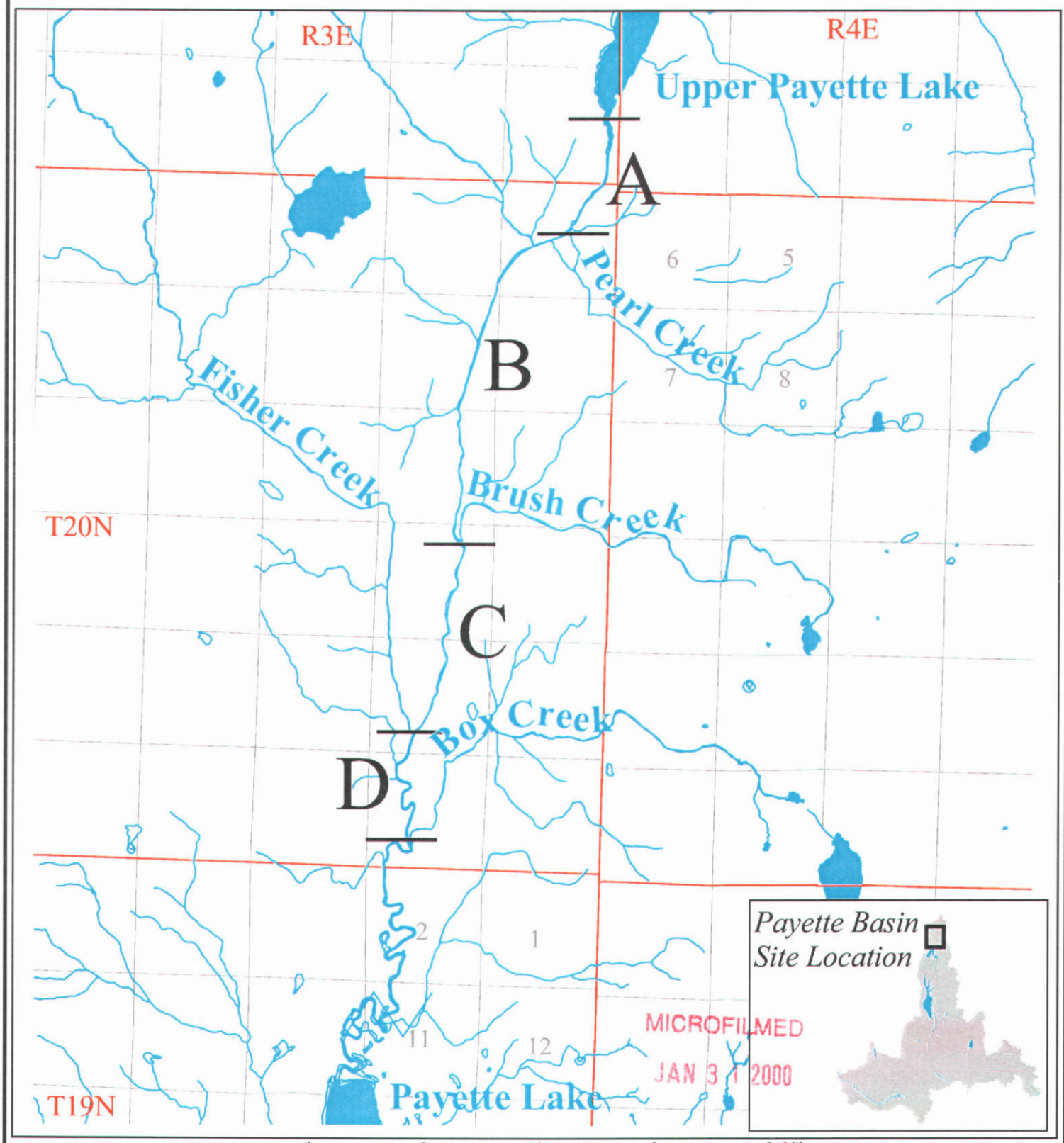
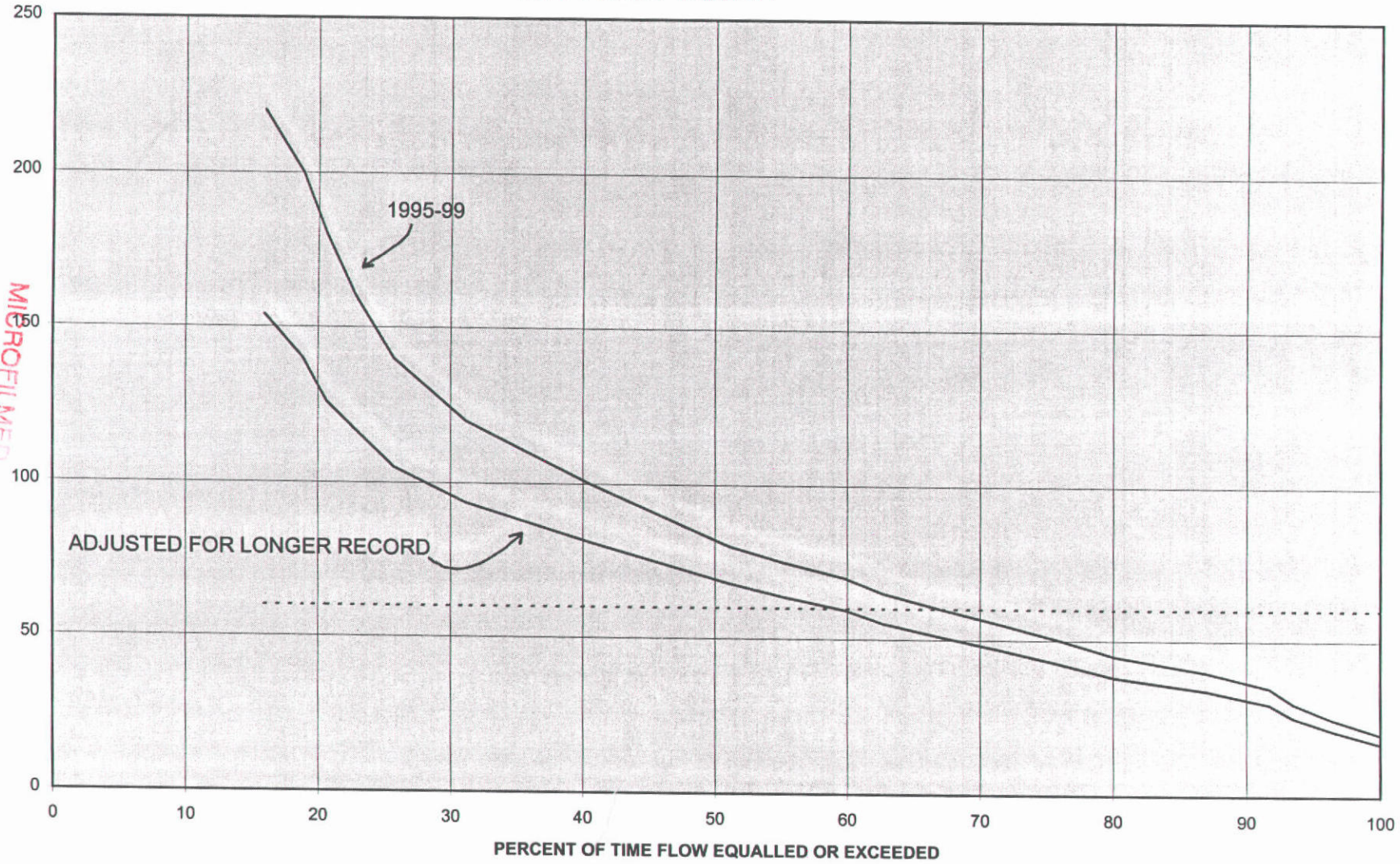
North Fork Payette River
Minimum Streamflow Reaches



FLOW DURATIONS NORTH FORK PAYETTE RIVER BL FISHER CREEK

JULY 1 TO SEPTEMBER 7



MICROFILMED
JAN 3 1 2000

5.36

Beginning Point

T. 21 N.

T. 20 N.

5.1

A

Creek splits to "North fork" & Fur Stone confluence

Pearl

5.23

B

5.26

C

5.35

D

Ending point

R3E

R4E

No gov't lots in relevant tracts

-SZ 8/19/99

IDWR MAP confirms QQ sites

MICROFILMED JAN 3 1 2000

PAYETTE NATIONAL FOREST

Lake

Creek

River

Pagette

Fork

North

Fisher

Brush

Box

BOUNDARY

Figure 2-1. Location of study area.

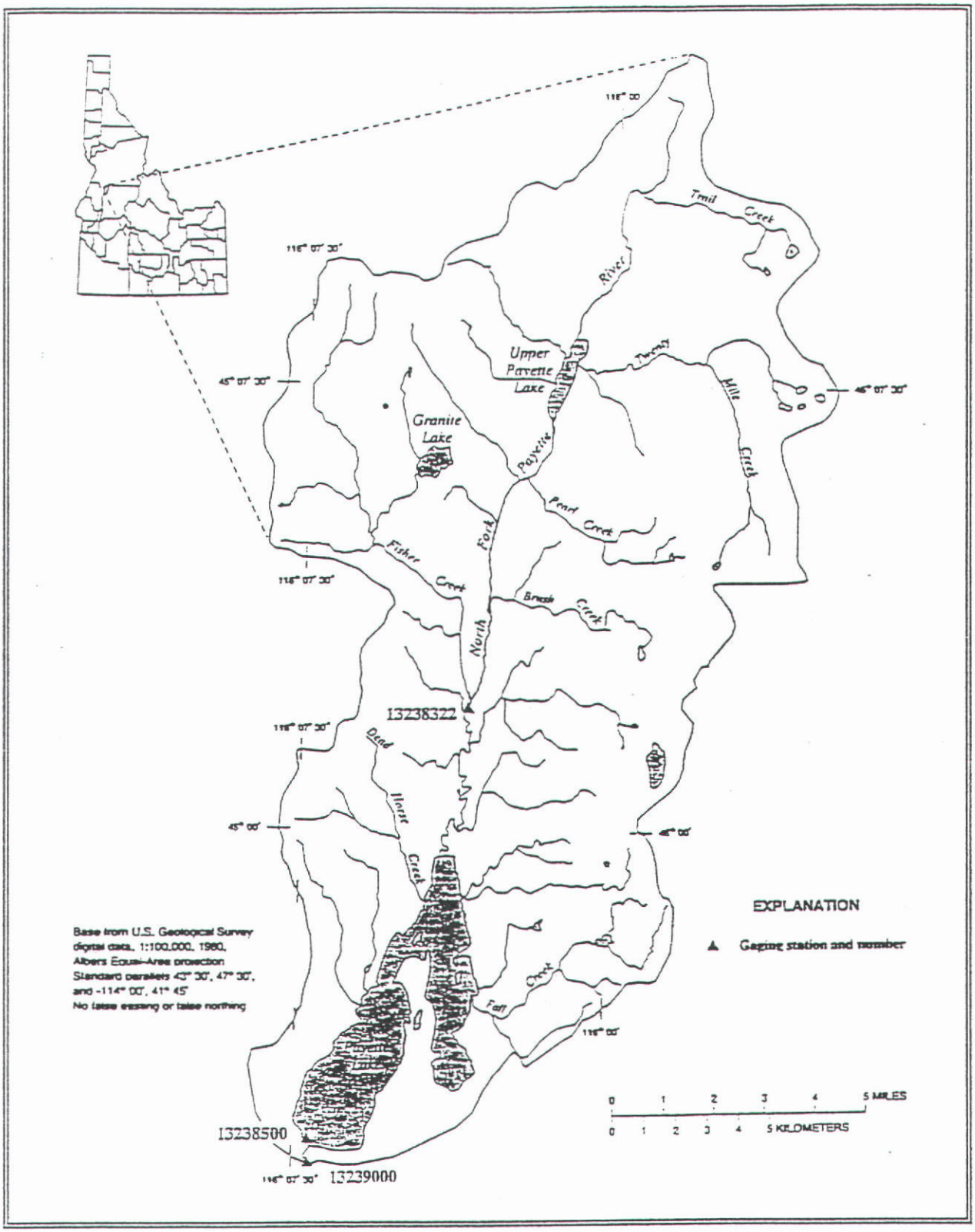


Figure 2-2. Major land ownership categories of the Payette Lake watershed.

