0.0000
1973	Black Canyon	PAYETTE RIVER	Renwick Creek	048	7/13/2004	566023	4913845	11	2	5.03	90	electrofish	0.0000	0.0000	0.0000	0.2111	0.0000	0.0000
1990	Black Canyon	PAYETTE RIVER	Shirts Creek	528	7/21/2004	564062	4889466	11	2	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	Black Canyon	PAYETTE RIVER	Lower Hill Creek	530	7/29/2004	566219	4868840	11	2	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2156	Black Canyon	PAYETTE RIVER	Jackass Creek	616	9/30/2004	566100	4864331	11	2	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2157	Black Canyon	PAYETTE RIVER	Coons Creek	1039	9/30/2004	555479	4871993	11	2	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2158	Black Canyon	PAYETTE RIVER	Yergenson Creek	514	9/30/2004	552657	4868479	11	2	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2176	Black Canyon	PAYETTE RIVER	Shafer Creek	83	10/12/2004	568814	4849163	11	2	1.81	100	electrofish	0.0000	0.0000	0.0000	0.0700	0.0000	0.0000
1964	Black Canyon	PAYETTE RIVER	Second Fork Squaw Creek	131	7/12/2004	558338	4907342	11	3	6.22	105	electrofish	0.0000	0.0000	0.0000	0.0286	0.0000	0.0000
1971	Black Canyon	PAYETTE RIVER	Squaw Creek	overdraw (XO4)	7/14/2004	563589	4925350	11	3	6.74	80	electrofish	0.0000	0.0000	0.0000	0.4500	0.0500	0.0000
1974	Black Canyon	PAYETTE RIVER	Second Fork Squaw Creek	overdraw	7/13/2004	563863	4912430	11	3	5.84	80	electrofish	0.0000	0.0000	0.0000	0.7125	0.0000	0.0000
1975	Black Canyon	PAYETTE RIVER	Squaw Creek	overdraw (X05)	7/15/2004	562005	4924337	11	3	7.03	100	electrofish	0.0000	0.0000	0.0000	0.6000	0.0000	0.0000
1976	Black Canyon	PAYETTE RIVER	Squaw Creek	047	7/15/2004	558070	4920597	11	3	10.32	100	electrofish	0.0000	0.0000	0.0000	0.4100	0.0000	0.0000
1995	Black Canyon	PAYETTE RIVER	Third Fork Squaw Creek	lowest (overdraw)	7/14/2004	562787	4919005	11	3	6.78	75	electrofish	0.0000	0.0000	0.0000	1.3333	0.0000	0.0000
2152	Black Canyon	PAYETTE RIVER	Little Squaw Creek	103	10/4/2004	565640	4896094	11	3	1.87	100	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2289	Black Canyon	PAYETTE RIVER	Squaw Creek	094	10/18/2004	554652	4908836	11	3	8.70	167	electrofish	0.0599	0.0000	0.0000	0.0359	0.0000	0.0000
2364	Black Canyon	PAYETTE RIVER	Big Willow Creek	Reg. 3, Culvert to Tributary	6/14/2001	545190	4883344	11	3	4.88	61.2	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2290	Black Canyon	PAYETTE RIVER	Squaw Creek	062	10/18/2004	555534	4890246	11	4	11.25	180	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2291	Black Canyon	PAYETTE RIVER	Squaw Creek	Sub for 11	10/26/2004	555665	4884823	11	4	13.30	106	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2292	Black Canyon	PAYETTE RIVER	Squaw Creek	074	10/26/2004	556817	4895949	11	4	13.55	89	electrofish	0.0449	0.0000	0.0000	0.0787	0.0000	0.0000
2563	Black Canyon	PAYETTE RIVER	Payette River	Blacks Bridge	7/28/2005	518035	4869205	11	5	53.40	1705	electrofish	1.1695	0.0000	0.0000	0.0000	0.0000	0.0000
40058	Black Canyon	PAYETTE RIVER	Payette River	Montour	8/1/2005	553453	4864329	11	6	82.1	1021	electrofish	1.4319	0.0000	0.0000	0.0000	0.0000	0.0000
40060	Black Canyon	PAYETTE RIVER	Payette River	Plaza Bridge	7/27/2005	543787	4861507	11	6	48.2	1007	electrofish	7.7607	0.0000	0.0000	0.0000	0.0000	0.0000
2279	Boise diversion	BOISE RIVER	Boise River	upper city sub for 141	11/8/2004	569166	4824253	11	6	39.13	950	electrofish	1.7684	0.0000	NA	1.4105	0.0000	0.0000
2281	Boise diversion	BOISE RIVER	Boise River	lower city	11/9/2004	566658	4827288	11	6	36.09	1240	electrofish	1.8887	0.0000	0.1000	1.1911	0.0000	0.0000
