



Tributary Pollutant Sources to the Hells Canyon Complex

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ABSTRACT

Idaho Power Company initiated studies in 1990 to provide the research necessary to develop protection, mitigation, and enhancement measures regarding water quality as part of its efforts to relicense the Hells Canyon Complex with the Federal Energy Regulatory Commission. This report focuses on tributary pollutant sources, particularly temperature and nutrients, to the Snake River from Swan Falls Dam to Hells Canyon Dam. It also includes a fundamental examination of the hydrology in the Hells Canyon Complex.

Tributary water temperatures consistently exceeded Idaho and Oregon coldwater biota and salmonid spawning temperature criteria in the Payette, Weiser, Powder, and Wildhorse rivers and Eagle and Pine creeks. Maximum water temperatures never exceeded 30 °C and were generally about 26 °C.

Median total phosphorus concentrations in most tributaries exceeded 0.070 mg/L. This value is recommended as a target for tributaries to the southwest Snake River. Concentrations in Eagle Creek and Wildhorse River were similar to the reference condition criterion recommended by the U.S. Environmental Protection Agency. Concentrations in the Malheur and Boise rivers were at least twice as high as concentrations in most of the other sources. Similarly, median orthophosphate concentrations in the Malheur and Boise rivers were also at least two times higher than in the other sources. One-third to three-fourths of the phosphorus in tributaries to the Hells Canyon Complex was biologically available, with the highest orthophosphate to total phosphorus ratios occurring during winter (November, December, and January). The lower ratios during the growing season suggested that algae process orthophosphates during that time.

A water balance analysis indicated most sources of inflow to the Hells Canyon Complex were accounted for in this study. Because calendar years 1995 and 1999 represented near-average to moderately-high water yields, nutrient loads during those years probably reflected near-average to moderately-high loads. This conclusion does not necessarily apply to all tributaries, since the Owyhee River water yields were below average during both years.

The Snake River inflow to the study area and the Boise River contributed over one-half of the total phosphorus and orthophosphate loads to the Hells Canyon Complex between April 1999 and April 2000. The relative contribution of phosphorus from tributaries generally decreased downstream, with the most noticeable decrease occurring to the Snake River downstream of Weiser, Idaho. A similar pattern was observed for nitrogen loads, with the Snake River inflow to the study area contributing nearly two-thirds of the nitrate load and nearly one-half of the ammonia load. The Malheur River nutrient load increased considerably between 1995 and 1999, probably because flows more than doubled.

The 1995 and 1999 orthophosphate load balances indicated considerable biological processing in the southwest Snake River upstream of Brownlee Reservoir. Substantial amounts of ammonia are apparently being transported from the deep waters of Brownlee Reservoir downstream.

1. INTRODUCTION

Idaho Power Company (IPC) owns and operates three hydroelectric facilities—collectively known as the Hells Canyon Complex (HCC)—in the Hells Canyon reach of the Snake River. The three reservoirs impounded by the facilities are Brownlee, Oxbow, and Hells Canyon. Reservoir storage is primarily used for hydropower generation (IPC 1997). Other uses include flood control, flow attenuation, recreation, and flow augmentation for anadromous fish in the Snake and Columbia rivers.

Water quality studies provide necessary information about conditions throughout the HCC. This information allows IPC the ability to address water quality and related concerns, such as eutrophication and its effects, and develop the necessary measures to control eutrophication. Studies prior to those discussed in this report have shown that low dissolved oxygen concentrations in Brownlee or Oxbow reservoirs were first reported in 1962 (Webb 1964, Ebel and Koski 1968). Others since have also documented hypoxic, or low dissolved oxygen, conditions in HCC reservoirs relative to Idaho and Oregon criteria (Bodien 1969, Worth and Braun 1993, Myers and Pierce 1999, IDEQ 2000). These low concentrations were thought to be caused by high levels of organic matter (Webb 1964, Worth 1994, Harrison et al. 1999). A 1990 fish kill in the upper end of Brownlee Reservoir was attributed to low dissolved oxygen concentrations (Myers and Pierce 1999).

Prompted by these water quality concerns, IPC initiated water quality studies in 1990. A preliminary assessment of data led researchers to conclude that water quality conditions in Brownlee Reservoir were largely the result of inflowing water quality (Harrison et al. 1999). Specifically, preliminary modeling indicated the high temperature and algae levels of inflows caused temperature, algae, and dissolved oxygen problems within Brownlee Reservoir. Earlier, Webb (1964) had come to a similar conclusion, identifying high loads of total suspended solids in the Boise, Malheur, and Owyhee rivers and high loads of organic matter, phosphorus, and nitrogen in the Boise and Malheur rivers. USEPA (n.d.) reported elevated temperature, suspended solids, and total phosphorus concentrations in the agricultural return drains (referred to in this report as drains) flowing into the southwest Snake River. Milligan et al. (1983) reported a high nutrient-load index for the HCC. Similar to Webb (1964), Worth and Braun (1993) reported increasing concentrations of total suspended solids, nitrogen, and chlorophyll *a* in the Snake River in a downstream progression. Worth (1994) determined the tributaries provided up to twice the phosphorus loads to the Snake River as compared with the background load measured at Swan Falls Dam. Clark and Bauer (1983) and IDEQ (1998a) summarized water quality data in the Boise River and concluded that temperature, nutrients, and periphytic algae exceeded applicable standards and guidelines in the lower river. Testing in the Boise River rated water quality significantly lower than pristine (IDEQ 2001). Most of the reported values were below minimum threshold values.

Myers et al. (1998) summarized 1995 tributary water quality data and nutrient loads to the Snake River from Swan Falls Dam to Farewell Bend, Oregon. They concluded that the Snake River at Swan Falls Dam, the Boise River, and the Payette River were the largest nutrient sources, contributing 75% of the total phosphorus and over 90% of the orthophosphate loads to

the Snake River. Flows in 1995 were found to be slightly below the average historic flows, suggesting that the loadings that year were somewhat below average. This study of tributary pollutant sources builds on these findings, as recommended in 1996 by the Aquatic Resources Work Group, a technical group formed as part of the collaborative process for relicensing the HCC (IPC 1999). This study focuses on similar objectives but incorporates additional sources throughout the HCC and multiple years. IPC expected these data to be useful in developing comprehensive measures for addressing water quality issues.

2. STUDY AREA

Hells Canyon is located in west-central Idaho and northeastern Oregon (Figure 1). The Snake River, a major tributary to the Columbia River, is the focal point of Hells Canyon. The HCC is located on the Snake River in the southern part of Hells Canyon and forms Brownlee, Oxbow, and Hells Canyon reservoirs. The study area, reaching from Swan Falls Dam to Hells Canyon Dam, includes the Snake River, its tributaries, and many of the drains that contribute upstream of Brownlee Reservoir.

2.1. Geologic and Climatic Setting

Brownlee Reservoir receives inflows from a 188,008-km² watershed (Brennan et al. 2000) that includes most of southern Idaho, southeastern Oregon, and small areas of Nevada, Utah, and Wyoming. This large drainage area encompasses several geomorphic landforms. Generally, the middle and upper Snake River basins drain the High Lava Plains and the Basin and Range landforms (Alt and Hyndman 1989). The High Lava Plains landform consists mostly of rhyolite ash and alluvial deposits beneath basalt flows. The Basin and Range landform is composed of granite and folded sedimentary rocks that form fault-block mountains. Some of these mountains, located in the southeastern part of the watershed, are rich in phosphorus. These landforms give way to the northern Rocky Mountains and the Yellowstone Plateau. Soils, of course, are mostly derived from the surrounding geological landforms. Jones (1993) reported most of the soils in the immediate area (Xerolls, Orthids, and Argids) were developed in dryer climates and are highly alkaline.

The watershed size does not increase substantially (only by 1,839 km²) below Brownlee Reservoir and before the end of the study reach (that is, through Oxbow and Hells Canyon reservoirs) because the Snake River enters the narrow Hells Canyon (Brennan et al. 2000). The canyon's geologic features are typified by the tightly folded and steeply-tilted layers of metamorphosed sedimentary and volcanic rocks of the Seven Devils complex, overlain by nearly horizontal flows of the Columbia Plateau basalts (Alt and Hyndman 1989). Other formations include alluvial fans created by small tributaries. Much of the area has nearly vertical slopes with little residual soil from weathered native rock.

Climate varies throughout the vast watershed. Generally, however, the summers are dominated by Pacific high-pressure systems, resulting in minimal precipitation, while late fall to early spring is influenced by cool, moist Pacific maritime air (Ross and Savage 1967). Periodically,

this pattern is interrupted by cool, dry continental air from the north. Most of the precipitation falls as rain at lower elevations and snow at higher elevations.

2.2. Hydrologic Setting and Land Uses

Oxbow Reservoir receives flows primarily out of Brownlee Reservoir. Hells Canyon Reservoir, in turn, receives discharged flows primarily from Oxbow Reservoir. Therefore, the hydrologic regime of Oxbow and Hells Canyon reservoirs is very similar to that of Brownlee Reservoir.

Brownlee Reservoir receives its highest inflows in May as snowmelt runoff (period of record at U.S. Geological Survey [USGS] gauge 13269000) (Brennan et al. 2000). Its lowest inflows occur in August when precipitation is lowest and irrigation diversions in the Snake River are highest (USBOR 1999). This general hydrologic regime is typical of most major tributaries to the HCC (Table 1). However, this regime is probably not reflective of the natural hydrologic processes since many of the tributaries are regulated by reservoirs for flood control, agricultural water supplies, power generation, and recreation (IDWR 1971). Many of the drains discharge small volumes of water (less than one cubic meter per second) from irrigated cropland adjacent to the Snake River (Myers et al. 1998).

General watershed information for each of the major tributaries is presented below. Hydrologic characteristics were summarized by the USGS, and land-use characteristics were summarized by Worth and Braun (1993), IDEQ and ODEQ (2001), and Chandler and Chapman (2001), unless otherwise noted.

2.2.1. Snake River

The Snake River above Swan Falls Dam is considered a tributary to the study area. It drains a watershed covering about 108,500 km² and contributes over one-half of the average annual discharge to the HCC (Table 2). Upstream of Swan Falls Dam, irrigated and dryland agriculture, livestock grazing, and confined animal-feeding operations predominate the landscape (Buhidar et al. 1999). Land development and timber harvest are less prevalent but may be locally notable. Hydroelectric development on the river is common.

2.2.2. Owyhee River

The Owyhee River drains 28,904 km² of southeastern Oregon, southwestern Idaho, and northern Nevada. Most of the lands are public rangelands used primarily for livestock grazing. Historically, uplands in the watershed were mined. Irrigated agriculture currently occurs along the river and its tributaries and below Owyhee Reservoir.

2.2.3. Boise River

The Boise River drains 10,282 km² of southwestern Idaho, accounting for 8.2% of the HCC average annual discharge (Table 2). Public forests along the headwaters comprise nearly one-half of the lands. Timber harvest was and is still a prevalent land use. Historically, placer mining

occurred in the forested waterways. Three reservoirs have been constructed on the Boise River for hydropower generation. Below Lucky Peak Reservoir, the lower one-third of the watershed is home to nearly one-third of Idaho's population, and contains almost 1,000 km² of irrigated agricultural lands (IDEQ 1998a). Five major municipal wastewater facilities discharge to the lower Boise River. Other important land uses in this area include livestock grazing, confined animal-feeding operations, orchards and vineyards, land development, and associated infrastructures.

2.2.4. Malheur River

The Malheur River enters the Snake River north of Ontario, Oregon, and drains 10,049 km² of southeastern Oregon. The watershed is comprised primarily of rangelands and agricultural lands with few forested acres. Much of the land is public, and grazing is the predominate use. Water storage and irrigation withdrawals are prevalent throughout the watershed, particularly along the Malheur River and its tributaries and below minor reservoirs.

2.2.5. Payette River

The Payette River drains 8,392 km² and flows into the Snake River at Payette, Idaho, contributing nearly 15% of the average annual discharge into the HCC (Table 2). Much of the lands are public forestlands with primary uses that include timber harvest and associated road construction. Dryland agriculture is common in the large valleys located high in the watershed, while irrigated agriculture is a primary use along the lower Payette River. Livestock grazing, confined animal-feeding operations, and municipalities are located throughout the watershed.

2.2.6. Weiser River

The Weiser River flows into the Snake River at Weiser, Idaho. It drains 3,781 km² and accounts for 5.4% of the HCC average annual discharge (Table 2). The headwaters of the Weiser River are forested, and timber harvest, road construction, and livestock grazing are the predominate land uses. The central part of the watershed is mostly rangeland, with livestock grazing an important land use. Irrigated agriculture and land development increase lower in the Weiser River watershed.

2.2.7. Burnt River

The Burnt River drains 800 km² and enters Brownlee Reservoir near Huntington, Oregon. Rangelands and forestlands comprise the uplands. Historically, mining, livestock grazing, and timber harvest were primary land uses. Today, extensive irrigation water withdrawals from the Burnt River support irrigated agriculture along the lower reaches of the river and its tributaries.

2.2.8. Powder River

The Powder River discharges directly into Brownlee Reservoir after draining a 3,393-km² watershed. Rangelands and forestlands occur equally, with livestock grazing and timber harvest

predominate land uses. Mining was important historically. The Powder River watershed is heavily diverted for agricultural irrigation near Baker City and Richland, Oregon.

2.2.9. Eagle Creek

Eagle Creek is a tributary of the Powder River and drains 404 km², with part of the watershed forming the Eagle Cap Wilderness in the Wallowa Mountains. The creek enters the Powder River below the USGS Powder River stream gauge and just upstream of the Powder River arm of Brownlee Reservoir. Average annual discharge is nearly equal to that of the Powder River (Table 2). Most of the watershed is public forestlands with some irrigated agriculture.

2.2.10. Wildhorse River

The Wildhorse River drains 458 km² and is a tributary of Oxbow Reservoir. The river begins in the southern Seven Devils Mountains on the Hells Canyon Wilderness boundary. Much of the watershed is public forestlands managed for timber harvest and livestock grazing. The Wildhorse River has very little water diverted for irrigated agriculture.

2.2.11. Pine Creek

Pine Creek is a tributary of Hells Canyon Reservoir and drains 596 km². The majority of the watershed is forested lands, with the remaining areas used as rangelands and irrigated agricultural lands. Historically, the Pine Creek watershed was used for extensive timber harvest and livestock grazing, and these uses continue. Water diversions are most common in the Pine Valley near Halfway, Oregon.

3. METHODS

3.1. Field Collection

3.1.1. Temperature

IPC placed HOBO® temperature data loggers in the Payette, Weiser, Powder, and Wildhorse rivers and in Eagle and Pine creeks. Locations were selected within these rivers and creeks where minor tributaries or drains would not influence water temperatures. The data loggers were also placed in locations that would minimize exposure to extreme low-flow conditions. Data loggers were placed in capped, cement-filled polyvinyl chloride pipes, which were anchored to the streambank. The recording interval was set at one hour.

3.1.2. Flow

Investigators used two standard protocols to measure discharge (Rantz 1982a,b). We obtained daily discharge data at the following locations:

- USGS stream gauge on the Snake River near Murphy, Idaho
- USGS stream gauge on the Snake River at Nyssa, Oregon
- USGS stream gauge on the Snake River near Weiser, Idaho
- USGS stream gauge on the Snake River below Hells Canyon Dam
- The first USGS or IPC stream gauge located upstream of the confluence with the Snake River on the Owyhee, Boise, Malheur, Payette, Weiser, Burnt, Powder, or Wildhorse rivers and Eagle or Pine creeks

IPC measured discharge from minor tributaries and drains during each nutrient sampling event by identifying maximum depth and then measuring velocity at six-tenths that depth. These measurements were collected from at least three locations along a cross section of the channel.

3.1.3. Nutrients

The Snake River, its major tributaries, and minor tributaries and drains located upstream of Brownlee Reservoir were sampled for nutrients (Appendix 1). The Snake River inflow to the study area near Murphy, Idaho, at Nyssa, Oregon, near Weiser, Idaho, and below Hells Canyon Dam were sampled biweekly to monthly from March 1995 through April 2000. Essentially, the major tributaries were sampled on two schedules. The Owyhee, Boise, Malheur, Payette, and Weiser rivers were sampled monthly from March through October 1995. These rivers, as well as the Burnt, Powder, and Wildhorse rivers and Eagle and Pine creeks, were also sampled monthly from April 1999 through April 2000. The Boise and Payette rivers were additionally sampled monthly from March 1998 through March 1999. USEPA (1975) was reviewed to identify minor tributaries and drains upstream of Brownlee Reservoir. Investigators visited each location to determine whether it was still active. Then each active site was sampled monthly from March through October 1995.

Major and minor tributary and drain nutrient samples were collected as close to the confluence with the Snake River as possible, but location varied depending on the stage of the river and the tributary or drain. Before April 1999, “grab” samples were collected, generally mid-channel about 0.3 m below the water’s surface. However, in April 1999, we incorporated depth-width integrated sampling. Ten equal-distance samples along a cross section of the stream were collected from the water’s surface to the bottom, based on the rate calculated in the thalweg for filling the sampler to 90% of its capacity. These samples were then placed in a churnsplitter. Investigators drew water samples into individual containers and labeled them according to site or river mile, location, duplicate or spike, date and time, and personnel collecting the sample. The samples were then stored in a dark, cool container for delivery to the laboratory.

3.2. Laboratory Analysis

Nutrient samples were taken to Alchem Laboratories Inc. within 48 h of collection. Samples were analyzed for total phosphorus, orthophosphate, nitrate nitrogen, Kjeldahl nitrogen, and ammonia nitrogen, following procedures listed in Table 3.

3.3. Quality Control and Assurance

3.3.1. Temperature

HOBO® temperature data loggers were maintained according to manufacturer specifications. Data were downloaded from the loggers and graphed by date. Misrepresentative data (those data collected before and after deployment into the stream) and data representative of dewatered conditions were removed. Dewatered conditions were determined by comparison with air temperatures.

3.3.2. Nutrients

Before sampling began at any site, investigators carefully examined and cleaned all sampling equipment and other items that could contaminate the samples. All sampling equipment and containers were rinsed twice with sample water. All equipment was reexamined after sampling.

Random duplicate samples were collected and field spikes prepared at about 20% of the scheduled sampling events. Duplicates, as the name implies, were collected as another sample of the same origin following field-collection protocol. This practice measures precision among the samples. Spikes were prepared by adding four milliliters (1 mg/L) of laboratory spike solution to one liter of sample water. This practice measures accuracy. Nutrient values were proofed by visual observation of outliers. Outliers were then verified with laboratory data sheets. Percent relative range (an estimator of precision) and percent recovery (an estimator of accuracy) were calculated following Bauer (1986).

3.4. Data Analysis

3.4.1. Temperature

The instantaneous maximum and daily average water temperatures were compared to the applicable Idaho coldwater biota and salmonid spawning criteria. The seven-day average maximum water temperature was compared with the applicable Oregon salmonid fish rearing, salmonid fish spawning, and bull trout criteria. The number of days exceeding criteria was reported. Temperature exemption criteria, that is when the ambient air temperature during the warmest seven-day period of the year exceeds the 90th percentile of the seven-day average maximum air temperature calculated in a yearly series over the historic record (IDAPA 58.01.02).

n.d., OAR 340-041 n.d.) were not applied. Therefore, the reported number of days exceeding criteria is likely conservative.

3.4.2. Nutrients

Nutrient concentration data reported as less than the detection limit were incorporated into analyses as one-half the detection limit. Total nitrogen was calculated by adding nitrate nitrogen and Kjeldahl nitrogen.

We summarized data to calculate the ratio of orthophosphate to total phosphorus and the ratio of biologically available nitrogen (nitrate and ammonia) to biologically available phosphorus (orthophosphate) for the nutrient sources to the HCC. Mean, standard deviation, median, minimum, and maximum nutrient concentration and ratio values were calculated. Then nutrient concentration data were compared with recommended targets and standards.

3.4.3. Nutrient Loads

We calculated nutrient loads using discharge and nutrient concentration data. Two methods were used, depending on the size of the tributary. Daily discharge data and measured nutrient concentration data collected biweekly to monthly were used for the Snake River and major tributaries, which included the Owyhee, Boise, Payette, Weiser, Burnt, Powder, and Wildhorse rivers and Eagle and Pine creeks. Corresponding flow and nutrient concentration data were used for the minor tributaries and drains.

Daily nutrient concentrations were calculated using linear interpolation between the biweekly to monthly measurements for the Snake River and major tributaries. FLUX, an interactive program designed to estimate the load of nutrients passing a tributary sampling location over a given period of time (Walker 1999), was used as the interpolation tool and load estimator. Wetherbee (2000) reported the interpolated nutrient-concentration output generated using FLUX Method 2 (flow-weighted average concentration) was similar to the nutrient concentration estimated by linear interpolation. This similarity can be explained by the fact that model residuals are interpolated on a logarithmic scale, and both methods converge on the measured data. Therefore, the interpolated output generated by FLUX Method 2 was used as an estimate of linearly interpolated nutrient concentrations. Maximum sample interval was used as the maximum interpolation interval.

We investigated flow/concentration and season/concentration relations before we analyzed the data. When appropriate, data were stratified by flow or by season to converge mean loading estimates among the various FLUX calculation methods and to yield minimum coefficients of variation. Walker (1999) reported that, in most cases, Method 2 estimates have the lowest uncertainty when stratifying data, unless stratification does not capture essential features of the flow/concentration relation, and Method 2 should be used if convergence is reached. He also stated that Method 2 is generally the most robust method of estimating nutrient loads, and this method should be used if loads must be generated from limited data. To obtain the estimated daily nutrient loads, we multiplied the interpolated daily nutrient concentrations by the daily discharge values. Monthly loads were then determined by summing the daily values.

Monthly nutrient concentrations were not available for the Boise River in May or June 1995. Nutrient-concentration data for the Boise River near Parma, Idaho, were obtained from the USGS gauging station (Brennan et al. 1996). Myers et al. (1998) compared the USGS and IPC data for March, April, July, August, and October and found that USGS and IPC nutrient concentrations varied because of differing sampling locations, sampling techniques, and analysis procedures. Rather than using the USGS nutrient concentrations for May and June, they conducted a regression analysis of the relation between the USGS and IPC data for each nutrient constituent. They established a regression equation based on these data. The regression equation was then used to establish “modified USGS” data for May and June 1995. These modified data were used in our analyses.

We used direct load averaging to calculate nutrient loads for the minor tributaries and drains. The monthly nutrient concentration was multiplied by the measured discharge for the day on which the sample was collected. We then multiplied the result by the number of days in the month. Monthly estimates for each minor tributary and drain were combined to calculate a composite load.

4. RESULTS AND DISCUSSION

4.1. Temperature

Idaho has established coldwater biota temperature criteria of 22 °C for the instantaneous maximum and 19 °C for the daily average as well as salmonid spawning criteria of 13 °C instantaneous maximum and 9 °C daily average (IDAPA 58.01.02. n.d.). Oregon, similarly, has set a seven-day average maximum criterion of 17.8 °C for salmonid fish rearing, 12.8 °C for salmonid fish spawning, and 10 °C for bull trout (OAR 340-041 n.d.). Water temperatures in the study area consistently exceeded the respective criteria (Table 4). Maximum temperatures among the tributaries never exceeded 30 °C and were generally about 26 °C (Appendix 2). Even Wildhorse River and Eagle Creek, which are probably minimally affected by anthropogenic, or human-caused, factors, exceeded the criteria during most years. Tributaries varied greatly in terms of onset and duration of warming. Some tributaries exceeded the coldwater biota and salmonid fish rearing criteria as early as May, while others did not exceed them until late July and August. However, similar annual patterns were evident among tributaries. Generally, the earliest dates of water temperatures exceeding the criteria and the longest duration of exceedance occurred in 2001. [Water year 2001 was dryer than normal with flows in the Snake River below Hells Canyon Dam only 51% of period of record (O’Dell et al. 2002)].

4.2. Flow

An understanding of hydrologic processes supports interpreting the nutrient loading analysis. To aid this understanding, the following sections compare flow volume for calendar years 1995 and 1999 with historic data and discuss the water balance (or an accounting of water flow) in the HCC.

4.2.1. Calendar Year and Historic Flow Comparison

We compared calendar year flows with historic flows to characterize the annual magnitude of flow during the study. The period of record used for historic flows varied by source. Calendar year 1995 inflows to the HCC, compared with historic flows, ranged from a low of 37% for the Owyhee River to a high of 151% for Pine Creek (Figure 2). Upstream of the Payette River, inflows were below historic flows. This lower magnitude of flows is why Myers et al. (1998) concluded nutrient loads in 1995 were probably representative of below average loads, since only tributaries upstream of Brownlee Reservoir were included in that study. Throughout the rest of the HCC, flows nearly matched or exceeded historic flows. Overall, the flow through the HCC, as measured in the Snake River below Hells Canyon Dam, was nearly equivalent (96%) to the historic flow record. Calendar year 1999 flows were greater than historic flows, except in the Owyhee River, where flows were 87% of historic flows. Flow through the HCC during calendar year 1999 was moderately high, measuring 122% of historic flows for the Snake River below Hells Canyon Dam. The greatest difference in calendar year flows was in the Malheur River where flows more than doubled between 1995 and 1999. These data indicate that nutrient loads should reflect near-average (only sources upstream from Brownlee Reservoir were sampled in 1995) to moderately high loads. Obviously, nutrient loads from individual tributaries will vary.

4.2.2. Water Balance

Comparing the sum of all measured inflows with the measured outflow provides an accounting of water flow, or a water balance (Figure 3). Inflows to the Snake River at Nyssa, Oregon, were slightly lower than outflows in 1995 because we used composite minor tributaries and drains for this study, rather than individual measured flows. Therefore, minor tributaries and drains that contributed to the Snake River upstream of Nyssa, Oregon, were not accounted for until the Snake River near Weiser, Idaho. In 1999, inflows to the Snake River near Weiser, Idaho, were generally about 10% lower than outflows. Minor tributaries and drains were not sampled in 1999. Using the 1995 flow data from the minor tributaries and drains in our 1999 calculations improved the 1999 water balance slightly. It is apparent from these data that not all inflows to the HCC had been accounted for in this study. However, comparisons of inflow and outflow data indicate most inflows had been accounted for, which, in turn, indicates that most of the pollutant sources and nutrient loads were measured.

4.3. Nutrients

Investigators collected 1,022 nutrient samples from 94 locations in the HCC between March 1995 and April 2000. These samples were analyzed for total phosphorus, orthophosphate, nitrate nitrogen, Kjeldahl nitrogen, and ammonia nitrogen (Appendix 3). More than 180 additional samples were collected, analyzed, and used as measures of precision and accuracy.

Precision and accuracy measures indicated reliable nutrient data. Total phosphorus average relative range was six percent for all samples (Table 5). That is, a sample was expected to be within six percent of a duplicate sample. Average relative range was five percent for

orthophosphate, three percent for nitrate, and 17% for ammonia. Average recovery was 106% for total phosphorus, 103% for orthophosphate, 102% for nitrate, and 99% for ammonia.

Phosphorus occurs naturally in waters as biologically available orthophosphate and organically bound phosphate. A digestion method, which oxidizes organic matter to effectively release phosphorus as orthophosphate, is used to determine total phosphorus (APHA 1989). Nitrogen is also found naturally in many forms. Nitrate, ammonia, and organic nitrogen are all biologically interconvertible. Nitrifying bacteria can convert ammonium ions into nitrates, and denitrifying bacteria can change nitrates back to atmospheric nitrogen (Bitton 1999). Blue-green algae can fix atmospheric nitrogen to ammonium ions. Nitrogen fixation can represent a significant addition of nitrogen into an aquatic system (Goldman and Horne 1983).

4.3.1. Phosphorus

Figure 4 illustrates the median total phosphorus and orthophosphate concentrations and associated percentiles for the Snake River inflow to the study area and the major tributaries. It also provides the composite concentrations for the minor tributaries and drains (combined in Figure 4 as drains). The patterns for both phosphorus forms were similar. Generally, the median total phosphorus concentrations in the Malheur (0.337 mg/L) and Boise (0.305 mg/L) rivers were at least twice as high as in most other sources (Table 6). Minor tributaries and drains and the Burnt River also had relatively high median total phosphorus concentrations. Similarly, median orthophosphate concentrations in the Malheur and Boise rivers were also at least twice as high as in other sources, at about 0.230 mg/L. Flow volumes did not seem to affect the high total phosphorus concentration measured in June 1995 in the Owyhee River: daily discharges measured a week before and a week following the nutrient sampling date were the same as for the sampling date (Hubbard et al. 1997a). Based on concentrations measured in individual drains over all sampling dates, there were higher concentrations of both total phosphorus and orthophosphate than those reported above (Appendix 3).

Our findings concur with those of other researchers. Webb (1964) sampled orthophosphate concentrations in the Boise River that ranged from 0.26 to 2.50 mg/L. Worth and Braun (1993) reported average total phosphorus concentrations in the Boise River (0.37 mg/L) similar to those found in this study and reported higher concentrations in the Owyhee, Payette, and Weiser rivers. These higher concentrations might have been the result of less dilution from flows, since the flows in the Snake River in 1992 were only about 60% of average (Harenberg et al. 1993). USEPA (n.d.) sampled drains in 1974 and 1975. Generally, they reported similar total phosphorus concentrations.

Excessive nutrient levels can lead to nuisance growth of algae and aquatic plants. However, neither Idaho nor Oregon has established numeric phosphorus criteria. The draft *Snake River–Hells Canyon Total Maximum Daily Load* recommends a total phosphorus target of 0.070 mg/L (IDEQ and ODEQ 2001). The median total phosphorus concentration in most sources to the HCC exceeded the target (Table 6). The Wildhorse River and Eagle Creek, two tributaries that originate in or near wilderness areas, had median total phosphorus concentrations near or below the US Environmental Protection Agency's recommended total phosphorus criterion of 0.042 mg/L for reference conditions in the Snake River Basin ecoregion (USEPA 2000).

4.3.2. Orthophosphate to Total Phosphorus Ratio

A relatively high percentage of the phosphorus is readily available for biological uptake when the ratio of orthophosphate to total phosphorus (Op:Tp) is large. When such a ratio exists, and environmental conditions are favorable, algae biomass can increase rapidly. Orthophosphates made up 33 to 78% of the total phosphorus present in sources to the HCC (Figure 5). These values were similar to those reported by Worth and Braun (1993). Ratio percentages varied greatly by sample date as indicated by the associated error bars on Figure 5. The mean Op:Tp ratio for all sources was significantly higher ($P = <0.001$) during the winter (November, December, January) than during the rest of the year. Biological uptake is the most plausible explanation for this phenomenon. The reduced rate of biological uptake of orthophosphate by algae in the dormant season (winter) probably results in higher orthophosphate concentrations and thus higher Op:Tp ratios. In the southwest Snake River, higher chlorophyll *a* concentrations have been documented for summer than for fall (Worth and Braun 1993).

4.3.3. Nitrogen

Nitrate and ammonium ions are considered the most important nitrogen forms that support aquatic plant growth (Goldman and Horne 1983). Figure 6 illustrates the median nitrate and ammonia concentrations and associated percentiles for the Snake River inflow to the study area, major tributaries, and the composite of minor tributaries and drains (combined in Figure 6 as drains). Median nitrate concentrations were highest in the Malheur River with a median concentration of 2.600 mg/L. The highest individually measured nitrate concentrations consistently occurred in drains (Appendix 3). The greatest concentration measured was 14.600 mg/L (Table 6). Concentrations from the Malheur River and minor tributaries and drains, with median nitrate concentrations over 2.000 mg/L, were nearly 2 to 40 times higher than those from most other sources. The Boise River also had relatively high nitrate concentrations (a median value of 1.520 mg/L). The concentration and rate of supply of nitrate is closely connected to land-use practices (Goldman and Horne 1983). Nitrate ions are quite easily lost from the land and move easily through soils. This pattern contrasts with orthophosphate and ammonium ions, which are retained by soil-particle charges. Plants use ammonia for growth more readily than they use nitrate because using nitrate requires additional energy and a particular enzyme (Goldman and Horne 1983). This preference for ammonia over nitrate may explain the relatively low ammonia concentrations as compared with nitrate.

Again, our findings concur with those reported by other researchers. Webb (1964) reported nitrate concentrations in the Boise River ranging from 0.10 to 1.45 mg/L. USEPA (n.d.) sampled drain waters and found concentrations as high as 5.6 mg/L, which is similar to the levels we measured. Worth and Braun (1993) reported comparable total nitrogen concentrations in the Payette and Weiser rivers but lower concentrations in the Boise and Owyhee rivers.

As with phosphorus, neither Idaho nor Oregon has established numeric nitrogen criteria. USEPA (2000) has recommended a total nitrogen (nitrate and Kjeldahl nitrogen) reference condition criterion of 0.544 mg/L for the Snake River Basin ecoregion. Similar to total phosphorus, the Wildhorse River and Eagle Creek, as well as Pine Creek, had median total nitrogen concentrations below this criterion.

4.3.4. Total Nitrogen to Total Phosphorus Ratio

The limiting-nutrient concept is based on the assumption that the abundance of any organism is determined by the abundance of the substance that is necessary to the organism but least available in the environment. This concept, in concert with the stoichiometry of the photosynthesis equation, led to the development of the nitrogen to phosphorus (N:P) ratio. Only biologically available forms of the nutrients are used in the equation because using only these forms allows researchers to approximate the immediate needs of the aquatic community. Ryding and Rast (1989) stated that N:P ratios less than about seven indicate nitrogen-limited environments, while ratios greater than seven indicate that phosphorus is probably the limiting substance. Using the stoichiometric ratio values, we found tributary sources upstream of Brownlee Reservoir are apparently mostly phosphorus limited, while those downstream appear to be nitrogen limited (Figure 5). Phosphorus has been identified as the key nutrient to control for water quality to improve in the draft *Snake River-Hells Canyon Total Maximum Daily Load* (IDEQ and ODEQ 2001) and in many freshwater systems in general (Welch 1992).

4.4. Nutrient Loads

The lower Snake River is designated as water quality limited (IDEQ 1998b) and requires the development of a total maximum daily load. The relative contribution of nutrient loads will provide essential information for watershed planning. These data, as well as load balances, are presented for 1995 and 1999. Data in 1995 include the months from March through October, often referred to as the growing season (Appendix 4). Data in 1999, unless otherwise stated, include the months from April 1999 through April 2000.

Most tributary sources did not show strong nutrient concentration dependence with either season or flow. The Owyhee River total phosphorus concentrations were statistically higher ($P = 0.018$) between June and September than the rest of the year, and therefore nutrient concentrations were stratified by these months. Total phosphorus concentrations in the Boise River ($r^2 = 0.8068$, $n = 45$), Wildhorse River ($r^2 = 0.6549$, $n = 15$), and Pine Creek ($r^2 = 0.5306$, $n = 15$) were moderately to highly dependent on flows. Nutrient concentrations were stratified at 2,224 hm^3/yr in the Boise River, 60 hm^3/yr in the Wildhorse River, and 491 hm^3/yr in Pine Creek.

There is high confidence in most of the load estimates. Walker (1999) stated that coefficients of variation less than 0.2 may be adequate for modeling purposes, especially in minor tributaries. Coefficients of variation less than 0.1 are adequate for use in mass-balance modeling. Nearly 70% of the nutrient forms had coefficients of variation less than 0.2, and most were less than 0.1. Only tributaries with small sample sizes had nutrient form coefficients of variation mostly greater than 0.2 (the Owyhee River, Weiser River, and Pine Creek). Load estimates for particular nutrient forms may be less precise in these tributaries.

4.4.1. Phosphorus Load Balance

The relation between the 1995 and 1999 phosphorus load balances (which compare the sums of measured inflowing loads to measured loads at a particular location) are similar. Generally, the total phosphorus load increases in the Snake River through Weiser, Idaho, while the orthophosphate load decreases (Figure 7). Myers et al. (1998) attributed the greater total phosphorus load leaving the Snake River in 1995 to in-channel scouring of sediment and associated phosphorus. Both 1995 and 1999 were nearly average or above average flow years in the Snake River (Figure 2). Additionally, the 1999 load balance did not include minor tributaries and drains. Algae, which use orthophosphate to grow, probably cause the decrease in the orthophosphate load in the river. Worth and Braun (1993) reported that levels of chlorophyll *a* more than doubled in late August in the Snake River between the Payette and Weiser rivers. Load balancing through the HCC indicates that the larger particulate form of total phosphorus decreases, probably because of settling in the reservoirs, while the orthophosphate load increases slightly. The source of this increase might be unaccounted tributary sources, such as Brownlee Creek, or internal reservoir loading.