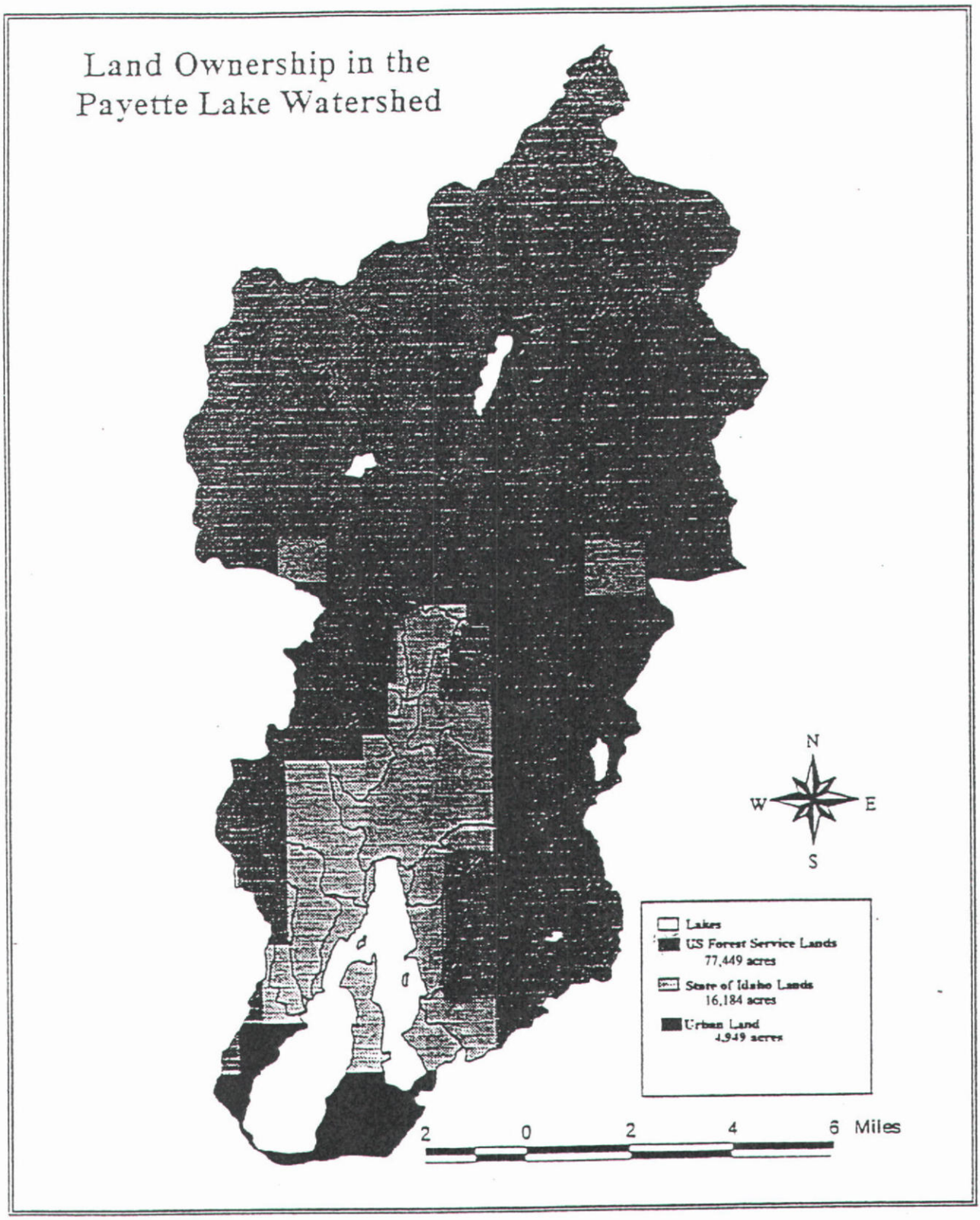


Figure 2-3. Streams and lakes in the subwatersheds of Paytte Lake watershed

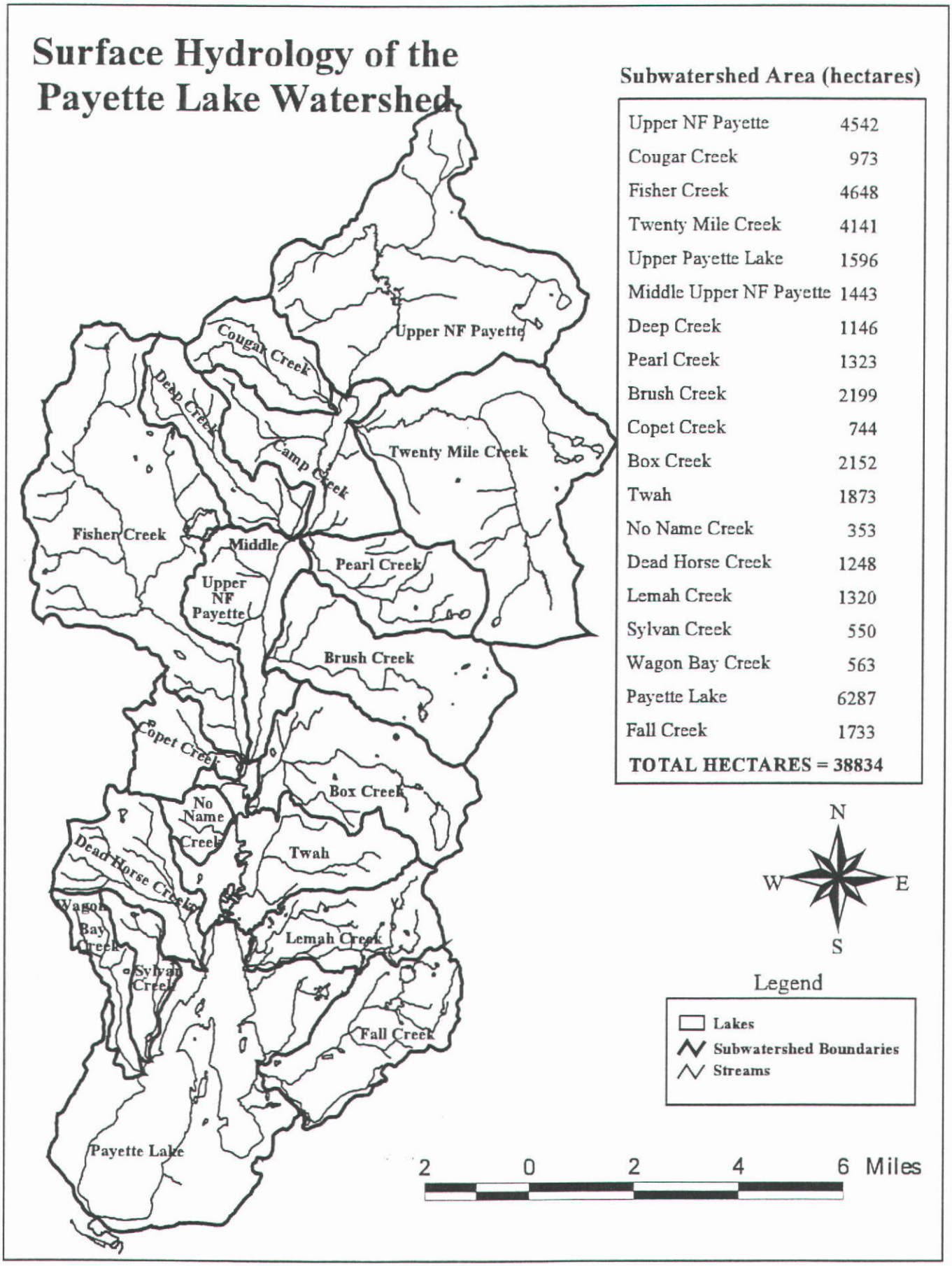


Figure 2 - 5. Major rock types of the Payette Lake watershed

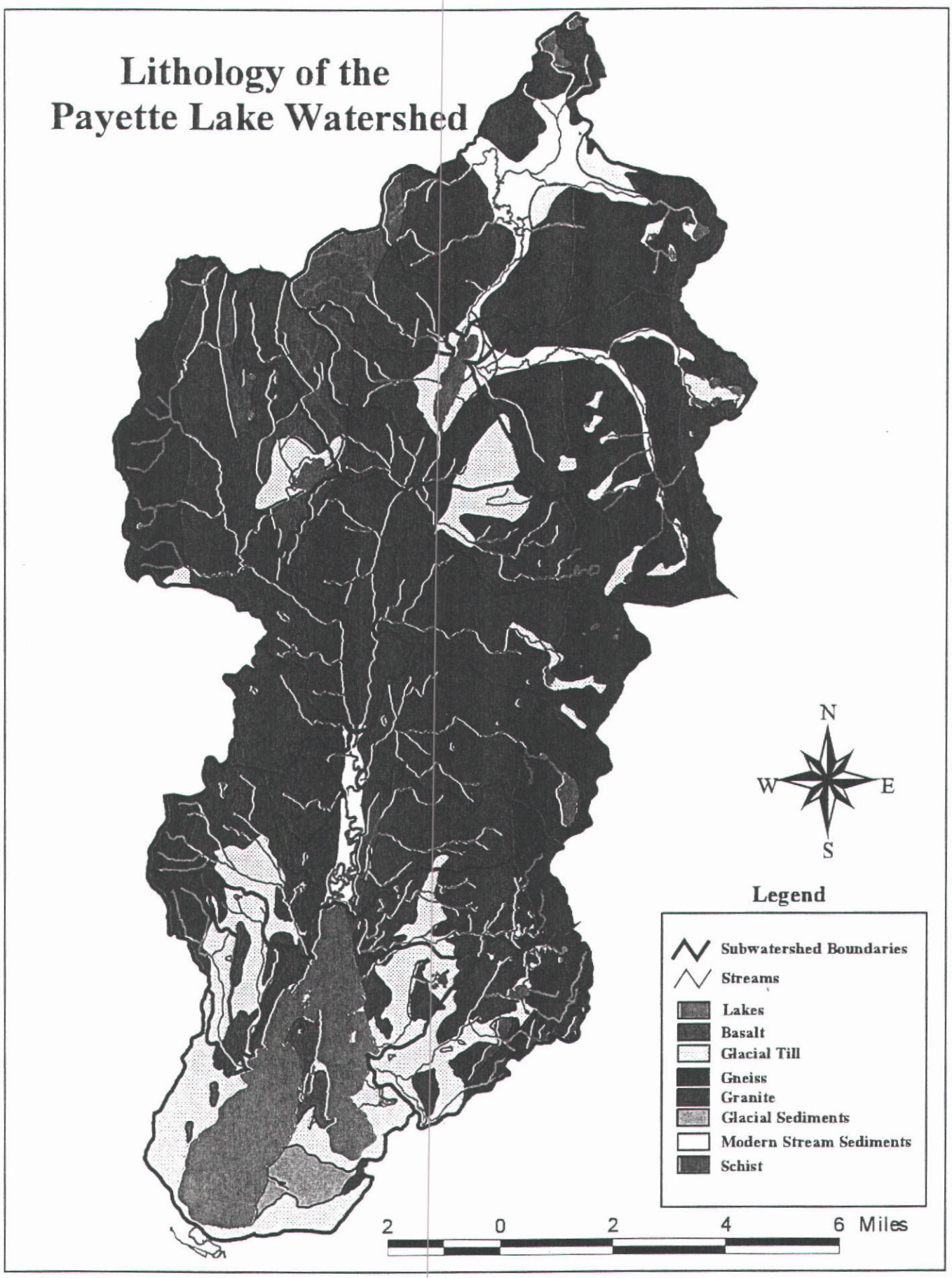


Figure 2-6. Fire related tree mortality in the Payette Lake watershed.

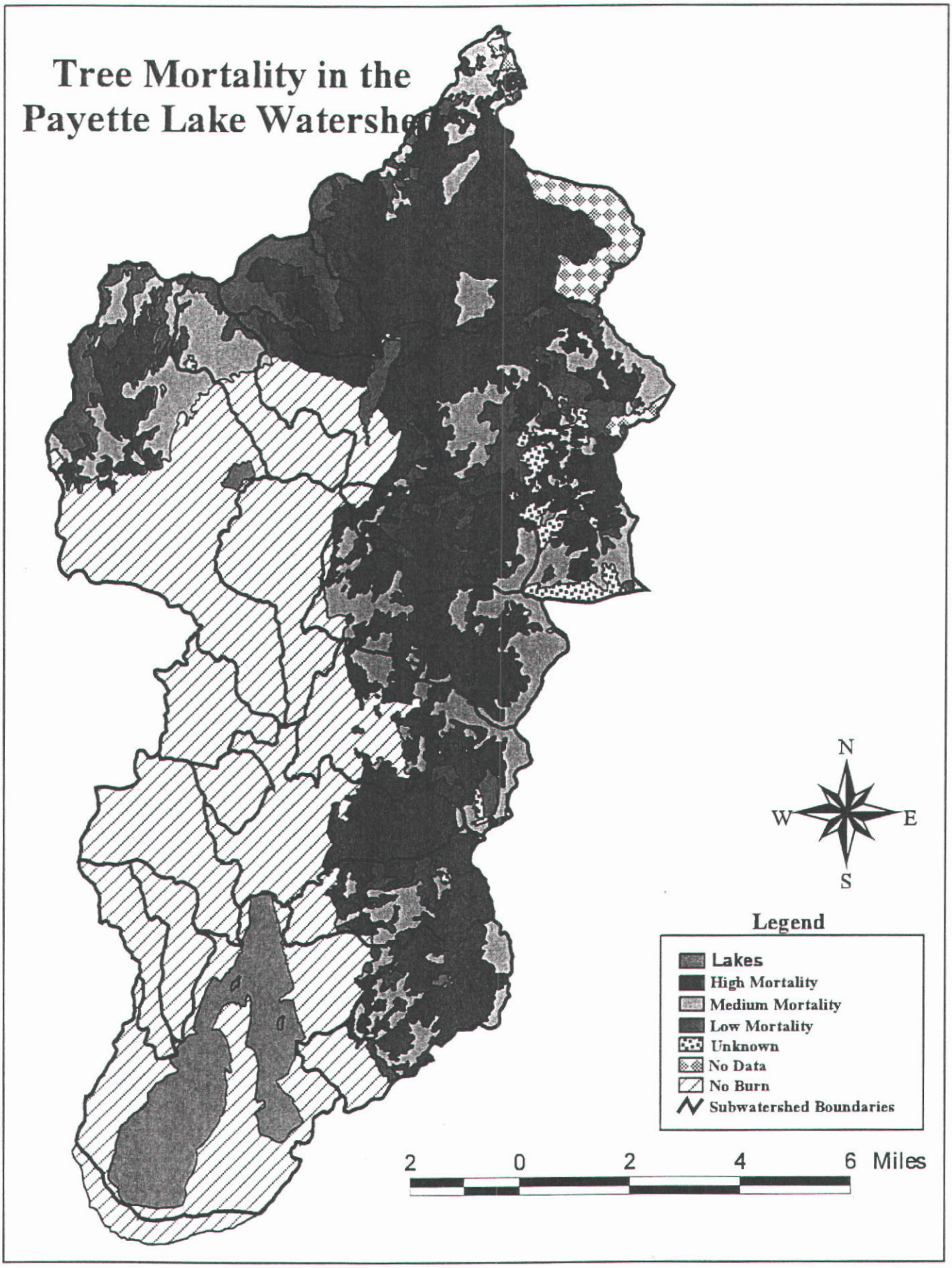


Figure 3-2. Location of U.S. Geological Discharge Monitoring Stations.

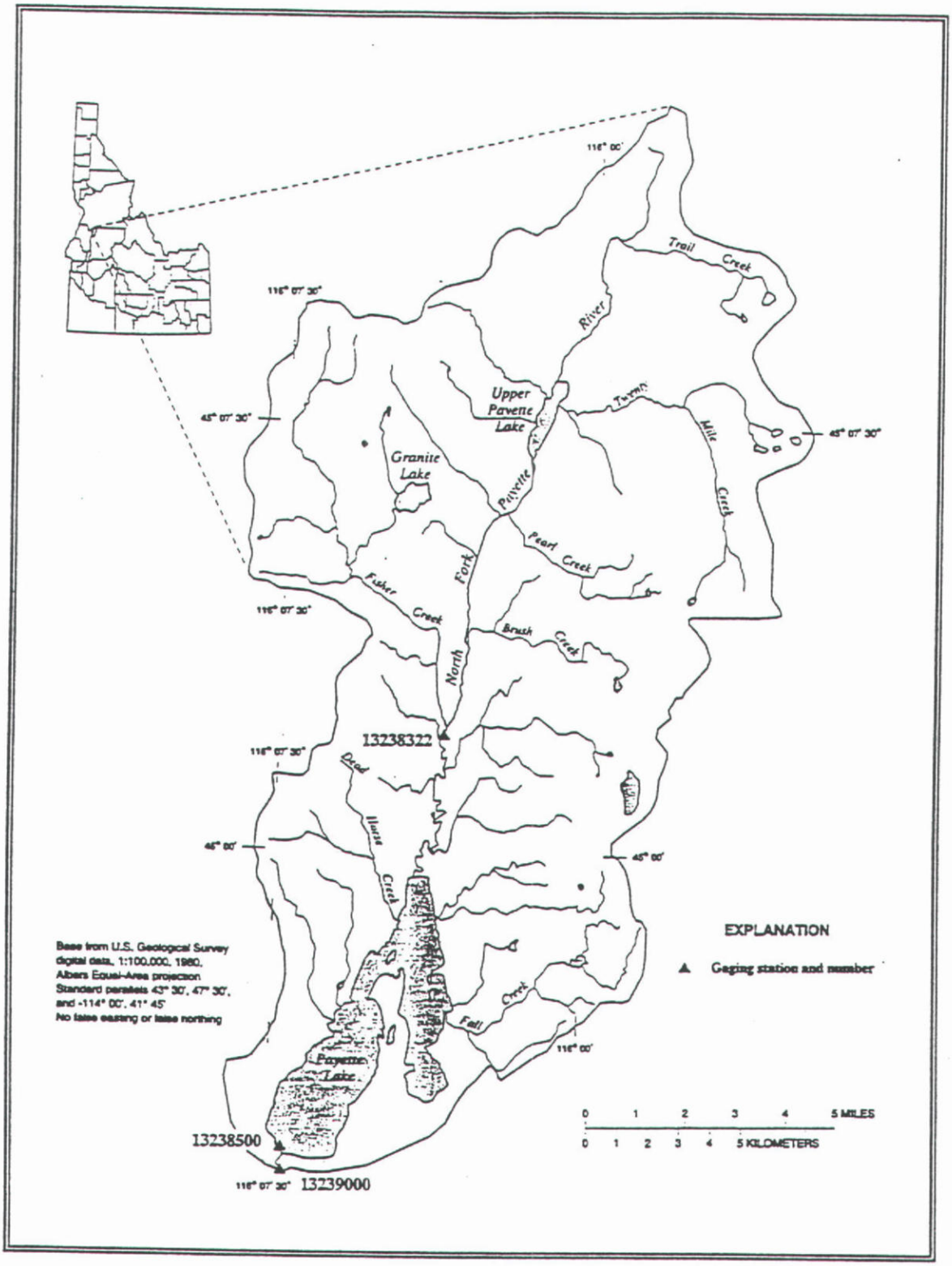


Figure 3-3. Locations of limnetic and littoral sampling stations.