2280	Boise diversion	BOISE RIVER	Boise River	reg 3, middle section	11/8/2004	567800	4826093	11	6	38.11	1080	electrofish	2.1046	0.0000	0.2019	0.7472	0.0000	0.0000
1981	Deadwood	MF Payette River	Bridge Creek	111	7/19/2004	592935	4912414	11	1	1.32	100	electrofish	0.0000	0.0000	0.0000	0.0700	0.0000	0.0000
1998	Deadwood	MF Payette River	MF Payette River	150	7/21/2004	597900	4933024	11	1	2.71	90	electrofish	0.0000	0.0000	0.0000	0.0000	0.1000	0.0000
2009	Deadwood	MF Payette River	Unnamed to MF Pine Cr.	552	7/27/2004	600959	4887846	11	1	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2104	Deadwood	MF Payette River	Bull Creek	101	9/15/2004	608948	4926312	11	1	3.34	84	electrofish	0.0000	0.0000	0.0000	0.0000	0.0833	0.0000
1984	Deadwood	PAYETTE RIVER	Peace Creek	071	7/20/2004	598487	4909824	11	1	3.16	85	electrofish	0.0000	0.0000	0.0000	0.1059	0.0000	0.1000
1986	Deadwood	PAYETTE RIVER	Left Fork Danskin Creek	582	7/20/2004	592921	4881866	11	1	0.90	50	electrofish	0.0000	0.0000	0.0000	0.1800	0.0000	0.0000
1988	Deadwood	PAYETTE RIVER	EF Big Pine Creek	638	7/20/2004	601230	4885004	11	1	1.59	70	electrofish	0.0000	0.0000	0.0000	0.2429	0.0000	0.0000
1992	Deadwood	PAYETTE RIVER	Unnamed to Clear Creek	569	7/21/2004	617159	4892309	11	1	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1993	Deadwood	PAYETTE RIVER	Cow Creek	1053	7/21/2004	590288	4887040	11	1	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1996	Deadwood	PAYETTE RIVER	Six Mile Creek	081	7/21/2004	582872	4906152	11	1	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2102	Deadwood	PAYETTE RIVER	Unnamed Trib to 16 mile creek	588	9/14/2004	596921	4923995	11	1	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2007	Deadwood	SF Payette River	Kettle Creek	17	7/28/2004	624659	4886925	11	1	1.55	100	electrofish	0.0000	0.0000	0.0000	0.1100	0.0000	0.0000
2008	Deadwood	SF Payette River	Warm Springs Creek	151	7/27/2004	636051	4906715	11	1	4.41	72	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.4722
2012	Deadwood	SF Payette River	Silver Creek	518	7/28/2004	649437	4893558	11	1	1.90	100	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1989	Deadwood	MF Payette River	Rattlesnake Creek	099 (alt. site)	7/20/2004	590804	4902200	11	2	4.18	70	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2298	Deadwood	MF Payette River	Silver Creek	Reg 3 site #3	9/9/2004	598690	4914767	11	2	4.08	56	snorkel	0.0000	0.0000	0.0000	0.0536	0.0000	0.0000
1977	Deadwood	PAYETTE RIVER	Long Fork Silver Creek	007	7/19/2004	598915	4915320	11	2	3.67	95	electrofish	0.0000	0.0000	0.0000	0.2105	0.0000	0.0211
1987	Deadwood	PAYETTE RIVER	Danskin Creek	25	7/20/2004	594169	4880129	11	2	1.93	86	electrofish	0.0000	0.0000	0.0000	0.2209	0.0000	0.0000
2003	Deadwood	SF Payette River	NF Baron Creek	1090	7/27/2004	652347	4888906	11	2	4.99	30	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2006	Deadwood	SF Payette River	SF Clear Creek	38	7/28/2004	624765	4898001	11	2	4.66	90	electrofish	0.0000	0.0000	0.0000	0.1667	0.0333	0.0000
2010	Deadwood	SF Payette River	Kirkham Creek	28	7/27/2004	618599	4883713	11	2	1.62	100	electrofish	0.0000	0.0000	0.0000	0.0500	0.0000	0.0000
1905	Deadwood	MF Payette River	Lightning Creek	34	7/22/2004	586017	4892979	11	3	7.38	110	electrofish	0.0000	0.0000	0.0000	0.1636	0.0000	0.0000
2299	Deadwood	MF Payette River	Silver Creek	Reg 3, site 1	9/9/2004	594257	4908184	11	3	7.77	47.3	snorkel	0.0000	0.0000	0.0000	0.2114	0.0000	0.0211

Appendix A. Continued.