4.4.2. Nitrogen Load Balance

Nitrogen load balancing indicates a very good balance for nitrate (Figure 8). Ammonia load, however, increases substantially between the inflow to the HCC and the outflow measured below Hells Canyon Dam. Myers and Pierce (1999) reported that the high ammonia concentrations measured in the deep water of Brownlee Reservoir were the source of ammonia being transported downstream.

4.4.3. Tributary Nutrient Loads

Myers et al. (1998) reported tributary nutrient loads for the 1995 growing season (March through October). Comparing 1995 and 1999 growing season loads might indicate patterns relative to water yield. The phosphorus loads for most sources during the growing season in 1999 were slightly lower than those for the same period in 1995, except in the Malheur and Weiser rivers (Figure 9). The slightly larger loads in 1995 could have been caused by higher flows scouring and flushing materials that had accumulated during several preceding years of below-average flows (Myers et al. 1998). Conversely, the slightly lower loads in 1999 may be the result of dilution caused by the higher than average flows during that year. The large increase in the Malheur River phosphorus load can probably be explained by the fact that flows between the 1995 and 1999 calendar years more than doubled (Figure 2). The phosphorus loads for the Owyhee River were consistently lower than loads for other tributaries, perhaps reflecting the recurrent low water yields. The Owyhee River was only 37% of historic flows in calendar year 1995 and 87% in 1999. These flows represent the lowest flows measured in any tributary for both years. The phosphorus loads measured in the study area, with the exception of the load for the Owyhee River, may be indicative of those expected during near-average to moderately high water years.

Nitrate loads during the 1999 growing season increased slightly, except for the Payette River, while ammonia loads were similar to phosphorus loads (Figure 10). Again, the Malheur River

loads increased in 1999. The Weiser River ammonia load decreased considerably. The increase in flow again explains the increase in the ammonia load for the Malheur River. The high uncertainty (i.e., coefficient of variation) observed in the Weiser River data might explain the apparent decrease, since water yield remained at nearly 140% of historic flows (Figure 2).

We sampled all major tributary sources of the HCC from April 1999 through April 2000 to provide a more comprehensive overview of tributary pollutant sources. Drain nutrient loads, as calculated for the 1995 growing season, were substituted in 1999. These data indicated that the largest phosphorus contributors to the HCC are the Snake River inflow to the study area and the Boise River (Figure 11). These two sources contributed over one-half of the phosphorus load to the HCC (Table 7). The relative contribution generally decreased downstream. As noted earlier, we probably underestimated the Owyhee River's contribution of phosphorous because we sampled the Owyhee River during recurrent years of low water yields.

A similar load pattern to that of phosphorus was observed for nitrate (Figure 12). The Snake River inflow to the study area and the Boise River contributed 80% of the nitrate load to the HCC, with the Snake River accounting for nearly two-thirds of all nitrate loads. For ammonia loads in the study area, there was no clear pattern of dominant contribution, except for the primary contributor, the Snake River. The Payette River was the second highest ammonia contributor in 1999.

5. SUMMARY AND CONCLUSIONS

Below are the major findings of IPC's study of the tributary pollutant sources to the HCC.

1. Water temperatures in tributaries of the HCC were consistently above Idaho and Oregon coldwater biota and salmonid spawning criteria. Maximum temperatures never exceeded 30 °C and were generally about 26 °C.
2. Flows in tributaries to the HCC were generally at or above average historic flows, representing near-average to moderately-high water yield in the HCC. The 1995 calendar year flow averaged 96% of historic flows while the 1999 calendar year flow averaged 122%. Flows in the Owyhee River were consistently below average, while those in the Malheur River more than doubled in 1999.
3. The sum of all measured inflows closely matched the measured outflow. This finding indicates a good water balance: that is, little water was lost to or gained from unmeasured sources, including tributaries, drains, and groundwater.
4. The median total phosphorus concentrations in the Malheur (0.337 mg/L) and Boise (0.305 mg/L) rivers were at least twice the concentrations of most other sources. The median total phosphorus concentration in almost all sources of the HCC exceeded the recommended draft *Snake River-Hells Canyon Total Maximum Daily Load* target of 0.070 mg/L. Median total phosphorus concentrations in Wildhorse River and Eagle Creek were near or below the recommended criterion of 0.042 mg/L for reference conditions in the Snake River Basin

ecoregion. Similar to total phosphorus, orthophosphate concentrations in the Malheur and Boise rivers were at least two times higher than the concentrations in other sources, measuring about 0.230 mg/L.

5. The Op:Tp ratio percentage ranged from 33 to 78% and was highly variable by sample date. The mean Op:Tp ratio for all sources was significantly higher ($P = <0.001$) in winter (November, December, January), suggesting algae use orthophosphate during the growing season.
6. The Malheur River and drains had a median nitrate concentration greater than 2.000 mg/L, or nearly 2 to 40 times greater than the concentration of most other sources. Ammonia concentrations were low, often near the detection limit. Similar to total phosphorus, Wildhorse River and Eagle Creek, as well as Pine Creek, had total nitrogen concentrations below the recommended criterion of 0.544 mg/L for reference conditions in the Snake River Basin ecoregion.
7. There does not appear to be a clear nutrient-limiting form. Based on stoichiometric ratio values, tributary sources upstream of Brownlee Reservoir are mostly phosphorus limited, while those downstream are nitrogen limited.
8. The 1995 and 1999 orthophosphate load balances indicated considerable biological processing in the southwest Snake River upstream of Brownlee Reservoir. Substantial amounts of ammonia are apparently being transported from the deep waters of Brownlee Reservoir downstream.
9. In 1995 and 1999, nutrient loads to the HCC during the growing season were generally similar, suggesting loads indicative of near-average to moderately-high water years, except for perhaps the Owyhee River. The Malheur River loads increased considerably between 1995 and 1999, probably because flows more than doubled.
10. The Snake River inflow to the study area and the Boise River contributed over one-half of the total phosphorus and orthophosphate loads to the HCC, as measured between April 1999 and April 2000. The relative contribution of phosphorous from the tributaries generally decreased downstream, with the most noticeable decrease occurring to the Snake River downstream of Weiser, Idaho. A similar pattern was observed for nitrogen loads since the Snake River inflow to the study area contributed nearly two-thirds of the nitrate load and nearly one-half of the ammonia load.

6. ACKNOWLEDGMENTS

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Table 1. Monthly mean discharge (cubic meters per second^a) over period of record for major tributaries to the Hells Canyon Complex.

Location	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Snake River at Murphy ^b	331.92	340.13	351.46	386.01	373.26	374.68	228.74	211.61	242.11	299.63	322.57	326.54
Owyhee River ^c	4.19	11.33	30.25	47.83	24.52	9.52	4.93	4.39	3.65	1.91	0.28	0.69
Boise River ^d	44.01	58.11	73.97	86.97	87.74	60.72	28.26	22.29	28.29	31.10	29.74	31.89
Malheur River ^c	10.73	16.74	20.50	21.18	10.28	5.72	3.60	3.65	5.24	4.98	4.19	4.42
Payette River ^b	62.30	73.18	97.08	148.40	192.35	187.28	58.23	36.56	40.98	41.72	47.07	57.04
Weiser River ^b	26.99	42.68	69.33	70.89	73.66	45.11	11.16	6.40	5.21	5.32	8.89	17.98
Burnt River ^e	0.68	1.18	3.12	7.11	5.49	3.40	2.86	3.00	2.16	0.68	0.40	0.49
Powder River ^e	2.92	5.38	8.61	8.44	9.18	7.79	3.12	2.65	1.86	0.88	0.62	1.54
Eagle Creek ^f	3.17	3.60	5.49	12.01	26.20	28.43	11.78	4.16	2.97	2.97	3.48	3.31
Wildhorse River ^g	1.40	3.82	7.70	10.48	10.54	6.37	2.01	0.87	0.74	0.80	0.98	1.44
Pine Creek ^g	7.36	11.16	17.70	18.80	24.92	21.30	5.49	1.37	1.47	1.92	3.60	6.03

^a To convert cubic meters per second to cubic feet per second multiply by 35.31.

^b Data summarized by Brennan et al. (2000).

^c Data summarized by Herrett et al. (2001).

^d Data summarized by Brennan et al. (1998).

^e Data summarized by Hubbard et al. (1998).

^f Data summarized by Hubbard et al. (1999).

^g Data summarized by Brennan et al. (1997).

Table 2. Tributary contribution by drainage area and annual mean discharge over period of record relative to the Snake River at Hells Canyon Dam and water yield per land unit.

	US Geological Survey Gauge	Drainage Area		Annual Mean Discharge		Water Yield Per Land Area
		km ² ^a	% ^b	m ³ /s ^a	% ^b	
Snake River at Murphy ^c	13172500	108,521	57.2	315.2	53.1	0.0029
Owyhee River ^d	13183000	28,904	15.2	11.9	2.0	0.0004
Boise River ^e	13213000	10,282	5.4	48.5	8.2	0.0047
Malheur River ^d	13233300	10,049	5.3	9.2	1.6	0.0009
Payette River ^c	13251000	8,392	4.4	86.8	14.6	0.0103
Weiser River ^c	13266000	3,781	2.0	31.9	5.4	0.0084
Burnt River ^f	13273000	800	0.4	2.5	0.4	0.0031
Powder River ^g	13286700	3,393	1.8	7.0	1.2	0.0021
Eagle Creek ^h	13288200	404	0.2	9.0	1.5	0.0223
Wildhorse River ^l	13289960	458	0.2	3.8	0.6	0.0083
Pine Creek ^l	13290190	596	0.3	9.9	1.7	0.0166
Snake River at Hells Canyon Dam ^c	13290450	189,847	100.0	593.9	100.0	0.0031

^a To convert square kilometers to square miles multiply by 0.3861 and cubic meters per second to cubic feet per second multiply by 35.31.

^b Values as percentage at Hells Canyon Dam.

^c Data summarized by Brennan et al. (2000).

^d Data summarized by Herrett et al. (2001).

^e Data summarized by Brennan et al. (1998).

^f Data summarized by Hubbard et al. (1998).

^g Data summarized by Hubbard et al. (1997b).

^h Data summarized by Hubbard et al. (1999).

^l Data summarized by Brennan et al. (1997).

Table 3. Measure, technique, and method detection limits used in constituent analyses.

Measure	Technique	Detection Limit
Temperature	Onset Computer Corp. (2001): Hobo® thermistor	-5 to 37 °C
Flow	Rantz (1982a,b): stream-gauging or direct measurement	a
Total phosphorus	USEPA (1983): 365.2 (Colorimetric, Ascorbic Acid)	0.01 mg/L
Orthophosphate	USEPA (1983): 365.2 (Colorimetric, Ascorbic Acid)	0.005 mg/L
Kjeldahl nitrogen	USEPA (1983): 351.1 (Potentiometric, Ion Selective Probe)	0.1 mg/L
Ammonia nitrogen	USEPA (1983): 350.1 (Potentiometric, Ion Selective Probe)	0.01 mg/L
Nitrate nitrogen	USEPA (1983): 300.0 (Ion Chromatography)	0.1mg/L

^a Detection limit dependant on instrument.

Table 4. Sample period, period when temperature exceeded criteria, and frequency of noncompliance with Idaho and Oregon temperature criteria for tributaries to the Hells Canyon Complex.

Inflow Sources		Salmonid Rearing						
		Salmonid Spawning ^a			Coldwater Biota ^b			Bull Trout
		9 °C ^c	12.8 °C ^d	13 °C ^e	17.8 °C ^d	19 °C ^c	22 °C ^e	10 °C ^d
Payette River	1999	43		42		54	49	
	2000	104		87		78	65	
	2001	114		91		106	94	
	2002	104		83		86	63	
Weiser River	1999					59	55	
	2000					22	18	
	2001					79	76	
	2002					87	81	
Wildhorse River	1997	28		28		2	1	
	1998	52		20		0	0	
	1999	54		41		7	43	
	2000	74		48		5	0	
	2001	80		62		21	22	
	2002	34		18		0	0	
Powder River	1997				40			
	1998		62		14			
	1999		60		113			
	2000		76		128			
	2001		87		155			
	2002		55		35			
Eagle Creek	1997				30			
	1998		0		0			
	1999		4		48			
	2000		24		6			
	2001		5		87			
	2002		0		0			
Pine Creek	1998		0		0			60
	1999		0		77			168
	2000		0		90			210
	2002		0		0			59

^a Salmonid Spawning criteria were applied from March 15 to July 15 based on rainbow/redband trout.

^b Salmonid Rearing/Coldwater Biota criteria were applied during the entire calendar year.

^c Idaho daily average water temperature.

^d Oregon seven-day average maximum water temperature.

^e Idaho instantaneous maximum water temperature.

Table 5. Percent average relative range (precision) and percent average recovery (accuracy) for nutrient duplicate and spike samples from tributaries to the Hells Canyon Complex.

		Phosphorus		Nitrogen		
		Total	Ortho	Nitrate	Kjeldahl	Ammonia
Percent Average Relative Range						
Snake River	Average	5	7	2	18	14
	Count	50	50	50	50	50
Major Tributaries	Average	8	7	4	27	16
	Count	45	45	45	45	45
Drains	Average	6	3	3	10	19
	Count	89	89	89	89	89
Combined	Average	6	5	3	17	17
	Count	184	184	184	184	184
Percent Average Recovery						
Snake River	Average	106	102	103	99	105
	Count	50	50	50	50	50
Major Tributaries	Average	109	105	101	100	102
	Count	45	45	45	45	45
Drains	Average	105	102	101	98	97
	Count	88	88	88	88	88
Combined	Average	106	103	102	99	100
	Count	183	183	183	183	183

Table 6. Statistical summary of nutrient concentrations (mg/L) for tributaries to the Hells Canyon Complex.

Tributary	Phosphorus		Nitrogen			Total
	Total	Ortho	Nitrate	Kjeldahl	Ammonia	
Snake River at Murphy						
Mean	0.082	0.027	0.881	0.495	0.032	1.376
SD	0.021	0.018	0.368	0.184	0.026	0.290
Median	0.080	0.025	0.975	0.480	0.025	1.405
minimum	0.042	0.003	0.050	0.050	0.005	0.750
maximum	0.140	0.066	1.570	0.870	0.130	2.010
Owyhee River						
mean	0.237	0.077	1.661	0.641	0.065	2.302
SD	0.291	0.050	1.160	0.489	0.072	1.290
median	0.150	0.059	1.290	0.495	0.040	1.865
minimum	0.092	0.030	0.330	0.180	0.005	0.560
maximum	1.460	0.210	3.990	2.450	0.280	4.390
Boise River						
mean	0.307	0.228	2.133	0.547	0.054	2.680
SD	0.118	0.103	1.392	0.249	0.050	1.456
median	0.305	0.230	1.520	0.510	0.040	2.350
minimum	0.085	0.047	0.320	0.005	0.005	0.610
maximum	0.620	0.470	4.760	1.290	0.220	5.290
Malheur River						
mean	0.349	0.214	2.379	0.680	0.038	3.059
SD	0.108	0.063	1.180	0.329	0.033	1.226
median	0.337	0.224	2.600	0.640	0.025	3.100
minimum	0.212	0.090	0.260	0.050	0.005	0.840
maximum	0.610	0.310	4.760	1.550	0.150	5.300
Payette River						
mean	0.093	0.040	0.281	0.350	0.033	0.631
SD	0.057	0.022	0.237	0.159	0.023	0.346
median	0.080	0.033	0.240	0.310	0.030	0.570
minimum	0.029	0.014	0.010	0.050	0.005	0.100
maximum	0.361	0.110	0.930	0.760	0.080	1.570
Weiser River						
mean	0.172	0.060	0.270	0.538	0.029	0.808
SD	0.189	0.039	0.215	0.563	0.027	0.672
median	0.110	0.043	0.220	0.320	0.025	0.650
minimum	0.030	0.016	0.050	0.050	0.005	0.200
maximum	0.790	0.155	0.720	2.220	0.110	2.700

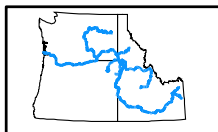
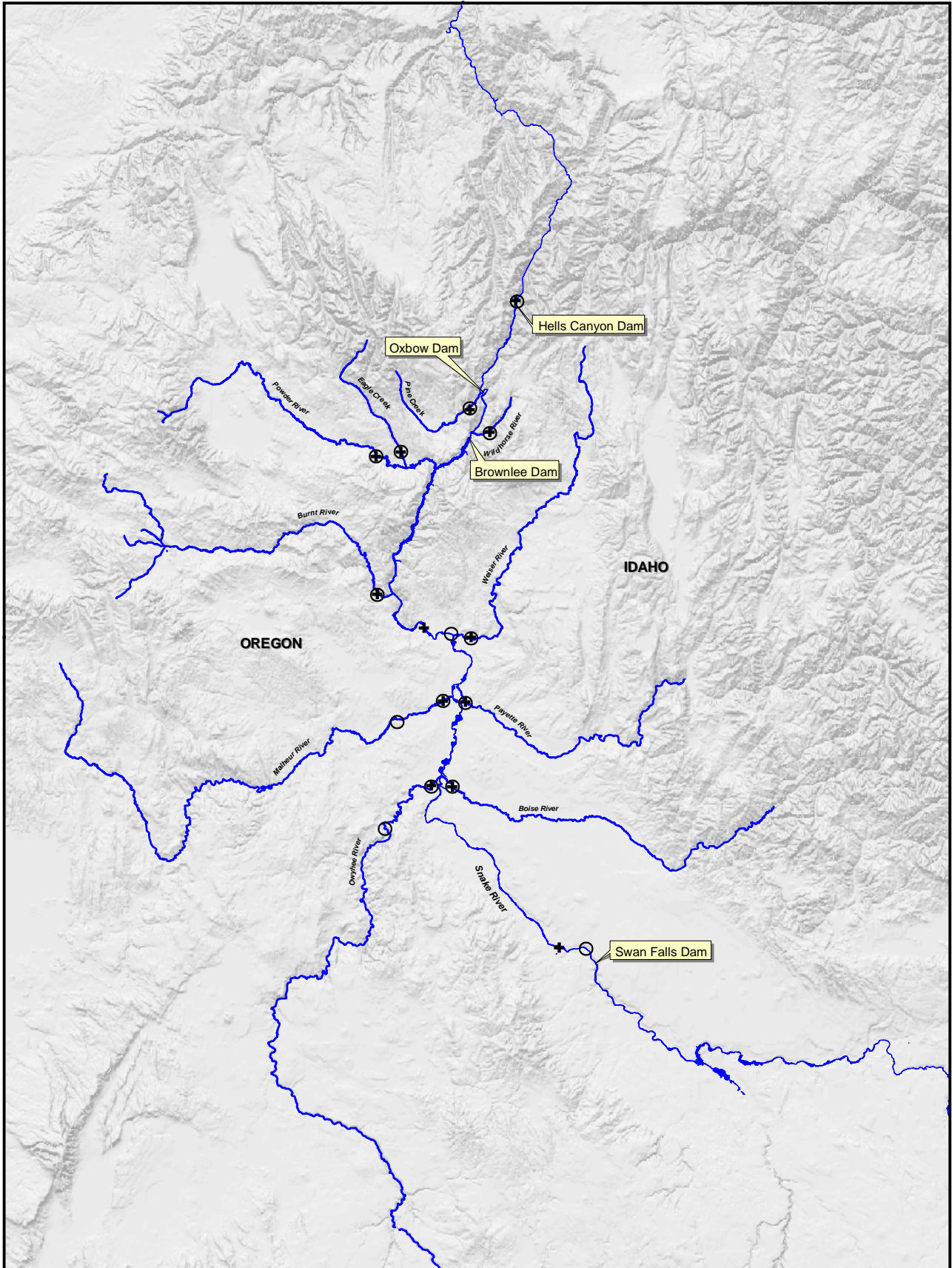
Table 6. (Cont.)

Tributary	Phosphorus		Nitrogen			Total
	Total	Ortho	Nitrate	Kjeldahl	Ammonia	
Composite Minor Tributaries and Drains						
mean	0.318	0.121	2.653	0.805	0.106	3.458
SD	0.474	0.135	2.313	1.148	0.656	2.494
median	0.220	0.090	2.160	0.630	0.025	3.030
minimum	0.050	0.005	0.050	0.050	0.025	0.270
maximum	6.280	2.170	14.600	16.700	13.100	21.060
Burnt River						
mean	0.218	0.107	0.171	0.489	0.025	0.659
SD	0.102	0.027	0.159	0.203	0.016	0.277
median	0.195	0.109	0.080	0.495	0.025	0.630
minimum	0.079	0.074	0.050	0.120	0.005	0.170
maximum	0.384	0.164	0.470	0.890	0.050	1.280
Powder River						
mean	0.146	0.095	0.137	0.490	0.019	0.627
SD	0.037	0.030	0.130	0.108	0.017	0.172
median	0.141	0.090	0.050	0.480	0.005	0.595
minimum	0.091	0.056	0.050	0.300	0.005	0.460
maximum	0.215	0.162	0.400	0.740	0.050	1.060
Eagle Creek						
mean	0.042	0.033	0.069	0.117	0.016	0.186
SD	0.029	0.026	0.051	0.138	0.014	0.163
median	0.035	0.024	0.050	0.050	0.005	0.100
minimum	0.013	0.010	0.050	0.050	0.005	0.100
maximum	0.129	0.102	0.220	0.560	0.040	0.710
Wildhorse River						
mean	0.042	0.028	0.085	0.120	0.021	0.205
SD	0.024	0.013	0.085	0.077	0.014	0.107
median	0.043	0.027	0.050	0.110	0.020	0.190
minimum	0.015	0.012	0.050	0.050	0.005	0.100
maximum	0.086	0.049	0.360	0.270	0.050	0.410
Pine Creek						
mean	0.054	0.030	0.156	0.181	0.023	0.337
SD	0.028	0.018	0.164	0.112	0.016	0.209
median	0.055	0.023	0.050	0.190	0.020	0.270
minimum	0.019	0.014	0.050	0.050	0.005	0.100
maximum	0.126	0.069	0.470	0.400	0.050	0.870

Table 7. Relative contribution as a percentage of nutrient loads to the Hells Canyon Complex from April 1999 through April 2000. Drains data were calculated from March through October 1995.

	Phosphorus		Nitrogen			
	Total	Ortho	Nitrate	Kjeldahl	Ammonia	Total
Snake River at Murphy	36	32	63	57	49	61
Owyhee River	1	1	1	1	1	1
Boise River	17	26	17	8	11	14
Malheur River	9	10	5	5	3	5
Payette River	11	10	3	10	17	5
Weiser River	11	8	2	9	6	5
Drains	6	4	4	4	7	4
Burnt River	3	2	1	1	1	1
Powder River	2	3	1	2	1	1
Eagle Creek	1	1	1	1	1	1
Wildhorse River	1	1	1	1	1	1
Pine Creek	2	2	1	1	2	1




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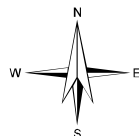


Vicinity Map



Legend

-  River
-  Sampling Location
-  Gauge Location



Hells Canyon Project - FERC No. 1971

Tech. Report E.2.2-1, Figure 1

Location of the Hells Canyon Complex Study Area

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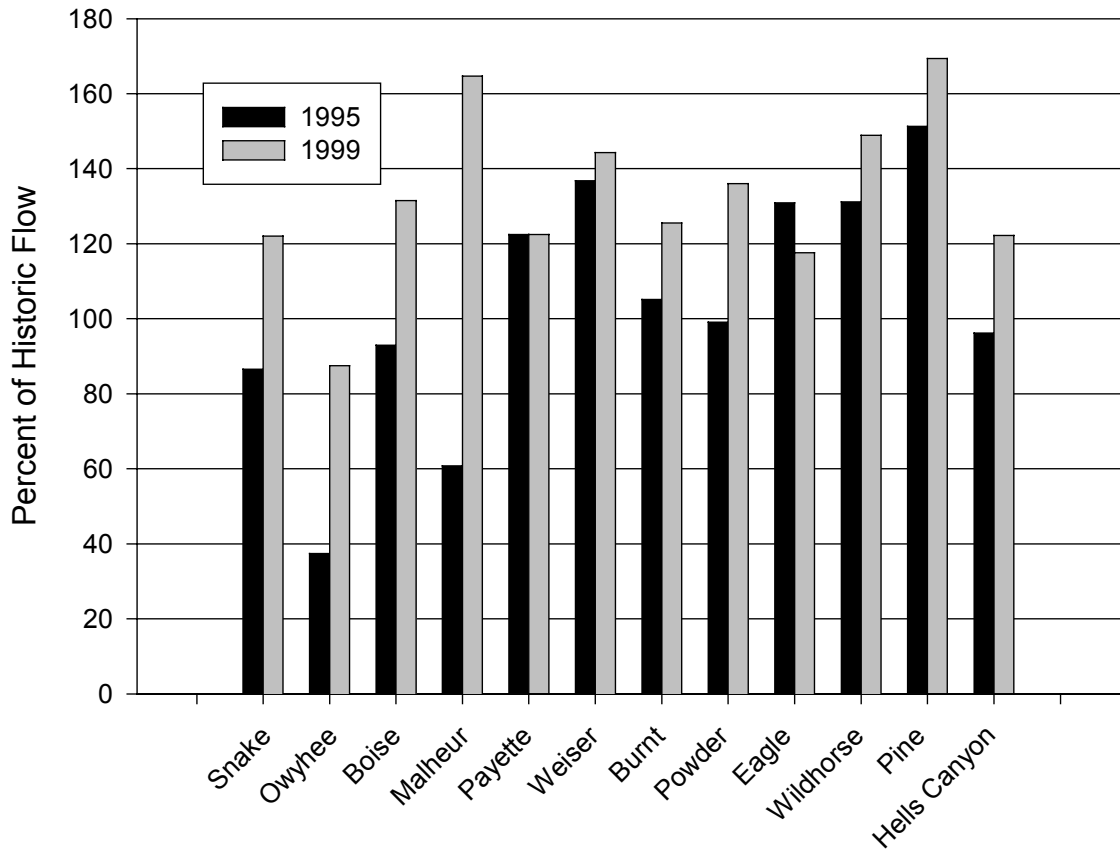


Figure 2. Calendar years 1995 and 1999 flows compared with historic flows for the Snake River and tributaries to the Hells Canyon Complex.

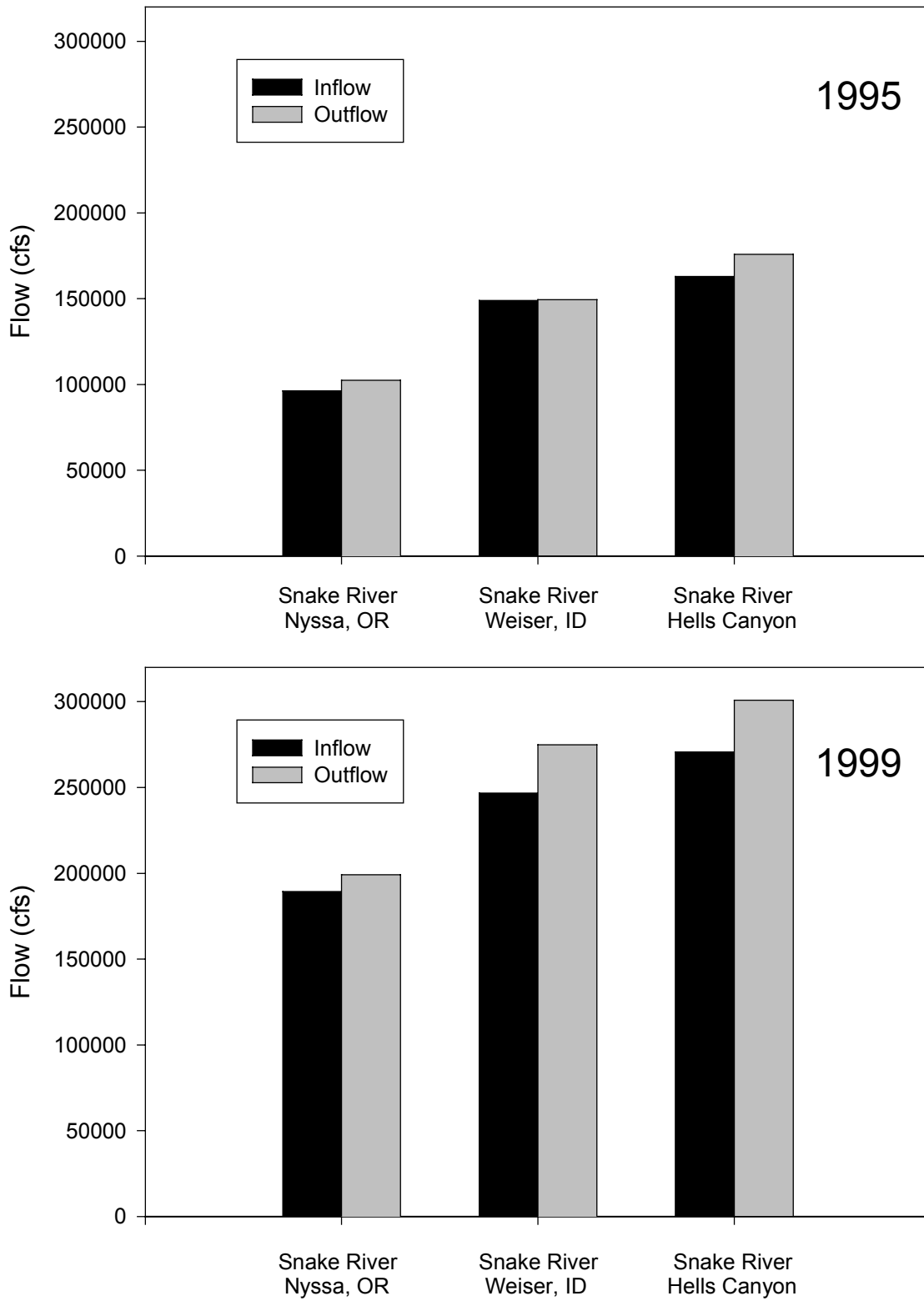


Figure 3. Water balances for calendar years 1995 and 1999 for the Snake River in the Hells Canyon Complex.

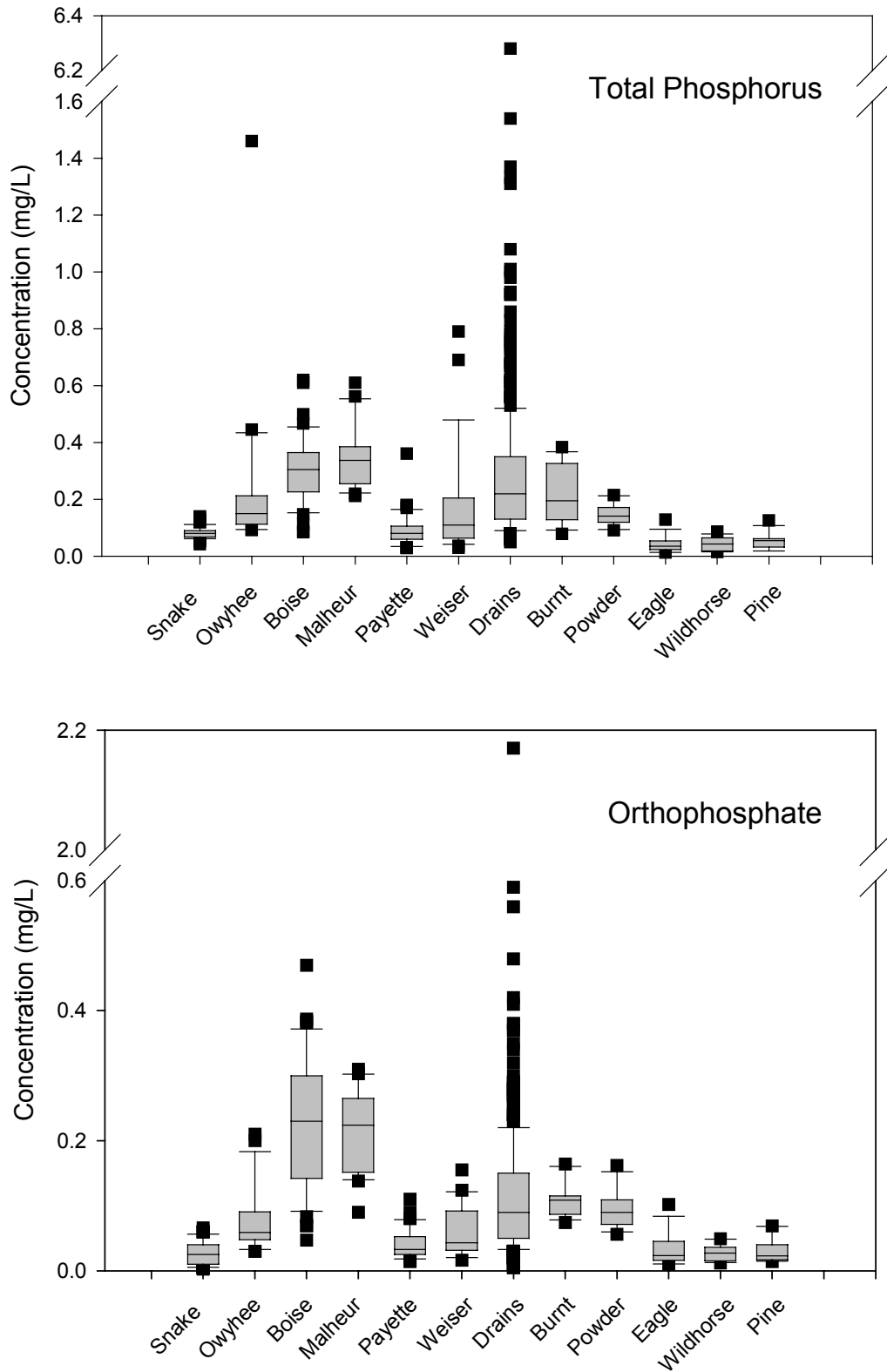


Figure 4. Distribution of total phosphorus and orthophosphate concentrations for tributaries to the Hells Canyon Complex.

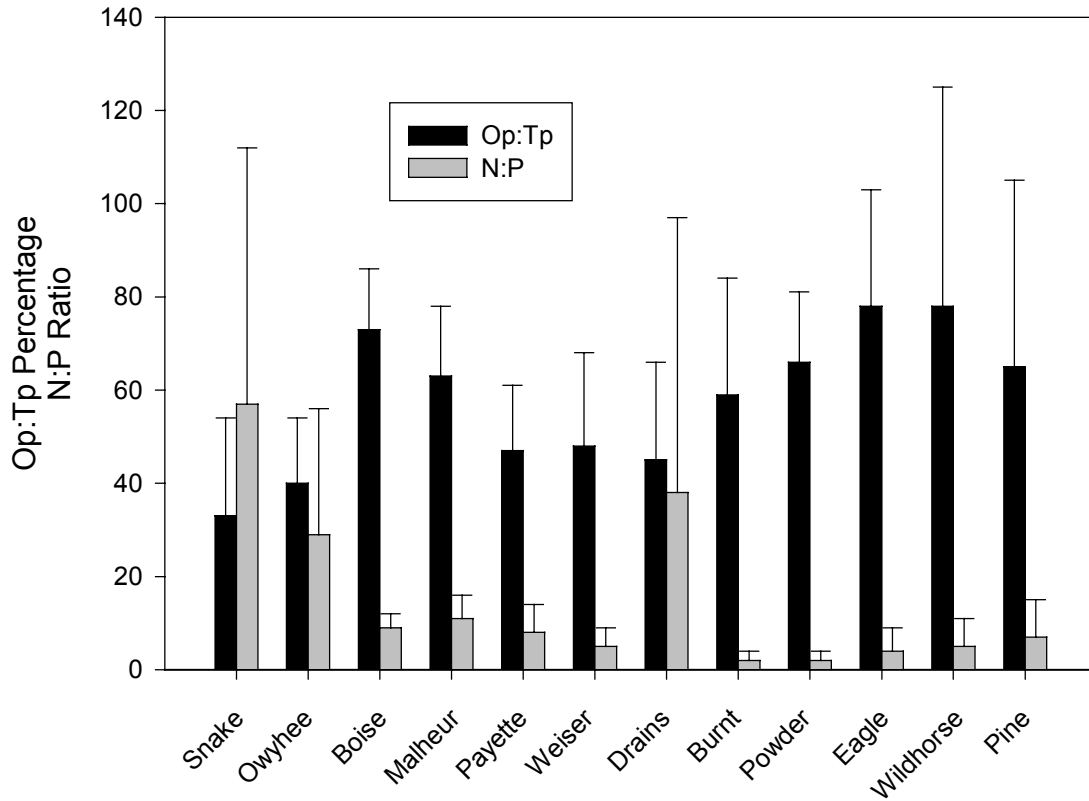


Figure 5. Orthophosphate to total phosphorus ratio percentages (Op:Tp) and biologically available nitrogen to biologically available phosphate ratios (N:P) and one standard deviation for tributaries to the Hells Canyon Complex.