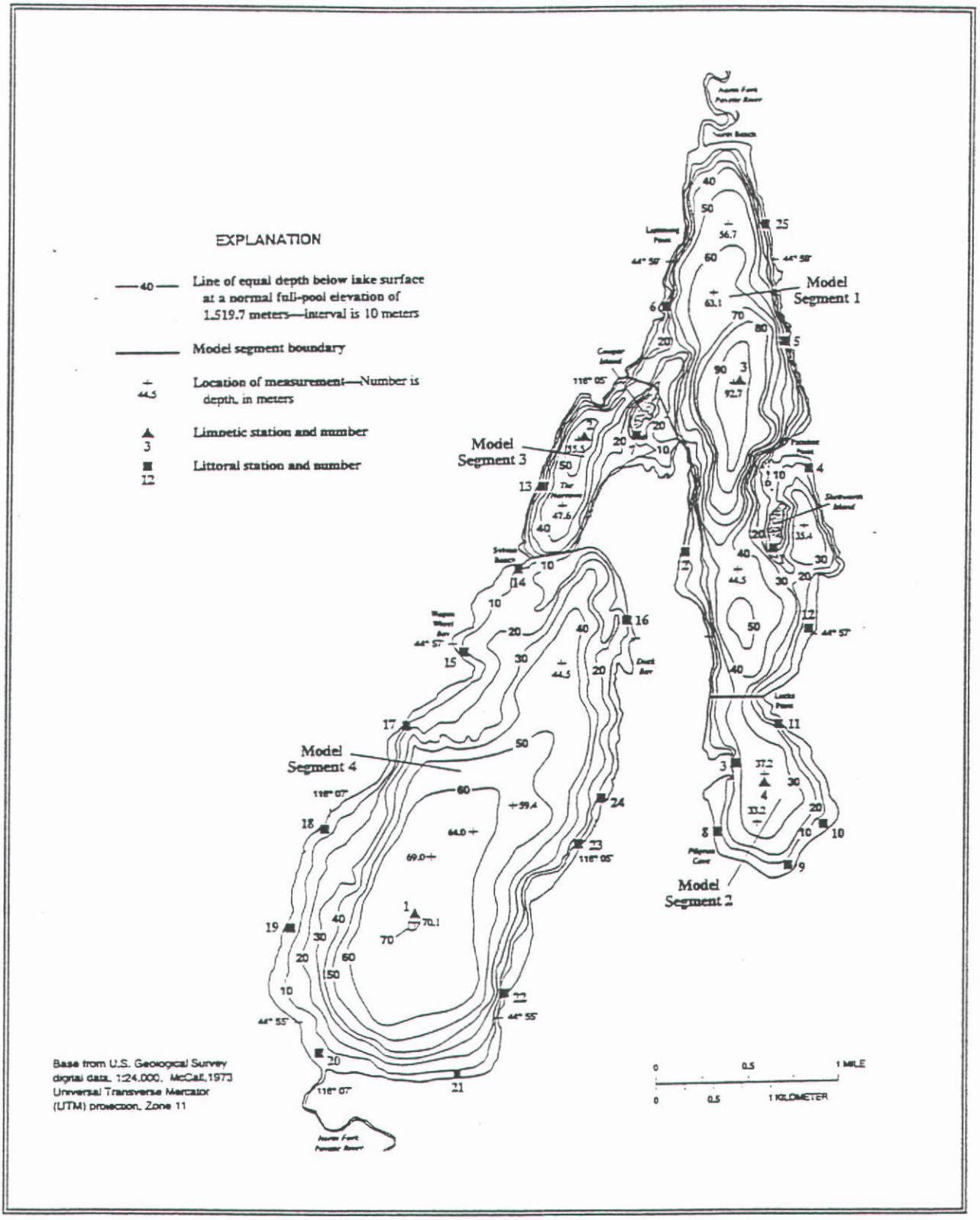


Figure 3 - 4. Watershed flow and water quality sampling sites

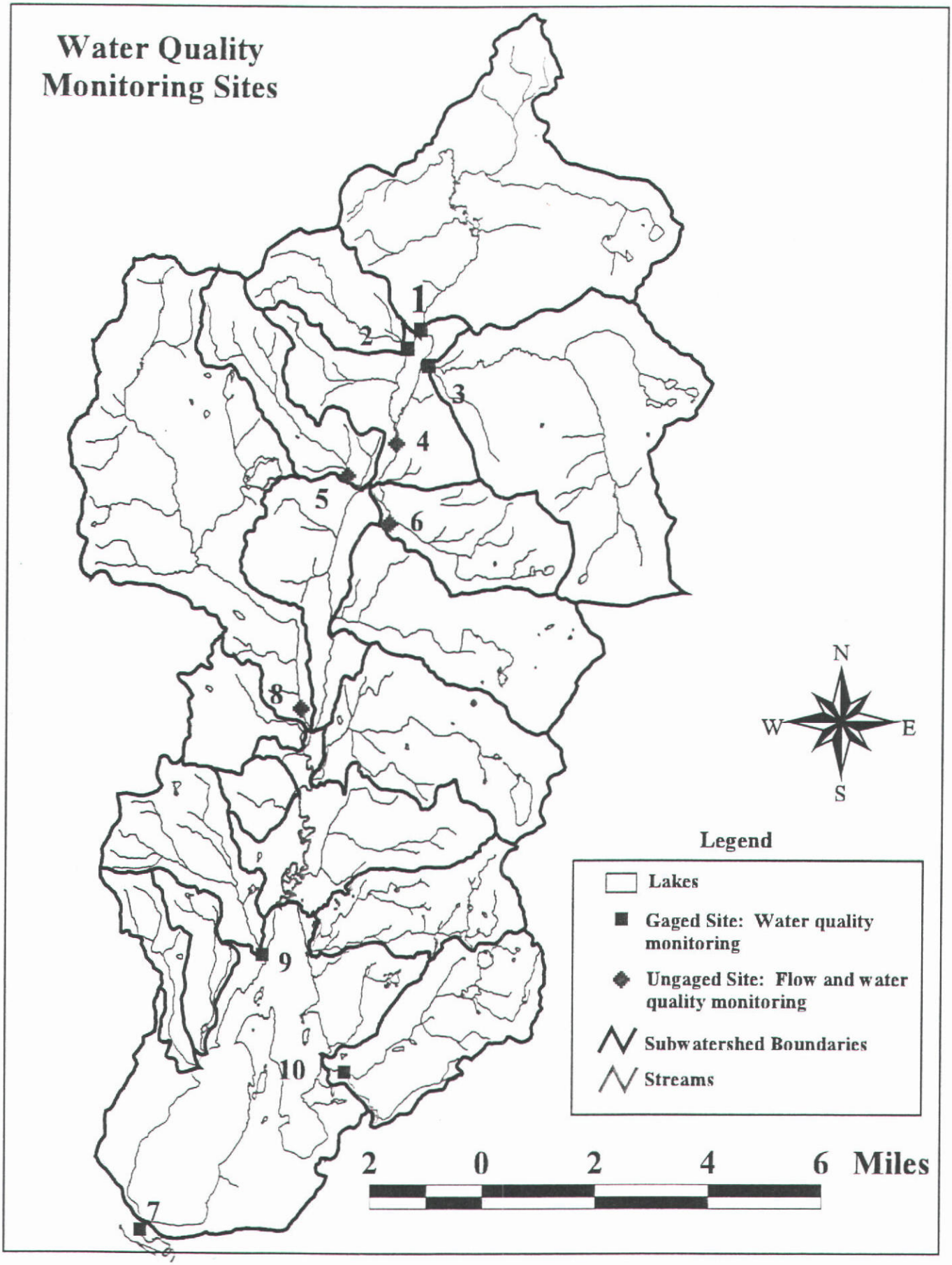


Figure 3 - 5. Bacteria and stormwater monitoring sites in the Payette Lake watershed

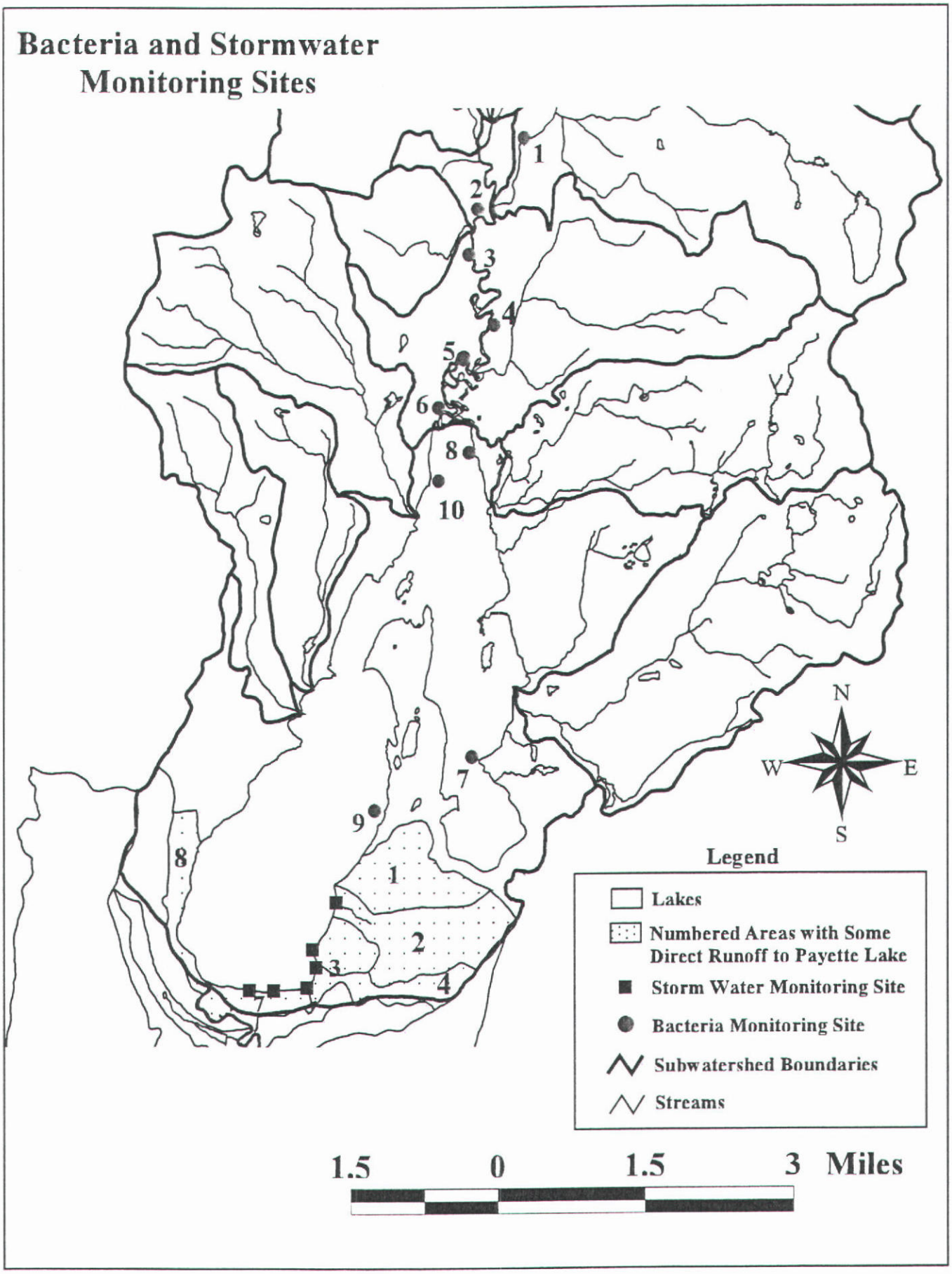


Figure 3 - 6. Stream habitat monitoring sites in the Payette Lake watershed

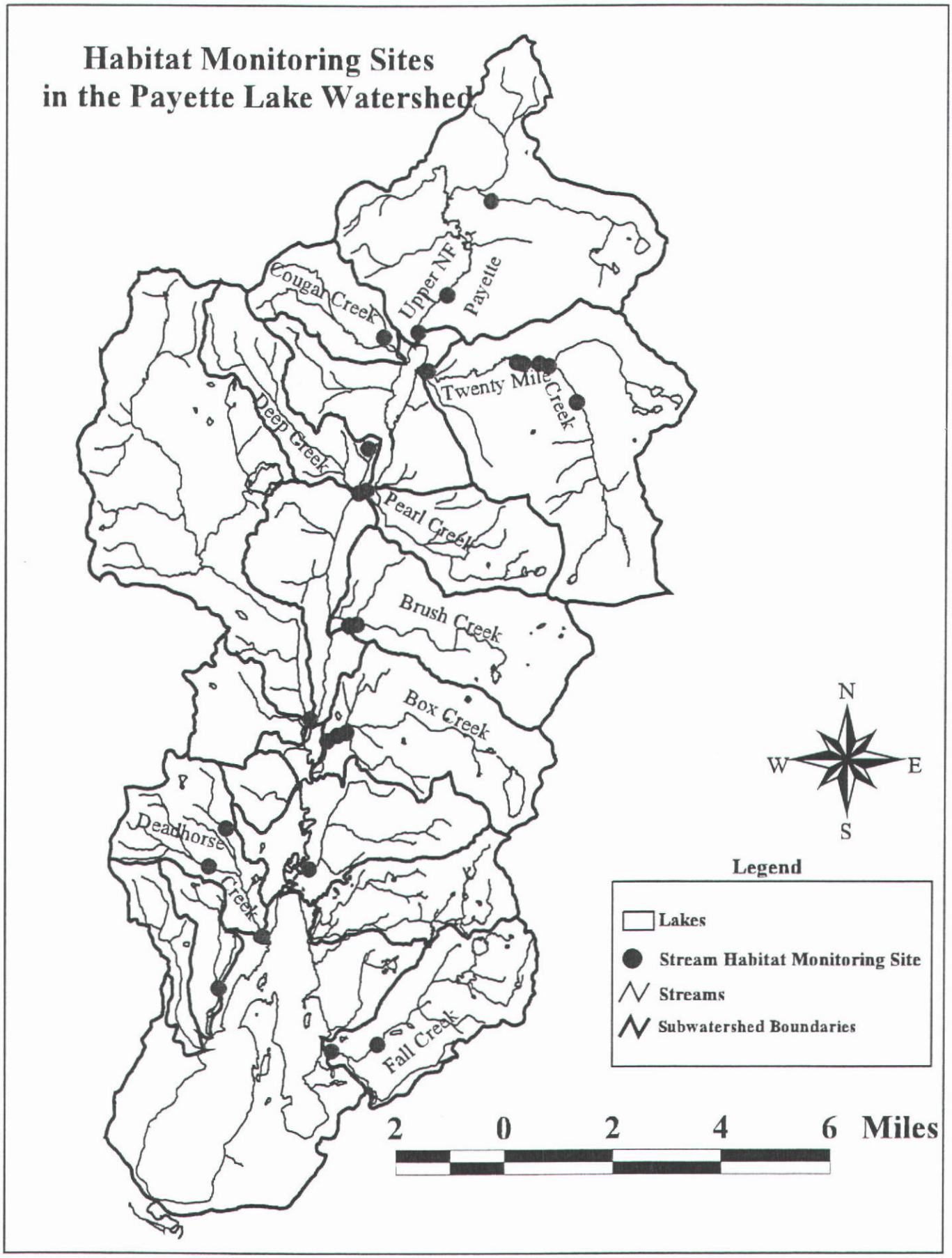


Figure 3-7 Minimum Stream Flow Assessment Sites. Study sites are marked (X).

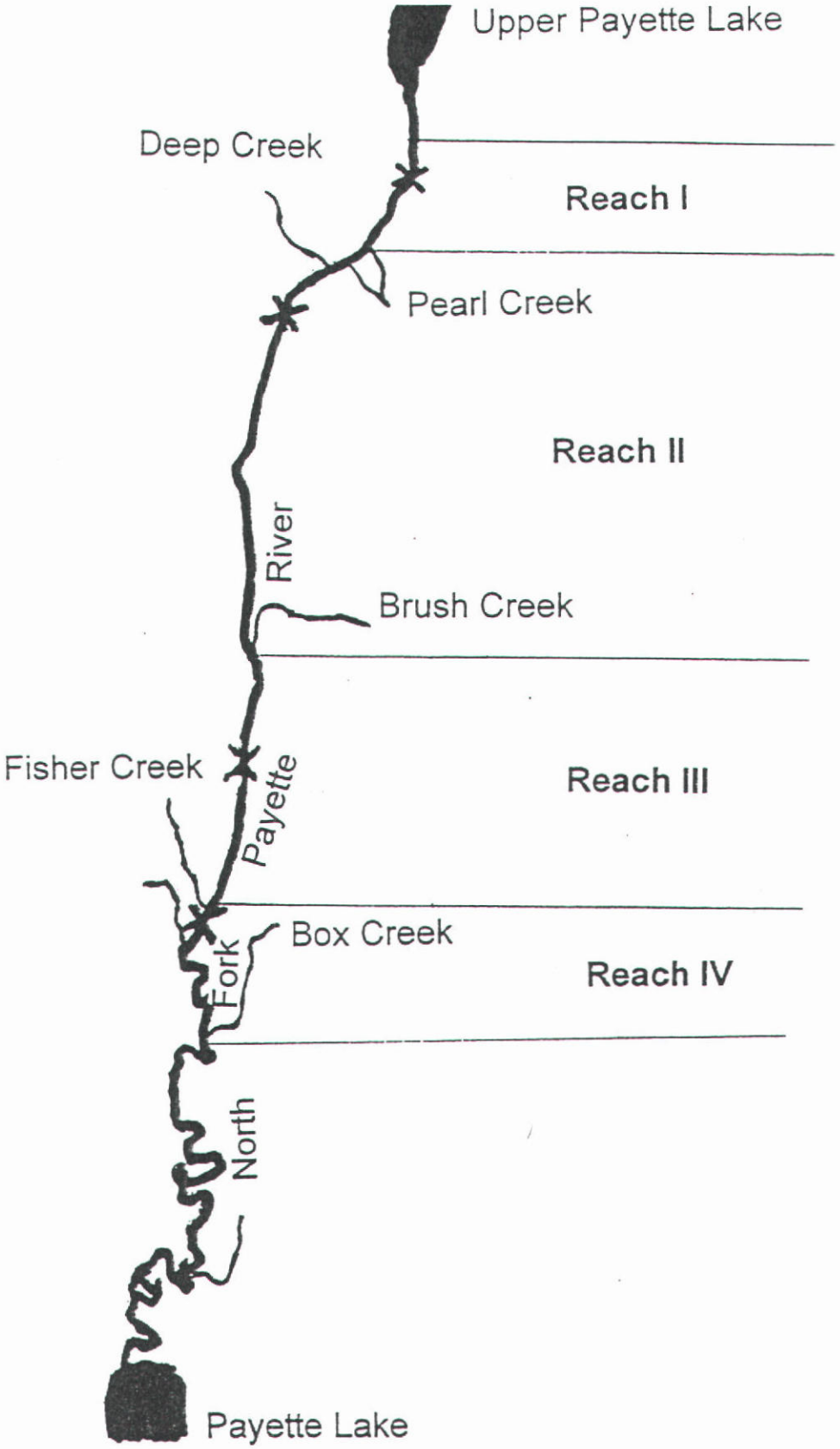


Figure 4-4. Daily Hydrographs representing a) gauged seasonal runoff from tributary streams; b) synoptic field flow measurements in the Upper Payette Lake drainage basin, and; c) average daily air temperature (degrees Celsius) at Secesh Summit Snotel Site. Trend line estimated for missing data by interpolation.