									Stream		Reach		Linear densities (fish/m)					
SLIN	Used for:	Subbasin	Stream name	Site name	Sample date	UTM East	UTM North	GPS zone	1:100,00 0	Width (m)	length (m)	Sampling technique	MWF	YCT	BNT	RBT/ HYB	BUT	BKT
2099	Deadwood	SF Payette River	SF Payette River	24	9/9/2004	650273	4881098	11	3	NA	NA	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2120	Deadwood	MF Payette River	MF Payette River	sub for 30	9/9/2004	590240	4907966	11	4	14.00	80	snorkel	0.0375	0.0000	0.0000	0.0750	0.0000	0.0000
2121	Deadwood	MF Payette River	MF Payette River	sub for 142	9/9/2004	588024	4898041	11	4	20.00	50	snorkel	0.2800	0.0000	0.0000	0.0000	0.0000	0.0000
2122	Deadwood	MF Payette River	MF Payette River	sub for 58	9/9/2004	588767	4900169	11	4	23.17	61	snorkel	0.9180	0.0000	0.0000	0.1967	0.0000	0.0000
2123	Deadwood	MF Payette River	MF Payette River	sub for 122	9/9/2004	587747	4897377	11	4	16.83	76	snorkel	0.1974	0.0000	0.0000	0.0000	0.0000	0.0000
2297	Deadwood	MF Payette River	MF Payette River	050	9/9/2004	580458	4883827	11	4	26.31	100	snorkel	0.0000	0.0000	0.0000	0.0600	0.0000	0.0000
2300	Deadwood	MF Payette River	MF Payette River	Reg 3, 1 A	9/2/2004	592438	4915554	11	4	12.65	69.5	snorkel	0.0432	0.0000	0.0000	0.0432	0.0000	0.0000
2301	Deadwood	MF Payette River	MF Payette River	Reg 3, section 1	9/2/2004	591834	4914166	11	4	22.78	97.6	snorkel	0.0205	0.0000	0.0000	0.0512	0.0000	0.0000
2302	Deadwood	MF Payette River	MF Payette River	Reg 3, site 2	10/15/2004	590956	4911379	11	4	11.50	70	snorkel	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000
2303	Deadwood	MF Payette River	MF Payette River	Reg 3 site 3	10/15/2004	590916	4909878	11	4	10.13	82	snorkel	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2293	Deadwood	SF Payette River	SF Payette River	Reg 3 - 1.3 mi. below hwy 21	9/10/2004	609145	4882252	11	4	20.06	110	snorkel	0.1636	0.0000	0.0000	0.2636	0.0000	0.0000
2294	Deadwood	SF Payette River	SF Payette River	Reg 3 - 2 mi downstream of Hwy	9/10/2004	608869	4881592	11	4	22.17	158	snorkel	0.4430	0.0000	0.0000	0.4304	0.0000	0.0000
2325	Deadwood	SF Payette River	SF Payette River	Reg 3, Bear Creek	8/19/2003	644633	4891138	11	4	19.67	57	snorkel	0.0877	0.0000	0.0000	0.1579	0.0000	0.0000
2326	Deadwood	SF Payette River	SF Payette River	Reg 3, Canyon Creek	8/19/2003	640403	4892274	11	4	13.33	73	snorkel	0.0959	0.0000	0.0000	0.3425	0.0000	0.0000
2327	Deadwood	SF Payette River	SF Payette River	Reg 3, Chapman Creek	8/19/2003	635021	4888397	11	4	25.17	105	snorkel	0.2000	0.0000	0.0000	0.0952	0.0000	0.0000
2328	Deadwood	SF Payette River	SF Payette River	Reg 3, #6	8/19/2003	645958	4891102	11	4	20.20	55	snorkel	0.0727	0.0000	0.0000	0.0000	0.0000	0.0000
2329	Deadwood	SF Payette River	SF Payette River	Reg 3, 31	8/19/2003	610157	4882107	11	4	38.00	70	snorkel	0.1429	0.0000	0.0000	0.6429	0.0000	0.0000
2330	Deadwood	SF Payette River	SF Payette River	Reg 3, 74.8	8/19/2003	613696	4880501	11	4	28.00	110	snorkel	0.0364	0.0000	0.0000	0.1182	0.0000	0.0000