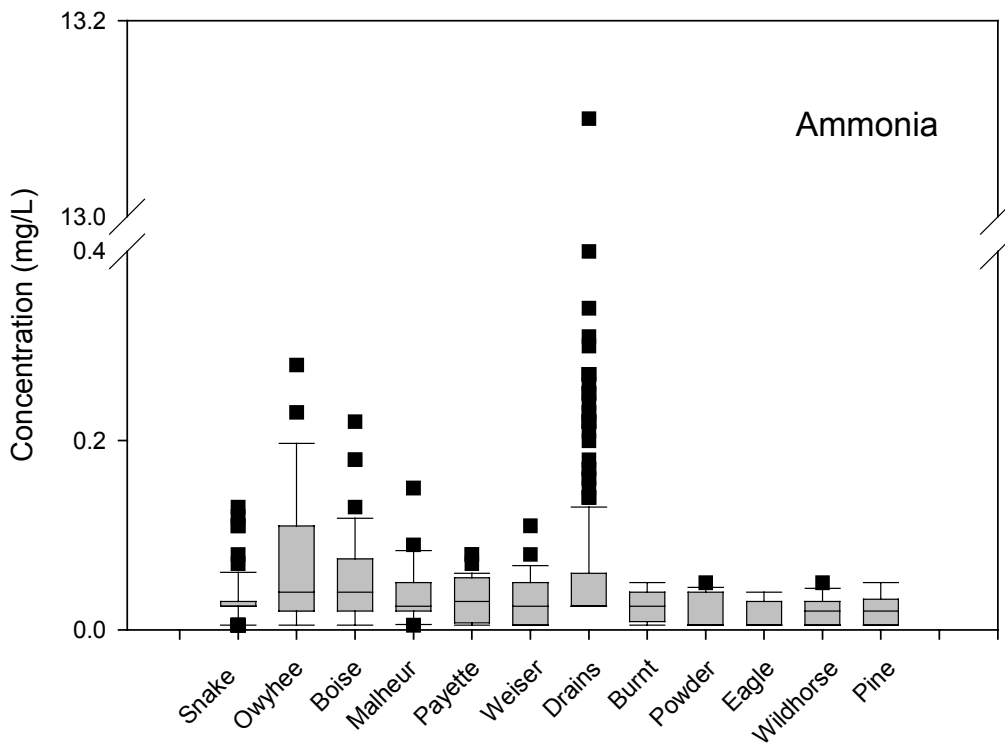
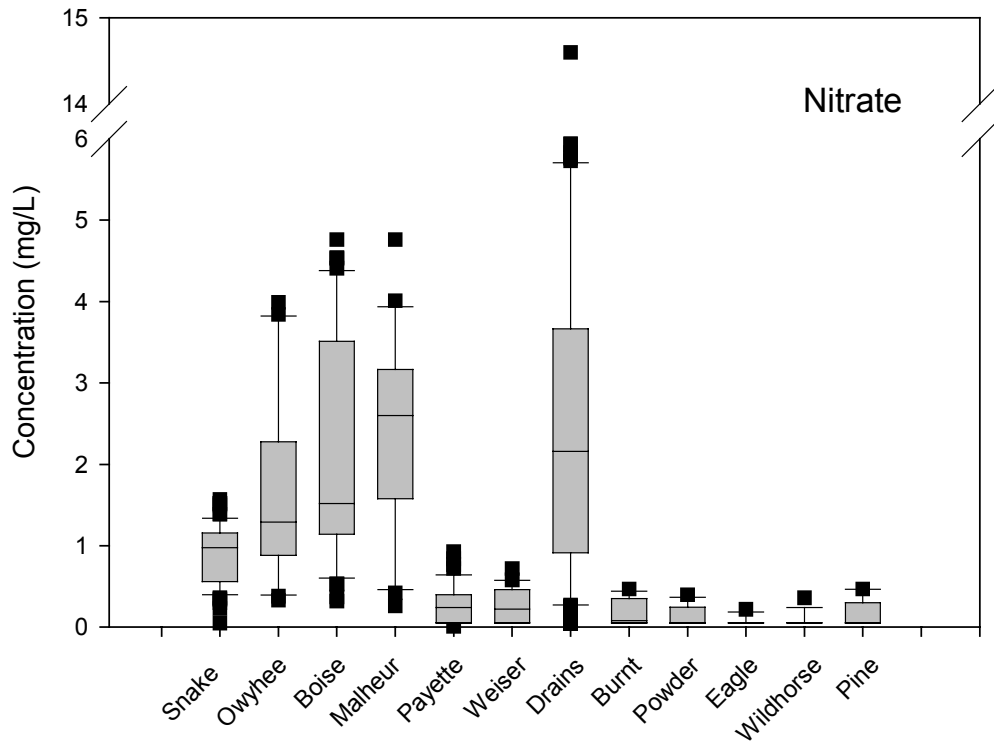


Figure 6. Distribution of nitrate and ammonia concentrations for tributaries to the Hells Canyon Complex.

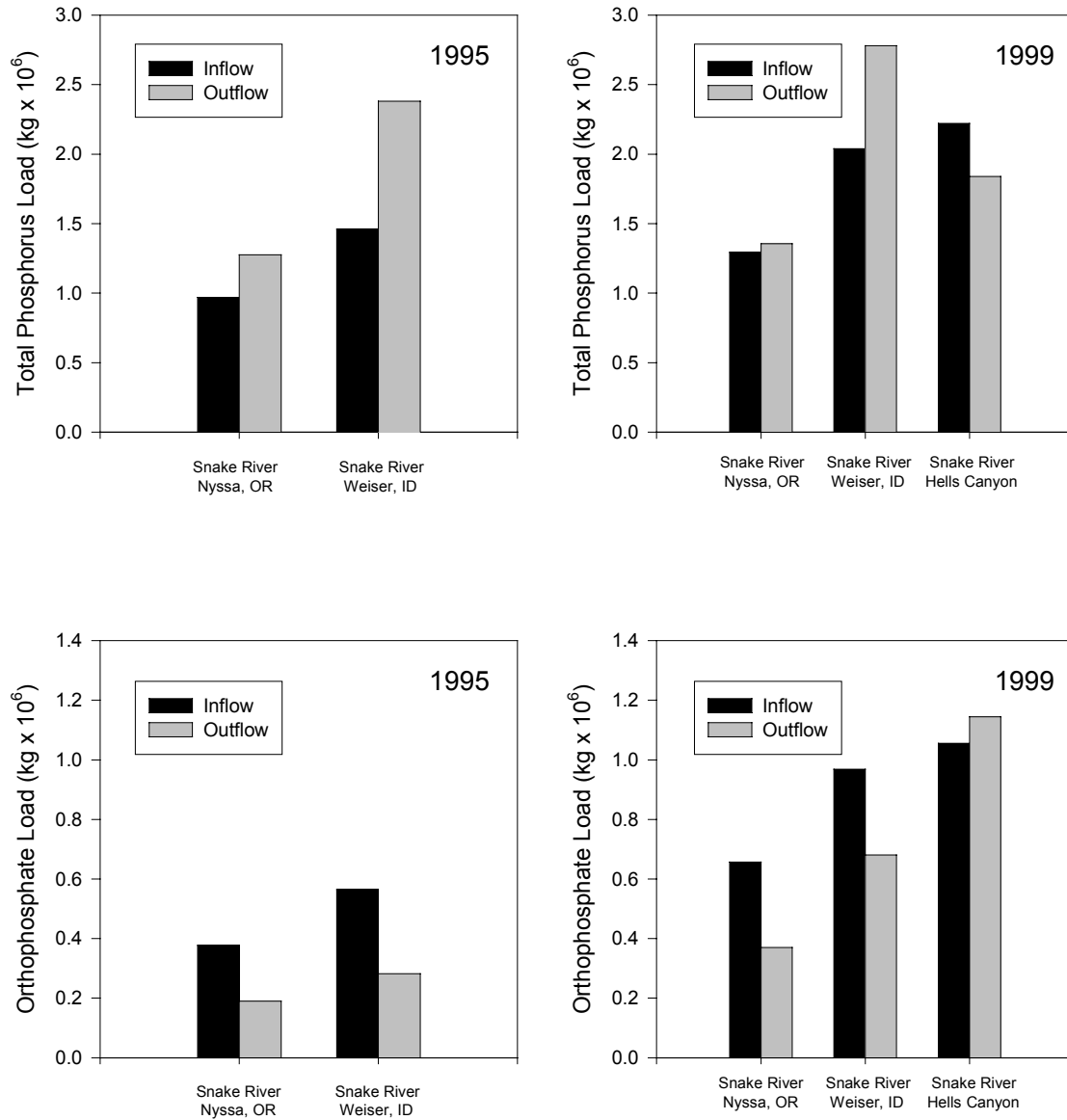


Figure 7. Total phosphorus and orthophosphate load balances for 1995 and 1999 for the Snake River in the Hells Canyon Complex.

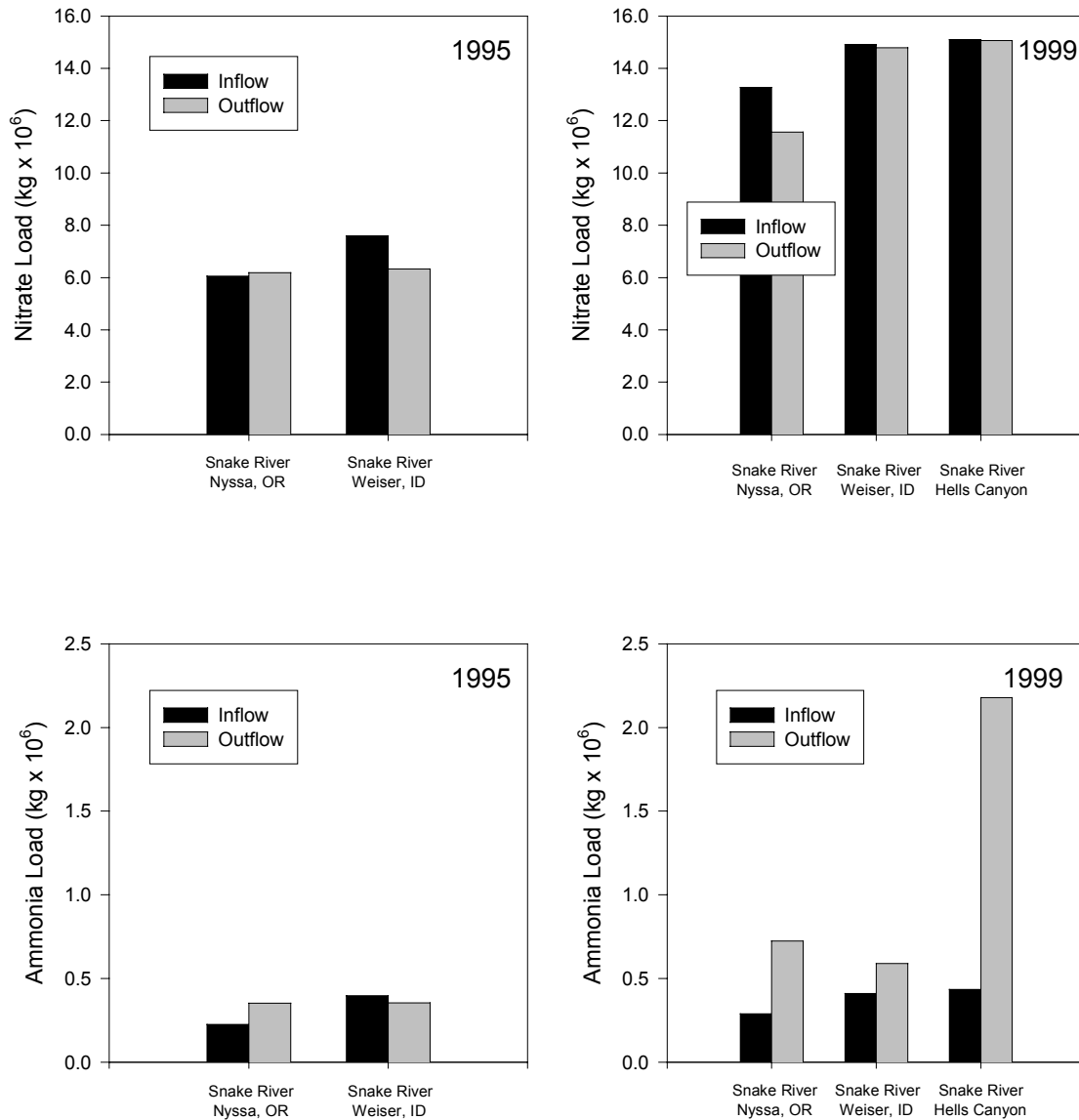


Figure 8. Nitrate and ammonia load balances for 1995 and 1999 for the Snake River in the Hells Canyon Complex.

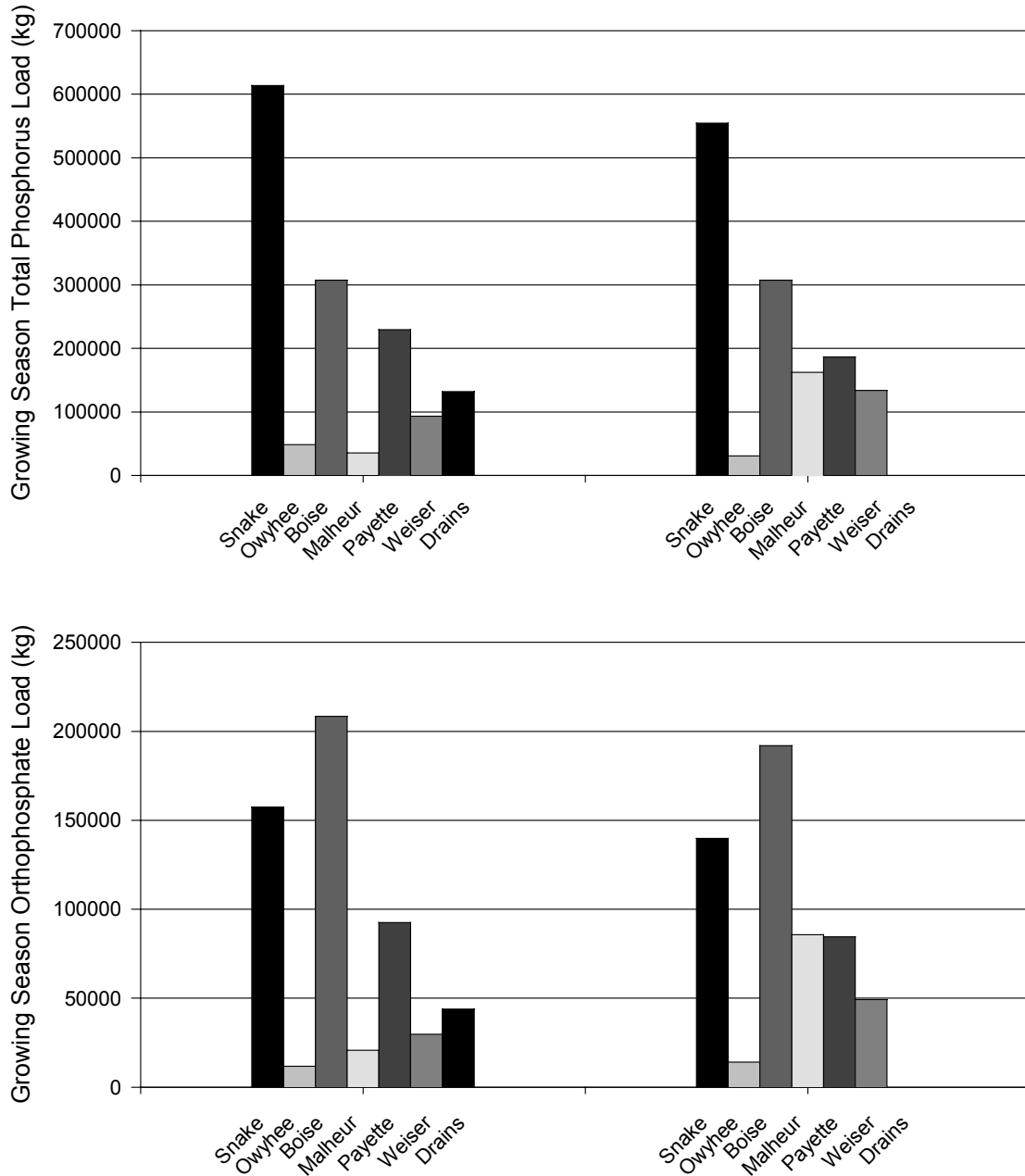


Figure 9. March through October (growing season) total phosphorus and orthophosphate loads for tributaries upstream of Brownlee Reservoir in 1995 and 1999.

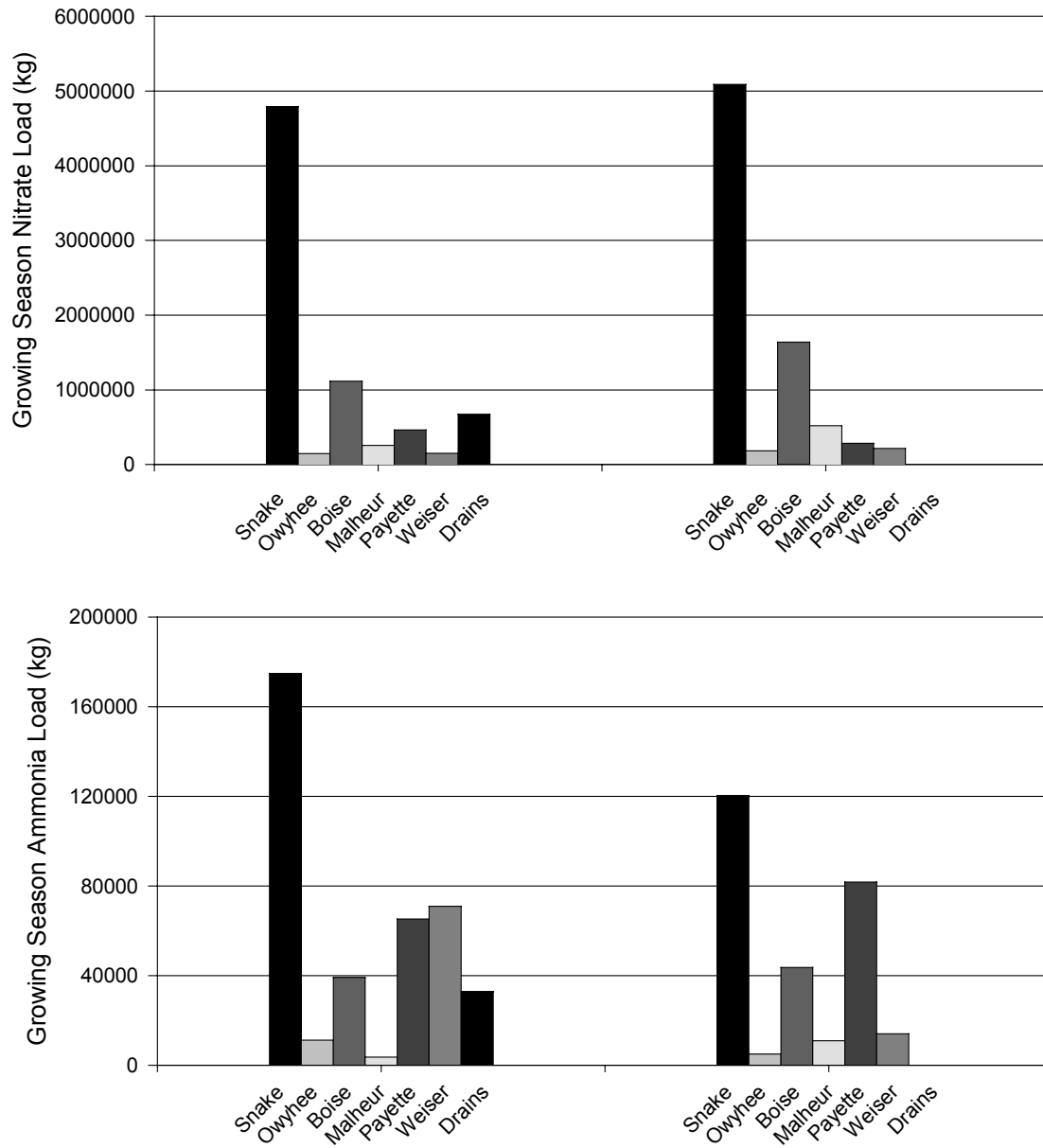


Figure 10. March through October (growing season) nitrate and ammonia loads for tributaries upstream of Brownlee Reservoir in 1995 and 1999.

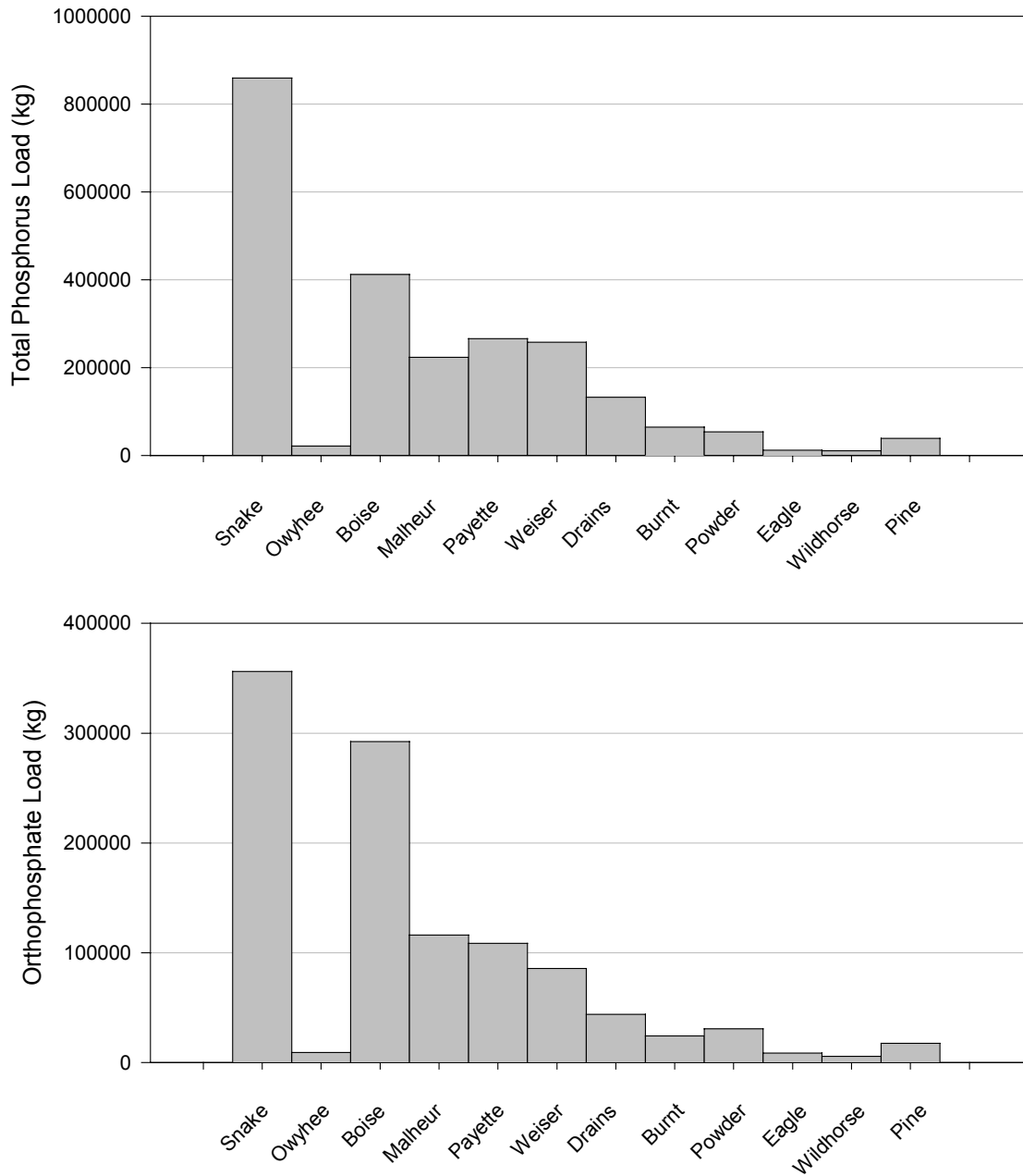


Figure 11. April 1999 through April 2000 total phosphorus and orthophosphate loads for tributaries to the Hells Canyon Complex. Drains loads represent data from March through October 1995.

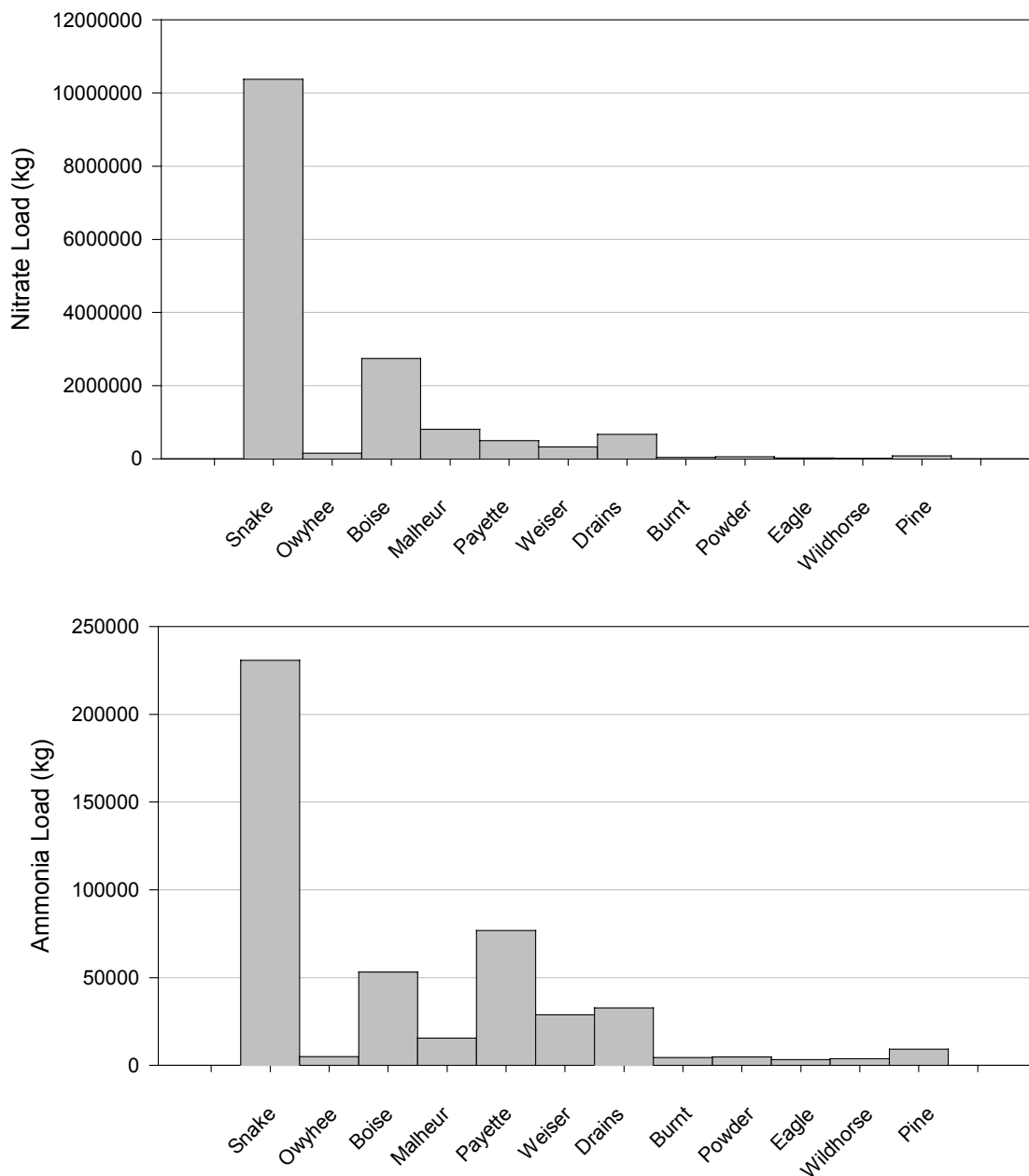


Figure 12. April 1999 through April 2000 nitrate and ammonia loads for tributaries to the Hells Canyon Complex. Drains loads represent data from March through October 1995.

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Appendix 1. Sampling locations in river miles (RM) for tributaries and drains to the Hells Canyon Complex.

RM	Sampling Locations
449.3	Snake River @ Celebration Park
447.5	Rabbit Creek
444.5	Drain
444.1	Drain
443.8	Drain
443.4	Drain
442.6	Grouch Drain
441.1	Reynolds Creek
439.6	Pipe Drain
438.9	Drain
438.1	Grouch Ditch
436.9	Drain
432.9	Cozy Basin Wasteway
432.2	Unnamed
431.8	Squaw Creek
431.7	Unnamed
430.7	Drain
429.6	South Valley Mound Wasteway
427.5	North Valley Mound Wasteway
426.8	Mitchel Drain
426.7	Penninger Drain
425.1	Drain
424.8	Drain
424.3	Lizard Lateral
423.7	Lizard Wasteway
423.2	Equalizer Drain
421.8	Isham Drain
421.4	Frohman Wasteway
421.3	Watson Lateral
420.1	Drain
419	Jump Creek
417.7	Hellyer Drain
417.1	Drain

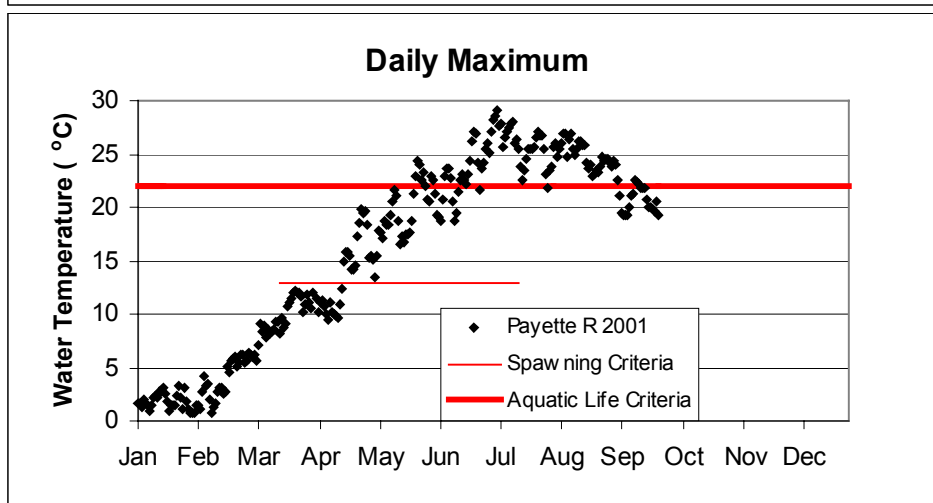
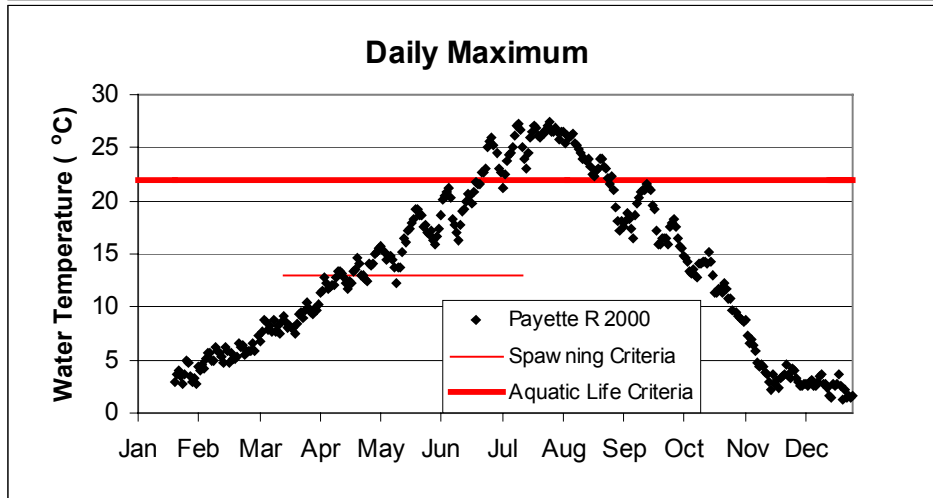
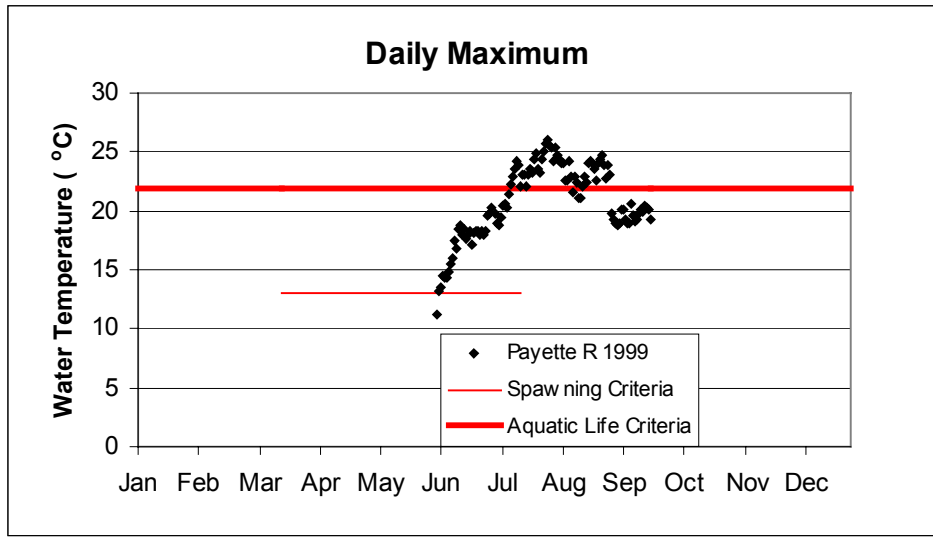
RM	Sampling Locations
403.6	Singer Drain
401.3	Central Alkali Drain
401	Drain
400.3	Drain
399	Kingman Drain
398.2	South Boise Drain
397.3	Drain
396.7	Owyhee River
396.4	Boise River
395.9	Sand Run Drain
394.7	Locket Gulch
389	Drain near Apple Valley
388.2	Drain
387.9	Grandview Avenue Drain
387.1	Delta Drain
385.5	Locker Avenue Drain
385	Snake River @ Nyssa
384.6	Drain
384.1	Drain
383.6	Drain
383.4	Homestead Gulch
382	Ashlock Gulch
381	Hurd Gulch
377.9	Drain
377.8	Drain
375.3	Little Whitney Gulch
368.5	Malheur River
365.6	Payette River
362.7	Wood Drain
359.9	Drain
357	Buttermilk Slough
356.3	Drain
351.6	Weiser River

Appendix 1. (Cont.)