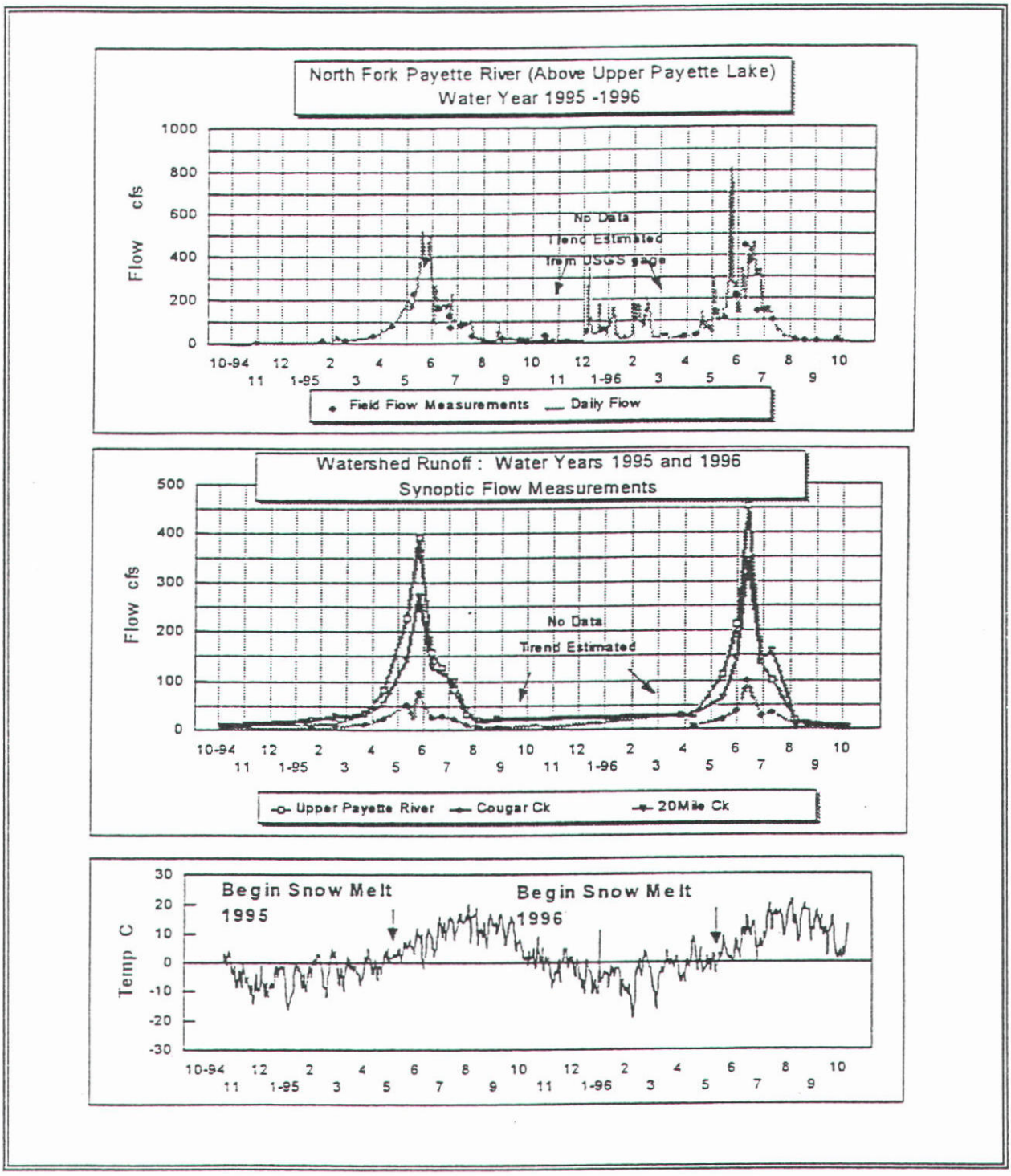
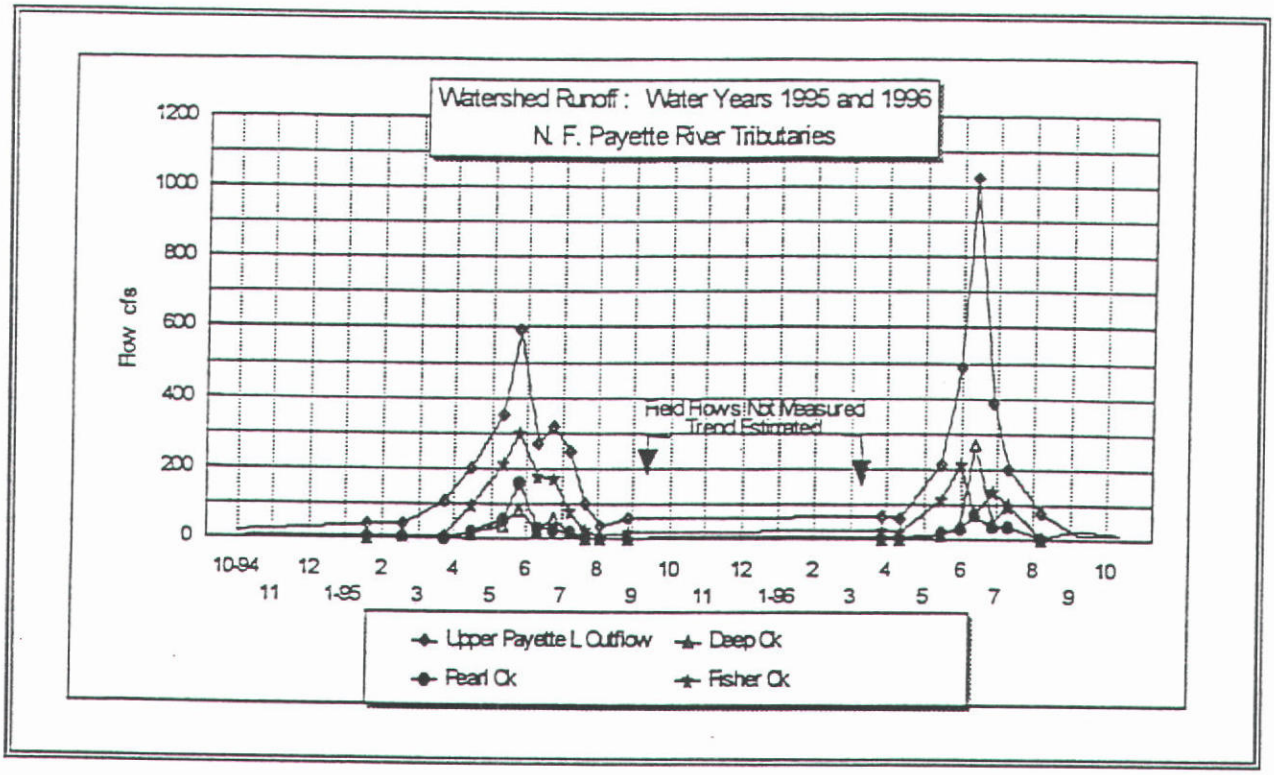


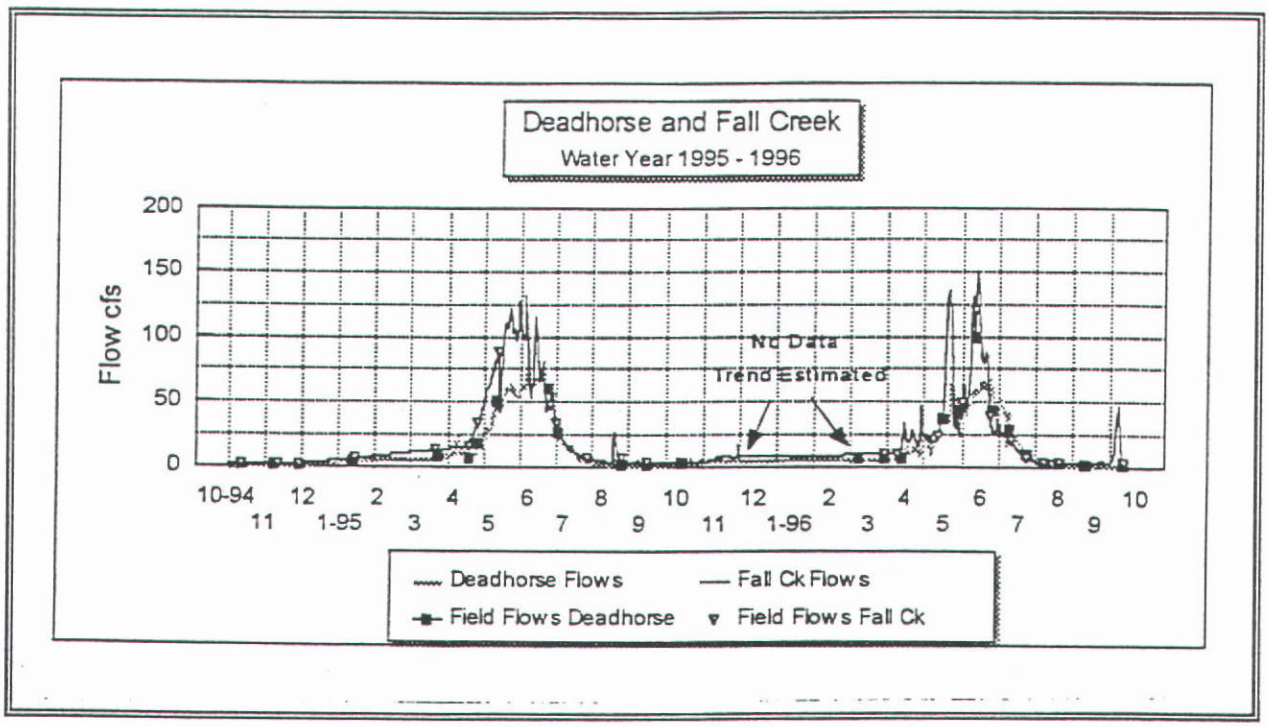
Figure 4-6. Comparison of synoptic stream flow measurements taken in the tributaries of the mainstem N.F. Payette River.



A comparison of the total runoff estimated by the above combination of measured and extrapolated discharge from watersheds closely approximates the total cumulative flow measured at the USGS gauge site on the N.F. Payette River. The sum total contribution of discharge by subwatershed upstream of the USGS gauge was approximately 258 hm^3 (105,412 cf) and 335 hm^3 (136,870 cf) during water years 1995 and 1996, respectively. Differences between these estimates and the USGS gauge were 15% and 17% for each respective water year.

Big Payette Lake Tributaries: Data obtained from continuous water level recorders installed on both the Deadhorse and Fall Creek watersheds are presented in Figure 4-7. Hydrographs from these sites also showed similar intra and inter annual variations in flow rates. Peak discharge rates for Fall Creek, however, were considerably greater compared to the Deadhorse site during snowmelt in WY1996. Fall Creek discharge volumes ranged from 0.6 to 132 cfs and 1.3 to 151 cfs in water year 1995 and 1996, respectively. Discharge volumes from Deadhorse Creek ranged from 0.1 to 72.6 cfs and from 0.1 to 66.7 cfs during the same period. Total annual volume streamflow for Fall Creek was 17.3 hm^3 in 1995 and totaled 15.3 hm^3 in 1996. For Deadhorse Creek, the annual total streamflow was 11.7 hm^3 in 1995 and totaled 11.4 hm^3 in 1996.

Figure 4-7. Daily hydrograph representing seasonal runoff from tributary streams draining to Big Payette Lake.



A portion of the headwaters for Fall Creek originates as spillover from Blackwell Lake. This is a small, regulated glacial lake located in the upper third of the basin. Discussions with the local operators of the control structures indicate water levels in this lake are actively regulated during the spring and late summer. Records detailing the manipulations in storage are not maintained. Consequently, the effects of the fluctuations in the lake storage volume on the stream hydrograph could not be determined.

Water budgets were extrapolated for other major tributaries draining to Big Payette Lake using the unit area water yields from Deadhorse and Fall Creek (Table 4-5). Monthly water yields for Lemah Creek were computed using monthly yields from Fall Creek. Both watersheds are similar in size, soil type and in the proportion of total watershed area burned. Water yields for Lemah and Sylvan Creeks were computed based on monthly yields from Deadhorse Creek. From these estimates, tributaries directly draining to the Big Payette Lake contributed approximately 52.2 hm^3 (21,343 cf) and 48.2 hm^3 (19,698 cf) of runoff in water years 1995 and 1996, respectively.

Figure 4-8. Stream conductivity and pH of burned and unburned watersheds.

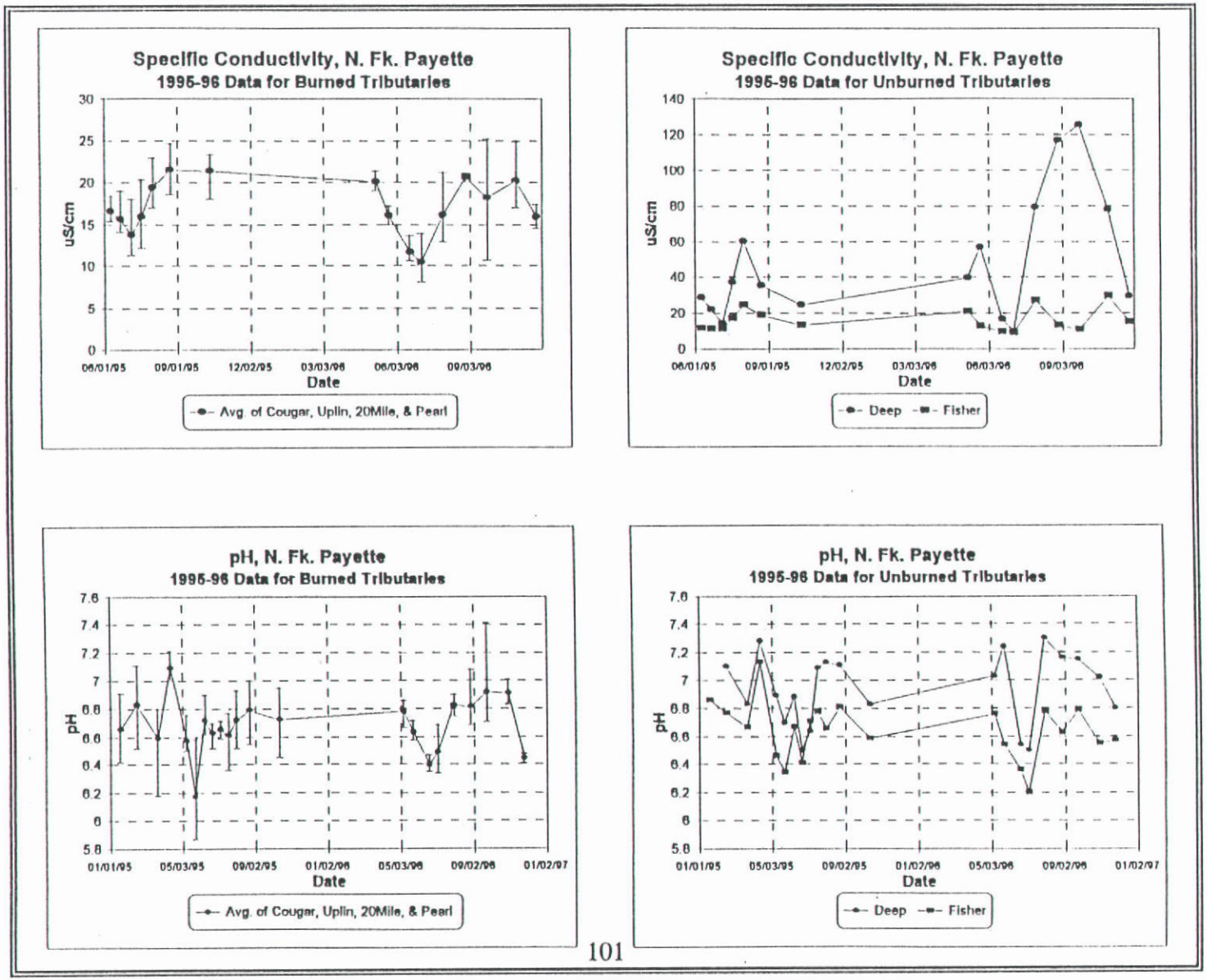


Figure 4-9. Total Phosphorus (TP) and Total Solids (TS) observed in samples from watersheds above Upper Payette Lake.

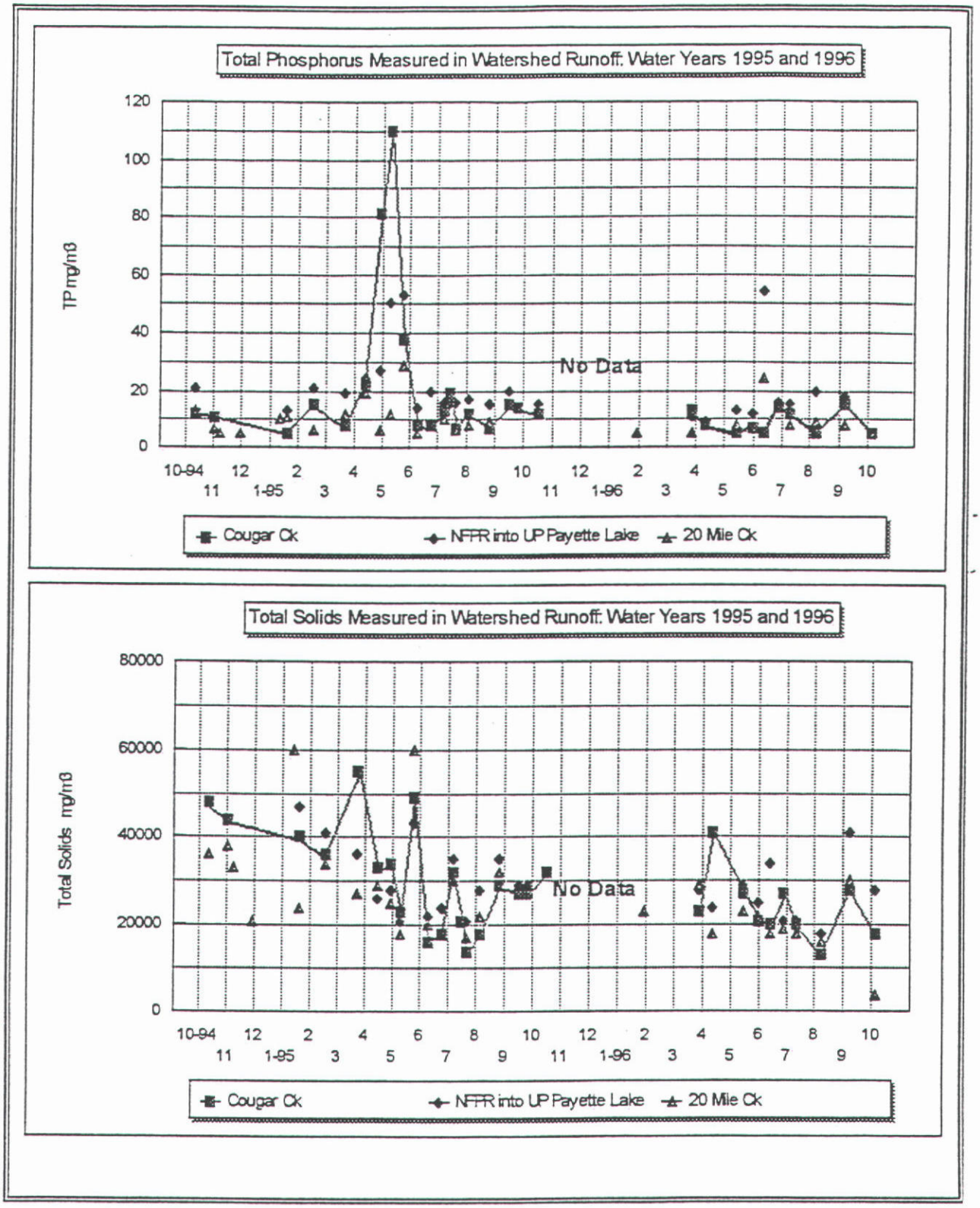


Figure 4-10. Inorganic nitrogen (DIN) and organic nitrogen (Org-N) observed in samples from watersheds above Upper Payette Lake.