2331	Deadwood	SF Payette River	SF Payette River	Reg 3, 76.3	8/18/2003	616156	4880666	11	4	17.80	160	snorkel	0.1688	0.0000	0.0000	0.5125	0.0000	0.0000
2332	Deadwood	SF Payette River	SF Payette River	Reg 3, 77.5	8/18/2003	617090	4880544	11	4	22.00	117	snorkel	0.2222	0.0000	0.0000	0.4017	0.0000	0.0000
2333	Deadwood	SF Payette River	SF Payette River	Reg 3, 79.7	8/18/2003	620160	4881000	11	4	30.50	75	snorkel	0.2267	0.0000	0.0000	0.0667	0.0000	0.0000
2334	Deadwood	SF Payette River	SF Payette River	Reg 3, 82.4	8/18/2003	623030	4883804	11	4	26.50	79	snorkel	0.2025	0.0000	0.0000	0.1013	0.0000	0.0000
2335	Deadwood	SF Payette River	SF Payette River	Reg 3, 83.1	8/18/2003	624041	4884444	11	4	18.17	148	snorkel	0.1014	0.0000	0.0000	0.3041	0.0000	0.0000
2336	Deadwood	SF Payette River	SF Payette River	Reg 3, 85.3	8/18/2003	625327	4885145	11	4	25.33	144	snorkel	0.2431	0.0000	0.0000	0.0278	0.0000	0.0000
2337	Deadwood	SF Payette River	SF Payette River	Reg 3, 86.7	8/18/2003	629264	4886201	11	4	19.17	78	snorkel	0.1538	0.0000	0.0000	0.0256	0.0000	0.0000
2338	Deadwood	SF Payette River	SF Payette River	Reg 3, 92.3	8/19/2003	636545	4889895	11	4	17.83	61	snorkel	0.1311	0.0000	0.0000	0.3770	0.0000	0.0000
2559	Lake Walcott	Snake River	Snake River	at Blackfoot	9/26/2005	391056	4786226	12	7	70.5	2735	electrofish	3.4845	0.0139	0.1616	0.0282	0.0000	0.0000
904	Palisades	Palisades/Salt	Bilk Creek	Upper	7/29/2002	476072	4770960	12	1	1.64	89	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
897	Palisades	Palisades/Salt	Bilk Creek	lower	7/27/2002	478445	4772484	12	1	2.13	92	electrofish	0.0000	0.0435	0.0000	0.0000	0.0000	0.0000
898	Palisades	Palisades/Salt	Barnes Creek	Upper	7/27/2002	474645	4773186	12	1	1.65	91	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
946	Palisades	Palisades/Salt	Burns Creek	upper	8/25/2002	493881	4774054	12	1	1.40	87	electrofish	0.0000	0.0115	0.0000	0.0000	0.0000	0.0000
928	Palisades	Palisades/Salt	Camp Creek	middle	8/12/2002	475883	4794662	12	1	1.44	101	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
958	Palisades	Palisades/Salt	Unknown Tributary to NF Bear Creek	upper	8/26/2002	473355	4796320	12	1	1.08	86	electrofish	0.0000	0.0465	0.0000	0.0000	0.0000	0.0000
901	Palisades	Palisades/Salt	Fish Creek	Upper	7/28/2002	486110	4773306	12	2	1.94	80	electrofish	0.0000	0.1000	0.0000	0.0000	0.0000	0.0000
895	Palisades	Palisades/Salt	City Creek	Upper	7/26/2002	471900	4774061	12	2	1.46	91	electrofish	0.0000	0.0220	0.0000	0.0000	0.0000	0.0000
894	Palisades	Palisades/Salt	City Creek	Lower	7/26/2002	471722	4774453	12	2	1.45	93.2	electrofish	0.0000	0.0429	0.0000	0.0000	0.0000	0.0000
908	Palisades	Palisades/Salt	Burns Creek	Lower	7/30/2002	495975	4775588	12	2	1.68	100	electrofish	0.0000	0.0400	0.0000	0.0000	0.0000	0.0000
785	Palisades	Palisades/Salt	Barnes Creek	Upper (above 1st fork)	10/22/1999	472335	4775758	12	2	3.17	77.74	electrofish	0.0000	1.1963	0.0000	0.0000	0.0000	0.0000