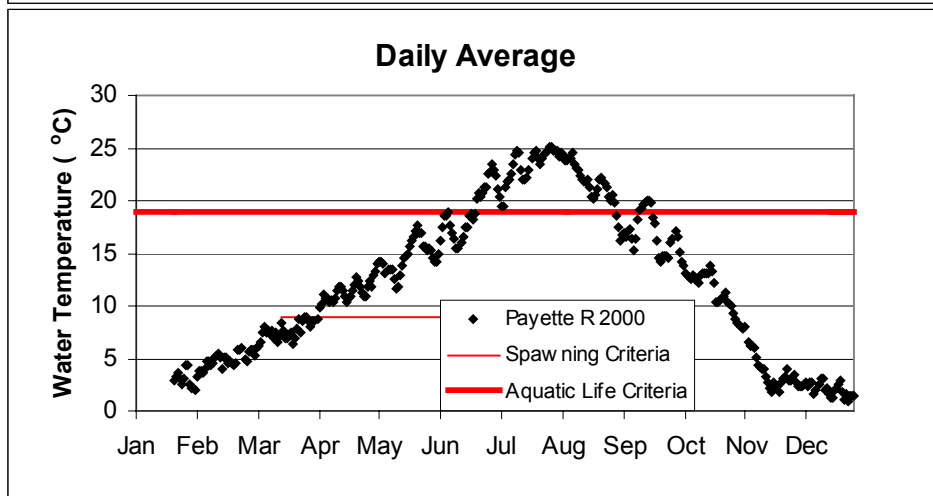
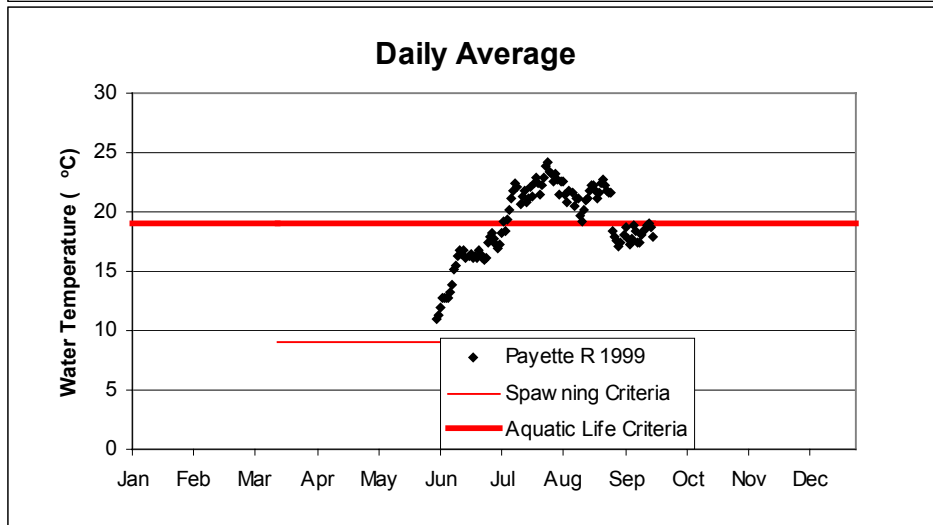
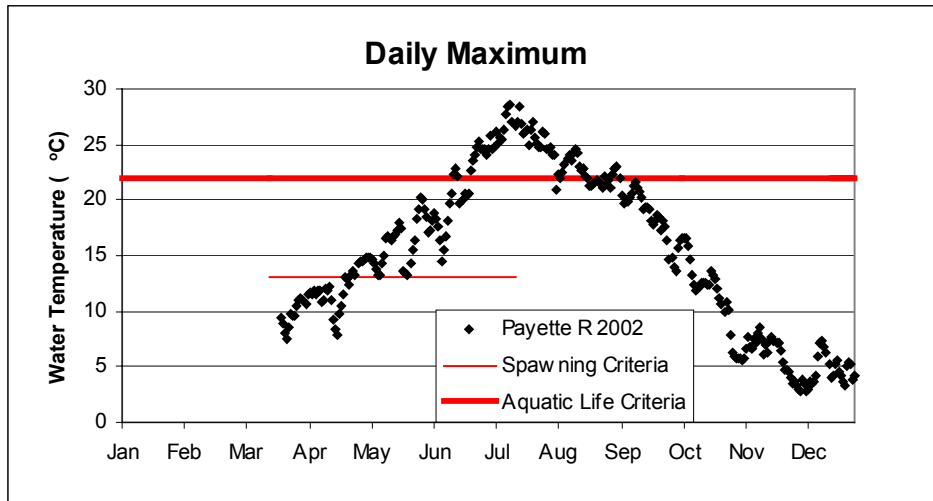
RM	Sampling Locations
416.8	Fargo Wasteway
415.6	Griffith Drain
415.5	Drain
415	Gem District G Canal
414.4	Drain
413.8	Federal Drain
413.5	Dutton Drain
413.1	Laht Drain
412	South Arena Drain
411.7	Riverside Canal
410.5	Drain
410.3	Patch Wasteway
409.3	Allen Drain
408.4	Welch Drain

RM	Sampling Locations
351.2	Drain
349.6	Jenkins Creek
348.7	Smith-Hemenway Lateral
344.9	Drain
343	Scott Creek
342.6	Warm Springs Creek
342.4	Hog Creek
340	Snake River @ Porters Island
327.5	Burnt River
296.0	Powder River
7.5	Eagle Creek
283.3	Wildhorse River
269.6	Pine Creek
247.0	Snake River @ Hells Canyon

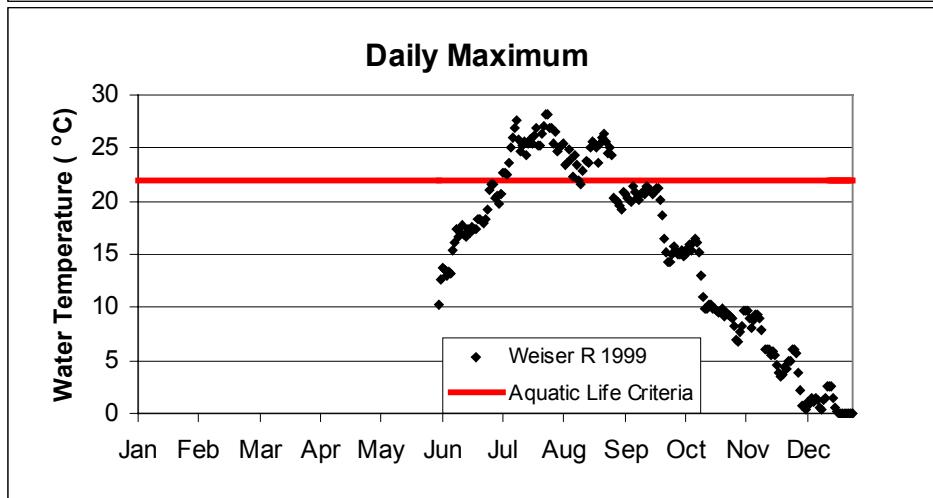
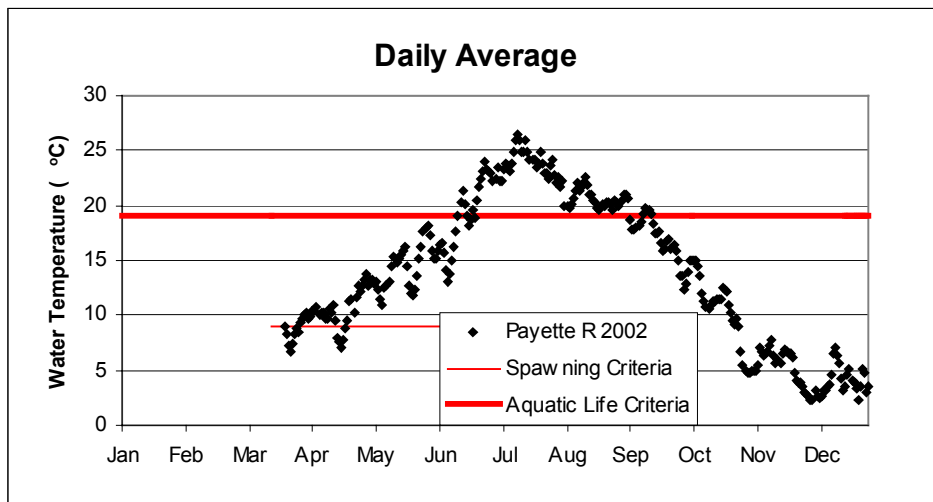
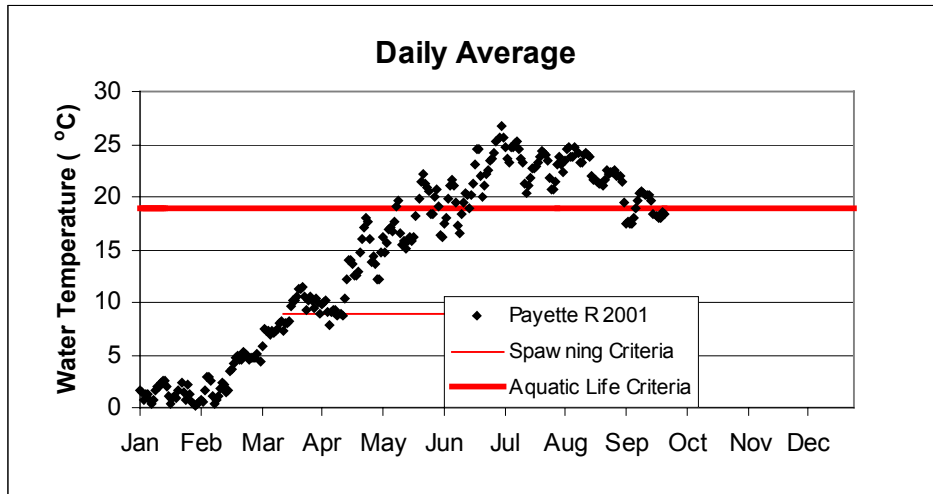
Appendix 2. Temperature profiles for select tributaries to the Hells Canyon Complex.



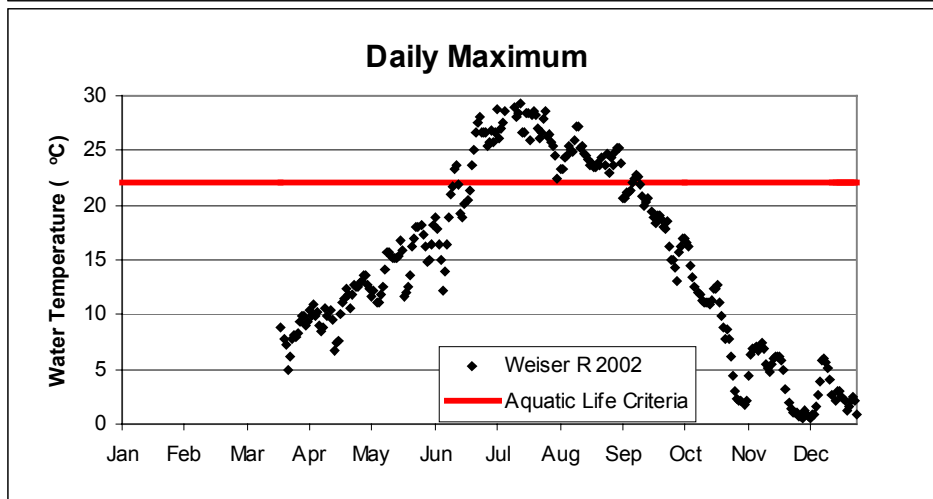
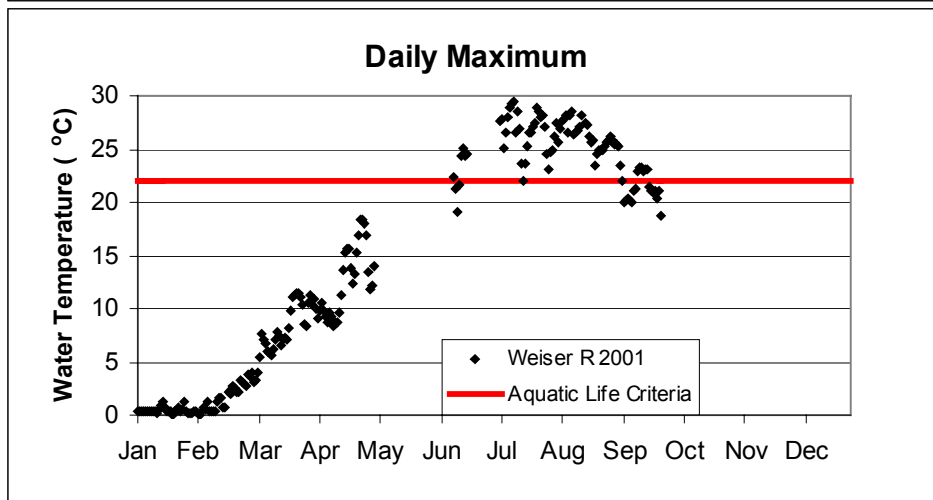
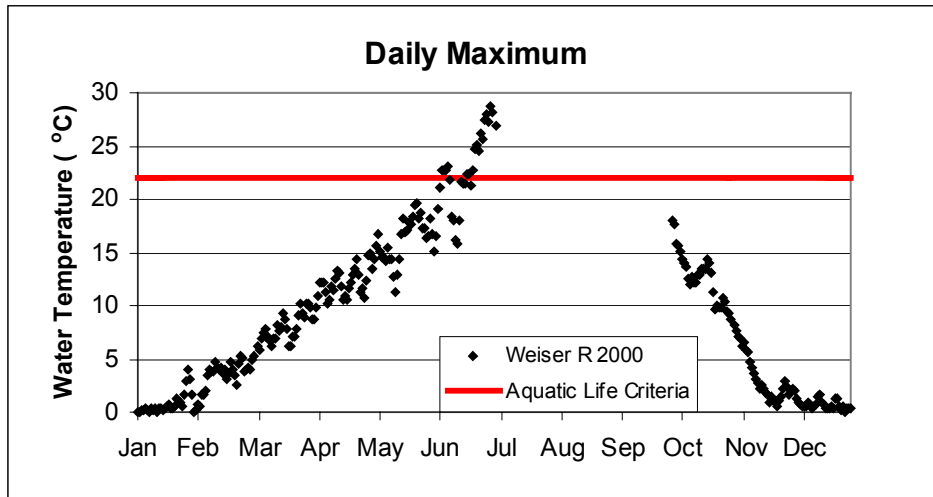
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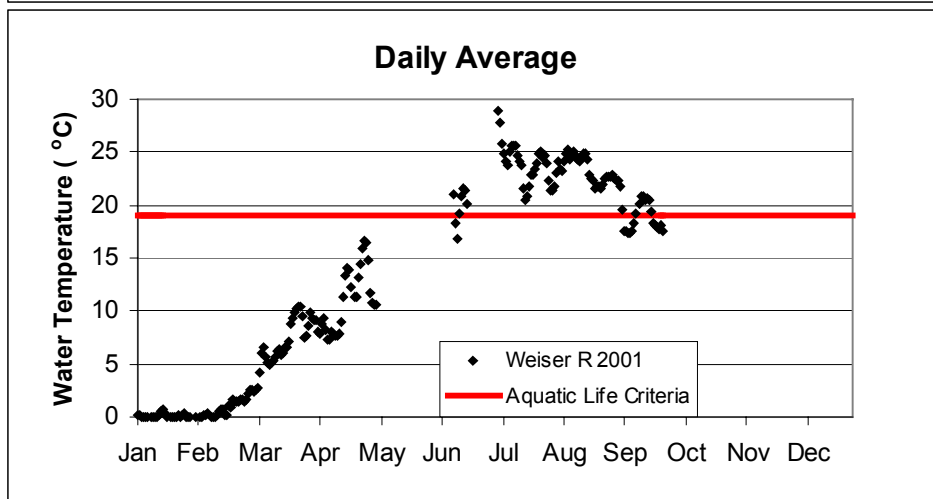
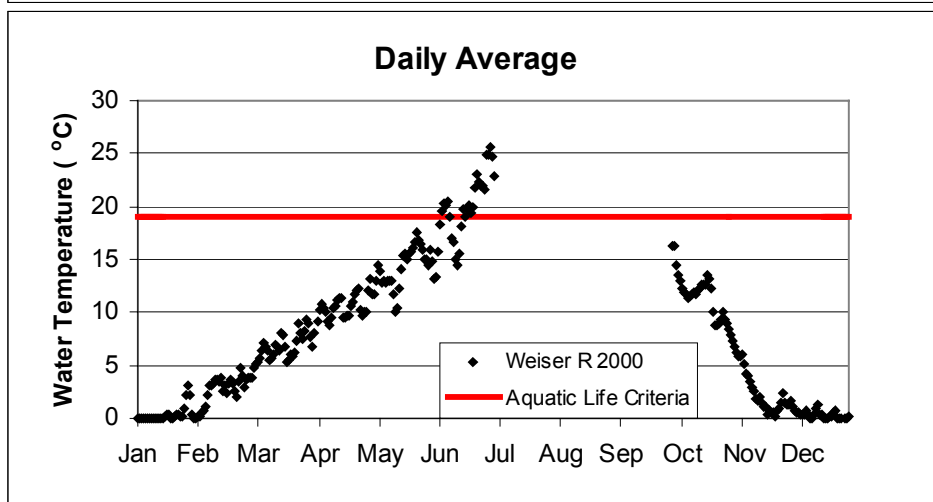
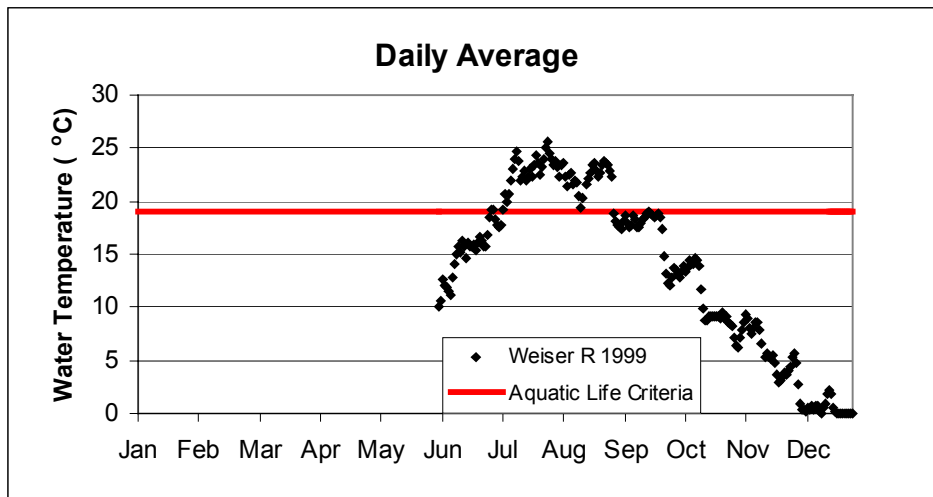
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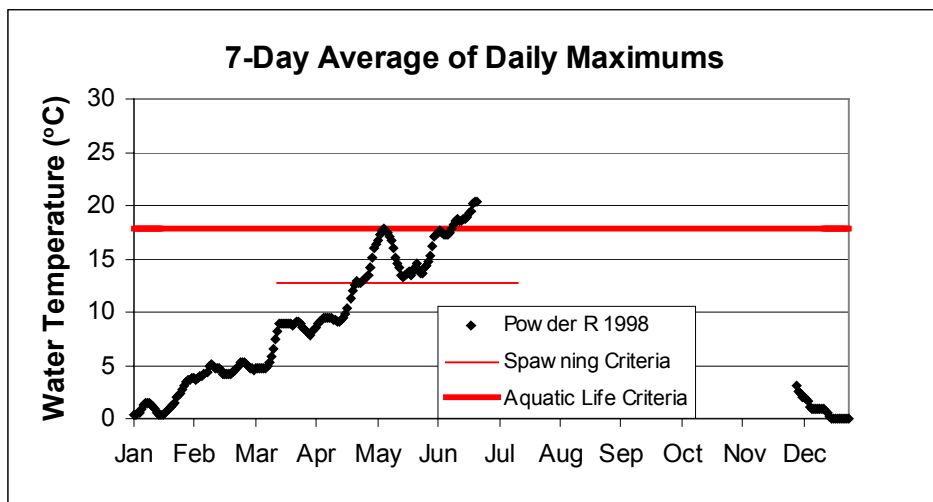
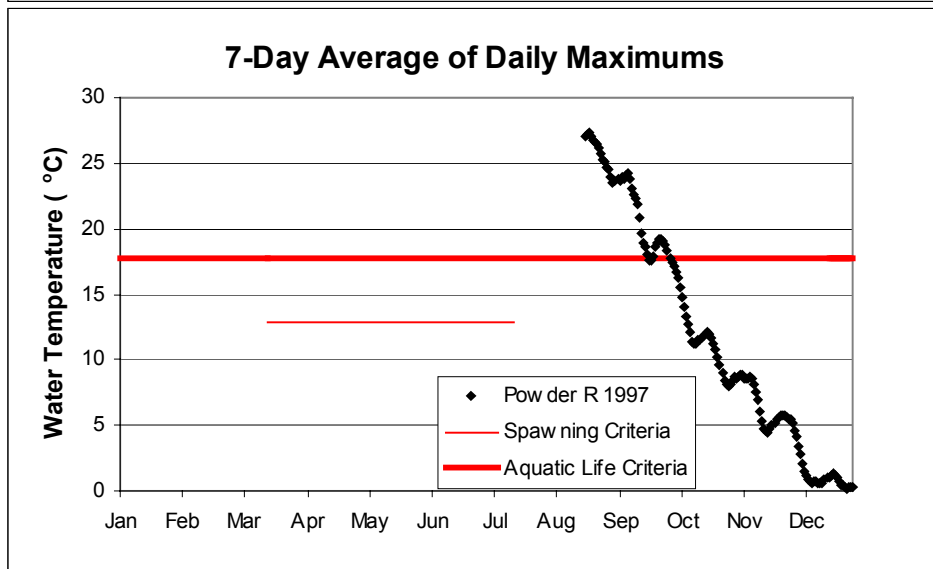
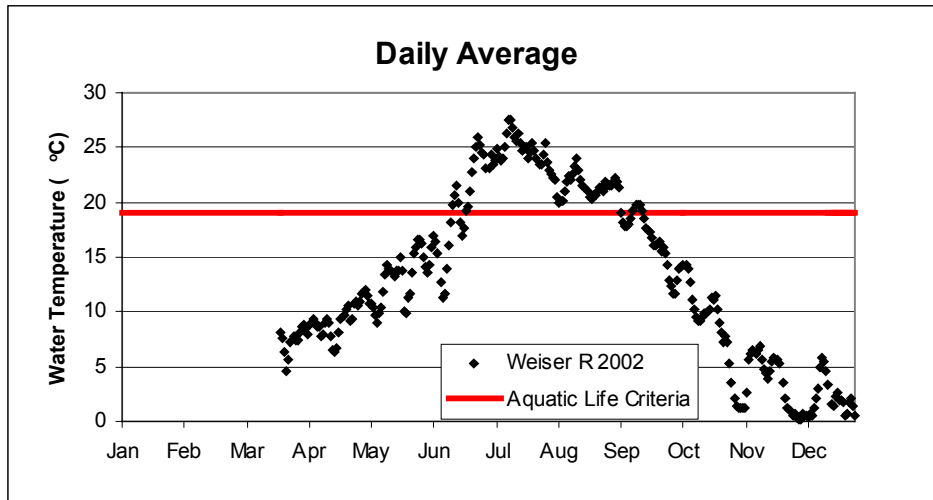
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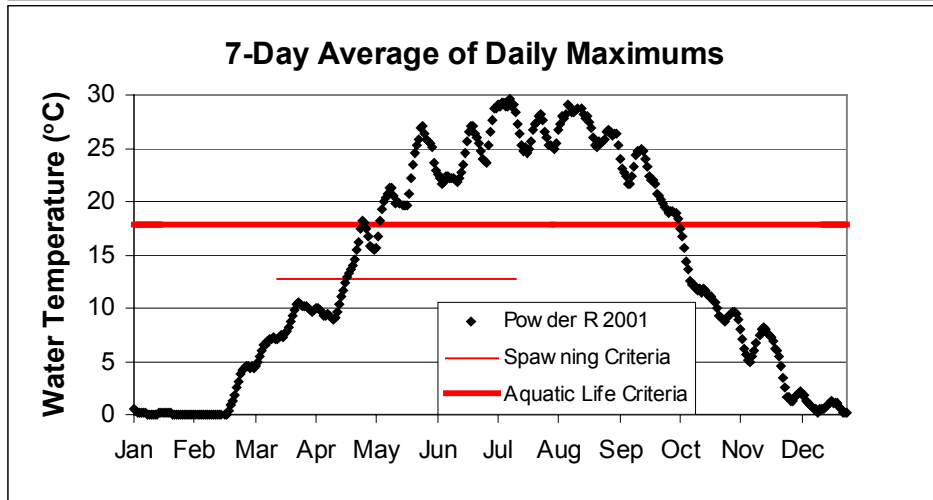
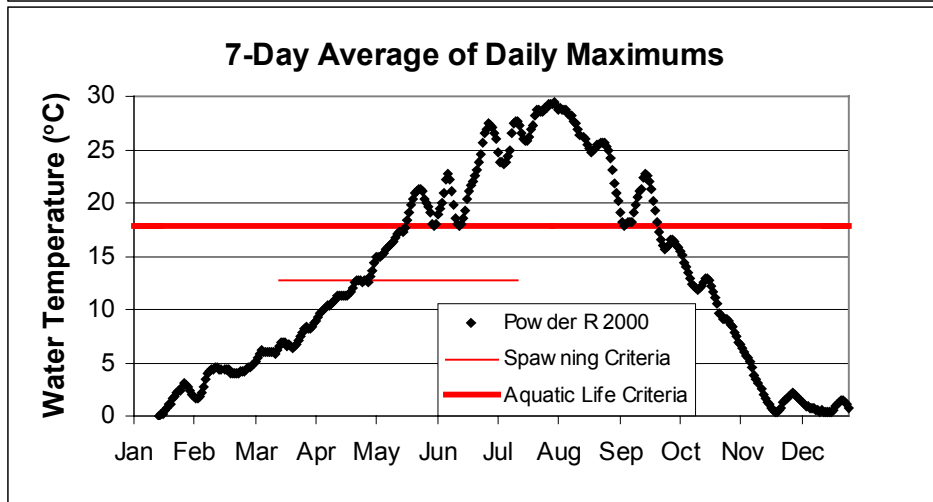
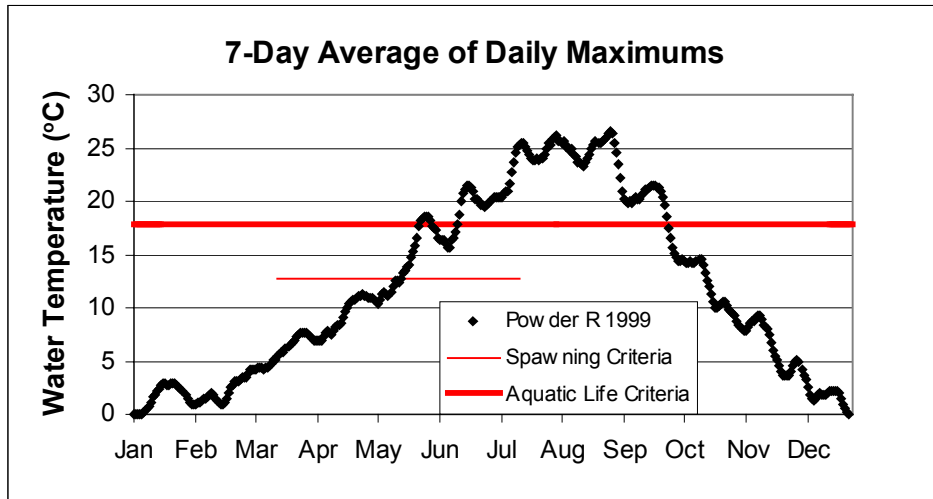
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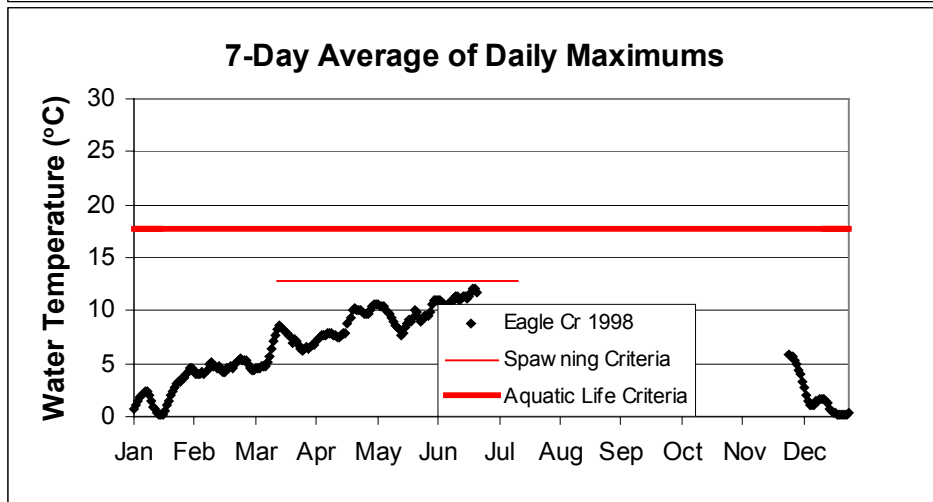
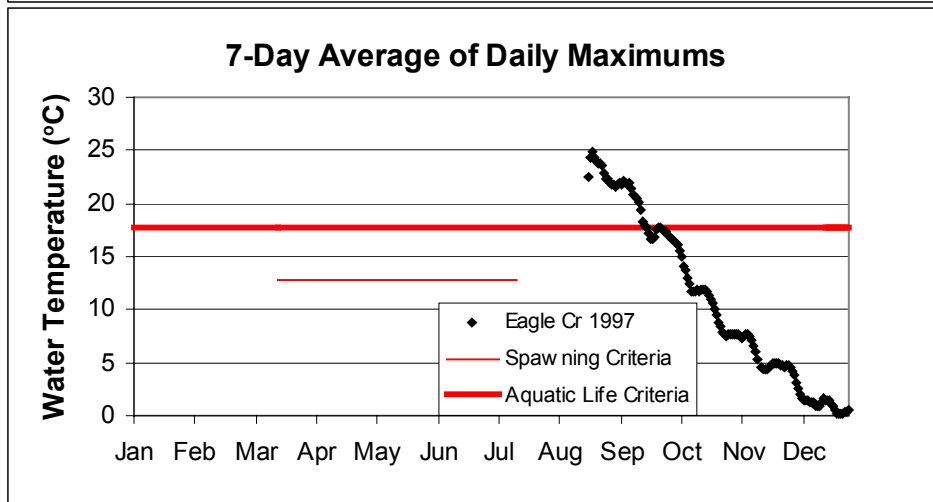
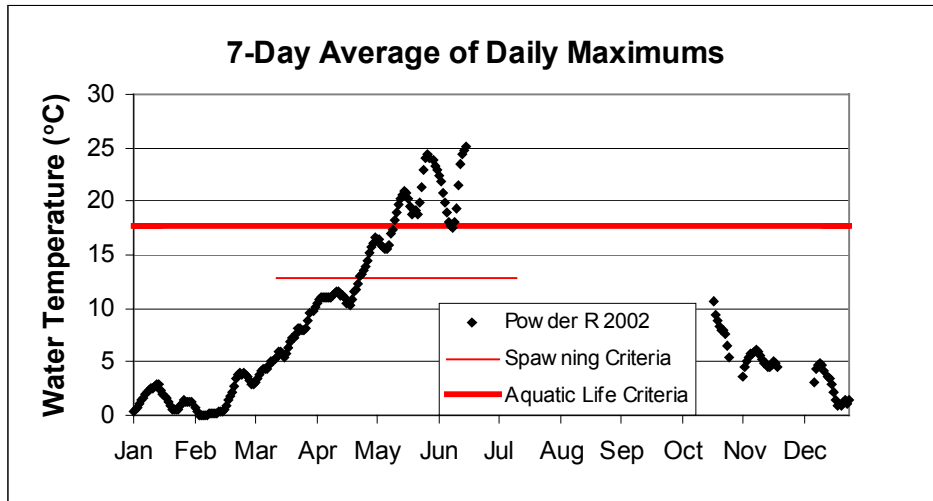
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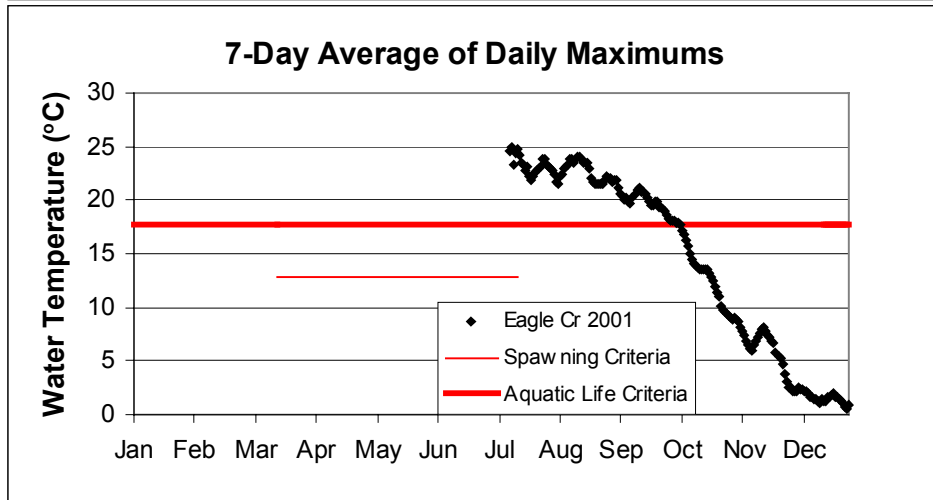
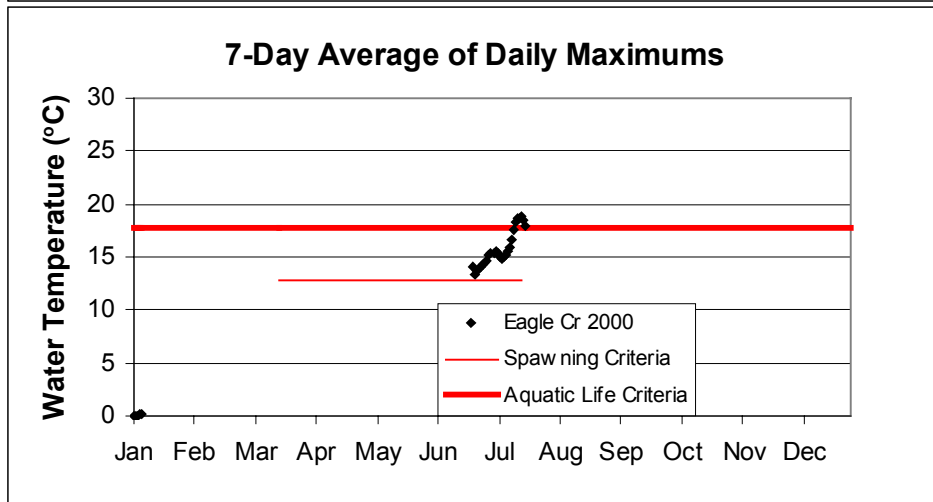
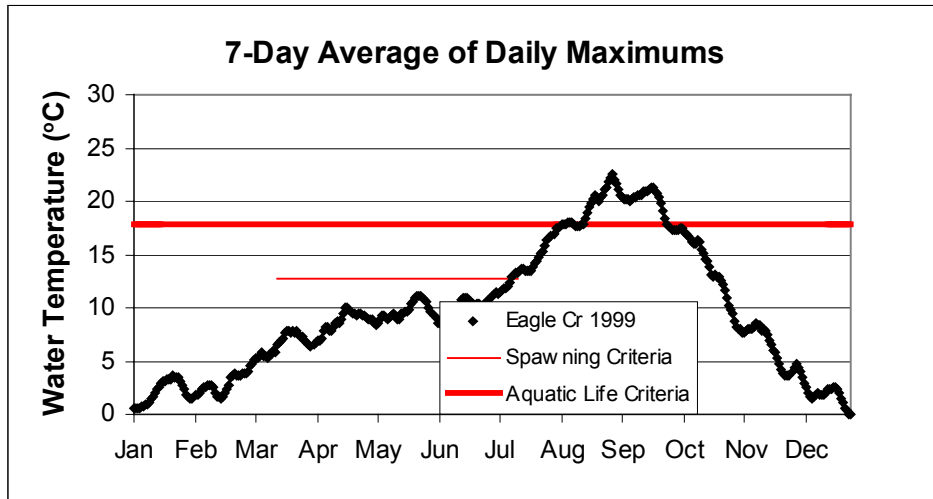
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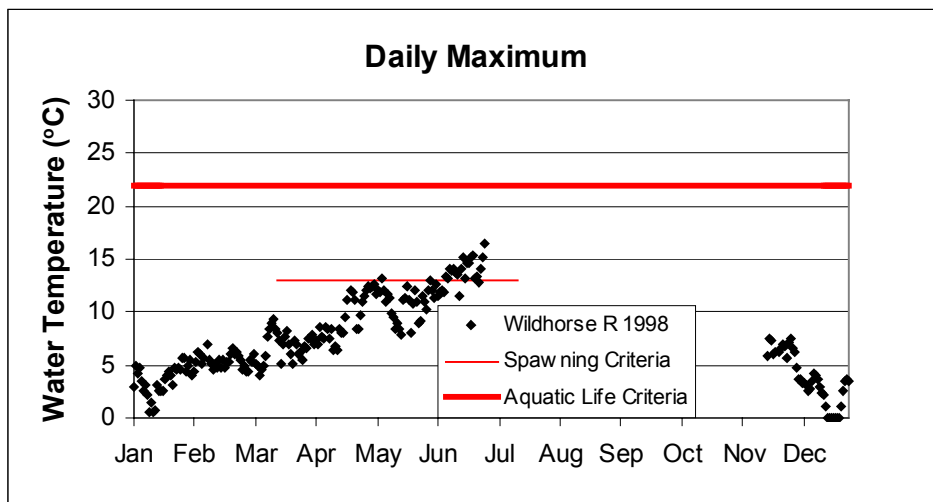
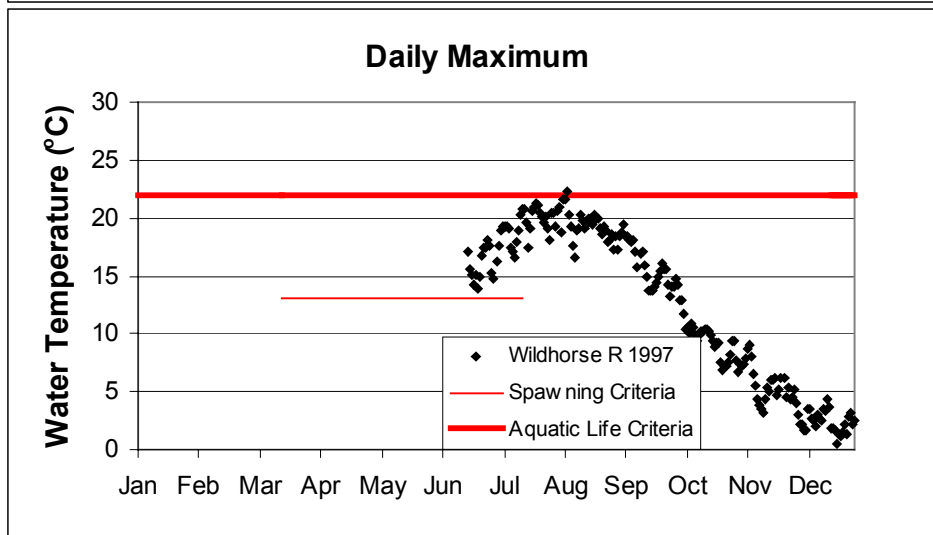
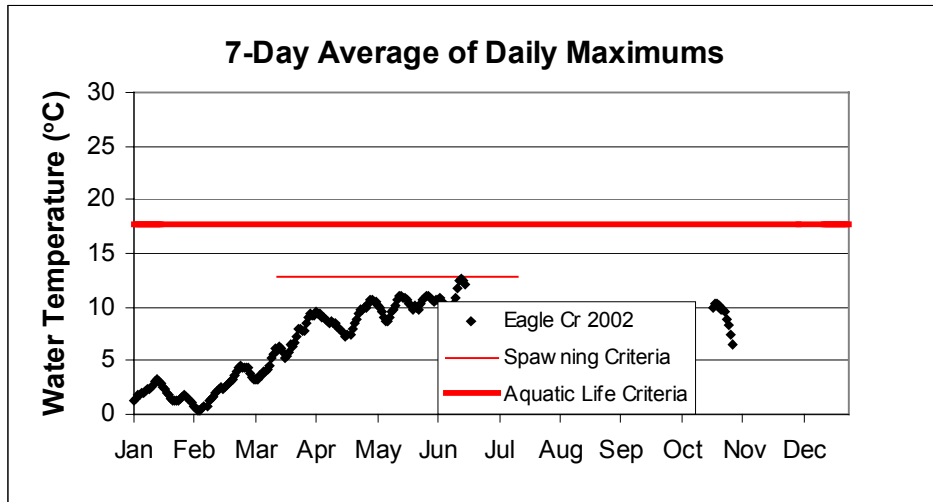
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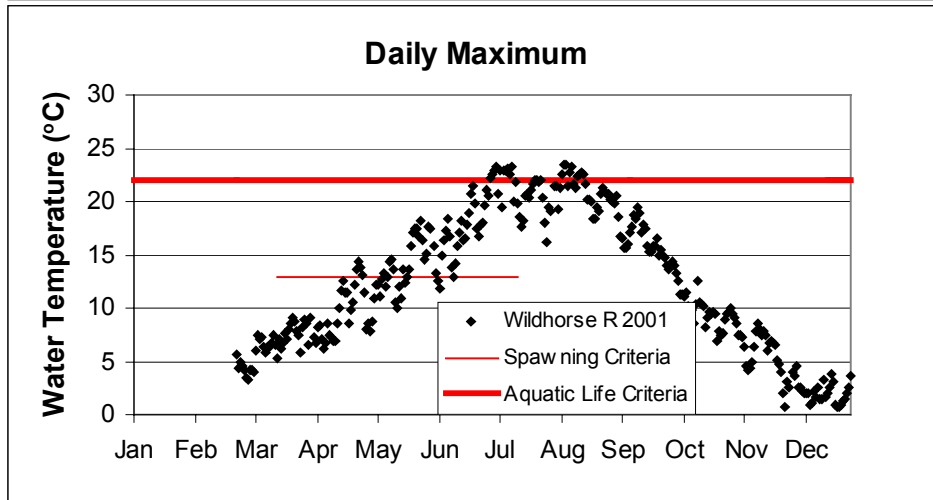
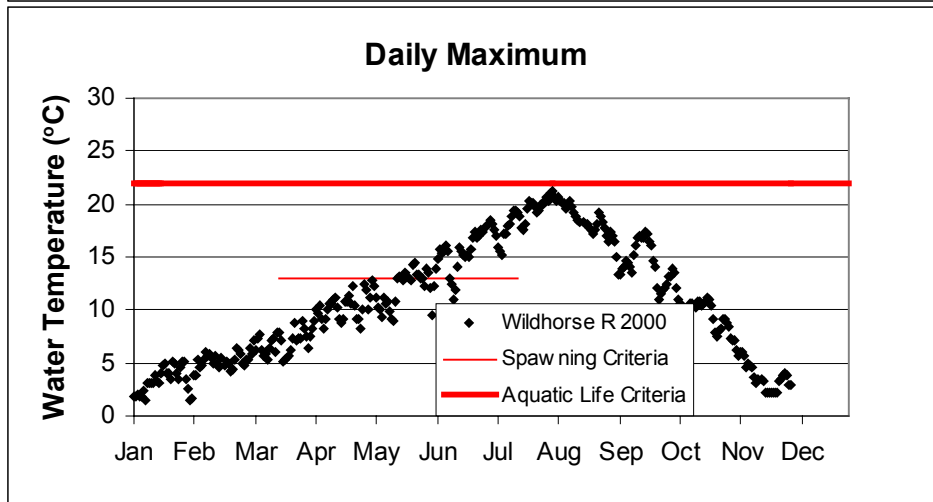
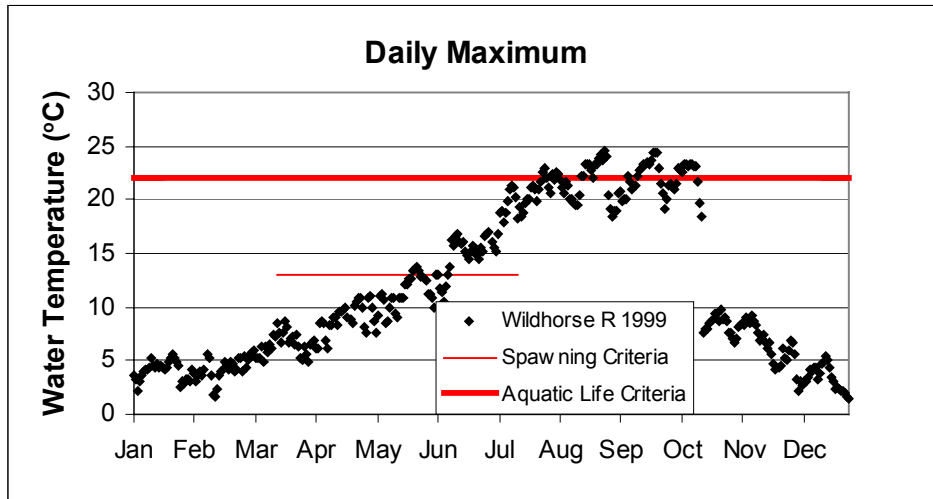
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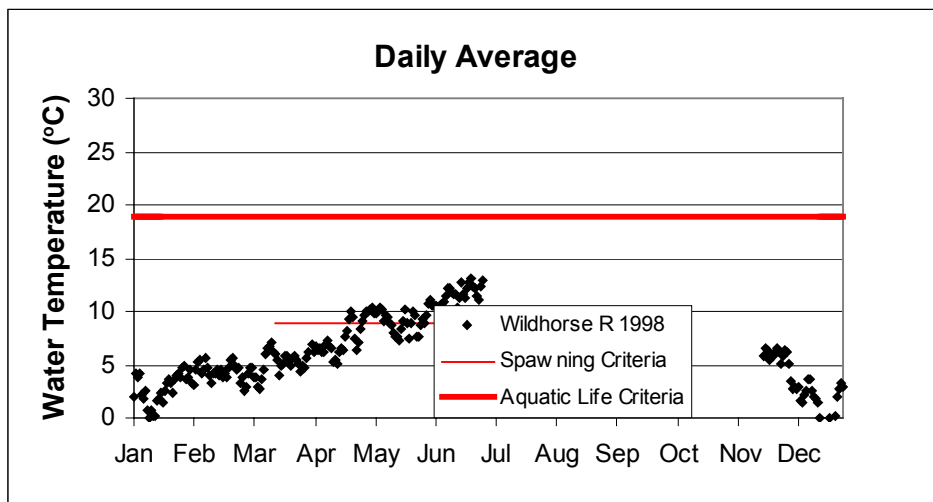
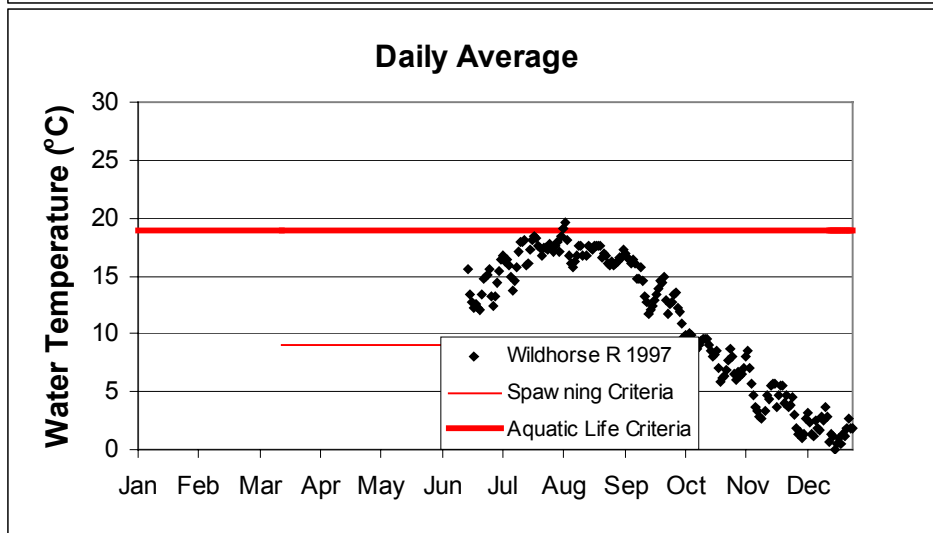
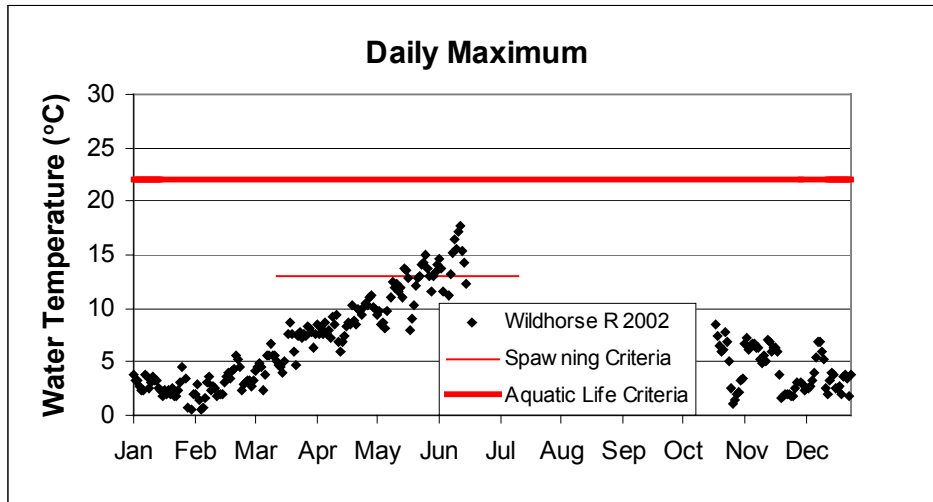
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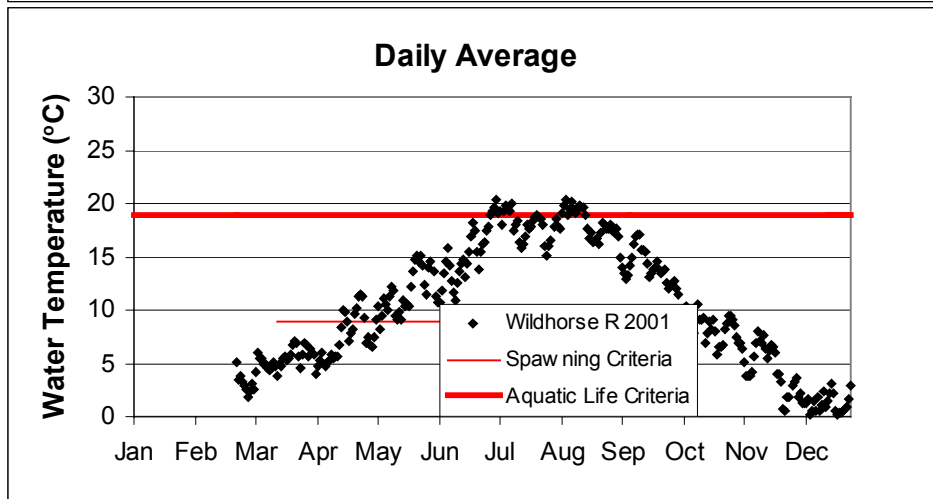
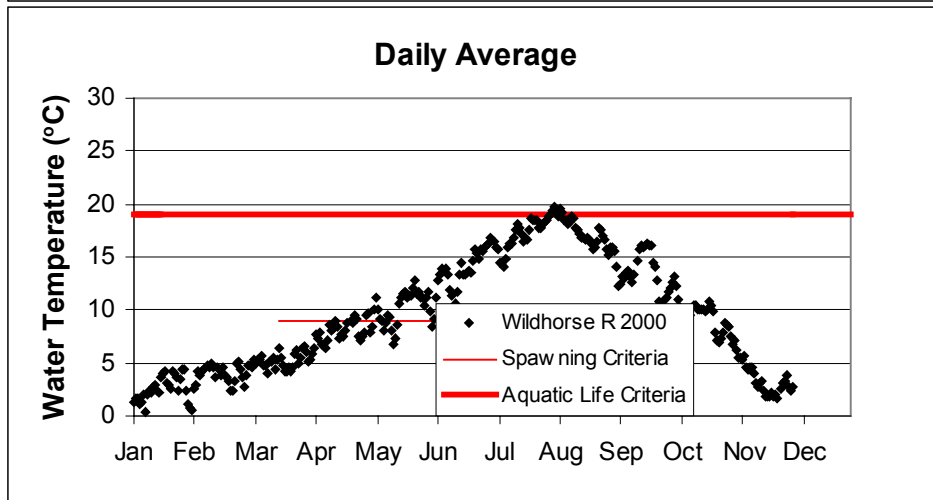
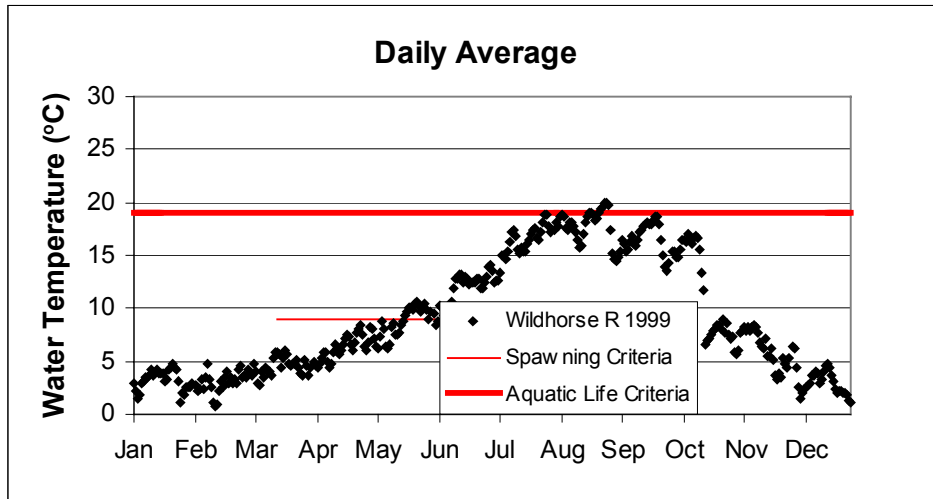
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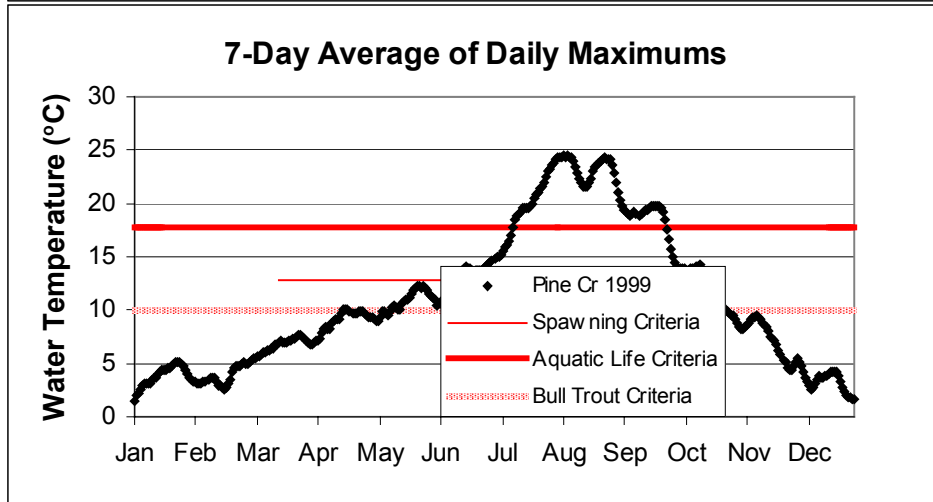
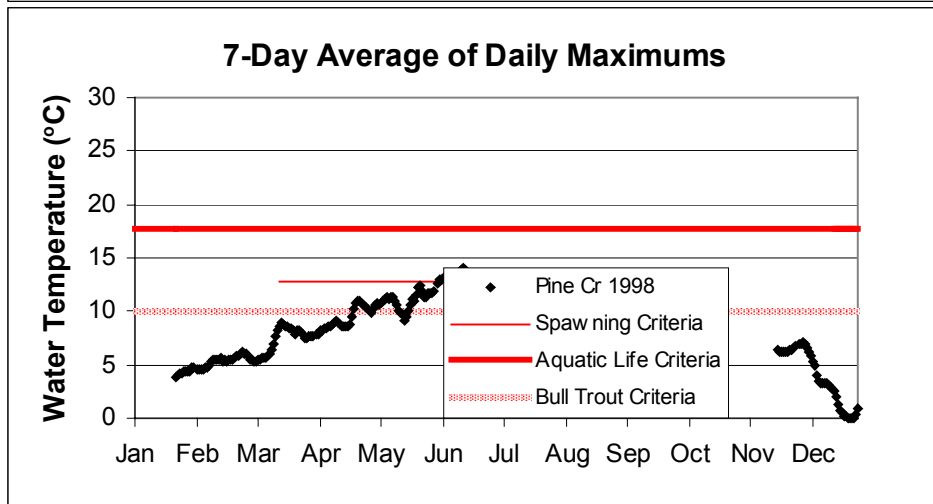
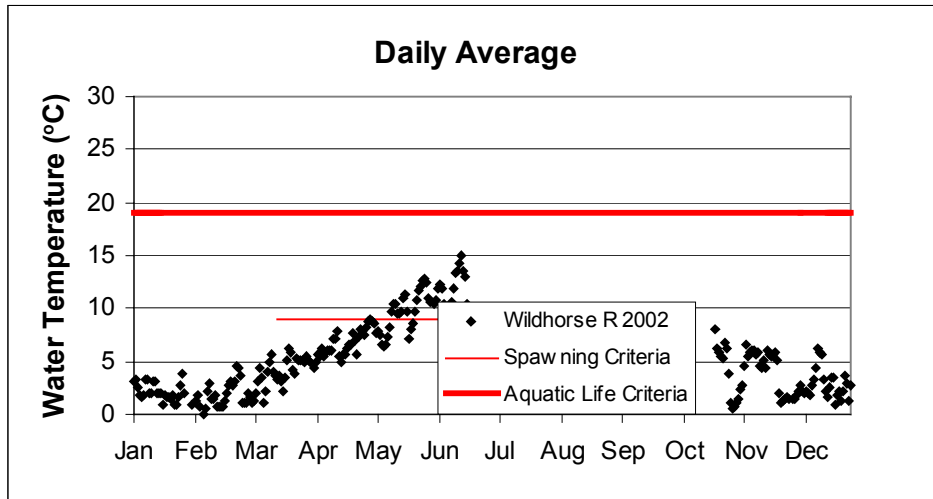
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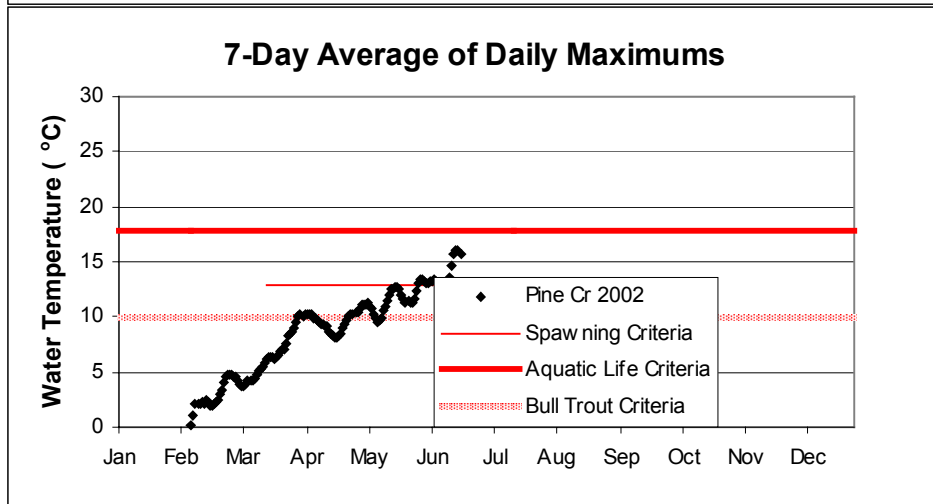
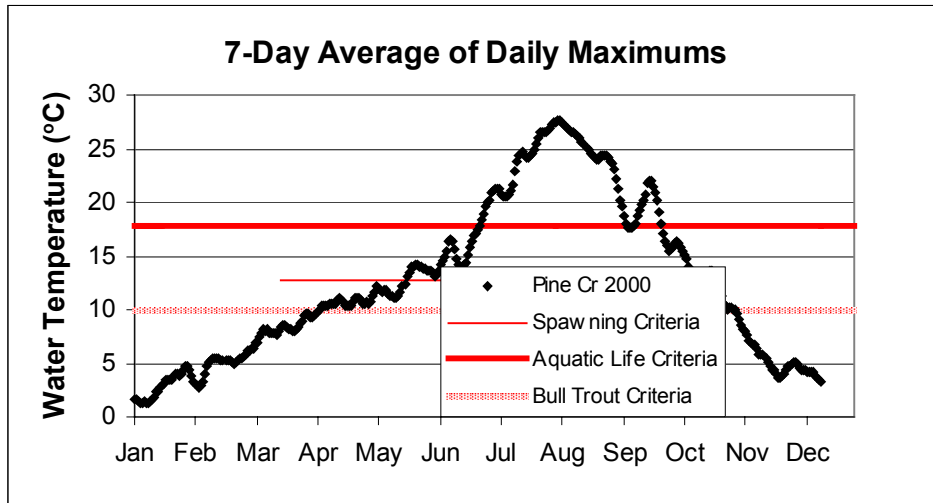
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Appendix 3. Tributary nutrient concentrations (mg/l) and ratios for the Hells Canyon Complex.