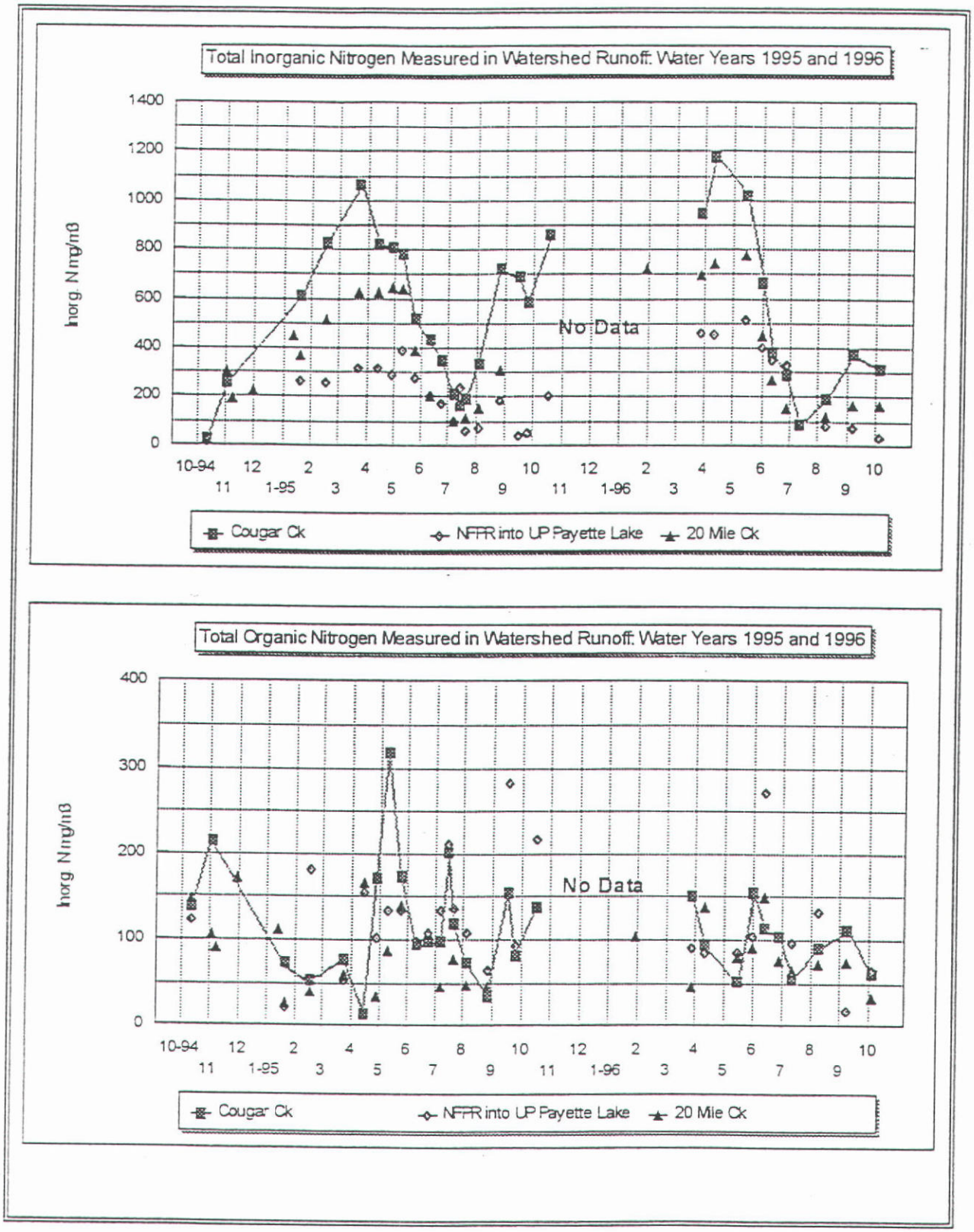


Figure 4-11. Total Phosphorus (TP) and Total Solids (TS) observed in samples from watersheds tributary to the N.F. Payette River mainstem.

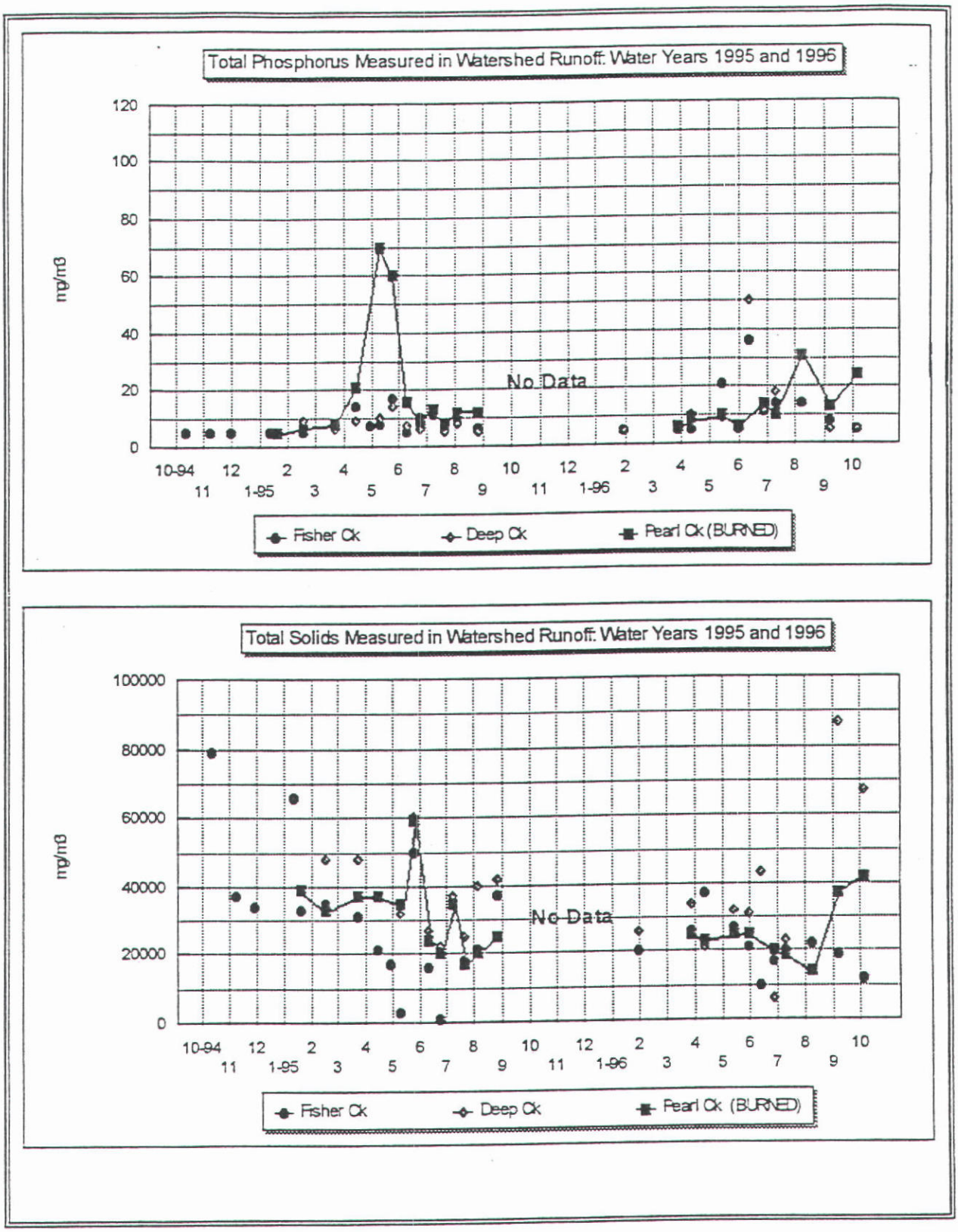


Figure 4-12. Inorganic nitrogen (DIN) and organic nitrogen (Org_N) observed in samples from watersheds draining to the N.F. Payette River mainstem.

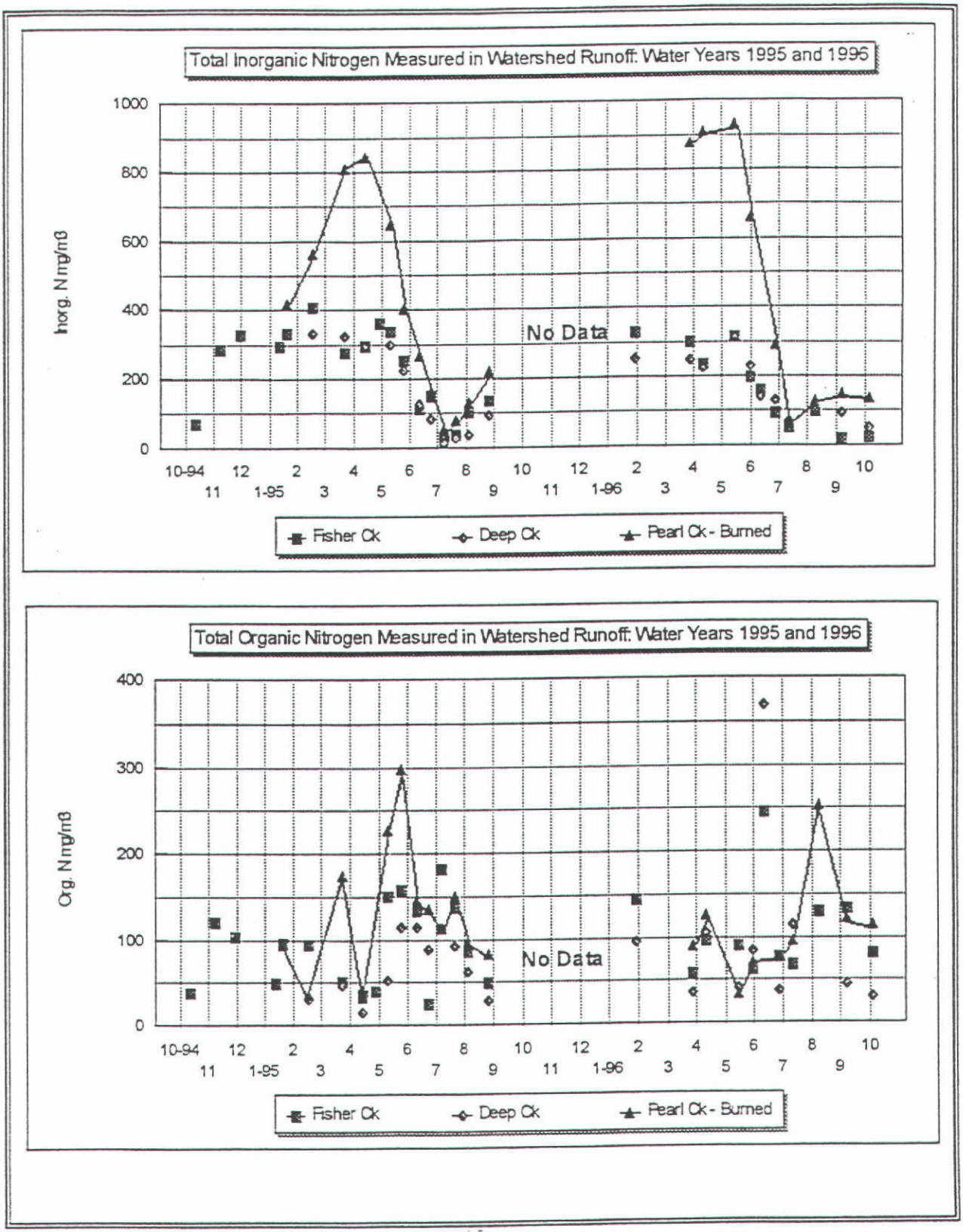
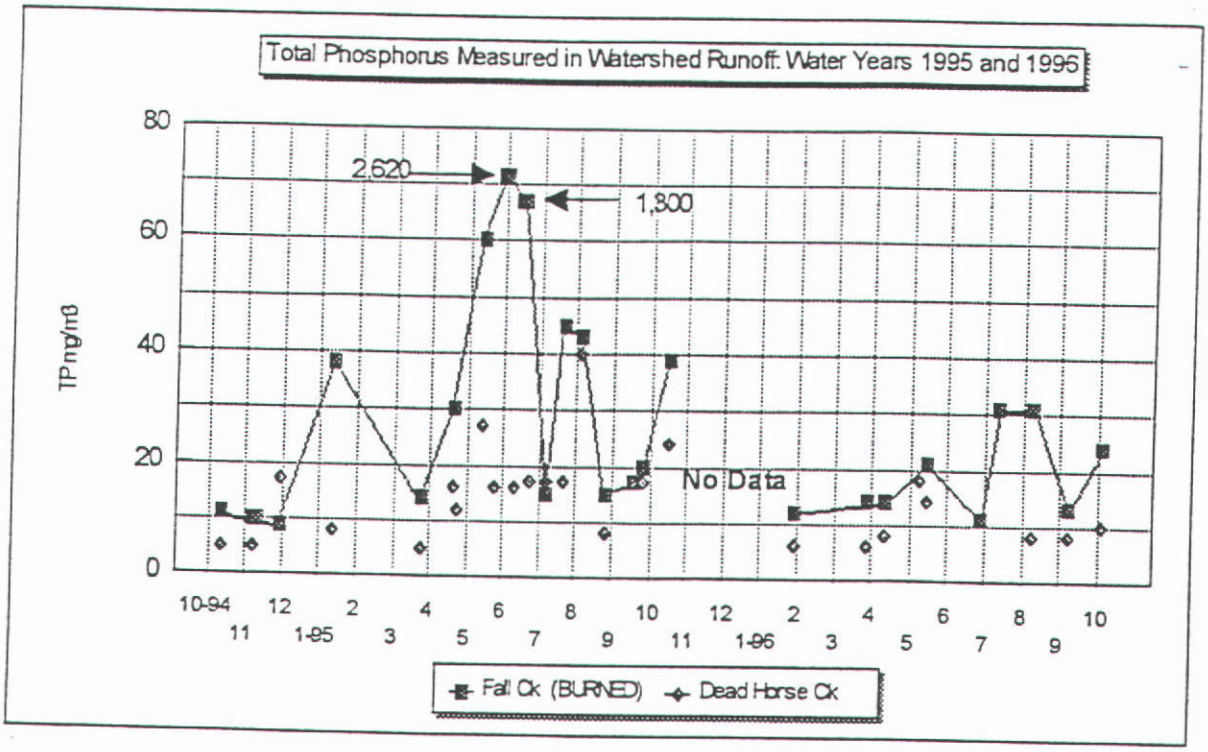


Figure 4-13. Total Phosphorus (TP) and Total Solids (TS) observed in samples from watersheds tributary to Big Payette Lake.