784	Palisades	Palisades/Salt	Barnes Creek	Lower	10/22/1999	472268	4776309	12	2	2.71	101.3	electrofish	0.0000	0.6910	0.0000	0.0000	0.0000	0.0000
889	Palisades	Palisades/Salt	Trout Creek	upper	7/25/2002	493736	4776961	12	2	2.11	100	electrofish	0.0000	0.0150	0.0150	0.0000	0.0000	0.0000
891	Palisades	Palisades/Salt	Trout Creek	lower	7/25/2002	494260	4778209	12	2	2.58	100	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
887	Palisades	Palisades/Salt	Bitters Creek	upper	7/25/2002	490837	4779326	12	2	1.93	96.5	electrofish	0.0000	0.0104	0.0000	0.0000	0.0000	0.0000
888	Palisades	Palisades/Salt	Bitters Creek	lower	7/25/2002	490812	4779621	12	2	1.45	100	electrofish	0.0000	0.0100	0.0000	0.0000	0.0000	0.0000
890	Palisades	Palisades/Salt	Unknown trib to McCoy Creek	lower	7/25/2002	487540	4781565	12	2	1.42	90	electrofish	0.0000	0.0111	0.0000	0.0000	0.0000	0.0000
896	Palisades	Palisades/Salt	Unknown Trib of McCoy Creek	Middle	7/27/2002	487330	4782313	12	2	0.97	90	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
902	Palisades	Palisades/Salt	Williams Creek	Only	7/28/2002	490003	4783628	12	2	1.60	59.2	electrofish	0.0000	0.1689	0.0000	0.0000	0.0000	0.0000
892	Palisades	Palisades/Salt	Elk Creek	upper	7/26/2002	482023	4786691	12	2	2.73	100	electrofish	0.0000	0.2600	0.0000	0.0000	0.0000	0.0000
893	Palisades	Palisades/Salt	Elk Creek	lower	7/26/2002	481606	4787693	12	2	2.52	100	electrofish	0.0000	0.2200	0.0000	0.0000	0.0000	0.0000
932	Palisades	Palisades/Salt	Bear Creek	Middle	8/13/2002	479088	4791637	12	2	8.36	115	electrofish	0.0000	0.2696	0.0000	0.0000	0.0000	0.0000
929	Palisades	Palisades/Salt	Camp Creek	Lower	8/12/2002	475196	4793715	12	2	1.17	79.4	electrofish	0.0000	0.1889	0.0000	0.0000	0.0000	0.0000
959	Palisades	Palisades/Salt	Unknown Tributary to NF Bear Creek	lower	8/26/2002	473129	4796047	12	2	1.99	100	electrofish	0.0000	0.1900	0.0000	0.0000	0.0000	0.0000
906	Palisades	Palisades/Salt	Iowa Creek	Upper	7/29/2002	479818	4773734	12	3	2.98	85	electrofish	0.0000	0.3412	0.0000	0.0000	0.0000	0.0000
779	Palisades	Palisades/Salt	Comb Creek	@ mouth	10/21/1999	485800	4775500	12	3	1.79	92	electrofish	0.0000	0.3370	0.0000	0.0000	0.0000	0.0000
781	Palisades	Palisades/Salt	Fish Creek	below confluence w/ Comb Cr	10/23/1999	485809	4775782	12	3	3.23	92	electrofish	0.0000	2.1196	0.0000	0.0000	0.0000	0.0000
907	Palisades	Palisades/Salt	Iowa Creek	Lower	7/29/2002	479465	4775912	12	3	3.65	100	electrofish	0.0000	0.1800	0.0000	0.0000	0.0000	0.0000
20	Palisades	Palisades/Salt	Iowa Creek	Site 1	10/18/2000	479814	4777204	12	3	3.55	99	electrofish	0.0000	0.9293	0.0000	0.0000	0.0000	0.0000
780	Palisades	Palisades/Salt	Fish Creek	Lower	10/21/1999	485578	4777936	12	3	3.74	100	electrofish	0.0000	1.7400	0.0000	0.0000	0.0000	0.0000
782	Palisades	Palisades/Salt	McCoy Creek	above confluence w/ Clear Cr	10/22/1999	476710	4778500	12	3	3.27	144	electrofish	0.0000	0.8681	0.0000	0.0000	0.0000	0.0000