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Snake River at Celebration Park (RM 449.3).								
Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
03/14/95	0.03	0.14	21	1.22	0.37	0.025	1.59	42
03/28/95	0.04	0.09	44	1.2	0.05	0.025	1.25	31
04/13/95	0.005	0.08	6	1.1	0.81	0.025	1.91	225
04/26/95	0.005	0.12	4	0.65	0.71	0.025	1.36	135
05/10/95	0.005	0.13	4	0.64	0.86	0.025	1.5	133
06/13/95	0.06	0.1	60	0.59	0.38	0.05	0.97	11
06/30/95	0.01	0.11	9	0.3	0.67	0.025	0.97	33
07/10/95	0.02	0.07	29	0.36	0.51	0.025	0.87	19
08/01/95	0.04	0.08	50	0.98	0.42	0.025	1.4	25
08/14/95	0.04	0.1	40	0.97	0.54	0.025	1.51	25
08/28/95	0.04	0.09	44	1.01	0.51	0.025	1.52	26
09/05/95	0.03	0.12	25	0.98	0.55	0.025	1.53	34
09/25/95	0.05	0.1	50	1.17	0.41	0.025	1.58	24
10/04/95	0.04	0.13	31	1.2	0.05	0.025	1.25	31
10/17/95	0.02	0.07	29	1.08	0.46	0.025	1.54	55
11/01/95	0.01	0.07	14	1.14	0.44	0.025	1.58	117
11/29/95	0.03	0.08	38	1.01	0.56	0.13	1.57	38
12/27/95	0.06	0.1	60	1.52	0.38	0.12	1.9	27
01/24/96	0.05	0.09	56	1.32	0.44	0.025	1.76	27
02/21/96	0.06	0.14	43	1.12	0.26	0.025	1.38	19
03/19/96	0.005	0.09	6	0.62	0.64	0.025	1.26	129
04/25/96	0.04	0.09	44	0.49	0.65	0.025	1.14	13
05/30/96	0.005	0.11	5	0.35	0.87	0.025	1.22	75
06/17/96	0.01	0.09	11	0.05	0.84	0.025	0.89	8
07/29/96	0.005	0.1	5	0.55	0.62	0.025	1.17	115
08/16/96	0.02	0.08	25	0.81	0.52	0.025	1.33	42
09/24/96	0.03	0.08	38	1.12	0.44	0.025	1.56	38
10/30/96	0.03	0.11	27	1.39	0.3	0.025	1.69	47
11/27/96	0.03	0.07	43	1.33	0.48	0.08	1.81	47
12/17/96	0.04	0.07	57	1.52	0.17	0.025	1.69	39
01/28/97	0.06	0.09	67	1.19	0.32	0.025	1.51	20
02/27/97	0.04	0.08	50	0.97	0.43	0.025	1.4	25
03/26/97	0.02	0.07	29	0.62	0.54	0.025	1.16	32
04/29/97	0.02	0.08	25	0.6	0.77	0.025	1.37	31
05/28/97	0.02	0.08	25	0.49	0.72	0.025	1.21	26
06/26/97	0.04	0.1	40	0.43	0.38	0.025	0.81	11

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Snake River at Celebration Park (RM 449.3).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
07/31/97	0.014	0.059	24	0.79	0.43	0.07	1.22	61
08/28/97	0.005	0.066	8	0.65	0.76	0.11	1.41	152
09/29/97	0.024	0.084	29	0.78	0.85	0.06	1.63	35
10/28/97	0.005	0.072	7	0.83	0.64	0.05	1.47	176
12/29/97	0.027	0.054	50	1.22	0.4	0.02	1.62	46
01/29/98	0.01	0.063	16	0.99	0.5	0.005	1.49	100
02/25/98	0.027	0.063	43	1.01	0.33	0.03	1.34	39
03/25/98	0.005	0.084	6	0.64	0.65	0.04	1.29	136
04/30/98	0.005	0.064	8	0.4	0.7	0.03	1.1	86
05/26/98	0.009	0.075	12	0.4	0.35	0.05	0.75	50
06/30/98	0.005	0.065	8	0.23	0.61	0.005	0.84	47
07/31/98	0.005	0.052	10	0.52	0.77	0.01	1.29	106
08/26/98	0.0025	0.065	4	0.73	0.53	0.04	1.26	308
09/24/98	0.033	0.071	46	1.13	0.46	0.005	1.59	34
10/29/98	0.008	0.042	19	1.16	0.51	0.03	1.67	149
11/24/98	0.038	0.093	41	1.23	0.43	0.11	1.66	35
12/29/98	0.046	0.064	72	1.13	0.41	0.005	1.54	25
01/28/99	0.045	0.068	66	1.12	0.31	0.05	1.43	26
02/24/99	0.041	0.063	65	1.12	0.3	0.005	1.42	27
03/24/99	0.012	0.082	15	0.72	0.48	0.005	1.2	60
04/30/99	0.007	0.061	11	0.43	0.45	0.005	0.88	62
05/18/99	0.022	0.076	29	0.43	0.43	0.005	0.86	20
06/30/99	0.015	0.058	26	0.34	0.52	0.05	0.86	26
07/21/99	0.026	0.063	41	0.54	0.67	0.02	1.21	22
08/18/99	0.032	0.068	47	0.83	0.49	0.03	1.32	27
09/30/99	0.015	0.074	20	1.02	0.57	0.03	1.59	70
10/27/99	0.018	0.061	30	1.15	0.38	0.01	1.53	64
11/23/99	0.05	0.067	75	1.31	0.24	0.04	1.55	27
12/28/99	0.06	0.077	78	1.5	0.18	0.04	1.68	26
01/26/00	0.056	0.073	77	1.39	0.28	0.005	1.67	25
02/23/00	0.066	0.088	75	1.57	0.44	0.02	2.01	24
04/18/00	0.017	0.076	22	0.5	0.55	0.02	1.05	31
Mean	0.027	0.082	33	0.881	0.495	0.032	1.376	57
SD	0.018	0.021	21	0.368	0.184	0.026	0.290	55
Median	0.025	0.080	29	0.975	0.480	0.025	1.405	35
Minimum	0.003	0.042	4	0.050	0.050	0.005	0.750	8
Maximum	0.066	0.140	78	1.570	0.870	0.130	2.010	308

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Owyhee River (RM 3.3).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
03/16/95	0.03	0.16	19	3.22	0.73	0.11	3.95	111
04/13/95	0.03	0.16	19	1.32	0.63	0.025	1.95	45
05/23/95	0.05	0.16	31	0.38	0.18	0.025	0.56	8
06/27/95	0.21	1.46	14	1.87	2.45	0.23	4.32	10
07/25/95	0.12	0.38	32	1.44	1.27	0.12	2.71	13
08/29/95	0.09	0.21	43	1.53	0.69	0.07	2.22	18
09/19/95	0.07	0.22	32	1.32	0.23	0.11	1.55	20
10/19/95	0.05	0.14	36	1.09	0.48	0.025	1.57	22
04/01/99	0.057	0.117	49	0.8	0.29	0.005	1.09	14
04/29/99	0.075	0.172	44	0.94	0.41	0.02	1.35	13
05/19/99	0.048	0.125	38	0.33	0.41	0.005	0.74	7
06/30/99	0.144	0.408	35	2.01	1.1	0.28	3.11	16
07/21/99	0.2	0.445	45	1.26	1.03	0.11	2.29	7
08/17/99	0.092	0.188	49	1.26	0.52	0.06	1.78	14
09/30/99	0.048	0.093	52	1.04	0.36	0.04	1.40	23
10/26/99	0.046	0.095	48	0.91	0.45	0.04	1.36	21
11/23/99	0.059	0.095	62	3.78	0.37	0.04	4.15	65
12/28/99	0.062	0.101	61	3.84	0.41	0.03	4.25	62
01/25/00	0.059	0.092	64	3.99	0.4	0.02	4.39	68
02/23/00	0.067	0.13	52	3.07	0.6	0.05	3.67	47
03/22/00	0.048	0.134	36	0.72	0.51	0.005	1.23	15
04/18/00	0.04	0.134	30	0.42	0.58	0.005	1.00	11
Mean	0.077	0.237	40	1.661	0.641	0.065	2.302	29
SD	0.050	0.291	14	1.160	0.489	0.072	1.290	27
Median	0.059	0.150	41	1.290	0.495	0.040	1.865	17
Minimum	0.030	0.092	14	0.330	0.180	0.005	0.560	7
Maximum	0.210	1.460	64	3.990	2.450	0.280	4.390	111

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Boise River (RM 3.7).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
03/16/95	0.47	0.62	76	4.15	0.96	0.18	5.11	9
04/13/95	0.27	0.44	61	1.46	1	0.07	2.46	6
05/18/95	0.15	0.22	68	0.32	0.41	0.01	0.73	2
06/14/95	0.23	0.36	64	0.94	0.88	0.06	1.82	4
07/25/95	0.24	0.35	69	1.38	0.57	0.025	1.95	6
08/29/95	0.27	0.35	77	1.75	0.7	0.025	2.45	7
09/19/95	0.26	0.35	74	1.89	0.51	0.025	2.40	7
10/19/95	0.3	0.34	88	2.83	0.38	0.025	3.21	10
03/25/98	0.136	0.204	67	1.43	0.38	0.05	1.81	11
04/30/98	0.175	0.28	63	1.2	0.5	0.09	1.70	7
05/13/98	0.102	0.247	41	0.74	0.59	0.13	1.33	9
05/28/98	0.083	0.147	56	0.53	0.37	0.05	0.90	7
06/10/98	0.07	0.115	61	0.37	0.24	0.11	0.61	7
06/23/98	0.131	0.177	74	0.9	0.51	0.02	1.41	7
07/08/98	0.161	0.222	73	1.16	0.28	0.05	1.44	8
07/21/98	0.226	0.338	67	1.4	0.81	0.09	2.21	7
08/05/98	0.237	0.327	72	1.52	0.83	0.005	2.35	6
08/18/98	0.204	0.278	73	1.48	0.58	0.01	2.06	7
09/02/98	0.097	0.305	32	1.67	0.97	0.06	2.64	18
09/16/98	0.232	0.29	80	1.85	0.53	0.005	2.38	8
09/30/98	0.23	0.288	80	1.98	0.48	0.07	2.46	9
10/14/98	0.247	0.272	91	2.81	0.47	0.01	3.28	11
10/27/98	0.3	0.337	89	3.68	0.35	0.04	4.03	12
11/23/98	0.288	0.351	82	4.13	0.54	0.04	4.67	14
12/15/98	0.361	0.394	92	4.14	0.33	0.005	4.47	11
12/28/98	0.34	0.38	89	4.36	0.71	0.07	5.07	13
01/12/99	0.365	0.4	91	4.54	0.56	0.04	5.10	13
01/26/99	0.381	0.467	82	4.53	0.58	0.22	5.11	12
02/09/99	0.387	0.499	78	4.41	0.88	0.18	5.29	12
02/23/99	0.127	0.189	67	1.12	0.76	0.03	1.88	9
03/15/99	0.069	0.085	81	0.65	0.005	0.04	0.66	10
04/02/99	0.047	0.088	53	0.53	0.15	0.005	0.68	11
04/29/99	0.148	0.236	63	1.07	0.38	0.05	1.45	8
05/19/99	0.193	0.285	68	1.25	0.5	0.005	1.75	7
06/30/99	0.163	0.247	66	1.21	0.49	0.11	1.70	8
07/21/99	0.251	0.37	68	1.48	0.68	0.05	2.16	6
08/17/99	0.201	0.27	74	1.64	0.7	0.02	2.34	8