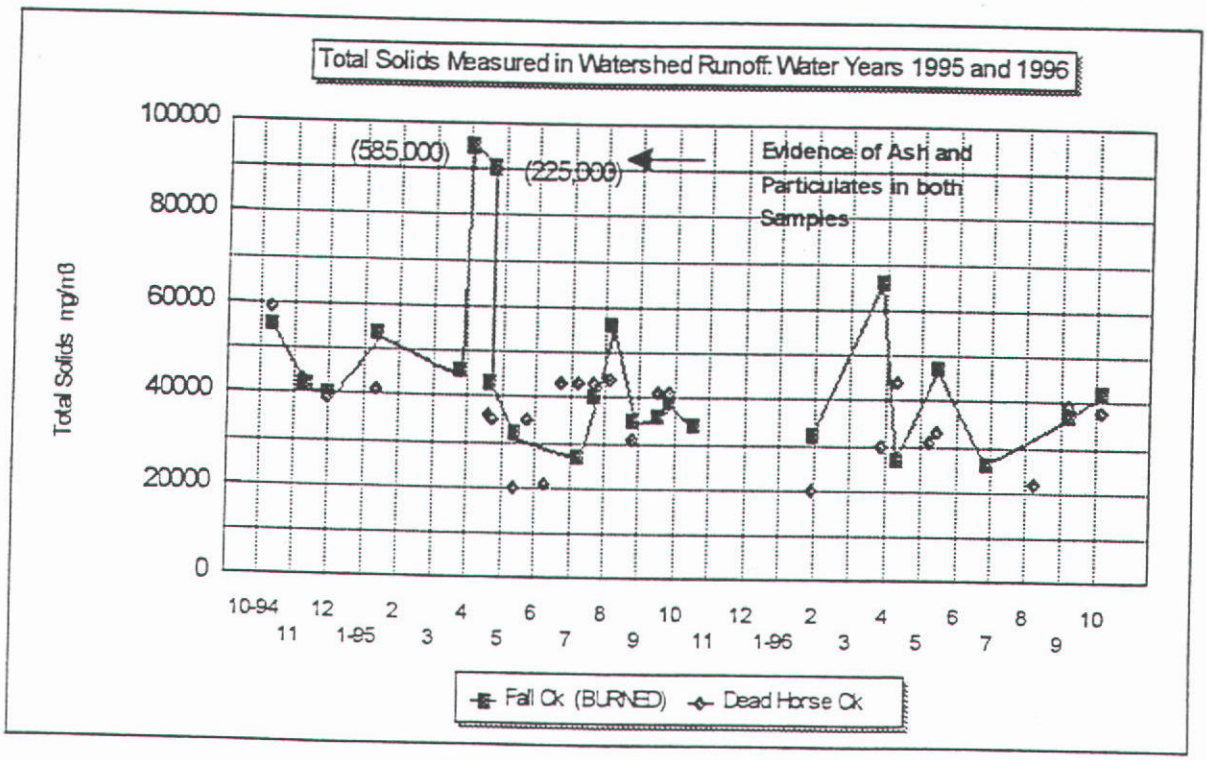
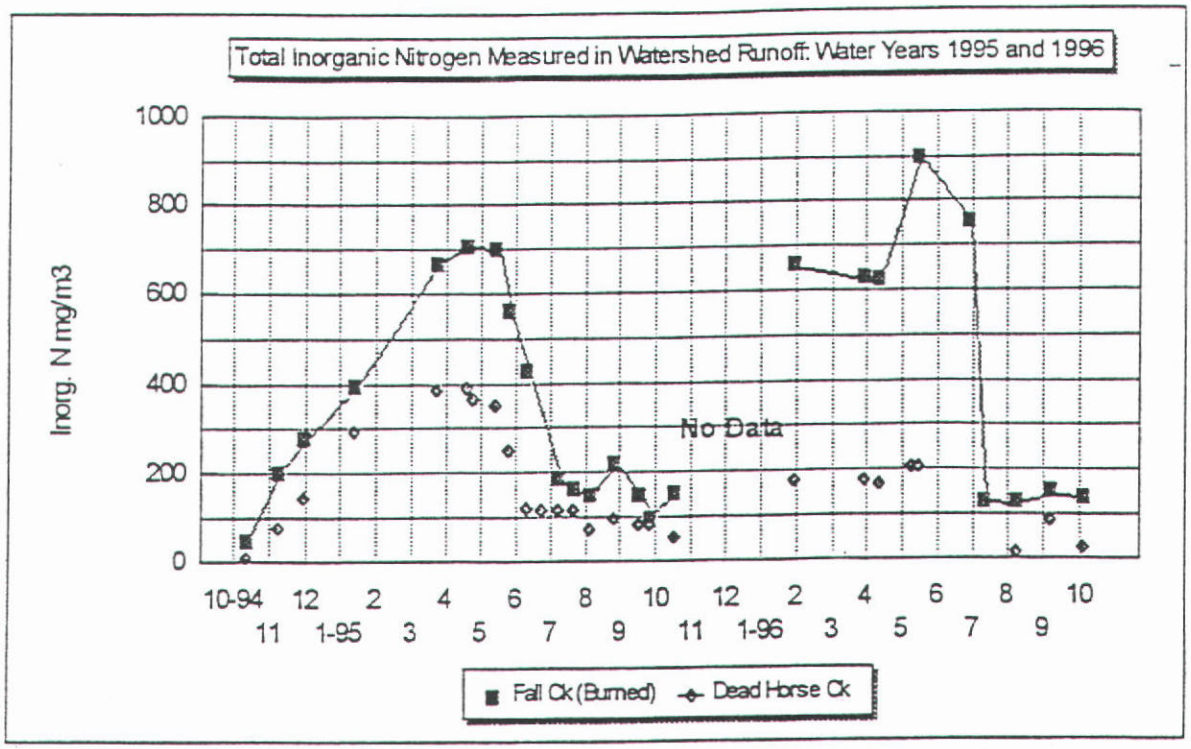


Figure 4-14. Inorganic nitrogen (DIN) and organic nitrogen (Org_N) observed in samples from watersheds draining to Big Payette Lake.



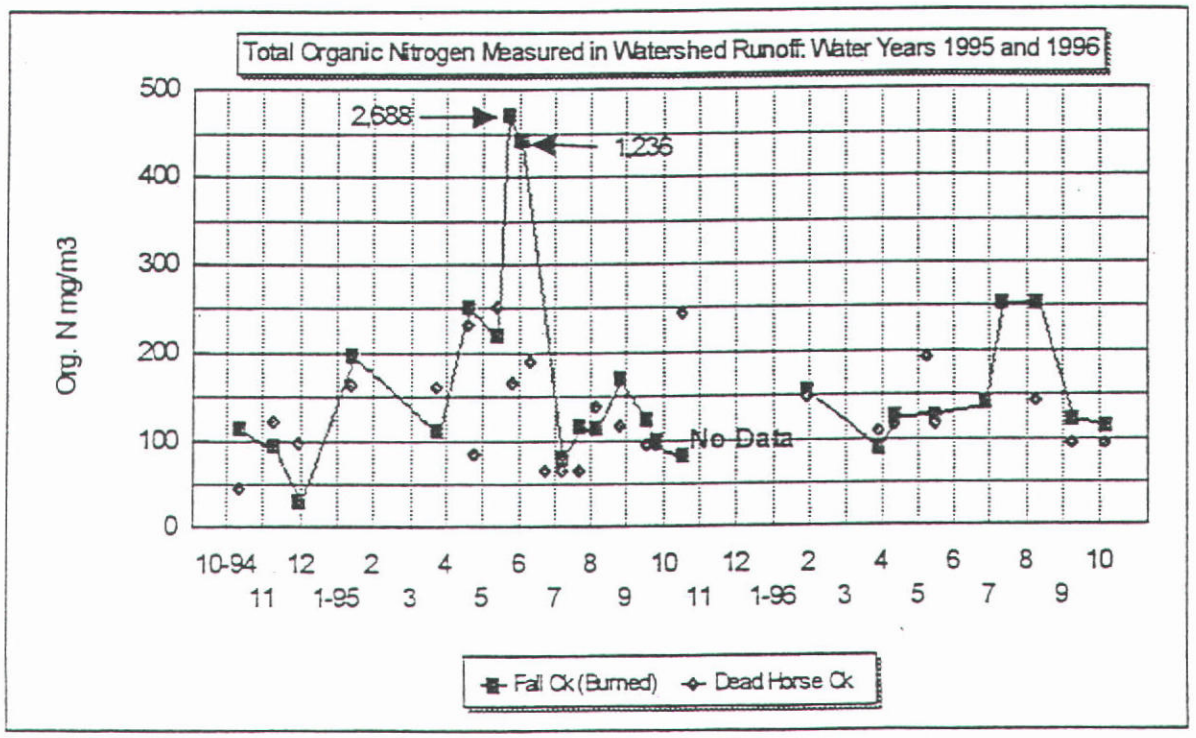


Figure 4-15. Comparison of annual trends in Total Phosphorus (PP + DisP), particulate phosphorus (PP), dissolved inorganic phosphorus (Dis-P) and flow for burned watersheds discharging to Upper Payette Lake. Note that some samples contained unusually high proportions of dissolved inorganic phosphorus.

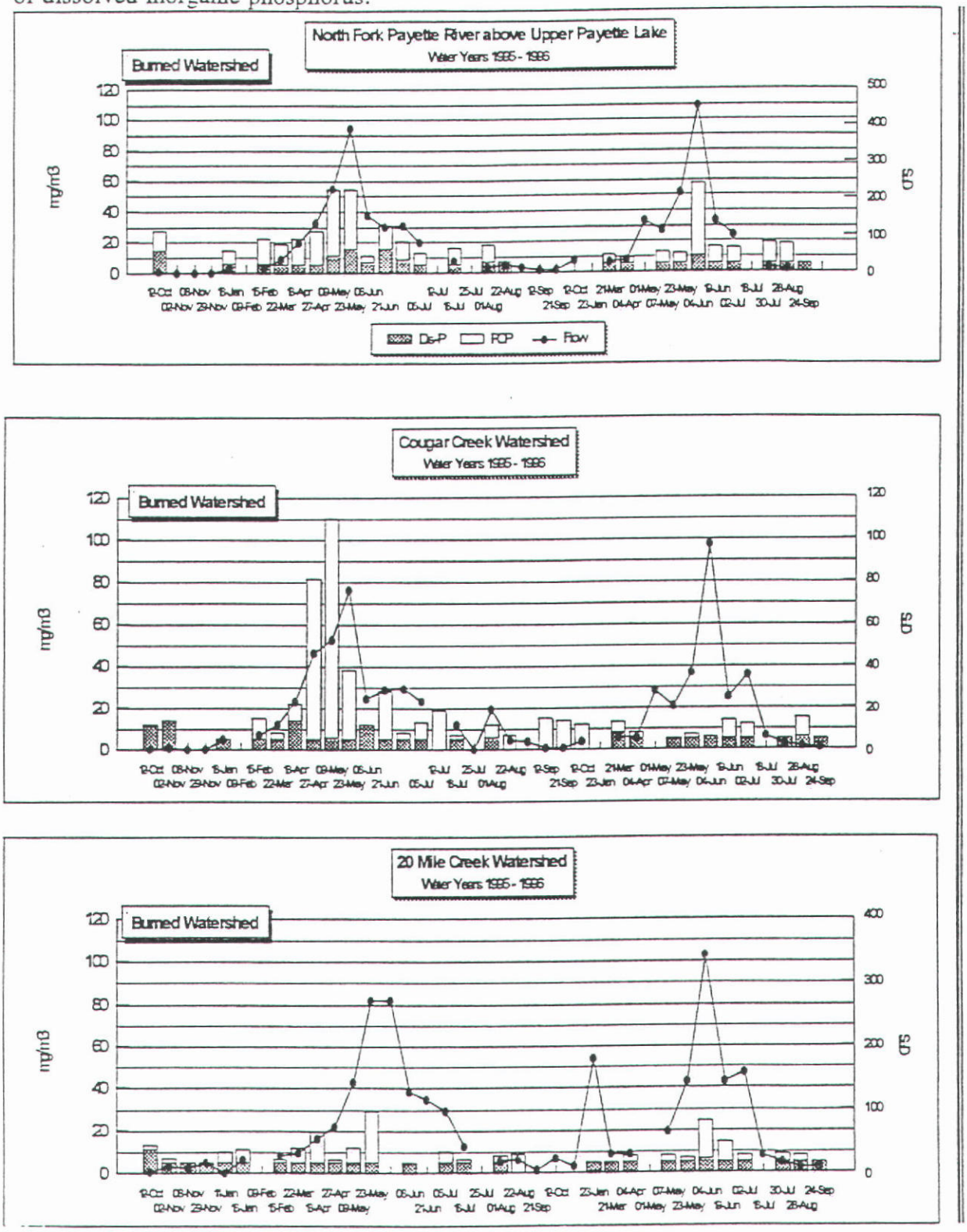
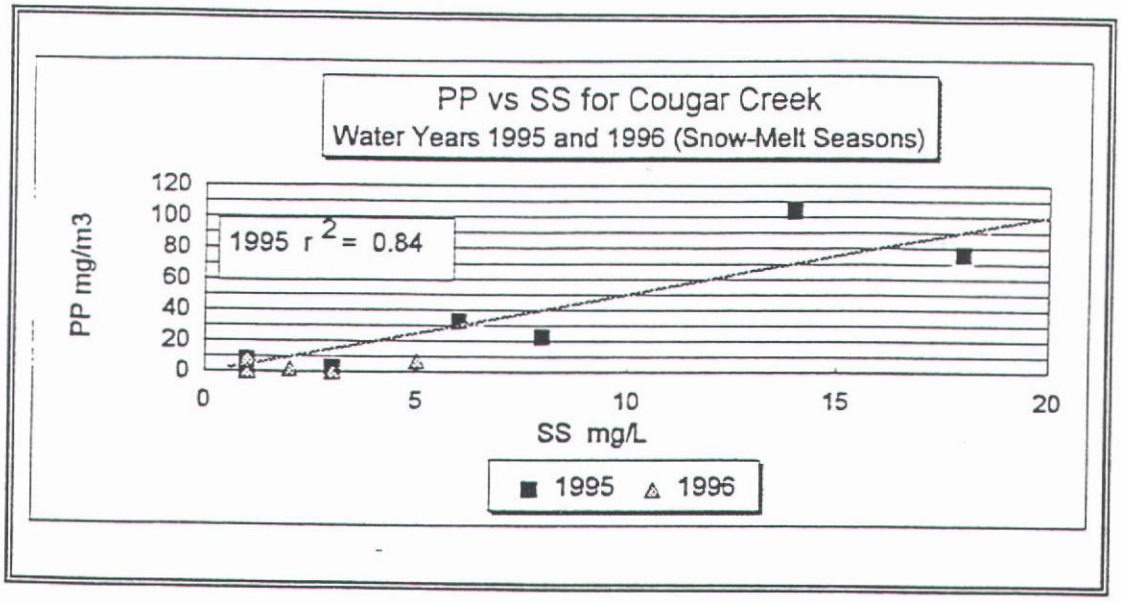


Figure 4-16. Linear regression of particulate phosphorus (PP) on suspended sediment (SS) concentrations from Cougar Creek water quality samples.



More extensive and intensive fires in the Pearl Creek watershed were associated with a higher proportional export of particulate P in the first year snowmelt. Whereas, the proportion of particulate P measured in the lighter burned Fisher Creek and Deep Creek watersheds was relatively constant during the first year snowmelt. Greater increases were observed in these latter watersheds associated with higher peak flows in the following year snowmelt.

The apparent decline in phosphorus concentrations instream waterr from burned watersheds is consistent with observations from other northwest studies. Gluns and Toews (1989) reported similar declines in phosphorus concentrations during the second year runoff following a wildfire. They reported that concentrations were undetectable in the third year runoff. Total and orthophosphorus concentrations were two to three times greater in burned watersheds of north-central Washington three to five years following wildfire (Tiedmann, 1978). Other studies following the Yellowstone Wildfire reported elevated concentrations of phosphorus in streams but levels were within pre-burn ranges of variability (Mahoney, et al., 1988).

Wildfire effects on watershed nitrogen sources are typically more prolonged. Robinson et al. (1993) reported elevated N-NO_3 levels five years after wildfires in Yellowstone National Park. Similar results were also reported for wildfires in Glacier National Park streams in which pulses of nitrogen continued to enter streams during spring runoff five years following the fire. An increase in stream water nitrate nitrogen (principally NO3-N) during the second year of snowmelt was also reported by Tiedemann et al. (1978), Stotlemyer (1987), and Gluns and Toews (1989).

Figure 4-17. Box plot comparisons summarizing nutrient and sediment data for combined water years 1995 and 1996. UPR = Upper Payette River, UPLout = Upper Payette Lake outflow, all other watersheds as designated.

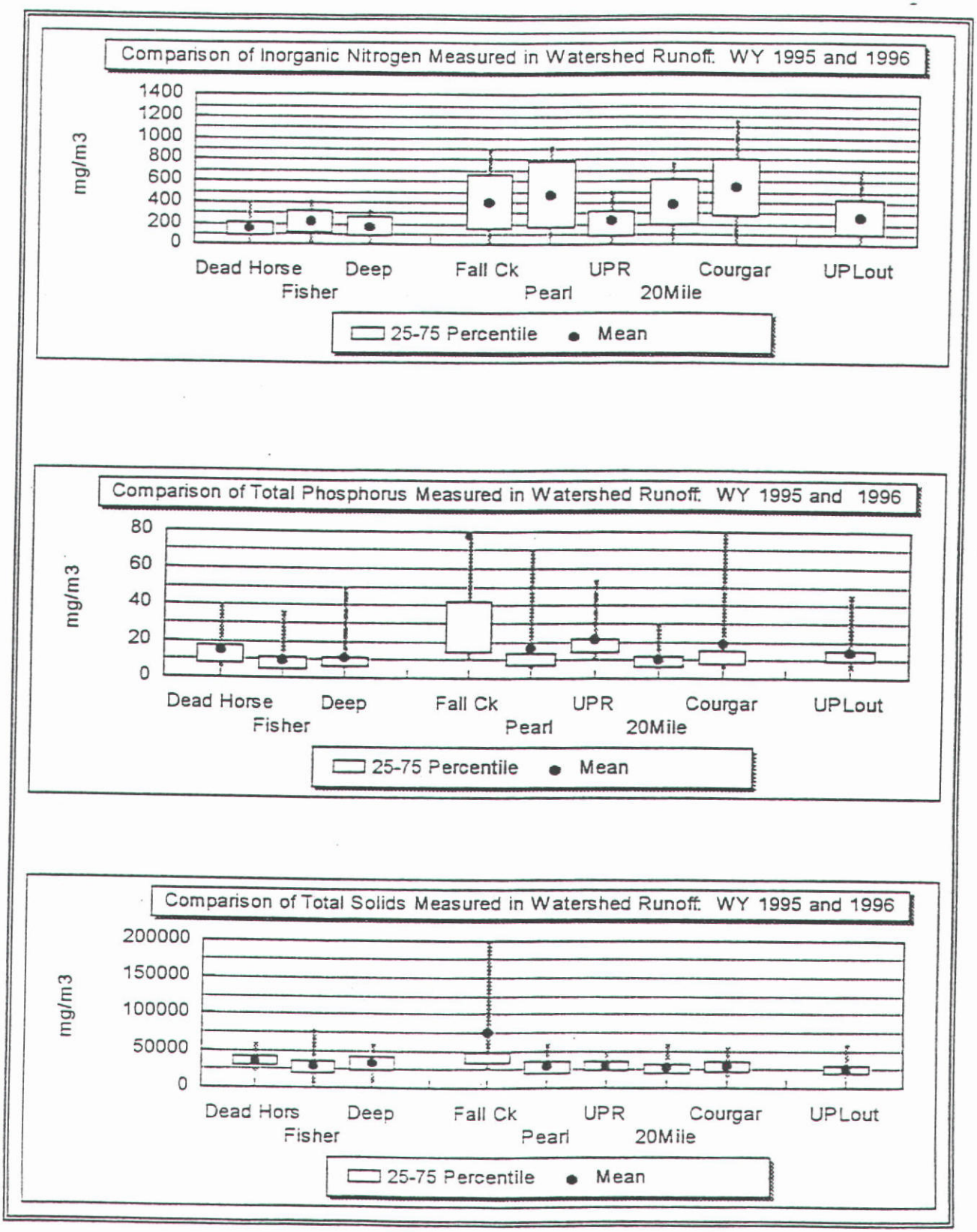


Figure 4-18. Comparison of inflow and outflow concentrations of nutrients and suspended sediments for Upper Payette Lake.