783	Palisades	Palisades/Salt	Clear Creek	@ confluence w/ McCoy Cr	10/22/1999	476730	4778700	12	3	3.17	122	electrofish	0.0000	0.3770	0.0000	0.0000	0.0000	0.0000
900	Palisades	Palisades/Salt	Clear Creek	Lower	7/27/2002	474568	4779670	12	3	3.30	103	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
903	Palisades	Palisades/Salt	Clear Creek	Upper	7/29/2002	473594	4780130	12	3	2.30	97.4	electrofish	0.0000	0.1437	0.0000	0.0000	0.0000	0.0000
788	Palisades	Palisades/Salt	Jensen Creek	Lower (below culvert)	10/23/1999	487569	4780325	12	3	3.58	43.6	electrofish	0.0000	0.5963	0.0000	0.0000	0.0000	0.0000
947	Palisades	Palisades/Salt	Indian Creek	upper	8/25/2002	495053	4789367	12	3	3.32	91	electrofish	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
930	Palisades	Palisades/Salt	Bear Creek	upper	8/12/2002	472339	4790044	12	3	4.64	88.2	electrofish	0.0000	0.1814	0.0000	0.0000	0.0000	0.0000
931	Palisades	Palisades/Salt	Bear Creek	upper-upper	8/12/2002	471537	4790281	12	3	4.37	49.2	electrofish	0.0000	0.1423	0.0000	0.0000	0.0000	0.0000
6	Palisades	Palisades/Salt	Elk Creek	Only (1980's site)	9/26/2000	481860	4790587	12	3	3.62	146	electrofish	0.0000	2.2192	0.0000	0.0000	0.0000	0.0000
127	Palisades	Palisades/Salt	McCoy Creek	Site 2 (below Iowa Creek)	9/8/2000	483801	4778223	12	4	8.73	388	electrofish	0.0000	1.1750	0.0000	0.0000	0.0000	0.0000
126	Palisades	Palisades/Salt	McCoy Creek	Site 1 (@ Jensen Creek)	9/8/2000	487648	4780309	12	4	9.29	375	electrofish	0.0000	0.3523	0.0085	0.0042	0.0000	0.0000
21	Palisades	Palisades/Salt	Bear Creek	Only (1980's site)	9/25/2000	481528	4791386	12	4	8.27	145.7	electrofish	0.0000	2.2030	0.0000	0.0070	0.0000	0.0000
137	Palisades	Palisades/Salt	Big Elk Creek	Site 1 (YMCA Camp)	9/11/2000	491079	4796975	12	4	6.90	100	electrofish	0.0000	0.3400	0.0000	0.0000	0.0000	0.0000
138	Palisades	Palisades/Salt	Big Elk Creek	Site 2	9/11/2000	493081	4797837	12	4	7.73	150	electrofish	0.0000	0.5933	0.0000	0.0000	0.0000	0.0000
943	Palisades	Palisades/Salt	Deadman Canyon	only	8/23/2002	490976	4812049	12	4	1.46	37.5	electrofish	0.0000	0.4533	0.0000	0.0000	0.0000	0.0000
NA	Palisades	Palisades/Salt	Salt River	Thayne	NA	498050	4755692	12	5	29.1	9254	electrofish	NA	0.2359	0.6423	0.0074	0.0000	0.0006
NA	Palisades	Palisades/Salt	Salt River	Etna	NA	497332	4767748	12	5	34.1	9656	electrofish	NA	0.1869	0.1585	0.0116	0.0000	0.0000
NA	Palisades	Palisades/Salt	Salt River	Hwy 238	NA	501042	4745970	12	5	33.2	9656	electrofish	NA	0.2680	0.7260	0.0035	0.0000	0.0000
NA	Palisades	Palisades/Salt	Salt River	Auburn	NA	502007	4740419	12	5	42.6	9656	electrofish	NA	0.1172	0.3717	0.0007	0.0000	0.0027
40045	Palisades	SFSR Below	SF Snake River	Twin Bridges	9/21/2005	440507	4834936	12	6	41.8	2900	electrofish	5.7600	0.2869	1.4783	0.0272	0.0000	0.0000
40043	Palisades	SFSR Below	SF Snake River	Palisades	9/22/2005	481658	4800251	12	6	96.4	3150	electrofish	12.5727	0.1102	0.0546	0.7917	0.0000	0.0000

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