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Boise River (RM 3.7).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
09/30/99	0.177	0.231	77	1.91	0.59	0.03	2.50	11
10/27/99	0.299	0.343	87	3.34	0.51	0.005	3.85	11
11/23/99	0.345	0.374	92	4.19	0.31	0.05	4.50	12
12/28/99	0.311	0.35	89	4.04	0.3	0.08	4.34	13
01/25/00	0.366	0.446	82	4.76	0.48	0.09	5.24	13
02/24/00	0.384	0.61	63	3.11	1.29	0.09	4.40	8
03/22/00	0.132	0.197	67	1.46	0.26	0.005	1.72	11
04/19/00	0.101	0.156	65	0.67	0.33	0.02	1.00	7
Mean	0.228	0.307	73	2.133	0.547	0.054	2.680	9
SD	0.103	0.118	13	1.392	0.249	0.050	1.456	3
Median	0.230	0.305	73	1.520	0.510	0.040	2.350	9
Minimum	0.047	0.085	32	0.320	0.005	0.005	0.610	2
Maximum	0.470	0.620	92	4.760	1.290	0.220	5.290	18

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Malheur River (RM 0.4).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
03/16/95	0.15	0.23	65	1.65	0.44	0.025	2.09	11
04/13/95	0.09	0.22	41	1.5	0.78	0.025	2.28	17
05/23/95	0.17	0.32	53	2.3	0.69	0.025	2.99	14
06/27/95	0.26	0.61	43	2.75	0.05	0.06	2.80	11
07/25/95	0.3	0.52	58	2.72	1.55	0.025	4.27	9
08/29/95	0.31	0.39	79	3.63	0.89	0.025	4.52	12
09/19/95	0.27	0.36	75	3.36	0.39	0.09	3.75	13
10/19/95	0.21	0.26	81	2.7	0.64	0.025	3.34	13
04/01/99	0.138	0.25	55	0.61	0.42	0.01	1.03	4
04/29/99	0.149	0.38	39	0.42	0.62	0.02	1.04	3
05/20/99	0.24	0.366	66	1.91	0.73	0.005	2.64	8
06/30/99	0.303	0.562	54	2.7	1.37	0.15	4.07	9
08/17/99	0.26	0.405	64	2.97	0.92	0.04	3.89	12
09/29/99	0.224	0.289	78	2.6	0.72	0.03	3.32	12
10/26/99	0.159	0.212	75	2.54	0.56	0.04	3.10	16
11/22/99	0.206	0.241	85	3.44	0.44	0.01	3.88	17
12/27/99	0.24	0.345	70	4.01	0.39	0.06	4.40	17
01/25/00	0.275	0.336	82	4.76	0.54	0.04	5.30	17
02/23/00	0.231	0.368	63	2.13	0.81	0.06	2.94	9
03/22/00	0.153	0.336	46	0.99	0.76	0.005	1.75	7
04/18/00	0.147	0.337	44	0.26	0.58	0.02	0.84	2
Mean	0.214	0.349	63	2.379	0.680	0.038	3.059	11
SD	0.063	0.108	15	1.180	0.329	0.033	1.226	5
Median	0.224	0.337	64	2.600	0.640	0.025	3.100	12
Minimum	0.090	0.212	39	0.260	0.050	0.005	0.840	2
Maximum	0.310	0.610	85	4.760	1.550	0.150	5.300	17

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Snake River at Nyssa (RM 385).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
03/16/95	0.04	0.17	24	1.63	0.49	0.025	2.12	41
03/28/95	0.04	0.12	33	1.23	0.28	0.025	1.51	31
04/13/95	0.01	0.13	8	1.24	0.82	0.06	2.06	130
04/26/95	0.005	0.2	3	0.69	0.88	0.025	1.57	143
05/10/95	0.005	0.26	2	0.31	0.47	0.025	0.78	67
05/23/95	0.01	0.18	6	0.45	0.49	0.025	0.94	48
06/14/95	0.05	0.13	38	0.61	0.66	0.025	1.27	13
06/27/95	0.01	0.26	4	0.39	1.13	0.025	1.52	42
07/25/95	0.06	0.19	32	0.86	0.95	0.07	1.81	16
08/17/95	0.03	0.12	25	0.93	0.93	0.15	1.86	36
08/29/95	0.04	0.15	27	1.03	0.8	0.09	1.83	28
09/08/95	0.02	0.14	14	0.93	0.6	0.025	1.53	48
09/19/95	0.03	0.12	25	1.08	0.5	0.025	1.58	37
10/06/95	0.04	0.1	40	1.29	0.71	0.25	2.00	39
10/19/95	0.02	0.11	18	1.2	0.45	0.025	1.65	61
11/08/95	0.01	0.14	7	1.29	0.92	0.2	2.21	149
12/27/95	0.07	0.1	70	1.67	0.37	0.05	2.04	25
01/24/96	0.05	0.09	56	1.47	0.46	0.15	1.93	32
02/21/96	0.07	0.18	39	1.04	0.41	0.025	1.45	15
03/19/96	0.02	0.12	17	0.56	0.39	0.025	0.95	29
04/25/96	0.04	0.1	40	0.42	0.77	0.025	1.19	11
05/30/96	0.01	0.13	8	0.16	0.96	0.025	1.12	19
06/17/96	0.005	0.13	4	0.05	0.7	0.025	0.75	15
07/29/96	0.005	0.13	4	0.66	1.1	0.25	1.76	182
08/16/96	0.005	0.1	5	0.78	0.65	0.06	1.43	168
09/24/96	0.03	0.1	30	1.21	0.87	0.15	2.08	45
10/30/96	0.03	0.11	27	1.58	0.57	0.13	2.15	57
11/27/96	0.01	0.08	13	1.48	0.67	0.11	2.15	159
12/17/96	0.03	0.07	43	1.73	0.41	0.025	2.14	59
01/28/97	0.06	0.15	40	1.19	0.51	0.025	1.70	20
02/27/97	0.04	0.09	44	0.95	0.28	0.025	1.23	24
03/26/97	0.01	0.06	17	0.58	0.45	0.025	1.03	61
04/29/97	0.03	0.11	27	0.55	0.76	0.28	1.31	28
05/28/97	0.005	0.11	5	0.45	0.69	0.025	1.14	95
06/26/97	0.04	0.12	33	0.57	0.42	0.025	0.99	15
07/31/97	0.005	0.097	5	0.92	0.96	0.16	1.88	216
08/28/97	0.005	0.091	5	0.7	0.86	0.01	1.56	142

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Snake River at Nyssa (RM 385).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
09/29/97	0.005	0.097	5	0.86	0.88	0.07	1.74	186
10/28/97	0.005	0.084	6	0.91	0.87	0.08	1.78	198
11/26/97	0.005	0.131	4	1.2	0.72	0.06	1.92	252
12/29/97	0.021	0.052	40	1.33	0.32	0.05	1.65	66
01/29/98	0.005	0.059	8	1.13	0.55	0.05	1.68	236
02/25/98	0.027	0.074	36	1.06	0.64	0.07	1.70	42
03/25/98	0.005	0.099	5	0.57	0.64	0.05	1.21	124
04/30/98	0.005	0.092	5	0.44	0.58	0.08	1.02	104
05/26/98	0.022	0.104	21	0.4	0.61	0.04	1.01	20
06/30/98	0.005	0.103	5	0.32	0.83	0.08	1.15	80
07/31/98	0.006	0.052	12	0.61	0.97	0.07	1.58	113
08/26/98	0.0025	0.1	3	0.79	0.95	0.05	1.74	336
09/24/98	0.02	0.095	21	1.15	0.7	0.08	1.85	62
10/29/98	0.009	0.066	14	1.19	0.61	0.06	1.80	139
11/24/98	0.03	0.099	30	1.44	0.53	0.06	1.97	50
12/29/98	0.045	0.053	85	1.31	0.33	0.005	1.64	29
01/28/99	0.048	0.063	76	1.23	0.36	0.09	1.59	28
02/24/99	0.041	0.07	59	1.19	0.48	0.05	1.67	30
03/24/99	0.011	0.104	11	0.61	0.57	0.05	1.18	60
04/29/99	0.013	0.096	14	0.55	0.65	0.07	1.20	48
05/18/99	0.017	0.101	17	0.44	0.62	0.02	1.06	27
06/30/99	0.013	0.097	13	0.3	0.77	0.07	1.07	28
07/21/99	0.031	0.121	26	0.64	1.04	0.09	1.68	24
08/18/99	0.023	0.112	21	0.77	0.95	0.01	1.72	34
09/30/99	0.006	0.075	8	1.01	0.94	0.05	1.95	177
10/27/99	0.017	0.064	27	1.3	0.39	0.04	1.69	79
11/23/99	0.048	0.064	75	1.54	0.24	0.07	1.78	34
12/28/99	0.06	0.076	79	0.59	0.28	0.12	0.87	12
01/26/00	0.044	0.077	57	1.5	0.37	0.05	1.87	35
02/23/00	0.059	0.095	62	1.37	0.46	0.13	1.83	25
03/22/00	0.016	0.093	17	0.79	0.51	0.005	1.30	50
04/18/00	0.021	0.112	19	0.48	0.78	0.005	1.26	23
Mean	0.024	0.110	25	0.912	0.645	0.066	1.556	74
SD	0.019	0.042	21	0.411	0.227	0.059	0.383	69
Median	0.020	0.100	19	0.920	0.640	0.050	1.650	45
Minimum	0.003	0.052	2	0.050	0.240	0.005	0.750	11
Maximum	0.070	0.260	85	1.730	1.130	0.280	2.210	336

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Payette River (RM 2.1).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
03/16/95	0.05	0.11	45	0.26	0.19	0.025	0.45	6
04/13/95	0.03	0.07	43	0.24	0.33	0.025	0.57	9
05/23/95	0.03	0.08	38	0.05	0.05	0.025	0.10	3
06/27/95	0.03	0.09	33	0.11	0.23	0.025	0.34	5
07/25/95	0.11	0.18	61	0.72	0.69	0.025	1.41	7
08/29/95	0.08	0.17	47	0.93	0.64	0.025	1.57	12
09/19/95	0.09	0.16	56	0.84	0.34	0.06	1.18	10
10/19/95	0.02	0.08	25	0.41	0.37	0.025	0.78	22
03/25/98	0.014	0.12	12	0.05	0.41	0.06	0.46	8
04/28/98	0.022	0.065	34	0.05	0.17	0.07	0.22	5
05/13/98	0.025	0.078	32	0.05	0.24	0.005	0.29	2
05/28/98	0.053	0.18	29	0.05	0.46	0.06	0.51	2
06/10/98	0.019	0.05	38	0.05	0.27	0.005	0.32	3
06/23/98	0.032	0.07	46	0.05	0.24	0.005	0.29	2
07/08/98	0.033	0.068	49	0.05	0.17	0.03	0.22	2
07/21/98	0.045	0.102	44	0.27	0.44	0.03	0.71	7
08/05/98	0.055	0.1	55	0.37	0.63	0.02	1.00	7
08/18/98	0.05	0.109	46	0.58	0.45	0.005	1.03	12
09/02/98	0.081	0.14	58	0.77	0.55	0.06	1.32	10
09/16/98	0.069	0.148	47	0.59	0.45	0.05	1.04	9
09/30/98	0.052	0.1	52	0.5	0.53	0.06	1.03	11
10/14/98	0.034	0.084	40	0.43	0.38	0.005	0.81	13
10/27/98	0.015	0.029	52	0.22	0.24	0.03	0.46	17
11/23/98	0.019	0.095	20	0.01	0.46	0.08	0.47	5
12/15/98	0.026	0.04	65	0.23	0.52	0.03	0.75	10
12/28/98	0.017	0.03	57	0.19	0.42	0.005	0.61	11
01/12/99	0.025	0.032	78	0.19	0.31	0.005	0.50	8
01/27/99	0.046	0.098	47	0.31	0.31	0.06	0.62	8
02/09/99	0.047	0.092	51	0.27	0.48	0.02	0.75	6
02/23/99	0.054	0.085	64	0.25	0.47	0.03	0.72	5
03/15/99	0.038	0.053	72	0.13	0.18	0.05	0.31	5
03/31/99	0.032	0.067	48	0.13	0.28	0.08	0.41	7
04/29/99	0.033	0.066	50	0.05	0.27	0.01	0.32	2
05/20/99	0.027	0.088	31	0.05	0.22	0.005	0.27	2
06/29/99	0.022	0.054	41	0.05	0.16	0.04	0.21	4
07/21/99	0.056	0.161	35	0.23	0.42	0.06	0.65	5
08/17/99	0.055	0.074	74	0.32	0.25	0.06	0.57	7

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Payette River (RM 2.1).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
09/29/99	0.038	0.076	50	0.59	0.43	0.02	1.02	16
10/26/99	0.031	0.052	60	0.29	0.27	0.05	0.56	11
11/22/99	0.018	0.031	58	0.27	0.14	0.05	0.41	18
12/27/99	0.018	0.036	50	0.56	0.18	0.05	0.74	34
01/26/00	0.03	0.075	40	0.39	0.22	0.005	0.61	13
02/23/00	0.078	0.361	22	0.3	0.76	0.04	1.06	4
03/22/00	0.038	0.058	66	0.15	0.23	0.005	0.38	4
04/19/00	0.03	0.061	49	0.05	0.29	0.005	0.34	2
Mean	0.040	0.093	47	0.281	0.350	0.033	0.631	8
SD	0.022	0.057	14	0.237	0.159	0.023	0.346	6
Median	0.033	0.080	47	0.240	0.310	0.030	0.570	7
Minimum	0.014	0.029	12	0.010	0.050	0.005	0.100	2
Maximum	0.110	0.361	78	0.930	0.760	0.080	1.570	34

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Weiser River (RM 0.5).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
04/10/95	0.03	0.11	27	0.19	0.32	0.11	0.51	10
05/24/95	0.02	0.08	25	0.1	0.27	0.05	0.37	8
06/28/95	0.03	0.06	50	0.05	0.26	0.025	0.31	3
07/26/95	0.11	0.18	61	0.57	0.52	0.025	1.09	5
08/30/95	0.12	0.18	67	0.5	0.3	0.025	0.80	4
09/20/95	0.11	0.24	46	0.42	0.81	0.05	1.23	4
10/19/95	0.02	0.05	40	0.05	0.32	0.025	0.37	4
03/31/99	0.043	0.073	59	0.41	0.52	0.005	0.93	10
04/21/99	0.057	0.229	25	0.05	0.52	0.05	0.57	2
05/04/99	0.034	0.12	28	0.05	0.29	0.005	0.34	2
05/18/99	0.034	0.045	76	0.05	0.16	0.005	0.21	2
05/24/99	0.034	0.26	13	0.05	0.54	0.02	0.59	2
06/29/99	0.037	0.054	69	0.05	0.15	0.005	0.20	1
07/21/99	0.078	0.15	52	0.22	0.7	0.005	0.92	3
08/17/99	0.106	0.141	75	0.29	0.52	0.05	0.81	3
09/29/99	0.063	0.113	56	0.34	0.41	0.04	0.75	6
10/26/99	0.016	0.03	53	0.05	0.25	0.005	0.30	3
11/22/99	0.024	0.036	67	0.1	0.18	0.005	0.28	4
12/27/99	0.036	0.068	53	0.72	0.05	0.02	0.77	21
01/27/00	0.053	0.109	49	0.45	0.32	0.01	0.77	9
02/15/00	0.076	0.69	11	0.58	1.44	0.06	2.02	8
02/23/00	0.124	0.79	16	0.41	2.08	0.04	2.49	4
02/23/00	0.155	0.338	46	0.48	2.22	0.08	2.70	4
03/22/00	0.063	0.074	85	0.47	0.18	0.005	0.65	8
04/19/00	0.033	0.075	44	0.1	0.12	0.005	0.22	3
Mean	0.060	0.172	48	0.270	0.538	0.029	0.808	5
SD	0.039	0.189	20	0.215	0.563	0.027	0.672	4
Median	0.043	0.110	50	0.220	0.320	0.025	0.650	4
Minimum	0.016	0.030	11	0.050	0.050	0.005	0.200	1
Maximum	0.155	0.790	85	0.720	2.220	0.110	2.700	21

Appendix 3. (Cont.)

Flow (cfs), nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for agricultural return drains to the Snake River (RM 340-449.3).

Date	River Mile	Flow	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
04/10/95	342.4	5	0.07	0.09	78	0.05	0.31	0.05	0.36	1
05/24/95	342.4	1.26	0.16	0.26	62	0.48	0.44	0.05	0.92	3
06/28/95	342.4	0.09	0.19	0.24	79	0.43	0.34	0.09	0.77	3
07/26/95	342.4	0.5	0.17	0.25	68	0.39	0.72	0.025	1.11	2
08/30/95	342.4	11.82	0.11	0.24	46	0.17	0.67	0.025	0.84	2
09/20/95	342.4	6.19	0.09	0.26	35	0.05	0.48	0.025	0.53	1
04/10/95	342.6	0.5	0.16	0.18	89	2.69	0.4	0.025	3.09	17
05/24/95	342.6	0.5	0.13	0.28	46	1.92	0.43	0.05	2.35	15
06/28/95	342.6	0.5	0.28	0.73	38	2.03	1.42	0.22	3.45	8
07/26/95	342.6	0.5	0.29	0.44	66	2.35	0.94	0.025	3.29	8
08/30/95	342.6	0.5	0.15	0.25	60	0.81	0.74	0.025	1.55	6
09/20/95	342.6	0.5	0.13	0.31	42	0.69	0.29	0.025	0.98	6
10/19/95	342.6	0.5	0.28	0.32	88	9.49	0.05	0.025	9.54	34
04/10/95	343	4.88	0.08	0.15	53	1.28	0.5	0.025	1.78	16
05/24/95	343	4.39	0.21	0.42	50	1.26	1.02	0.05	2.28	6
06/28/95	343	9	0.19	0.37	51	1.27	1.15	0.22	2.42	8
07/26/95	343	6.47	0.26	0.49	53	1.87	0.92	0.025	2.79	7
08/30/95	343	5.03	0.21	0.31	68	1.98	0.69	0.05	2.67	10
09/20/95	343	20.3	0.11	0.32	34	0.38	0.14	0.025	0.52	4
10/19/95	343	0.11	0.17	0.23	74	5.27	0.69	0.025	5.96	31
05/24/95	344.9	6.52	0.09	0.25	36	0.34	0.42	0.05	0.76	4
06/28/95	344.9	13.38	0.2	0.63	32	0.4	1.58	0.58	1.98	5
07/26/95	344.9	4.42	0.27	0.5	54	0.6	1.01	0.025	1.61	2
08/30/95	344.9	6.09	0.16	0.27	59	0.22	0.68	0.025	0.90	2
09/20/95	344.9	0.51	0.11	0.29	38	0.05	0.85	0.06	0.90	1
05/24/95	348.7	0.17	0.06	0.22	27	0.18	0.45	0.05	0.63	4
06/28/95	348.7	0.21	0.1	0.26	38	0.62	0.67	0.025	1.29	6
07/26/95	348.7	2.01	0.13	0.26	50	0.57	0.6	0.025	1.17	5
08/30/95	348.7	0.36	0.16	0.31	52	0.33	0.74	0.025	1.07	2
09/20/95	348.7	0.5	0.12	0.26	46	0.38	0.31	0.06	0.69	4
04/10/95	349.6	0.5	0.07	0.12	58	2.55	0.43	0.025	2.98	37
05/24/95	349.6	0.5	0.2	0.4	50	3.58	1.02	0.05	4.60	18
06/28/95	349.6	0.5	0.23	0.62	37	3.98	1.3	0.52	5.28	20
07/26/95	349.6	0.5	0.26	0.38	68	3.35	0.93	0.025	4.28	13
08/30/95	349.6	0.5	0.15	0.28	54	1.17	0.82	0.025	1.99	8
09/20/95	349.6	0.5	0.11	0.29	38	0.68	0.43	0.025	1.11	6

Appendix 3. (Cont.)

Flow (cfs), nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for agricultural return drains to the Snake River (RM 340-449.3).

Date	River Mile	Flow	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
10/19/95	349.6	0.5	0.18	0.23	78	8.07	0.46	0.025	8.53	45
04/10/95	351.2	0.5	0.01	0.06	17	0.58	0.79	0.025	1.37	61
05/24/95	351.2	0.5	0.02	0.18	11	0.35	0.72	0.05	1.07	20
06/28/95	351.2	0.5	0.01	0.17	6	0.21	1.02	0.025	1.23	24
07/26/95	351.2	0.5	0.06	0.19	32	0.83	0.87	0.025	1.70	14
08/30/95	351.2	0.5	0.04	0.17	24	0.93	0.89	0.025	1.82	24
09/20/95	351.2	0.5	0.06	0.18	33	1.21	0.31	0.05	1.52	21
10/19/95	351.2	0.5	0.005	0.11	5	1.11	0.68	0.025	1.79	227
04/10/95	356.3	0.5	0.14	0.18	78	10.5	0.14	0.09	10.64	76
05/24/95	356.3	0.5	0.07	0.53	13	2.08	1.36	0.05	3.44	30
06/28/95	356.3	0.5	0.12	0.31	39	3.66	1.03	0.025	4.69	31
07/26/95	356.3	0.5	0.17	0.58	29	2.23	1.01	0.025	3.24	13
08/30/95	356.3	0.5	0.16	0.38	42	4.97	0.72	0.025	5.69	31
09/20/95	356.3	0.5	0.12	0.36	33	3.15	0.15	0.025	3.30	26
10/19/95	356.3	0.5	0.1	0.17	59	4.66	0.41	0.025	5.07	47
04/10/95	357	0.79	0.04	0.11	36	0.05	1.26	0.025	1.31	2
08/30/95	357	3.08	0.07	0.18	39	0.18	0.78	0.07	0.96	4
09/20/95	357	5.78	0.08	0.23	35	0.05	0.4	0.025	0.45	1
10/19/95	357	1.1	0.05	0.13	38	0.05	0.49	0.025	0.54	2
10/19/95	359.9	0.5	0.22	0.27	81	3.89	0.65	0.09	4.54	18
04/10/95	362.7	28.96	0.16	0.24	67	0.22	0.05	0.05	0.27	2
05/24/95	362.7	50.27	0.03	0.12	25	0.1	0.45	0.05	0.55	5
06/28/95	362.7	29.98	0.04	0.11	36	0.05	0.33	0.025	0.38	2
07/26/95	362.7	7.91	0.1	0.16	63	0.65	0.49	0.06	1.14	7
08/30/95	362.7	16.44	0.11	0.31	35	0.38	0.39	0.025	0.77	4
09/20/95	362.7	10.85	0.08	0.13	62	0.53	0.1	0.025	0.63	7
10/19/95	362.7	10	0.04	0.09	44	0.05	0.32	0.025	0.37	2
03/16/95	375.3	0.5	0.07	0.19	37	1.39	0.53	0.025	1.92	20
04/11/95	375.3	0.5	0.08	0.24	33	2.13	1.35	0.13	3.48	28
06/27/95	375.3	0.5	0.13	0.25	52	1.03	1.06	0.09	2.09	9
07/25/95	375.3	0.5	0.1	0.19	53	1.02	0.85	0.025	1.87	10
08/29/95	375.3	0.5	0.09	0.11	82	1.45	0.61	0.025	2.06	16
09/19/95	375.3	0.5	0.11	0.16	69	1.71	0.3	0.08	2.01	16
10/19/95	375.3	0.5	0.12	0.22	55	1.07	0.81	0.025	1.88	9
03/16/95	377.8	0.5	0.22	0.38	58	7.96	0.87	0.31	8.83	38
04/11/95	377.9	45	0.08	0.48	17	2.02	1.79	0.25	3.81	28

Appendix 3. (Cont.)

Flow (cfs), nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for agricultural return drains to the Snake River (RM 340-449.3).

Date	River Mile	Flow	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
05/23/95	377.9	39.73	0.18	0.56	32	3.4	0.69	0.07	4.09	19
06/27/95	377.9	100.8	0.18	1.78	10	3.21	3.26	0.25	6.47	19
07/25/95	377.9	109.9	0.17	0.78	22	2.53	1.59	0.025	4.12	15
08/29/95	377.9	101.2	0.21	0.35	60	3.5	0.85	0.025	4.35	17
09/19/95	377.9	73.89	0.13	0.32	41	4.25	0.38	0.08	4.63	33
10/19/95	377.9	42.62	0.08	0.25	32	2.87	0.66	0.025	3.53	36
03/16/95	381	1.75	0.07	0.14	50	3.09	0.34	0.025	3.43	45
04/11/95	381	1.75	0.06	0.13	46	2.95	0.81	0.025	3.76	50
05/23/95	381	8.65	0.07	0.27	26	0.6	0.53	0.025	1.13	9
06/27/95	381	4.7	0.18	0.36	50	1.22	0.93	0.27	2.15	8
07/25/95	381	0.37	0.1	0.15	67	3.13	1.13	0.23	4.26	34
08/29/95	381	10.79	0.05	0.19	26	0.58	0.5	0.025	1.08	12
09/19/95	381	2.06	0.05	0.11	45	2.15	0.35	0.09	2.50	45
10/19/95	381	0.64	0.05	0.11	45	3.23	0.45	0.025	3.68	65
03/16/95	382	6.96	0.08	0.12	67	2.63	0.11	0.025	2.74	33
04/11/95	382	8.73	0.07	0.11	64	2.49	0.23	0.06	2.72	36
05/23/95	382	12.22	0.06	0.32	19	0.94	0.2	0.05	1.14	17
06/27/95	382	12.24	0.07	0.21	33	1.19	0.23	0.025	1.42	17
07/25/95	382	8.19	0.07	0.18	39	1.44	0.33	0.025	1.77	21
08/29/95	382	15.4	0.07	0.25	28	1.15	0.49	0.025	1.64	17
09/19/95	382	15.51	0.03	0.15	20	1.18	0.35	0.025	1.53	40
10/19/95	382	1.75	0.07	0.12	58	2.47	0.16	0.025	2.63	36
03/16/95	383.4	2	0.06	0.08	75	5.01	0.05	0.025	5.06	84
04/11/95	383.4	2.5	0.04	0.06	67	4.46	0.23	0.025	4.69	112
05/23/95	383.4	6.53	0.04	0.22	18	0.05	0.31	0.025	0.36	2
06/27/95	383.4	5.99	0.05	0.28	18	0.05	0.55	0.11	0.60	3
07/25/95	383.4	19.67	0.04	0.13	31	0.52	0.43	0.025	0.95	14
08/29/95	383.4	28.96	0.03	0.07	43	0.59	0.25	0.025	0.84	21
09/19/95	383.4	52.1	0.005	0.06	8	0.21	0.43	0.025	0.64	47
10/19/95	383.4	0.52	0.06	0.11	55	5.36	0.13	0.025	5.49	90
09/19/95	383.6	0.5	0.005	0.09	6	0.22	0.36	0.025	0.58	49
03/16/95	384.1	0.5	0.08	0.16	50	3.4	0.05	0.025	3.45	43
04/11/95	384.1	0.5	0.05	0.08	63	3.05	0.15	0.07	3.20	62
05/23/95	384.1	0.5	0.12	0.25	48	1.47	0.22	0.08	1.69	13
06/27/95	384.1	0.5	0.22	0.93	24	1.28	1.37	0.08	2.65	6
07/25/95	384.1	0.5	0.13	0.44	30	1.28	0.68	0.025	1.96	10

Appendix 3. (Cont.)

Flow (cfs), nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for agricultural return drains to the Snake River (RM 340-449.3).

Date	River Mile	Flow	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
08/29/95	384.1	0.5	0.14	0.35	40	1	0.62	0.025	1.62	7
09/19/95	384.1	0.5	0.12	0.27	44	1.07	0.41	0.025	1.48	9
10/19/95	384.1	0.5	0.14	0.21	67	2.13	0.49	0.025	2.62	15
05/23/95	384.6	0.5	0.05	0.1	50	6.8	0.13	0.025	6.93	137
06/27/95	384.6	0.5	0.09	0.15	60	7	0.35	0.025	7.35	78
07/25/95	384.6	0.5	0.1	0.19	53	4.44	0.45	0.025	4.89	45
08/29/95	384.6	0.5	0.34	0.37	92	4.34	0.82	0.025	5.16	13
09/19/95	384.6	0.5	0.06	0.09	67	7.18	0.05	0.025	7.23	120
10/19/95	384.6	0.5	0.07	0.13	54	6.25	0.05	0.025	6.30	90
03/16/95	385.5	6.07	0.08	0.24	33	5.56	0.05	0.025	5.61	70
06/27/95	385.5	1.35	0.13	0.27	48	2.07	0.97	0.025	3.04	16
07/25/95	385.5	10.99	0.13	0.27	48	2.67	0.83	0.025	3.50	21
08/29/95	385.5	6	0.14	0.22	64	2.97	0.63	0.025	3.60	21
09/19/95	385.5	5	0.11	0.21	52	2.75	0.43	0.06	3.18	26
10/19/95	385.5	2.33	0.12	0.22	55	3.29	0.32	0.025	3.61	28
03/16/95	387.1	0.5	0.11	0.16	69	11	0.05	0.025	11.05	100
04/11/95	387.1	0.5	0.1	0.11	91	10.3	0.05	0.025	10.35	103
05/23/95	387.1	0.5	0.08	0.18	44	5.77	0.23	0.05	6.00	73
06/27/95	387.1	0.5	0.16	0.49	33	2.44	0.77	0.025	3.21	15
07/25/95	387.1	0.5	0.15	0.42	36	2.01	0.77	0.025	2.78	14
08/29/95	387.1	0.5	0.19	0.35	54	2.2	0.64	0.025	2.84	12
09/19/95	387.1	0.5	0.13	0.43	30	2.54	0.41	0.025	2.95	20
10/19/95	387.1	0.5	0.19	0.24	79	4.26	0.34	0.025	4.60	23
03/16/95	387.9	1	0.09	0.13	69	8.73	0.05	0.025	8.78	97
05/23/95	387.9	6.82	0.13	0.51	25	1.13	0.57	0.025	1.70	9
06/27/95	387.9	2.55	0.13	0.61	21	1.07	0.96	0.025	2.03	8
07/25/95	387.9	15.61	0.16	0.44	36	1.39	0.55	0.025	1.94	9
08/29/95	387.9	16.27	0.19	0.35	54	1.65	0.6	0.025	2.25	9
09/19/95	387.9	23.27	0.14	0.35	40	1.63	0.5	0.07	2.13	12
10/19/95	387.9	3.14	0.26	0.34	76	2.25	0.46	0.025	2.71	9
03/16/95	388.2	1	0.07	0.18	39	6.02	0.05	0.025	6.07	86
04/11/95	388.2	2	0.09	0.11	82	5.83	0.38	0.025	6.21	65
05/23/95	388.2	6.83	0.11	0.33	33	1.94	0.38	0.025	2.32	18
06/27/95	388.2	5.36	0.12	0.22	55	2.58	0.76	0.025	3.34	22
07/25/95	388.2	4.46	0.13	0.26	50	3.69	0.86	0.025	4.55	29
08/29/95	388.2	6.82	0.17	0.25	68	3.02	0.39	0.025	3.41	18

Appendix 3. (Cont.)

Flow (cfs), nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for agricultural return drains to the Snake River (RM 340-449.3).

Date	River Mile	Flow	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
09/19/95	388.2	3.64	0.11	0.22	50	5.23	0.31	0.08	5.54	48
10/19/95	388.2	1.51	0.16	0.5	32	3.94	0.6	0.025	4.54	25
03/16/95	389	1	0.04	0.2	20	3.79	1	0.08	4.79	97
04/11/95	389	1	0.16	0.46	35	5.13	1.78	0.34	6.91	34
07/25/95	389	1.62	0.24	0.49	49	2.83	1.44	0.25	4.27	13
08/29/95	389	2	0.15	0.22	68	3.17	0.67	0.06	3.84	22
09/19/95	389	0.74	0.12	0.22	55	5.38	0.47	0.08	5.85	46
10/19/95	389	1.3	0.17	0.21	81	6.11	0.6	0.06	6.71	36
03/16/95	394.7	6.72	0.07	0.11	64	9.22	0.05	0.025	9.27	132
04/11/95	394.7	68.97	0.04	0.28	14	1.29	0.7	0.08	1.99	34
05/23/95	394.7	98.31	0.07	0.56	13	1.2	0.7	0.025	1.90	18
06/27/95	394.7	54.91	0.07	0.92	8	1.8	1.86	0.23	3.66	29
07/25/95	394.7	59.41	0.11	1.37	8	1.87	1.52	0.025	3.39	17
08/29/95	394.7	28.83	0.09	0.61	15	3.73	0.94	0.025	4.67	42
09/19/95	394.7	102.7	0.06	0.41	15	1.44	0.39	0.025	1.83	24
10/19/95	394.7	16.83	0.04	0.21	19	1.47	0.57	0.025	2.04	37
04/11/95	395.9	0.5	0.16	0.16	100	4.13	0.75	0.22	4.88	27
04/26/95	395.9	0.5	0.14	0.41	34	2.04	0.76	0.09	2.80	15
05/23/95	395.9	135.3	0.15	0.4	38	1.57	0.65	0.09	2.22	11
06/27/95	395.9	101.3	0.21	0.52	40	1.63	1.93	0.09	3.56	8
07/25/95	395.9	113.2	0.22	0.52	42	1.95	2.9	0.18	4.85	10
08/29/95	395.9	84.04	0.24	0.39	62	2.22	0.68	0.025	2.90	9
09/19/95	395.9	97.29	0.18	0.32	56	2.36	0.32	0.025	2.68	13
04/12/95	397.3	0.5	0.28	0.52	54	0.61	1.51	0.16	2.12	3
05/11/95	397.3	0.5	0.17	0.57	30	0.65	1.2	0.27	1.85	5
07/11/95	397.3	0.5	0.3	0.46	65	0.59	0.94	0.025	1.53	2
08/15/95	397.3	0.5	0.37	0.49	76	0.84	1.19	0.05	2.03	2
09/06/95	397.3	0.5	0.32	0.41	78	0.35	0.96	0.025	1.31	1
10/03/95	397.3	0.5	0.74	0.92	80	1.38	0.97	0.12	2.35	2
03/15/95	398.2	15.55	0.2	0.42	48	5.45	2.29	0.21	7.74	28
04/12/95	398.2	46.2	0.22	0.62	35	4.16	2.1	0.27	6.26	20
05/11/95	398.2	94.11	0.17	0.38	45	2.37	0.75	0.09	3.12	14
07/11/95	398.2	92.88	0.22	0.42	52	1.78	1.18	0.025	2.96	8
08/15/95	398.2	77.09	0.24	0.38	63	2.02	1.08	0.08	3.10	9
09/06/95	398.2	116	0.27	0.39	69	2.67	0.97	0.06	3.64	10
10/03/95	398.2	24.64	0.27	0.19	142	3.31	0.6	0.12	3.91	13

Appendix 3. (Cont.)

Flow (cfs), nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for agricultural return drains to the Snake River (RM 340-449.3).