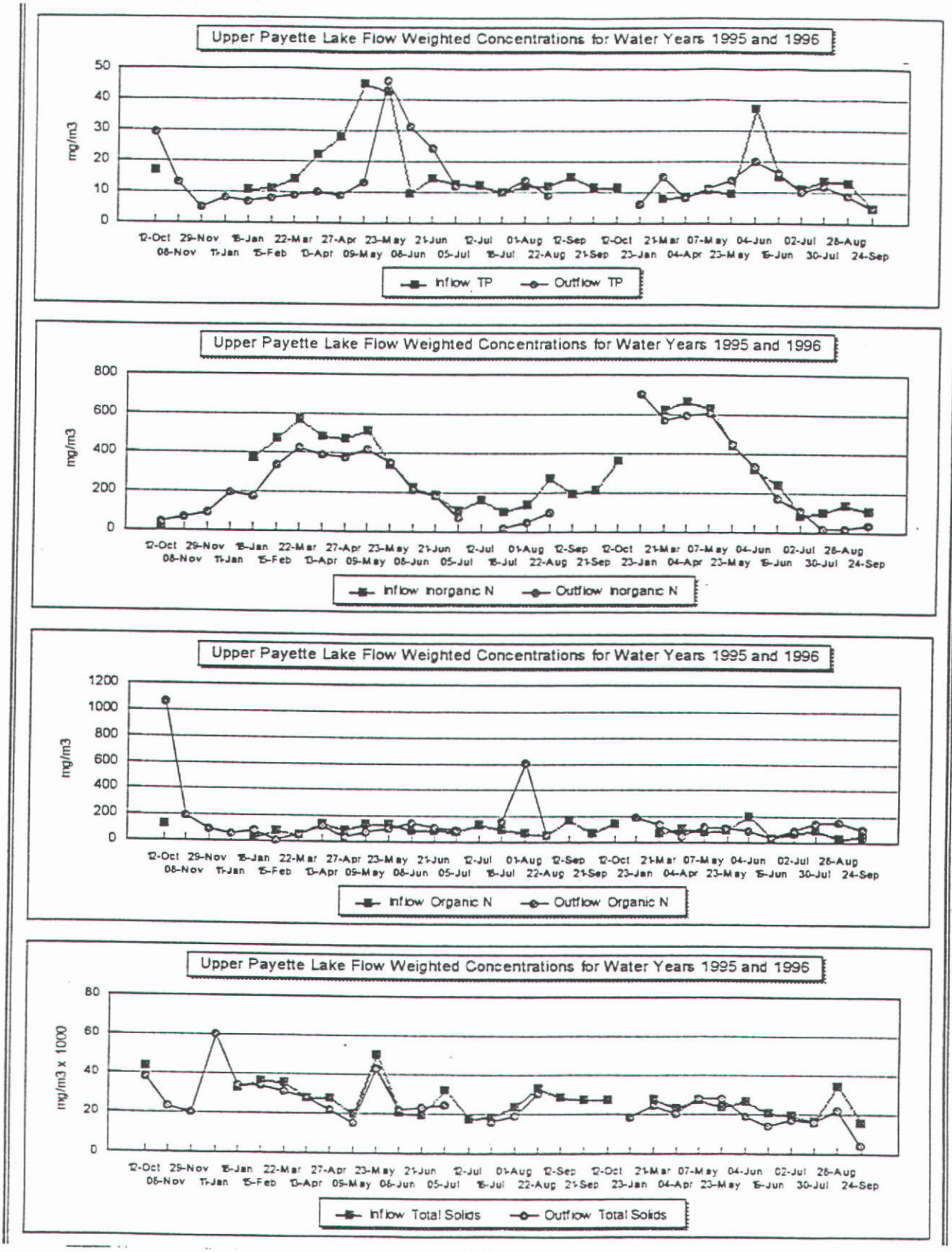


Figure 4-20. Phosphorus forms measured in streambed and stream bank sediments. (N = number of samples)

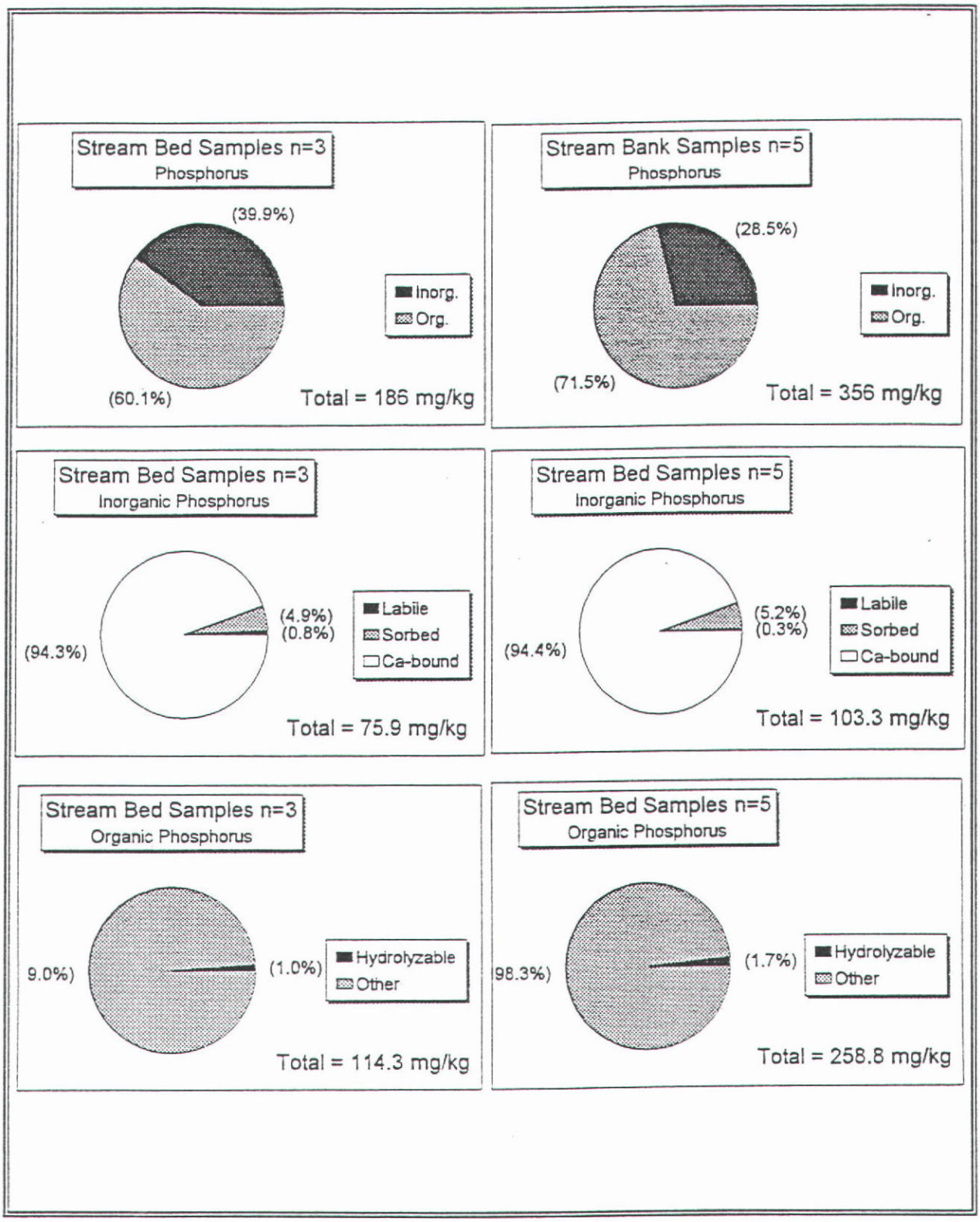


Figure 4-21. Temperature (degrees Celsius-C) and dissolved oxygen (mg/l) measured during synoptic sampling of watershed streams.

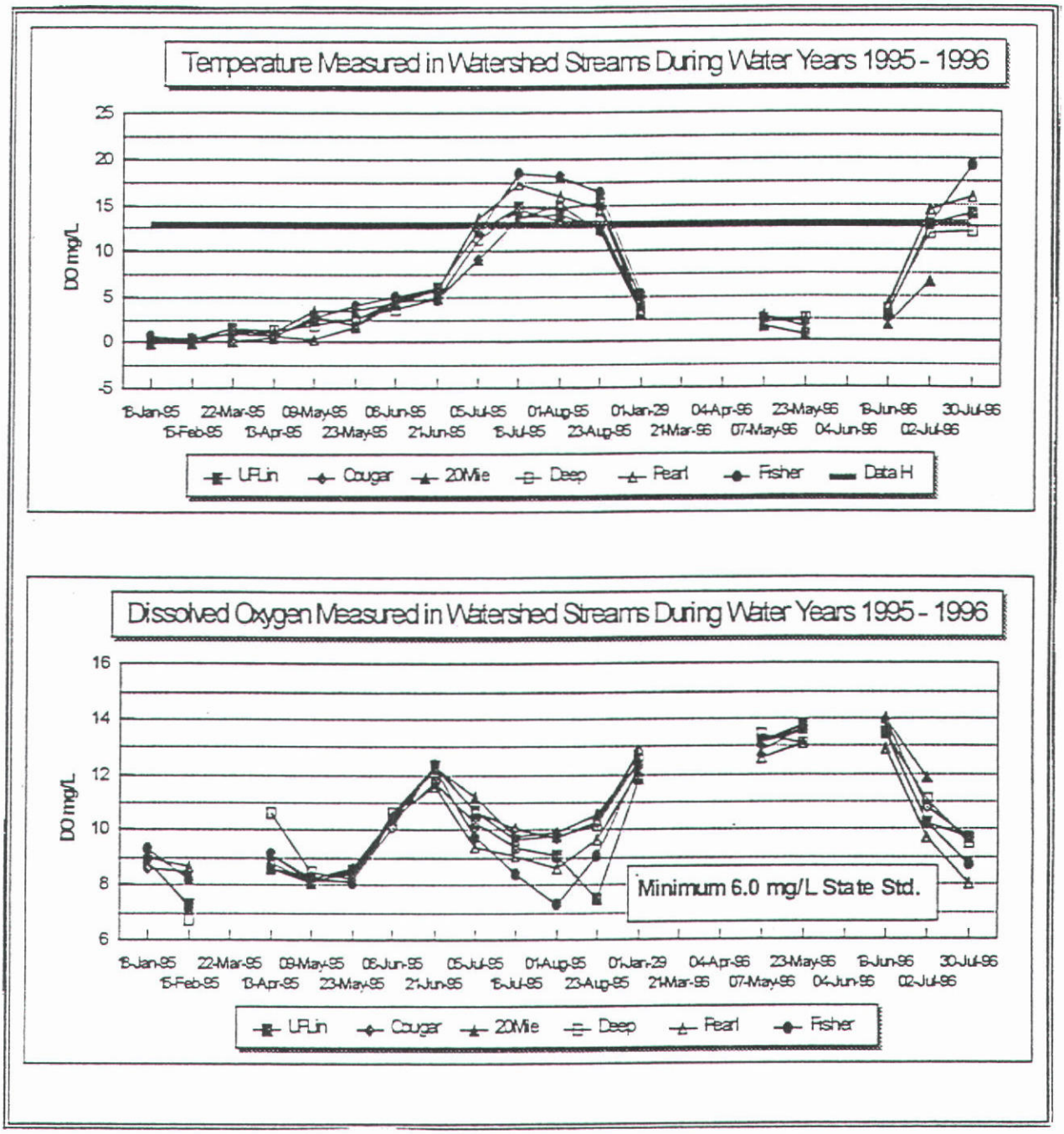
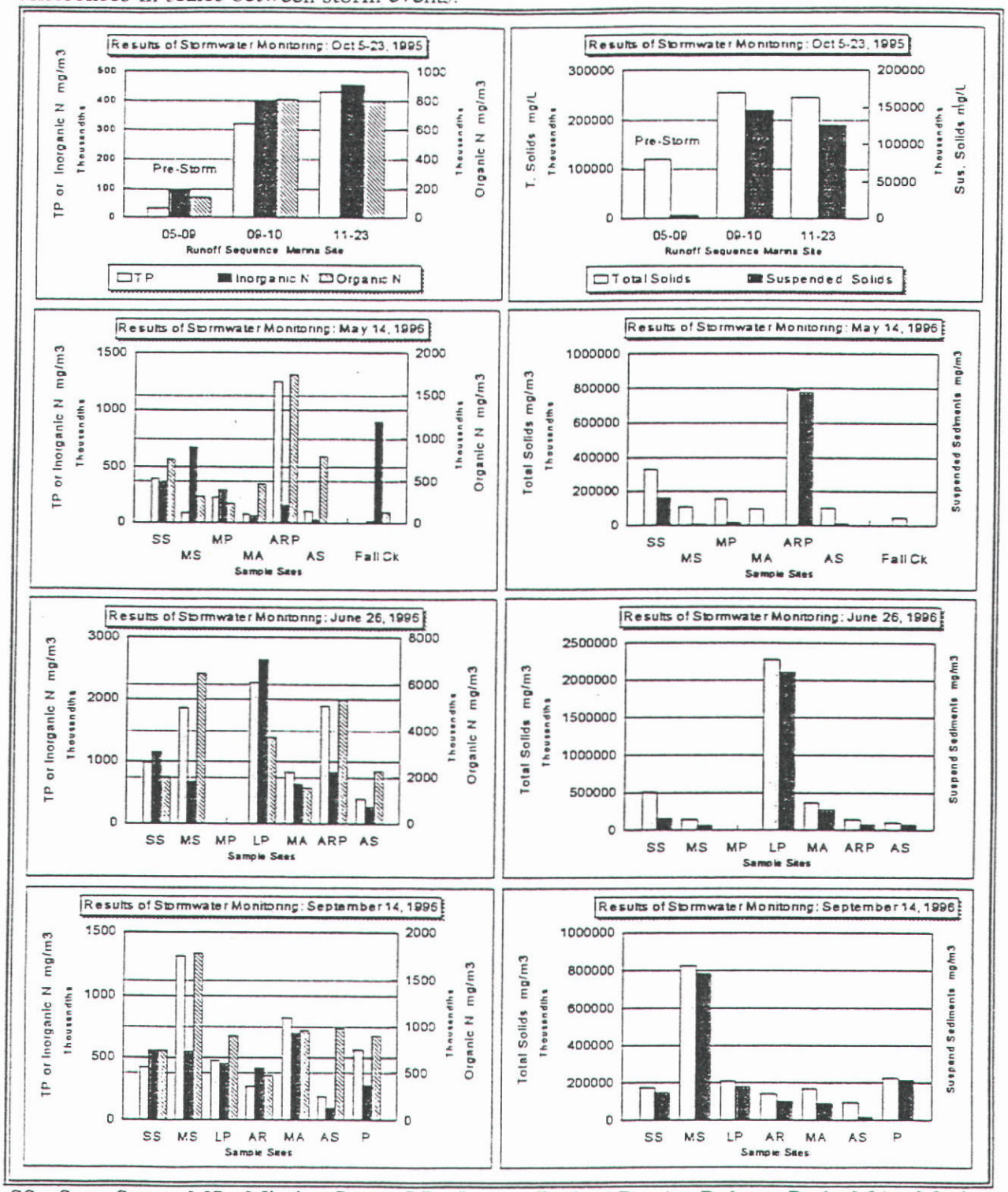


Figure 4-22. Total phosphorus (TP), inorganic nitrogen, organic nitrogen, total solids and suspended sediment concentrations measured and collected from developed areas. Note differences in scales between storm events.



SS=State Street, MS=Mission Street, LP=Legacy Park, AR=Art Roberts Park, MA=Marina, AS=Agate Street, P=Paul's

Figure 4-23. Bacteria results from stormwater sample collections. Note differences in scales between sample events. Fecal coliform samples included from N.F. Payette River on June 26 as a reference for other sources of bacteria.