Date	River Mile	Flow	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
04/12/95	399	3.06	0.14	0.33	42	4.63	1	0.1	5.63	34
05/11/95	399	14.12	0.05	0.79	6	1.71	1.81	0.46	3.52	43
07/11/95	399	24.76	0.12	0.35	34	1.13	0.75	0.025	1.88	10
08/15/95	399	25.3	0.1	0.19	53	1.32	0.69	0.025	2.01	13
09/06/95	399	16.6	0.12	0.22	55	2.85	0.64	0.025	3.49	24
10/03/95	399	4.3	0.12	0.28	43	2.78	0.05	0.025	2.83	23
07/11/95	400.3	0.5	0.11	0.17	65	3.92	0.82	0.025	4.74	36
08/15/95	400.3	0.5	0.56	0.7	80	3.38	1.54	0.025	4.92	6
09/06/95	400.3	0.5	0.16	0.2	80	11.9	1.14	0.025	13.04	75
10/03/95	400.3	0.5	0.22	0.32	69	5.93	0.97	0.08	6.90	27
08/01/95	401	0.5	0.02	0.11	18	0.9	0.93	0.025	1.83	46
04/12/95	401.3	0.5	0.08	0.12	67	5.76	0.64	0.1	6.40	73
05/11/95	401.3	0.5	0.09	0.23	39	6.75	0.63	0.025	7.38	75
07/11/95	401.3	0.5	0.15	0.3	50	3.68	0.72	0.025	4.40	25
08/15/95	401.3	0.5	0.14	0.2	70	4.42	0.87	0.025	5.29	32
09/06/95	401.3	0.5	0.12	0.18	67	6.37	0.57	0.025	6.94	53
10/03/95	401.3	0.5	0.14	0.22	64	5.28	0.34	0.025	5.62	38
04/12/95	403.6	0.5	0.42	0.68	62	4.01	1.1	0.025	5.11	10
05/11/95	403.6	0.5	0.21	0.42	50	2.72	0.7	0.025	3.42	13
07/11/95	403.6	0.5	0.29	0.75	39	3.16	2.33	0.58	5.49	13
08/15/95	403.6	0.5	0.48	0.67	72	3.58	1.44	0.46	5.02	8
09/06/95	403.6	0.5	0.27	0.45	60	4.06	0.6	0.025	4.66	15
10/03/95	403.6	0.5	0.23	0.29	79	3.81	0.19	0.025	4.00	17
03/15/95	408.4	1	0.24	0.37	65	2.31	3.61	1.93	5.92	18
04/12/95	408.4	8.03	0.28	0.42	67	3.17	1.01	0.12	4.18	12
05/11/95	408.4	2.7	0.18	0.52	35	2.78	0.49	0.17	3.27	16
07/11/95	408.4	6.22	0.24	0.35	69	1.78	0.73	0.025	2.51	8
08/15/95	408.4	7.49	0.29	0.38	76	1.95	0.9	0.025	2.85	7
09/06/95	408.4	5.75	0.28	0.35	80	2.39	1.08	0.07	3.47	9
10/03/95	408.4	4.75	0.2	0.24	83	3.08	0.62	0.06	3.70	16
03/15/95	409.3	0.5	0.05	0.12	42	2.54	0.47	0.025	3.01	51
04/12/95	409.3	0.5	0.24	0.34	71	3.88	1.11	0.025	4.99	16
05/11/95	409.3	0.5	0.09	0.33	27	1.76	0.49	0.025	2.25	20
06/14/95	409.3	0.5	0.19	0.3	63	3.38	1.02	0.06	4.40	18
07/11/95	409.3	0.5	0.11	0.19	58	2.56	0.65	0.025	3.21	24
08/15/95	409.3	0.5	0.13	0.2	65	2.26	0.8	0.025	3.06	18

Appendix 3. (Cont.)

Flow (cfs), nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for agricultural return drains to the Snake River (RM 340-449.3).

Date	River Mile	Flow	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
09/06/95	409.3	0.5	0.17	0.22	77	3.27	0.76	0.025	4.03	19
10/03/95	409.3	0.5	0.12	0.17	71	2.69	0.55	0.025	3.24	23
03/15/95	410.3	0.5	0.07	0.11	64	8.24	0.53	0.13	8.77	120
04/12/95	410.3	0.5	0.08	0.42	19	1.23	1.19	0.05	2.42	16
05/11/95	410.3	0.5	0.06	0.21	29	1.26	0.56	0.025	1.82	21
07/11/95	410.3	0.5	0.09	0.44	20	0.95	0.92	0.025	1.87	11
08/15/95	410.3	0.5	0.07	0.2	35	1.2	0.74	0.025	1.94	18
09/06/95	410.3	0.5	0.08	0.23	35	1.46	0.81	0.025	2.27	19
10/03/95	410.3	0.5	0.14	0.21	67	2.33	0.82	0.025	3.15	17
03/15/95	410.5	0.5	0.06	0.13	46	5.61	0.43	0.05	6.04	94
03/15/95	411.7	0.75	0.04	0.08	50	5.64	0.29	0.025	5.93	142
04/12/95	411.7	36.94	0.35	0.46	76	4.61	0.66	0.025	5.27	13
05/11/95	411.7	34.88	0.15	0.27	56	2.16	0.54	0.025	2.70	15
06/14/95	411.7	7.48	0.15	0.24	63	2.37	0.7	0.025	3.07	16
07/11/95	411.7	21.45	0.15	0.26	58	2	0.63	0.025	2.63	14
08/15/95	411.7	19.75	0.17	0.24	71	2.34	0.71	0.025	3.05	14
09/06/95	411.7	16.9	0.18	0.26	69	3.15	0.85	0.025	4.00	18
10/03/95	411.7	7.97	0.17	0.22	77	2.44	0.59	0.025	3.03	15
03/15/95	412	0.5	0.07	0.11	64	3.2	0.44	0.025	3.64	46
04/12/95	412	0.5	0.06	0.12	50	2.75	0.61	0.025	3.36	46
03/15/95	413.1	0.5	0.05	0.1	50	4	0.44	0.025	4.44	81
04/12/95	413.1	0.5	0.05	0.12	42	3.58	0.37	0.15	3.95	75
05/11/95	413.1	0.5	0.03	0.11	27	2.01	0.39	0.025	2.40	68
06/14/95	413.1	0.5	0.06	0.17	35	1.62	0.55	0.08	2.17	28
07/11/95	413.1	0.5	0.07	0.22	32	2.58	1.39	0.3	3.97	41
08/15/95	413.1	0.5	0.05	0.13	38	1.94	0.62	0.025	2.56	39
09/06/95	413.1	0.5	0.05	0.2	25	3.25	0.89	0.025	4.14	66
10/03/95	413.1	0.5	0.07	0.14	50	2.99	0.77	0.07	3.76	44
07/11/95	413.5	0.5	0.08	0.16	50	2.61	0.88	0.12	3.49	34
09/06/95	413.5	4.28	0.04	0.15	27	2.11	0.69	0.025	2.80	53
10/03/95	413.5	2.74	0.05	0.12	42	2.01	0.58	0.025	2.59	41
04/12/95	413.8	0.5	0.01	0.09	11	8.36	0.53	0.08	8.89	844
05/11/95	413.8	0.5	0.02	0.12	17	1.5	0.58	0.025	2.08	76
06/14/95	413.8	0.5	0.09	0.17	53	2.65	0.47	0.025	3.12	30
07/11/95	413.8	0.5	0.12	0.15	80	5.09	0.83	0.07	5.92	43
08/15/95	413.8	0.5	0.09	0.13	69	2.4	0.6	0.025	3.00	27

Appendix 3. (Cont.)

Flow (cfs), nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for agricultural return drains to the Snake River (RM 340-449.3).

Date	River Mile	Flow	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
09/06/95	413.8	0.5	0.07	0.12	58	3.42	0.54	0.025	3.96	49
10/03/95	413.8	0.5	0.08	0.13	62	2.33	0.45	0.025	2.78	29
03/15/95	414.4	0.5	0.08	0.12	67	9.89	0.05	0.025	9.94	124
03/15/95	415	1	2.17	2.72	80	4.36	16.7	13.1	21.06	8
04/12/95	415	1.7	0.59	0.86	69	1.51	5.33	2.09	6.84	6
07/11/95	415	3.91	0.37	0.76	49	2.21	2.76	0.7	4.97	8
08/15/95	415	10.99	0.18	0.41	44	1.98	1.1	0.14	3.08	12
09/06/95	415	6.81	0.11	0.42	26	3.34	1.85	0.26	5.19	33
10/03/95	415	0.37	0.69	1.08	64	3.52	5.39	3.14	8.91	10
03/15/95	415.5	225	0.09	0.2	45	1.73	0.65	0.45	2.38	24
04/12/95	415.5	231	0.11	0.14	79	0.45	0.55	0.2	1.00	6
05/11/95	415.5	51	0.15	1.31	11	0.38	1.25	0.025	1.63	3
06/14/95	415.5	13	0.12	0.3	40	2.16	0.87	0.025	3.03	18
07/11/95	415.5	35	0.152	0.36	42	1.21	0.85	0.025	2.06	8
08/15/95	415.5	42	0.08	0.18	44	1.45	0.62	0.025	2.07	18
09/06/95	415.5	38	0.07	0.2	35	1.74	0.87	0.025	2.61	25
10/03/95	415.5	42	0.1	0.23	43	2.23	0.58	0.025	2.81	23
05/11/95	415.6	0.5	0.02	0.06	33	0.05	0.4	0.025	0.45	4
06/14/95	415.6	0.5	0.04	0.14	29	0.68	0.74	0.025	1.42	18
07/11/95	415.6	0.5	0.04	0.09	44	0.13	0.47	0.025	0.60	4
08/15/95	415.6	0.5	0.03	0.11	27	1.07	0.57	0.05	1.64	37
09/06/95	415.6	0.5	0.04	0.08	50	2	0.39	0.025	2.39	51
10/03/95	415.6	0.5	0.04	0.1	40	0.6	0.37	0.025	0.97	16
03/15/95	416.8	0.5	0.06	0.1	60	5.94	0.05	0.025	5.99	99
04/12/95	416.8	0.5	0.04	0.08	50	5.12	0.27	0.025	5.39	129
05/11/95	416.8	0.5	0.005	0.05	10	0.21	0.35	0.025	0.56	47
06/14/95	416.8	0.5	0.02	0.07	29	0.11	0.33	0.025	0.44	7
07/11/95	416.8	0.5	0.04	0.09	44	0.16	0.45	0.025	0.61	5
08/15/95	416.8	0.5	0.02	0.12	17	0.47	0.78	0.025	1.25	25
09/06/95	416.8	0.5	0.02	0.13	15	0.7	0.66	0.025	1.36	36
10/03/95	416.8	0.5	0.03	0.08	38	0.81	0.48	0.08	1.29	30
06/14/95	417.1	0.5	0.11	0.41	27	2.8	1.25	0.14	4.05	27
07/11/95	417.1	0.5	0.09	0.3	30	2.56	0.88	0.025	3.44	29
08/15/95	417.1	0.5	0.07	0.23	30	2.63	0.6	0.025	3.23	38
09/06/95	417.1	0.5	0.09	0.16	56	4.31	0.68	0.025	4.99	48
10/03/95	417.1	0.5	0.11	0.18	61	3.87	0.72	0.14	4.59	36

Appendix 3. (Cont.)

Flow (cfs), nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for agricultural return drains to the Snake River (RM 340-449.3).

Date	River Mile	Flow	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
03/15/95	417.7	2.6	0.07	0.11	64	7.32	0.29	0.025	7.61	105
04/12/95	417.7	1.63	0.04	0.11	36	6.88	0.13	0.06	7.01	174
05/11/95	417.7	3.45	0.07	0.21	33	4.74	0.63	0.025	5.37	68
07/11/95	417.7	7.93	0.14	0.2	70	2.98	0.5	0.025	3.48	21
08/15/95	417.7	6.49	0.09	0.19	47	3.81	0.76	0.17	4.57	44
09/06/95	417.7	8.8	0.09	0.18	50	5.49	0.91	0.025	6.40	61
10/03/95	417.7	2.53	0.07	0.12	58	6.56	0.39	0.025	6.95	94
03/15/95	419	24	0.05	0.14	36	4.76	0.83	0.025	5.59	96
04/12/95	419	44.5	0.09	0.07	129	2.52	2.1	0.27	4.62	31
05/11/95	419	68	0.08	0.35	23	1.84	0.92	0.025	2.76	23
06/14/95	419	99	0.11	0.47	23	2.2	1.2	0.06	3.40	21
07/11/95	419	99	0.12	0.48	25	1.96	1.37	0.025	3.33	17
08/15/95	419	79	0.08	0.27	30	2.12	0.77	0.025	2.89	27
09/06/95	419	60	0.09	0.23	39	2.84	0.72	0.025	3.56	32
10/03/95	419	81	0.1	0.24	42	2.7	0.6	0.025	3.30	27
03/15/95	420.1	0.5	0.04	0.08	50	3.75	0.22	0.06	3.97	95
07/11/95	421.3	0.5	0.02	0.07	29	0.05	0.38	0.025	0.43	4
08/15/95	421.3	0.5	0.02	0.11	18	0.39	0.74	0.025	1.13	21
09/06/95	421.3	0.5	0.02	0.09	22	0.26	0.56	0.025	0.82	14
10/03/95	421.3	0.5	0.03	0.08	38	0.55	0.25	0.025	0.80	19
06/14/95	421.4	2.33	0.05	0.56	9	0.21	1.22	0.025	1.43	5
07/11/95	421.4	1.33	0.03	0.11	27	0.05	0.42	0.025	0.47	2
08/15/95	421.4	0.99	0.03	0.13	23	0.43	0.57	0.025	1.00	15
09/06/95	421.4	0.54	0.03	0.16	19	0.52	0.63	0.025	1.15	18
10/03/95	421.4	0.09	0.14	0.22	64	0.35	0.78	0.05	1.13	3
03/15/95	421.8	0.5	0.04	0.06	67	4.29	0.22	0.025	4.51	108
04/12/95	421.8	0.5	0.02	0.05	40	4.69	0.14	0.025	4.83	236
05/11/95	421.8	0.5	0.05	0.12	42	3.96	0.49	0.025	4.45	80
06/14/95	421.8	0.5	0.07	0.13	54	2.95	0.35	0.07	3.30	43
07/11/95	421.8	0.5	0.04	0.08	50	2.96	0.55	0.025	3.51	75
08/15/95	421.8	0.5	0.11	0.21	52	3.14	0.56	0.08	3.70	29
09/06/95	421.8	0.5	0.06	0.13	46	3.92	0.76	0.025	4.68	66
10/03/95	421.8	0.5	0.08	0.11	73	4.33	0.31	0.025	4.64	54
03/15/95	423.2	0.61	0.03	0.07	43	4.74	0.22	0.025	4.96	159
04/12/95	423.2	2.14	0.05	0.07	71	3.97	0.21	0.09	4.18	81
05/10/95	423.2	1.8	0.07	0.12	58	3.25	0.47	0.025	3.72	47

Appendix 3. (Cont.)

Flow (cfs), nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for agricultural return drains to the Snake River (RM 340-449.3).

Date	River Mile	Flow	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
06/14/95	423.2	2.35	0.04	0.08	50	3.66	0.62	0.025	4.28	92
08/15/95	423.2	0.42	0.06	0.15	40	2.56	0.63	0.06	3.19	44
09/06/95	423.2	3.37	0.03	0.14	21	2.61	0.78	0.025	3.39	88
10/03/95	423.2	1.06	0.03	0.1	30	3.22	0.43	0.025	3.65	108
03/15/95	423.7	2.53	0.12	0.21	57	3.92	1.5	0.85	5.42	40
05/10/95	423.7	19.07	0.01	0.08	13	0.54	0.38	0.025	0.92	57
06/13/95	423.7	3.18	0.04	0.06	67	2.54	0.36	0.08	2.90	66
07/10/95	423.7	19.6	0.04	0.32	13	0.22	0.96	0.025	1.18	6
08/15/95	423.7	2.47	0.02	0.17	12	1.25	0.61	0.025	1.86	64
09/06/95	423.7	71.85	0.02	0.14	14	0.85	0.82	0.025	1.67	44
10/03/95	423.7	4.43	0.03	0.08	38	0.76	0.39	0.025	1.15	26
05/10/95	424.3	0.5	0.07	0.17	41	0.3	0.5	0.025	0.80	5
06/13/95	424.3	0.5	0.22	0.25	88	0.29	0.73	0.07	1.02	2
07/10/95	424.3	0.5	0.24	1.01	24	0.14	1.48	0.06	1.62	1
08/15/95	424.3	0.5	0.04	0.42	10	0.59	0.96	0.025	1.55	15
09/06/95	424.3	0.5	0.41	0.74	55	0.79	1.68	0.025	2.47	2
10/03/95	424.3	0.5	0.08	0.19	42	0.52	0.48	0.025	1.00	7
03/15/95	424.8	0.5	0.08	0.14	57	7.27	0.17	0.025	7.44	91
05/11/95	424.8	0.5	0.09	0.36	25	1.24	1.07	0.025	2.31	14
07/10/95	424.8	0.5	0.06	0.32	19	0.68	0.82	0.025	1.50	12
08/15/95	424.8	0.5	0.07	0.29	24	1.08	0.71	0.025	1.79	16
09/06/95	424.8	0.5	0.07	0.26	27	1.32	0.74	0.025	2.06	19
10/03/95	424.8	0.5	0.07	0.26	27	1.6	0.49	0.025	2.09	23
05/10/95	425.1	0.5	0.1	0.13	77	6.46	0.4	0.025	6.86	65
06/13/95	425.1	0.5	0.14	6.28	2	0.55	11.8	0.4	12.35	7
07/10/95	425.1	0.5	0.14	5.6	3	0.92	8.73	0.16	9.65	8
08/14/95	425.1	0.5	0.05	0.4	13	3.84	1.37	0.06	5.21	78
09/05/95	425.1	0.5	0.05	0.38	13	5.41	1.33	0.025	6.74	109
10/04/95	425.1	0.5	0.05	0.26	19	5.5	0.82	0.025	6.32	111
03/14/95	426.7	0.72	0.06	0.32	19	4.63	0.18	0.025	4.81	78
05/10/95	426.7	4.73	0.04	0.21	19	1.93	0.63	0.025	2.56	49
06/13/95	426.7	1.87	0.08	0.42	19	2.42	1.1	0.08	3.52	31
07/10/95	426.7	5.83	0.07	0.47	15	1.81	0.97	0.06	2.78	27
08/14/95	426.7	0.5	0.05	0.17	29	1.89	0.72	0.025	2.61	38
09/05/95	426.7	4.81	0.03	0.16	19	3.26	0.87	0.025	4.13	110
10/04/95	426.7	1.78	0.05	0.16	31	3.28	0.53	0.025	3.81	66

Appendix 3. (Cont.)

Flow (cfs), nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for agricultural return drains to the Snake River (RM 340-449.3).

Date	River Mile	Flow	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
03/14/95	426.8	0.5	0.05	0.24	21	4.14	0.05	0.025	4.19	83
05/10/95	426.8	0.5	0.1	0.29	34	4.21	1.26	0.07	5.47	43
06/13/95	426.8	0.5	0.15	0.37	41	2.23	1.28	0.09	3.51	15
07/10/95	426.8	0.5	0.08	0.24	33	2.55	0.5	0.025	3.05	32
08/14/95	426.8	0.5	0.16	0.25	64	2.92	0.78	0.05	3.70	19
09/05/95	426.8	0.5	0.05	0.14	36	5.73	0.53	0.025	6.26	115
10/04/95	426.8	0.5	0.06	0.11	55	5.01	0.23	0.025	5.24	84
03/14/95	427.5	0.7	0.03	0.15	20	8.05	0.05	0.025	8.10	269
05/10/95	427.5	1.61	0.03	0.11	27	7.76	0.38	0.025	8.14	260
06/13/95	427.5	0.51	0.26	0.61	43	0.05	1.01	0.06	1.06	0
07/10/95	427.5	5.53	0.04	0.12	33	6.07	0.5	0.025	6.57	152
08/14/95	427.5	0.5	0.04	0.08	50	6.38	0.48	0.05	6.86	161
09/05/95	427.5	3.79	0.05	0.11	45	8.67	0.29	0.025	8.96	174
10/04/95	427.5	1.06	0.05	0.07	71	8.24	0.17	0.025	8.41	165
03/14/95	429.6	0.5	0.04	0.19	21	14.6	1.16	0.08	15.76	367
05/10/95	429.6	0.5	0.05	0.08	63	8.59	0.05	0.025	8.64	172
07/10/95	429.6	0.5	0.05	0.09	56	7.85	0.3	0.025	8.15	158
08/14/95	429.6	0.5	0.05	0.09	56	7.18	0.39	0.025	7.57	144
10/04/95	429.6	0.5	0.06	0.16	38	6.15	0.22	0.025	6.37	103
03/14/95	430.7	0.5	0.05	0.18	28	10	0.05	0.025	10.05	201
06/13/95	431.7	0.5	0.12	0.28	43	0.17	0.68	0.08	0.85	2
07/10/95	431.7	0.5	0.07	0.22	32	0.27	0.84	0.1	1.11	5
08/14/95	431.7	0.5	0.13	0.68	19	0.46	1.45	0.1	1.91	4
03/14/95	431.8	0.5	0.06	0.18	33	0.05	0.61	0.07	0.66	2
05/10/95	431.8	0.5	0.17	0.83	20	0.4	0.94	0.025	1.34	3
06/13/95	431.8	0.5	0.05	0.09	56	0.26	0.45	0.025	0.71	6
07/10/95	431.8	0.5	0.05	0.12	42	0.16	0.57	0.025	0.73	4
08/14/95	431.8	0.5	0.02	0.09	22	0.57	0.51	0.05	1.08	31
09/05/95	431.8	0.5	0.04	0.1	40	0.3	0.44	0.025	0.74	8
10/04/95	431.8	0.5	0.04	0.09	44	0.75	0.4	0.025	1.15	19
08/14/95	432.2	0.5	0.17	2.64	6	1.75	2.94	0.08	4.69	11
10/04/95	432.2	0.37	0.38	0.48	79	4.89	1.07	0.24	5.96	14
05/10/95	432.9	4.89	0.02	0.1	20	0.05	0.51	0.025	0.56	4
06/13/95	432.9	1.09	0.04	0.1	40	0.18	0.6	0.07	0.78	6
07/10/95	432.9	6.92	0.05	0.18	28	0.28	1.05	0.07	1.33	7
08/14/95	432.9	0.5	0.04	0.12	33	0.43	0.68	0.025	1.11	11

Appendix 3. (Cont.)

Flow (cfs), nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for agricultural return drains to the Snake River (RM 340-449.3).

Date	River Mile	Flow	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
09/05/95	432.9	1.58	0.02	0.15	13	0.39	0.97	0.05	1.36	22
10/04/95	432.9	0.76	0.04	0.11	36	0.82	0.9	0.025	1.72	21
03/14/95	436.9	0.44	0.06	0.56	11	1.8	1.18	0.07	2.98	31
05/10/95	436.9	1.83	0.07	0.23	30	0.25	0.74	0.025	0.99	4
06/13/95	436.9	2	0.11	0.12	92	0.05	0.33	0.06	0.38	1
07/10/95	436.9	6.81	0.09	0.21	43	0.22	0.74	0.025	0.96	3
08/14/95	436.9	0.5	0.14	0.36	39	1.11	0.84	0.025	1.95	8
09/05/95	436.9	3.62	0.12	0.23	52	0.97	0.89	0.09	1.86	9
10/04/95	436.9	1.16	0.13	0.32	41	1.03	0.81	0.09	1.84	9
05/10/95	438.1	0.5	0.08	0.16	50	2.32	0.41	0.025	2.73	29
06/13/95	438.1	0.5	0.12	0.3	40	1.93	0.59	0.025	2.52	16
07/10/95	438.1	0.5	0.12	0.32	38	3.15	0.96	0.13	4.11	27
08/14/95	438.1	0.5	0.12	0.22	55	2.15	0.51	0.06	2.66	18
09/05/95	438.1	0.5	0.11	0.21	52	3.15	0.6	0.025	3.75	29
10/04/95	438.1	0.5	0.11	0.33	33	2.78	0.72	0.025	3.50	26
06/13/95	438.9	2	0.38	1.88	20	2.03	1.71	0.08	3.74	6
07/10/95	438.9	2.64	0.19	0.98	19	3.17	1.09	0.07	4.26	17
09/05/95	438.9	1.74	0.14	0.3	47	3.22	0.74	0.06	3.96	23
05/10/95	439.6	0.5	0.17	1.54	11	0.19	1.13	0.06	1.32	1
06/13/95	439.6	0.5	0.29	0.67	43	0.21	0.78	0.1	0.99	1
07/10/95	439.6	0.5	0.12	1.33	9	0.55	1.78	0.025	2.33	5
08/14/95	439.6	0.5	0.28	0.51	55	1.68	1.28	0.025	2.96	6
09/05/95	439.6	0.5	0.2	0.43	47	0.53	0.78	0.025	1.31	3
03/14/95	441.1	0.5	0.09	0.22	41	0.24	0.56	0.025	0.80	3
05/10/95	441.1	0.5	0.12	0.35	34	0.29	0.6	0.025	0.89	3
08/14/95	441.1	0.5	0.14	0.21	67	1.05	0.55	0.025	1.60	8
09/05/95	441.1	0.5	0.18	0.25	72	1.3	0.45	0.025	1.75	7
10/04/95	441.1	0.5	0.15	0.2	75	1.81	0.42	0.025	2.23	12
03/14/95	442.6	0.5	0.07	0.24	29	4.91	0.71	0.09	5.62	71
05/10/95	442.6	0.5	0.1	0.25	40	2.71	0.77	0.09	3.48	28
06/13/95	442.6	0.5	0.21	0.38	55	1.64	0.74	0.025	2.38	8
07/10/95	442.6	0.5	0.12	0.36	33	2.72	1.08	0.09	3.80	23
08/14/95	442.6	0.5	0.15	0.29	52	1.79	0.59	0.025	2.38	12
09/05/95	442.6	0.5	0.13	0.26	50	2.9	0.5	0.025	3.40	23
10/04/95	442.6	0.5	0.15	0.21	71	2.56	0.4	0.025	2.96	17
03/14/95	443.4	0.5	0.08	0.16	50	5.39	0.05	0.025	5.44	68

Appendix 3. (Cont.)

Flow (cfs), nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for agricultural return drains to the Snake River (RM 340-449.3).

Date	River Mile	Flow	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
08/14/95	443.4	0.5	0.07	0.13	54	4.52	0.36	0.025	4.88	65
09/05/95	443.8	0.5	0.09	0.16	56	4.83	0.38	0.025	5.21	54
07/10/95	444.1	0.5	0.18	0.21	86	0.82	0.7	0.025	1.52	5
03/14/95	444.5	0.5	0.04	0.21	19	10.9	0.05	0.025	10.95	273
03/14/95	447.5	0.54	0.04	0.21	19	1.44	0.21	0.025	1.65	37
05/10/95	447.5	0.47	0.09	1	9	2.44	1.53	0.22	3.97	30
07/10/95	447.5	0.26	0.03	0.07	43	0.87	0.55	0.025	1.42	30
08/14/95	447.5	0.5	0.02	0.08	25	0.95	0.4	0.025	1.35	49
09/05/95	447.5	1	0.06	0.16	38	1.21	0.25	0.025	1.46	21
10/04/95	447.5	0.12	0.02	0.08	25	1.36	0.22	0.025	1.58	69
Mean			0.121	0.318	45	2.653	0.805	0.106	3.458	38
SD			0.135	0.474	21	2.313	1.148	0.656	2.494	59
Median			0.090	0.220	43	2.160	0.630	0.025	3.030	20
Minimum			0.005	0.050	2	0.050	0.050	0.025	0.270	0
Maximum			2.170	6.280	142	14.600	16.700	13.100	21.060	844

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Snake River at Porter's Flat (RM 340).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
03/28/95	0.06	0.14	43	1.06	0.29	0.025	1.35	18
04/10/95	0.02	0.13	15	0.47	0.67	0.025	1.14	25
04/26/95	0.005	0.24	2	0.48	0.8	0.025	1.28	101
05/10/95	0.02	0.87	2	0.2	1.09	0.025	1.29	11
05/24/95	0.01	0.17	6	0.29	0.86	0.05	1.15	34
06/14/95	0.05	0.13	38	0.48	0.41	0.025	0.89	10
06/28/95	0.005	0.19	3	0.2	1.01	0.025	1.21	45
07/26/95	0.04	0.17	24	0.73	0.92	0.025	1.65	19
08/01/95	0.02	0.18	11	0.86	1.16	0.2	2.02	53
08/17/95	0.03	0.16	19	0.86	1.06	0.025	1.92	30
08/30/95	0.03	0.16	19	0.21	1	0.025	1.21	8
09/08/95	0.04	0.16	25	1.04	0.65	0.025	1.69	27
09/20/95	0.05	0.17	29	1.17	0.84	0.025	2.01	24
10/19/95	0.01	0.12	8	0.89	0.67	0.025	1.56	92
11/08/95	0.02	0.1	20	1.16	1.01	0.17	2.17	67
11/29/95	0.04	0.1	40	1.26	1.04	0.12	2.30	35
12/27/95	0.08	0.11	73	1.52	0.48	0.09	2.00	20
01/24/96	0.07	0.12	58	1.52	0.65	0.025	2.17	22
02/21/96	0.08	0.23	35	0.78	0.53	0.025	1.31	10
03/19/96	0.02	0.11	18	0.49	0.46	0.13	0.95	31
04/25/96	0.05	0.16	31	0.33	0.64	0.025	0.97	7
05/30/96	0.005	0.12	4	0.12	1.08	0.025	1.20	29
06/17/96	0.01	0.12	8	0.005	0.73	0.025	0.74	3
07/29/96	0.01	0.16	6	0.65	1.34	0.18	1.99	83
08/16/96	0.02	0.18	11	0.68	1.08	0.025	1.76	35
09/24/96	0.05	0.12	42	1.31	0.73	0.025	2.04	27
10/06/96	0.08	0.13	62	1.56	0.66	0.025	2.22	20
10/30/96	0.05	0.13	38	1.66	0.42	0.025	2.08	34
11/27/96	0.03	0.11	27	1.41	0.84	0.06	2.25	49
12/17/96	0.06	0.1	60	1.55	0.37	0.025	1.92	26
01/28/97	0.07	0.15	47	1.03	0.32	0.025	1.35	15
02/27/97	0.05	0.09	56	0.82	0.43	0.025	1.25	17
03/06/97	0.03	0.09	33	0.7	0.34	0.025	1.04	24
03/19/97	0.03	0.08	38	0.62	0.6	0.025	1.22	22
03/26/97	0.02	0.1	20	0.42	0.48	0.025	0.90	22
04/02/97	0.005	0.11	5	0.35	0.74	0.05	1.09	80
04/16/97	0.01	0.11	9	0.41	0.59	0.025	1.00	44

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Snake River at Porter's Flat (RM 340).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
04/29/97	0.04	0.13	31	0.51	1.1	0.05	1.61	14
05/15/97	0.005	0.18	3	0.34	1	0.025	1.34	73
05/28/97	0.02	0.12	17	0.47	0.78	0.06	1.25	27
06/11/97	0.005	0.12	4	0.27	0.85	0.025	1.12	59
06/25/97	0.04	0.13	31	0.51	0.87	0.05	1.38	14
07/24/97	0.005	0.131	4	0.58	1.06	0.1	1.64	136
07/31/97	0.012	0.08	15	0.96	0.65	0.04	1.61	83
08/28/97	0.005	0.131	4	0.58	0.92	0.01	1.50	118
09/03/97	0.005	0.115	4	0.73	1.23	0.08	1.96	162
09/18/97	0.046	0.125	37	1.05	0.84	0.02	1.89	23
09/29/97	0.005	0.115	4	0.79	0.93	0.04	1.72	166
10/14/97	0.005	0.108	5	0.84	0.97	0.04	1.81	176
10/28/97	0.012	0.086	14	1.01	0.93	0.03	1.94	87
11/12/97	0.005	0.085	6	0.98	0.71	0.02	1.69	200
11/26/97	0.005	0.093	5	1.22	0.81	0.04	2.03	252
12/23/97	0.039	0.07	56	1.4	0.31	0.01	1.71	36
12/29/97	0.038	0.068	56	1.39	0.27	0.005	1.66	37
01/08/98	0.026	0.076	34	1.32	0.51	0.05	1.83	53
01/20/98	0.061	0.177	34	1.21	0.71	0.02	1.92	20
01/29/98	0.038	0.11	35	1.09	0.68	0.005	1.77	29
02/04/98	0.045	0.096	47	1.31	0.44	0.05	1.75	30
02/18/98	0.044	0.102	43	1.23	0.41	0.005	1.64	28
02/25/98	0.038	0.074	51	1.02	0.42	0.08	1.44	29
03/03/98	0.021	0.092	23	0.95	0.58	0.03	1.53	47
03/17/98	0.005	0.122	4	0.58	1.04	0.04	1.62	124
03/25/98	0.025	0.163	15	0.53	0.61	0.04	1.14	23
04/03/98	0.025	0.118	21	0.63	0.6	0.02	1.23	26
04/15/98	0.013	0.111	12	0.47	0.58	0.05	1.05	40
04/28/98	0.005	0.128	4	0.38	0.56	0.04	0.94	84
05/13/98	0.03	0.148	20	0.49	0.51	0.01	1.00	17
05/26/98	0.04	0.17	24	0.34	0.56	0.005	0.90	9
05/28/98	0.065	0.267	24	0.33	0.55	0.05	0.88	6
06/10/98	0.016	0.079	20	0.27	0.64	0.005	0.91	17
06/23/98	0.007	0.06	12	0.17	0.63	0.3	0.80	67
06/30/98	0.0025	0.105	2	0.25	0.71	0.08	0.96	132
07/08/98	0.006	0.128	5	0.39	0.77	0.05	1.16	73
07/21/98	0.008	0.142	6	0.61	0.93	0.02	1.54	79

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Snake River at Porter's Flat (RM 340).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
07/31/98	0.013	0.168	8	0.66	0.94	0.005	1.60	51
08/05/98	0.003	0.133	2	0.51	1.07	0.04	1.58	183
08/18/98	0.005	0.151	3	0.71	1.28	0.01	1.99	144
08/26/98	0.0025	0.137	2	0.68	1.12	0.04	1.80	288
09/02/98	0.008	0.139	6	0.78	1.31	0.05	2.09	104
09/16/98	0.013	0.162	8	0.91	0.9	0.03	1.81	72
09/24/98	0.039	0.107	36	1.25	0.73	0.01	1.98	32
09/30/98	0.03	0.14	21	1.16	0.88	0.04	2.04	40
10/14/98	0.031	0.073	42	1.24	0.61	0.005	1.85	40
10/27/98	0.006	0.077	8	1.15	0.67	0.04	1.82	198
10/29/98	0.007	0.073	10	1.12	0.71	0.01	1.83	161
11/23/98	0.032	0.114	28	1.47	0.7	0.05	2.17	48
11/24/98	0.034	0.11	31	1.42	0.51	0.02	1.93	42
12/15/98	0.059	0.074	80	1.36	0.27	0.005	1.63	23
12/28/98	0.05	0.06	83	1.36	0.25	0.005	1.61	27
12/29/98	0.056	0.088	64	1.42	0.38	0.005	1.80	25
01/12/99	0.042	0.07	60	1.23	0.25	0.005	1.48	29
01/27/99	0.055	0.097	57	1.31	0.35	0.02	1.66	24
01/28/99	0.058	0.09	64	1.37	0.44	0.005	1.81	24
02/09/99	0.07	0.098	71	1.34	0.43	0.02	1.77	19
02/23/99	0.054	0.093	58	1.15	0.41	0.005	1.56	21
02/24/99	0.071	0.275	26	1.03	0.89	0.0099	1.92	15
03/15/99	0.043	0.089	48	0.59	0.43	0.02	1.02	14
03/24/99	0.021	0.11	19	0.5	0.24	0.005	0.74	24
03/31/99	0.018	0.108	17	0.43	0.51	0.01	0.94	24
04/29/99	0.027	0.227	12	0.39	0.79	0.005	1.18	15
04/30/99	0.023	0.123	19	0.42	0.49	0.005	0.91	18
05/12/99	0.027	0.105	26	0.5	0.75	0.02	1.25	19
05/18/99	0.023	0.114	20	0.42	0.62	0.005	1.04	18
05/26/99	0.018	0.141	13	0.2	0.79	0.005	0.99	11
06/22/99	0.026	0.119	22	0.05	0.73	0.06	0.78	4
06/29/99	0.02	0.1	20	0.23	0.65	0.01	0.88	12
07/07/99	0.021	0.126	17	0.4	1.19	0.04	1.59	21
07/22/99	0.031	0.165	19	0.43	1.11	0.01	1.54	14
07/27/99	.	0.121	.	0.46	0.84	0.07	1.30	.
08/10/99	0.012	0.136	9	0.57	0.97	0.03	1.54	50
08/18/99	0.011	0.118	9	0.55	0.9	0.14	1.45	63

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Snake River at Porter's Flat (RM 340).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
08/24/99	0.012	0.117	10	0.81	1.12	0.09	1.93	75
09/08/99	0.0025	0.11	2	0.8	0.71	0.005	1.51	322
09/20/99	0.017	0.084	20	0.92	0.74	0.02	1.66	55
09/30/99	0.005	0.108	5	0.98	0.96	0.04	1.94	204
10/05/99	0.01	0.109	9	0.87	1.16	0.04	2.03	91
10/19/99	0.006	0.083	7	1.17	0.6	0.02	1.77	198
10/27/99	0.027	0.075	36	1.37	0.42	0.005	1.79	51
11/03/99	0.009	0.086	10	1.18	0.7	0.05	1.88	137
11/16/99	0.03	0.083	36	1.32	0.52	0.0199	1.84	45
11/23/99	0.047	0.074	64	1.48	0.59	0.0399	2.07	32
12/09/99	0.058	0.079	73	1.8	0.46	0.71	2.26	43
12/21/99	0.069	0.091	76	1.65	0.05	0.03	1.70	24
12/28/99	0.059	0.08	74	2.02	0.26	0.0099	2.28	34
01/03/00	0.063	0.087	72	1.65	0.15	0.005	1.80	26
01/19/00	0.054	0.086	63	1.62	0.24	0.005	1.86	30
01/26/00	0.058	0.149	39	1.56	0.4	0.005	1.96	27
02/03/00	0.049	0.107	46	1.25	0.27	0.02	1.52	26
02/15/00	0.069	0.425	16	1	0.91	0.03	1.91	15
02/24/00	0.14	0.323	43	1.31	0.64	0.04	1.95	10
03/01/00	0.091	0.221	41	1.17	0.58	0.02	1.75	13
03/28/00	0.053	0.161	33	0.67	0.78	0.005	1.45	13
04/11/00	0.013	0.147	9	0.33	0.84	0.005	1.17	26
04/18/00	0.027	0.141	19	0.29	0.8	0.005	1.09	11
Mean	0.031	0.132	27	0.854	0.699	0.041	1.553	54
SD	0.024	0.082	21	0.449	0.274	0.071	0.408	59
Median	0.027	0.118	20	0.815	0.690	0.025	1.615	29
Minimum	0.003	0.060	2	0.005	0.050	0.005	0.735	3
Maximum	0.140	0.870	83	2.020	1.340	0.710	2.300	322

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Burnt River (RM 1.4).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
04/01/99	0.089	0.351	25	0.17	0.39	0.02	0.56	2
04/29/99	0.087	0.384	23	0.05	0.63	0.02	0.68	1
05/19/99	0.108	0.252	43	0.15	0.47	0.005	0.62	1
06/29/99	0.109	0.155	70	0.05	0.4	0.05	0.45	1
07/22/99	0.157	0.194	81	0.05	0.57	0.005	0.62	0
08/17/99	0.164	0.196	84	0.05	0.59	0.03	0.64	0
09/29/99	0.109	0.148	74	0.05	0.52	0.04	0.57	1
10/26/99	0.074	0.079	94	0.05	0.28	0.005	0.33	1
11/22/99	0.085	0.105	81	0.05	0.12	0.05	0.17	1
12/27/99	0.089	0.107	83	0.47	0.24	0.03	0.71	6
01/25/00	0.082	0.136	60	0.41	0.41	0.03	0.82	5
02/24/00	0.118	0.324	36	0.39	0.89	0.04	1.28	4
03/28/00	0.114	0.334	34	0.34	0.73	0.01	1.07	3
04/18/00	0.113	0.284	40	0.11	0.6	0.01	0.71	1
Mean	0.107	0.218	59	0.171	0.489	0.025	0.659	2
SD	0.027	0.102	25	0.159	0.203	0.016	0.277	2
Median	0.109	0.195	65	0.080	0.495	0.025	0.630	1
Minimum	0.074	0.079	23	0.050	0.120	0.005	0.170	0
Maximum	0.164	0.384	94	0.470	0.890	0.050	1.280	6

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Powder River (RM 9.6).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
04/01/99	0.082	0.142	58	0.2	0.39	0.005	0.59	3
04/29/99	0.056	0.15	37	0.05	0.44	0.005	0.49	1
05/19/99	0.102	0.176	58	0.05	0.55	0.005	0.60	1
06/29/99	0.105	0.139	76	0.05	0.51	0.03	0.56	1
07/22/99	0.143	0.209	68	0.05	0.58	0.005	0.63	0
08/17/99	0.162	0.169	96	0.05	0.6	0.05	0.65	1
09/29/99	0.09	0.117	77	0.05	0.46	0.02	0.51	1
10/26/99	0.072	0.091	79	0.05	0.41	0.04	0.46	1
11/22/99	0.09	0.12	75	0.05	0.44	0.005	0.49	1
12/27/99	0.063	0.096	66	0.33	0.3	0.005	0.63	5
01/25/00	0.08	0.143	56	0.4	0.5	0.04	0.90	6
02/24/00	0.122	0.215	57	0.32	0.74	0.04	1.06	3
03/23/00	0.095	0.14	68	0.22	0.52	0.005	0.74	2
04/18/00	0.069	0.136	51	0.05	0.42	0.005	0.47	1
Mean	0.095	0.146	66	0.137	0.490	0.019	0.627	2
SD	0.030	0.037	15	0.130	0.108	0.017	0.172	2
Median	0.090	0.141	67	0.050	0.480	0.005	0.595	1
Minimum	0.056	0.091	37	0.050	0.300	0.005	0.460	0
Maximum	0.162	0.215	96	0.400	0.740	0.050	1.060	6

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for Eagle Creek (RM 0.6).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
04/01/99	0.017	0.034	50	0.05	0.05	0.005	0.10	3
04/29/99	0.026	0.044	59	0.05	0.12	0.005	0.17	2
05/19/99	0.02	0.029	69	0.05	0.05	0.005	0.10	3
06/29/99	0.026	0.028	93	0.05	0.05	0.02	0.10	3
07/22/99	0.04	0.061	66	0.05	0.05	0.005	0.10	1
08/17/99	0.065	0.044	148	0.05	0.05	0.04	0.10	1
09/29/99	0.102	0.129	79	0.15	0.56	0.03	0.71	2
10/26/99	0.02	0.025	80	0.05	0.05	0.04	0.10	5
11/22/99	0.012	0.013	92	0.05	0.05	0.03	0.10	7
12/27/99	0.01	0.015	67	0.22	0.05	0.005	0.27	23
01/25/00	0.011	0.018	61	0.05	0.05	0.005	0.10	5
02/24/00	0.051	0.053	96	0.05	0.14	0.02	0.19	1
03/23/00	0.043	0.058	74	0.05	0.17	0.005	0.22	1
04/18/00	0.021	0.036	58	0.05	0.2	0.005	0.25	3
Mean	0.033	0.042	78	0.069	0.117	0.016	0.186	4
SD	0.026	0.029	25	0.051	0.138	0.014	0.163	5
Median	0.024	0.035	72	0.050	0.050	0.005	0.100	3
Minimum	0.010	0.013	50	0.050	0.050	0.005	0.100	1
Maximum	0.102	0.129	148	0.220	0.560	0.040	0.710	23

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Wildhorse River (RM 0.2).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
03/31/99	0.03	0.052	58	0.05	0.23	0.03	0.28	3
04/28/99	0.026	0.073	36	0.05	0.27	0.01	0.32	2
05/20/99	0.027	0.069	39	0.05	0.14	0.02	0.19	3
06/09/99	0.021	0.045	47	0.05	0.11	0.02	0.16	3
06/29/99	0.027	0.043	63	0.05	0.05	0.05	0.10	4
07/22/99	0.047	0.086	55	0.05	0.15	0.005	0.20	1
08/17/99	0.049	0.021	233	0.05	0.11	0.01	0.16	1
09/29/99	0.012	0.018	67	0.05	0.05	0.03	0.10	7
10/26/99	0.013	0.015	87	0.05	0.05	0.03	0.10	6
11/22/99	0.015	0.016	94	0.05	0.05	0.005	0.10	4
12/28/99	0.016	0.017	94	0.36	0.05	0.005	0.41	23
01/25/00	0.015	0.023	65	0.16	0.1	0.03	0.26	13
02/24/00	0.048	0.065	74	0.15	0.25	0.02	0.40	4
03/22/00	0.036	0.039	92	0.05	0.14	0.04	0.19	3
04/19/00	0.031	0.05	62	0.05	0.05	0.005	0.10	2
Mean	0.028	0.042	78	0.085	0.120	0.021	0.205	5
SD	0.013	0.024	47	0.085	0.077	0.014	0.107	6
Median	0.027	0.043	65	0.050	0.110	0.020	0.190	3
Minimum	0.012	0.015	36	0.050	0.050	0.005	0.100	1
Maximum	0.049	0.086	233	0.360	0.270	0.050	0.410	23

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for Pine Creek (RM 0.3).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
03/31/99	0.024	0.061	39	0.3	0.21	0.03	0.51	14
04/29/99	0.015	0.055	27	0.05	0.19	0.02	0.24	5
05/19/99	0.023	0.096	24	0.05	0.22	0.02	0.27	3
06/09/99	0.02	0.055	36	0.05	0.13	0.005	0.18	3
06/29/99	0.032	0.047	68	0.05	0.05	0.02	0.10	2
07/22/99	0.041	0.051	80	0.05	0.22	0.04	0.27	2
08/17/99	0.068	0.059	115	0.05	0.37	0.05	0.42	1
09/29/99	0.017	0.032	53	0.05	0.16	0.03	0.21	5
10/26/99	0.035	0.019	184	0.05	0.05	0.05	0.10	3
11/22/99	0.014	0.019	74	0.05	0.05	0.005	0.10	4
12/27/99	0.016	0.024	67	0.46	0.05	0.005	0.51	29
01/25/00	0.021	0.039	54	0.37	0.11	0.005	0.48	18
02/24/00	0.069	0.126	55	0.47	0.4	0.03	0.87	7
03/23/00	0.04	0.066	61	0.24	0.21	.	0.45	.
04/19/00	0.022	0.06	37	0.05	0.29	0.005	0.34	3
Mean	0.030	0.054	65	0.156	0.181	0.023	0.337	7
SD	0.018	0.028	40	0.164	0.112	0.016	0.209	8
Median	0.023	0.055	55	0.050	0.190	0.020	0.270	3
Minimum	0.014	0.019	24	0.050	0.050	0.005	0.100	1
Maximum	0.069	0.126	184	0.470	0.400	0.050	0.870	29

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Snake River below Hells Canyon Dam (RM 247).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
03/07/95	0.09	0.14	64	1.49	0.24	0.025	1.73	17
03/21/95	0.06	0.09	67	1.15	0.05	0.07	1.20	20
04/04/95	0.06	0.1	60	1.03	0.38	0.025	1.41	18
04/19/95	0.01	0.07	14	0.67	0.37	0.025	1.04	70
05/02/95	0.01	0.06	17	0.48	0.32	0.07	0.80	55
05/16/95	0.02	0.05	40	0.43	1.01	0.13	1.44	28
06/07/95	0.03	0.06	50	0.17	0.31	0.1	0.48	9
08/22/95	0.06	0.08	75	0.72	0.58	0.025	1.30	12
09/26/95	0.09	0.13	69	0.9	0.21	0.025	1.11	10
10/25/95	0.1	0.14	71	1.05	0.64	0.06	1.69	11
11/20/95	0.1	0.11	91	1.1	0.41	0.14	1.51	12
12/20/95	0.09	0.12	75	1.1	0.68	0.27	1.78	15
01/17/96	0.07	0.1	70	1.13	0.35	0.07	1.48	17
02/29/96	0.08	0.13	62	0.94	0.5	0.13	1.44	13
04/16/96	0.04	0.1	40	0.42	0.48	0.08	0.90	13
05/21/96	0.01	0.07	14	0.13	0.36	0.025	0.49	16
06/05/96	0.005	0.06	8	0.05	0.64	0.025	0.69	15
06/17/96	0.02	0.06	33	0.05	0.59	0.025	0.64	4
07/01/96	0.06	0.09	67	0.05	1.15	0.15	1.20	3
07/16/96	0.02	0.03	67	0.05	0.34	0.07	0.39	6
08/21/96	0.05	0.07	71	0.46	0.41	0.025	0.87	10
09/17/96	0.06	0.08	75	0.68	0.43	0.025	1.11	12
10/09/96	0.1	0.16	63	1.14	0.32	0.025	1.46	12
10/23/96	0.07	0.09	78	1.1	0.38	0.025	1.48	16
11/05/96	0.09	0.11	82	0.92	0.41	0.13	1.33	12
11/19/96	0.11	0.14	79	0.9	1.4	0.3	2.30	11
12/19/96	0.08	0.09	89	1.27	0.36	0.21	1.63	19
01/23/97	0.11	0.18	61	0.69	0.35	0.025	1.04	7
02/20/97	0.07	0.11	64	0.83	0.54	0.025	1.37	12
04/16/97	0.02	0.1	20	0.42	0.86	0.24	1.28	33
04/30/97	0.04	0.12	33	0.45	0.72	0.34	1.17	20
05/14/97	0.03	0.1	30	0.56	1.18	0.73	1.74	43
05/28/97	0.03	0.07	43	0.4	0.6	0.2	1.00	20
06/10/97	0.005	0.06	8	0.29	0.42	0.025	0.71	63
06/25/97	0.02	0.06	33	0.29	0.38	0.025	0.67	16
07/08/97	0.02	0.06	33	0.37	0.55	0.025	0.92	20
07/23/97	0.034	0.056	61	0.38	0.46	0.09	0.84	14

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Snake River below Hells Canyon Dam (RM 247).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
08/07/97	0.022	0.0049	449	0.41	0.41	0.3	0.82	32
08/19/97	0.039	0.053	74	0.58	0.38	0.03	0.96	16
09/03/97	0.052	0.08	65	0.71	0.54	0.06	1.25	15
09/18/97	0.063	0.089	71	0.89	0.57	0.4	1.46	20
09/30/97	0.079	0.106	75	0.93	0.8	0.08	1.73	13
10/14/97	0.073	0.087	84	0.76	0.61	0.24	1.37	14
10/30/97	0.057	0.082	70	0.89	0.83	0.23	1.72	20
11/12/97	0.049	0.079	62	0.98	0.58	0.27	1.56	26
11/25/97	0.052	0.073	71	0.94	0.71	0.28	1.65	23
12/09/97	0.051	0.074	69	0.91	0.93	0.34	1.84	25
12/23/97	0.038	0.059	64	1.1	0.47	0.25	1.57	36
01/07/98	0.051	0.066	77	1.16	0.49	0.25	1.65	28
01/20/98	0.058	0.061	95	1.22	0.42	0.13	1.64	23
02/04/98	0.05	0.07	71	1.19	0.48	0.17	1.67	27
02/18/98	0.052	0.088	59	1.14	0.47	0.07	1.61	23
04/02/98	0.03	0.072	42	0.65	0.67	0.12	1.32	26
04/28/98	0.024	0.053	45	0.39	0.35	0.11	0.74	21
05/27/98	0.056	0.156	36	0.39	0.38	0.1	0.77	9
06/23/98	0.011	0.046	24	0.14	0.4	0.005	0.54	13
07/07/98	0.027	0.038	71	0.13	0.27	0.09	0.40	8
07/21/98	0.029	0.044	66	0.28	0.31	0.04	0.59	11
08/18/98	0.05	0.07	71	0.48	0.77	0.08	1.25	11
09/16/98	0.071	0.098	72	0.77	0.52	0.04	1.29	11
10/27/98	0.08	0.095	84	1.18	0.46	0.02	1.64	15
11/23/98	0.08	0.104	77	1.07	0.92	0.12	1.99	15
12/28/98	0.067	0.074	91	1.28	0.56	0.18	1.84	22
01/26/99	0.054	0.082	66	1.18	0.36	0.07	1.54	23
02/23/99	0.063	0.083	76	1.32	0.38	0.03	1.70	21
03/31/99	0.045	0.103	44	0.49	0.72	0.11	1.21	13
04/28/99	0.039	0.103	38	0.34	0.67	0.1	1.01	11
05/26/99	0.023	0.078	29	0.32	0.57	0.05	0.89	16
06/23/99	0.011	0.049	22	0.14	0.81	0.09	0.95	21
07/27/99	.	0.039	.	0.19	0.43	0.14	0.62	.
08/26/99	0.063	0.08	79	0.64	0.36	0.06	1.00	11
09/20/99	0.085	0.115	74	0.88	0.53	0.05	1.41	11
10/19/99	0.064	0.088	73	0.88	0.34	0.03	1.22	14
11/03/99	0.104	0.123	85	0.71	0.48	0.2899	1.19	10

Appendix 3. (Cont.)

Nutrient concentrations (mg/L), orthophosphate/total phosphorus (Op:Tp) ratio (%), and available nitrogen/phosphorus (N:P) ratio for the Snake River below Hells Canyon Dam (RM 247).

Date	Ortho-phosphate	Total Phosphorus	Op:Tp Ratio	Nitrate Nitrogen	Kjeldahl Nitrogen	Ammonia Nitrogen	Total Nitrogen	N:P Ratio
11/17/99	0.076	0.089	85	0.99	0.97	0.28	1.96	17
12/20/99	.	0.077	.	1.15	0.26	0.21	1.41	.
01/04/00	0.063	0.073	86	1.4198	0.39	0.1298	1.81	25
01/19/00	.	0.076	.	1.7	0.43	0.1298	2.13	.
02/03/00	0.065	0.078	83	1.43	0.19	0.08	1.62	23
02/15/00	0.071	0.078	91	1.26	0.37	0.05	1.63	18
03/02/00	0.096	0.099	97	1.09	0.33	0.09	1.42	12
03/27/00	0.089	0.098	91	0.89	0.28	0.04	1.17	10
04/11/00	0.043	0.077	56	0.58	0.34	0.1	0.92	16
Mean	0.054	0.085	66	0.752	0.517	0.122	1.269	18
SD	0.028	0.030	49	0.402	0.236	0.117	0.429	11
Median	0.055	0.080	68	0.770	0.460	0.090	1.300	16
Minimum	0.005	0.005	8	0.050	0.050	0.005	0.390	3
Maximum	0.110	0.180	449	1.700	1.400	0.730	2.300	70

Appendix 4. Monthly load estimates for tributaries to the Hells Canyon Complex.

Monthly total phosphorus loads (kg).															
	Snake	Owyhee	Boise	Nyssa	Malheur	Payette	Weiser	Drains	Porters	Burnt	Powder	Eagle	Wildhorse	Pine	Hells Canyon
199503	70172	107	31206	103037	5035	36521	30684	4956	187159						178445
199504	46584	1536	40805	100887	4957	33004	19595	10310	240128						136664
199505	136748	8248	72427	330036	5422	55622	21138	23682	1015510						137755
199506	134219	18711	40520	270738	3794	57191	8913	27360	353143						162224
199507	50864	10414	39677	188374	5338	24840	4015	29765	203134						101205
199508	51931	4501	27279	96078	3568	6376	4108	15022	126716						81779
199509	67672	3808	27409	98101	4032	7621	3692	16372	136763						125870
199510	55491	1282	28190	88940	3473	8421	1216	4697	117799						141393
199803	90937		36709	136866		32565			260667						165158
199804	94562		33697	146788		29843			255960						142329
199805	113915		83775	245898		88670			618604						493133
199806	96265		58376	209738		44487			281397						255229
199807	40668		29704	69333		15050			156485						73153
199808	34280		28728	57674		9215			125427						70341
199809	45958		30756	83691		8224			140399						127929
199810	40206		26353	73459		5223			98113						112514
199811	66033		26040	86041		7704			114726						70494
199812	89612		27048	87961		6704			121604						123684
199901	81161		27196	77523		10366			130539						163688
199902	70323		39251	86021		19038			220741						167633
199903	95276		54014	182521		32461			358252						360729
199904	92468	1507	54897	184464	58639	31292	36861		437102	21252	9324	929	2922	3681	331544
199905	102607	3196	41415	171294	28480	42560	37312		314150	11940	6774	2171	3021	8558	211073
199906	94536	3274	27168	174481	16438	44054	22468		330717	3536	6422	2720	1357	6150	144457
199907	33772	3542	29480	78933	10446	19100	4298		132097	1497	1489	1374	418	2134	64165
199908	39556	2234	27307	84273	2442	9323	3533		114984	1257	650	252	69	418	69266
199909	45121	1598	23168	69977	3273	3662	1898		93767	1002	458	72	40	125	109654
199910	50906	867	23961	64090	7220	4443	696		98496	181	513	70	37	135	117268
199911	55663	470	25228	61655	4291	4893	616		92862	787	505	138	76	188	90715
199912	65490	401	24054	70391	4992	5143	1576		98430	848	470	130	46	404	80358
200001	79191	372	28553	91631	5299	8004	4095		142666	1064	2379	150	59	627	127024
200002	64362	420	36576	78568	8184	42254	105134		366984	2390	8211	487	409	5717	131940
200003	64991	1789	34410	96662	24294	27365	25832		282493	4766	7792	1006	1092	5108	187718
200004	70334	1868	35812	130218	49140	23831	13619		275810	13980	8532	2358	1230	5746	173113

Appendix 4. (Cont.)

Monthly orthophosphate loads (kg).															
	Snake	Owyhee	Boise	Nyssa	Malheur	Payette	Weiser	Drains	Porters	Burnt	Powder	Eagle	Wildhorse	Pine	Hells Canyon
199503	18578	20	23054	26316	3051	16474	8368	2302	79345						115412
199504	4031	311	25610	7034	2170	13980	5282	5166	20239						41313
199505	12753	2426	46179	14703	2671	21334	5457	5962	35229						48986
199506	45586	3177	24073	45211	1737	19949	3335	5051	59305						84400
199507	14810	2374	24570	28218	2818	11150	2283	8589	19393						62038
199508	22281	1706	20064	25512	2504	3312	2642	7494	20810						58498
199509	24422	1294	20841	21963	3089	3852	1914	6963	33930						89128
199510	14956	479	24036	20697	2764	2442	505	2377	14337						100259
199803	11413		24452	14412		3943			33873						79199
199804	6569		21650	7732		6954			29672						61721
199805	12023		42690	36796		27363			127356						185054
199806	9183		37125	22036		17191			50322						76810
199807	3445		20274	4832		7106			7875						47438
199808	2021		18065	2790		4733			3709						49600
199809	12011		19929	10499		4197			19544						93770
199810	11219		23014	12016		2380			23413						90030
199811	23017		22028	21660		2059			27239						56015
199812	52032		24184	50530		3404			81597						106362
199901	55533		23530	61526		6098			78706						120434
199902	45206		29151	53670		11032			103424						120728
199903	23227		38663	34690		20009			108616						195992
199904	11778	705	32207	22657	25809	15334	11180		60625	5033	4256	549	1227	1223	133940
199905	24398	1267	27870	26969	14953	15170	8678		58458	4150	3524	1508	1180	2275	69138
199906	25523	1069	15710	25434	9621	16172	6970		60435	2044	4432	2278	684	2710	36577
199907	12236	1497	19963	16552	5988	7296	2515		23810	1150	1074	1061	262	1422	31923
199908	17189	1077	20052	17032	1518	5860	2447		11016	1035	568	292	133	423	52915
199909	12233	810	17583	7916	2494	2113	1181		6860	772	378	71	41	88	82130
199910	13205	474	19903	11262	5505	2498	381		12360	141	401	56	29	156	87597
199911	31993	269	22842	34341	3508	2845	386		33618	629	381	120	50	170	77173
199912	50307	247	21650	54501	3714	2706	890		72359	697	318	97	43	277	69471
200001	61077	234	23896	59231	4084	3374	1975		81034	705	1376	95	44	361	107584
200002	47770	228	24957	45899	5305	10765	25684		113011	961	4669	425	290	3094	119191
200003	30385	658	22039	24278	12114	12226	16474		102333	1673	4920	791	925	2950	173972
200004	17914	581	23580	24032	21610	12355	6852		44783	5351	4591	1434	832	2322	103221

Appendix 4. (Cont.)

Monthly nitrate loads (kg).															
	Snake	Owyhee	Boise	Nyssa	Malheur	Payette	Weiser	Drains	Porters	Burnt	Powder	Eagle	Wildhorse	Pine	Hells Canyon
199503	694720	1913	192633	1004528	35822	90791	53000	64765	1405743						2024594
199504	465241	11424	119736	640157	34145	90744	32440	68051	659872						1323535
199505	710357	21501	111253	672985	38226	51352	28262	82080	676741						953876
199506	663129	25566	82223	833603	19923	56605	8935	70259	847471						546589
199507	320251	25649	115846	562785	26905	55918	8290	101413	494439						515922
199508	552666	25421	124085	648869	26691	31196	12036	102664	507066						644371
199509	666117	23700	150336	815763	37901	40392	7425	126946	833114						939116
199510	721165	10469	216101	1002661	35245	43064	1429	55127	906825						1034691
199803	876512		253879	1055359		14060			1340099						1724289
199804	645435		179250	760910		18329			1054941						1164223
199805	632720		301682	1000837		38662			1417216						1625731
199806	415283		219922	723463		31093			717281						709345
199807	234548		129060	385703		23087			539960						362859
199808	371319		146598	528744		43631			565924						482865
199809	672168		192026	904626		38080			995400						1032128
199810	897855		253438	1134397		28872			1346825						1200122
199811	1094423		297898	1357811		4228			1581254						780027
199812	1414907		297422	1762293		24950			2164823						1835545
199901	1375638		287912	1661607		45651			2066540						2509949
199902	1205138		307254	1505543		55774			1924944						2529460
199903	1036818		373652	1494605		76065			1788071						2829923
199904	716132	9489	296391	1066547	85940	36738	24619		1107581	4947	6463	1056	2243	8154	1299048
199905	614702	10223	198549	784489	84609	27014	12621		934908	4189	2065	3508	2279	5485	787147
199906	546784	10972	88205	612720	81741	34186	9779		269966	3095	2131	4794	1475	5645	475048
199907	264802	12624	128932	365062	55845	25509	5570		396865	3134	423	1568	389	1776	263519
199908	460788	13138	158565	581716	15005	34827	7063		591374	3174	186	261	184	378	482753
199909	597815	15081	173244	752426	28638	23307	4990		821714	3213	175	83	104	158	864179
199910	849896	10464	219778	1107262	76652	28115	1609		1221022	3252	253	123	116	290	1024927
199911	1075704	12369	270886	1363561	57844	38974	1709		1555526	3292	240	502	145	576	838240
199912	1277081	15512	274581	831346	62064	65308	11830		2100006	3331	1060	1232	550	4616	1185409
200001	1518954	15200	307359	1311574	68978	57382	21184		2254715	3371	6817	760	607	7078	2619480
200002	1155309	11550	236772	1230531	55364	54687	111762		1566927	3410	14401	587	1077	24750	2025446
200003	782875	11348	210311	910005	81740	46090	84472		1314727	3450	11403	913	1675	18370	1862572
200004	514369	6653	178449	640691	50239	24692	25764		650363	3489	4394	3037	1297	6594	1335538

Appendix 4. (Cont.)

Monthly ammonia loads (kg).															
	Snake	Owyhee	Boise	Nyssa	Malheur	Payette	Weiser	Drains	Porters	Burnt	Powder	Eagle	Wildhorse	Pine	Hells Canyon
199503	14328	61	8446	16851	551	8830	30684	9388	33450						63795
199504	12230	263	5565	24960	537	11183	18437	7123	32509						54236
199505	34554	1246	5641	40229	473	17778	14629	3247	89268						274691
199506	52297	3686	7784	40173	347	16487	4451	5021	65784						230913
199507	15946	2451	5735	43374	329	5031	889	3054	34947						74632
199508	14023	1470	1949	77841	206	923	571	1751	44515						30655
199509	15428	1673	1962	32994	685	2254	715	2352	21120						28118
199510	15949	252	2068	75850	409	2719	487	837	31872						47100
199803	43288		9074	84948		16600			73145						208125
199804	44634		9669	101921		23880			80399						263077
199805	66063		33157	122385		20373			59326						416413
199806	23209		29254	117666		6052			165965						76459
199807	4788		6468	67248		4647			46276						92957
199808	13731		1496	42589		1381			22251						69918
199809	7393		2688	60863		3368			30295						56905
199810	13600		2554	64690		1640			18583						30197
199811	63475		2788	57306		6745			28365						54925
199812	25576		1589	19857		3848			10371						240778
199901	28618		6740	50052		3630			13083						203538
199902	15108		9325	77935		6195			18007						81638
199903	6329		14322	99504		29605			34441						264559
199904	6702	98	6223	114061	2823	13767	5429		19083	1143	318	106	687	1676	335780
199905	8708	176	2319	53679	837	3868	2763		22388	399	240	418	789	1737	164719
199906	34622	1072	8907	80981	1589	14395	1890		69782	464	744	1221	814	1078	195172
199907	15944	1262	5977	51786	2390	9508	241		28273	470	113	329	123	1092	181630
199908	16457	689	2340	13281	450	6070	918		60682	477	115	122	30	348	89746
199909	18809	622	2513	25127	356	1474	672		16486	484	94	28	45	113	53622
199910	12726	304	1051	41462	1036	3029	176		24876	491	152	73	68	229	63871
199911	23315	196	2043	57483	311	6847	93		52225	497	42	261	26	94	251529
199912	35124	135	4579	98079	584	7385	377		223970	504	24	95	14	90	213679
200001	13628	92	5958	85744	726	1714	515		7926	511	494	44	52	94	202559
200002	10627	130	5752	79074	1091	4258	11616		37693	518	1623	164	161	1220	107792
200003	15686	97	1880	16744	934	2591	3254		15642	524	545	142	719	1035	117387
200004	18241	70	3560	6023	2313	1971	910		9481	531	312	304	229	517	199863

Appendix 4. (Cont.)

Monthly Kjeldahl loads (kg).															
	Snake	Owyhee	Boise	Nyssa	Malheur	Payette	Weiser	Drains	Porters	Burnt	Powder	Eagle	Wildhorse	Pine	Hells Canyon
199503	138889	478	50806	284438	10736	72924	89263	17815	392109						236744
199504	279665	5176	88670	469163	15846	114373	58173	37490	894709						624915
199505	782455	10525	150901	829222	13212	56547	69350	37905	2315554						1616974
199506	605068	27439	101735	1202859	1143	94884	34645	62339	1424697						915521
199507	325363	25976	81128	894607	6855	77359	13513	78305	1100739						619830
199508	282101	14833	50181	615292	9053	24096	8654	36180	819794						538199
199509	272794	6082	42780	452025	5754	20256	10528	35205	653146						329627
199510	191235	3371	33299	474642	7394	34484	6614	12083	689332						451044
199803	638208		68197	964332		110670			1477758						1243111
199804	891313		61268	935441		86793			1253696						1126535
199805	711585		194399	1480505		246736			1942063						1577004
199806	659131		136514	1453712		175461			1806935						1258001
199807	467132		59288	792570		52014			974303						538991
199808	355539		70341	700107		43936			1018051						664938
199809	323305		65577	670398		30551			963378						738579
199810	383552		38855	619941		29253			780796						564514
199811	413732		34647	554441		44510			755921						522232
199812	505805		32899	514929		74458			485210						978522
199901	426396		38123	458822		65097			502966						869790
199902	330590		93337	554646		97518			864455						764546
199903	530910		21472	1072064		128316			1313589						2160020
199904	619375	3683	89621	1148299	96629	129077	108780		1735837	30327	26582	2529	11439	12912	2229081
199905	639824	9864	69696	1095618	52562	122740	87449		1777592	21456	21007	4125	7414	21256	1488371
199906	714430	9262	61161	1262593	36907	122576	53789		1983892	13762	22297	4794	2693	11635	1822426
199907	331693	8681	56734	661200	25557	52732	16764		1019583	14000	4660	1568	656	5106	812668
199908	306317	6080	66840	735551	6003	31079	13572		897134	14237	2184	274	302	2339	418061
199909	340067	5527	59468	767854	8147	17383	6933		737944	14474	1745	207	136	674	496421
199910	343928	3928	44295	540630	18490	23675	3852		798062	14711	2177	189	116	472	471885
199911	238495	1962	25478	273667	8645	23086	3139		674078	14948	1926	452	204	487	648938
199912	177810	1605	20406	261409	6618	24723	2151		310142	15186	1533	455	137	908	362294
200001	257128	1581	29151	400892	7644	27338	8893		347362	15423	8127	439	230	1672	613816
200002	298899	1894	63716	380943	17059	97217	354115		805326	15660	28435	1304	1565	17718	481201
200003	378633	7040	55254	523026	53410	87691	101667		1043289	15897	27993	2985	3783	16474	582780
200004	490842	7859	69302	868547	89143	109786	23670		1537571	16135	27339	11863	1673	25831	727124

Appendix 4. (Cont.)

Monthly total nitrogen loads (kg).															
	Snake	Owyhee	Boise	Nyssa	Malheur	Payette	Weiser	Drains	Porters	Burnt	Powder	Eagle	Wildhorse	Pine	Hells Canyon
199503	848207	2401	245532	1290538	46776	164518	142262	82580	1802789						2298889
199504	779160	16649	208434	1123184	50246	205975	90820	105541	1584179						1958541
199505	1507536	32185	250420	1503739	51853	108248	98009	119985	3035014						2606748
199506	1291228	53401	169827	2051780	22089	153080	43896	132598	2364276						1473331
199507	659431	51818	188110	1481302	36959	135107	22825	179718	1643848						1157852
199508	835276	40640	174279	1265011	36180	55425	20777	138844	1343415						1197754
199509	948271	30311	193812	1269289	43906	61121	18426	162151	1509734						1301948
199510	932490	13819	250298	1483933	42797	78235	8181	67210	1596516						1507887
199803	1544928		322270	2032947		125224			2847805						3025421
199804	1547364		241402	1697384		106080			2310921						2291797
199805	1358002		500003	2483569		286172			3369679						3210058
199806	1104464		356652	2190201		206928			2530666						2012964
199807	705808		189564	1183163		75395			1516220						905924
199808	733621		217429	1231548		87969			1584987						1157181
199809	1000570		258709	1587706		68691			1967261						1787710
199810	1281568		292826	1755430		58686			2131796						1776322
199811	1509199		332873	1915697		54410			2342112						1316754
199812	1920797		331145	2282300		102680			2657097						2837829
199901	1803956		326223	2121191		111195			2571750						3386133
199902	1537216		416769	2065372		153566			2789863						3310599
199903	1586785		439387	2597105		205013			3116112						5277674
199904	1342074	13182	385520	2217717	184611	167745	138867		2859361	36233	33940	3586	13688	21840	3533779
199905	1256046	20429	265997	1884734	140860	149870	100834		2729191	26086	23078	7678	9733	26816	2280147
199906	1266757	20260	141790	1890128	118845	157016	64916		2294523	17021	24429	9588	4201	17506	2341627
199907	598973	21408	185704	1029163	81805	78843	22372		1417122	17305	5084	3137	1067	6935	1091939
199908	772153	19331	225554	1319188	21192	66476	20729		1490388	17589	2371	538	499	2728	930661
199909	937940	20620	233138	1522984	36840	40695	11968		1561759	17873	1920	299	244	841	1362317
199910	1199104	14296	265472	1682524	95226	51883	5645		2041084	18156	2431	319	232	779	1504036
199911	1319577	14669	297291	1647881	66656	62426	5175		2235496	18440	2191	968	349	1098	1513606
199912	1457381	17118	294993	1113065	68720	90407	16067		2444561	18724	2757	1753	727	5860	1586255
200001	1780464	16789	337503	1722169	76759	85441	32072		2606944	19008	14983	1249	858	8798	3240537
200002	1459832	13531	307445	1615023	73500	156789	485109		2406333	19292	43089	1918	2612	42638	2514573
200003	1213503	18710	269488	1448392	137058	135139	212561		2389112	19575	39550	3900	5502	35080	2446979
200004	1023458	14611	248671	1526944	141942	136774	50466		2198664	19859	32181	14902	3022	33705	2068169