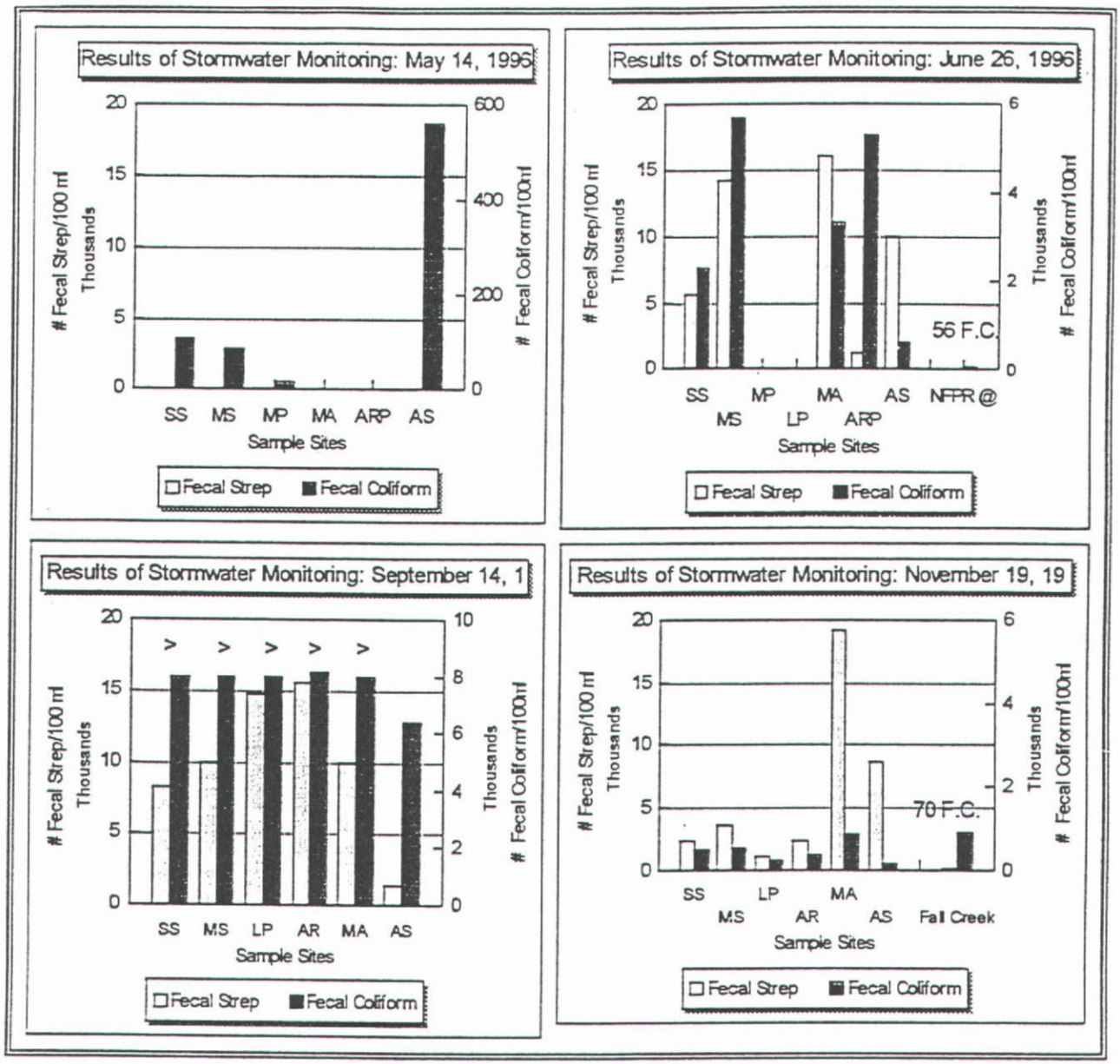


Figure 4 - 25. Existing and possible landslides in the Payette Lake Watershed

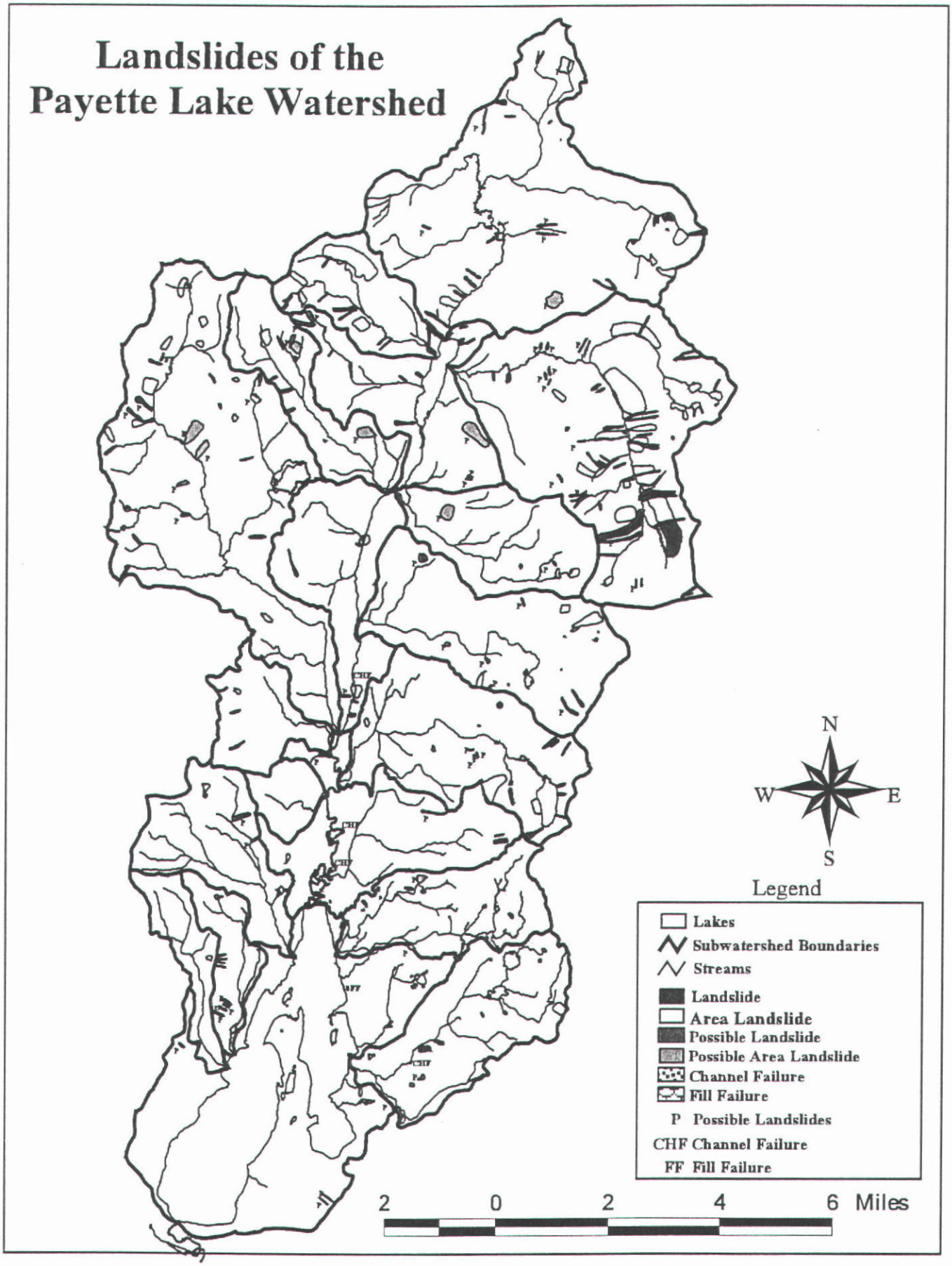


Figure 4 - 26. Road segments delivering sediment to streams in the Payette Lake watershed

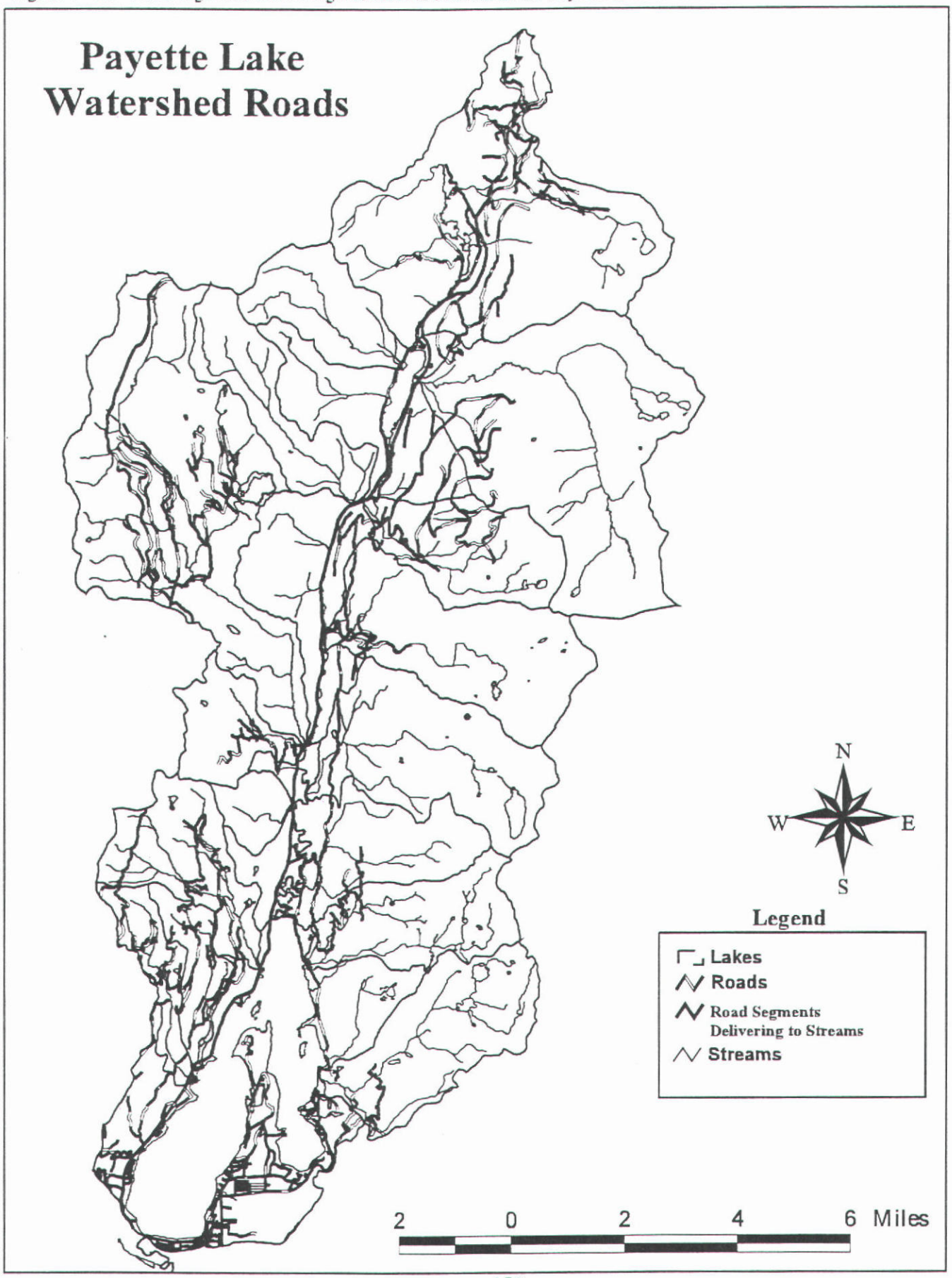




Plate 1



Plate 2

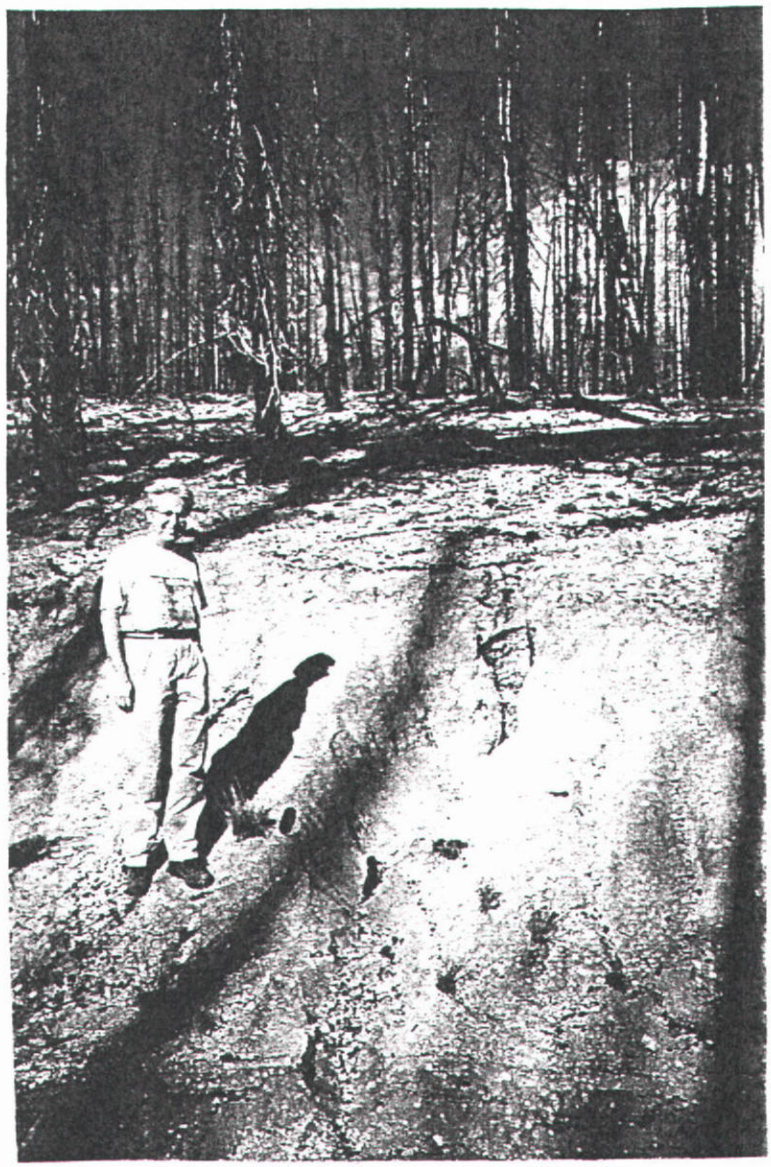


Plate 3



Plate 4

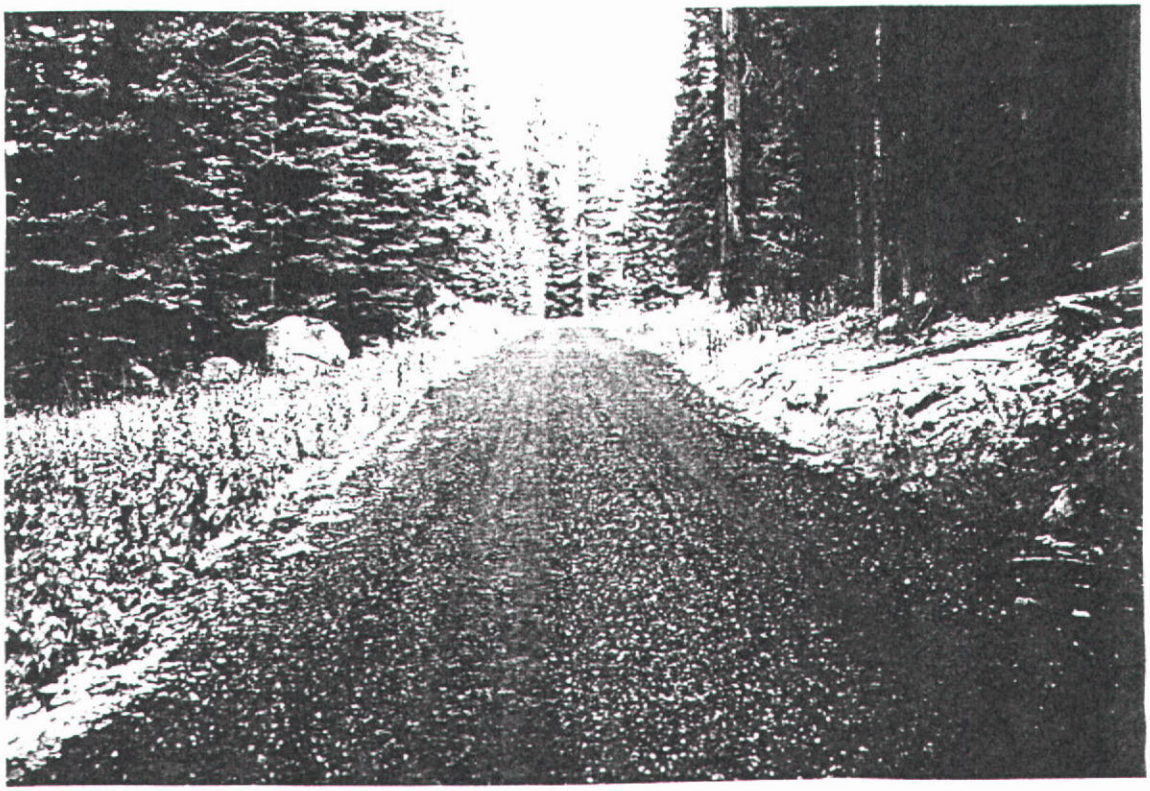


Plate 5



Plate 6



Plate 7

Figure 4-27. Mass wasting hazard ratings for the Payette Lake Watershed.

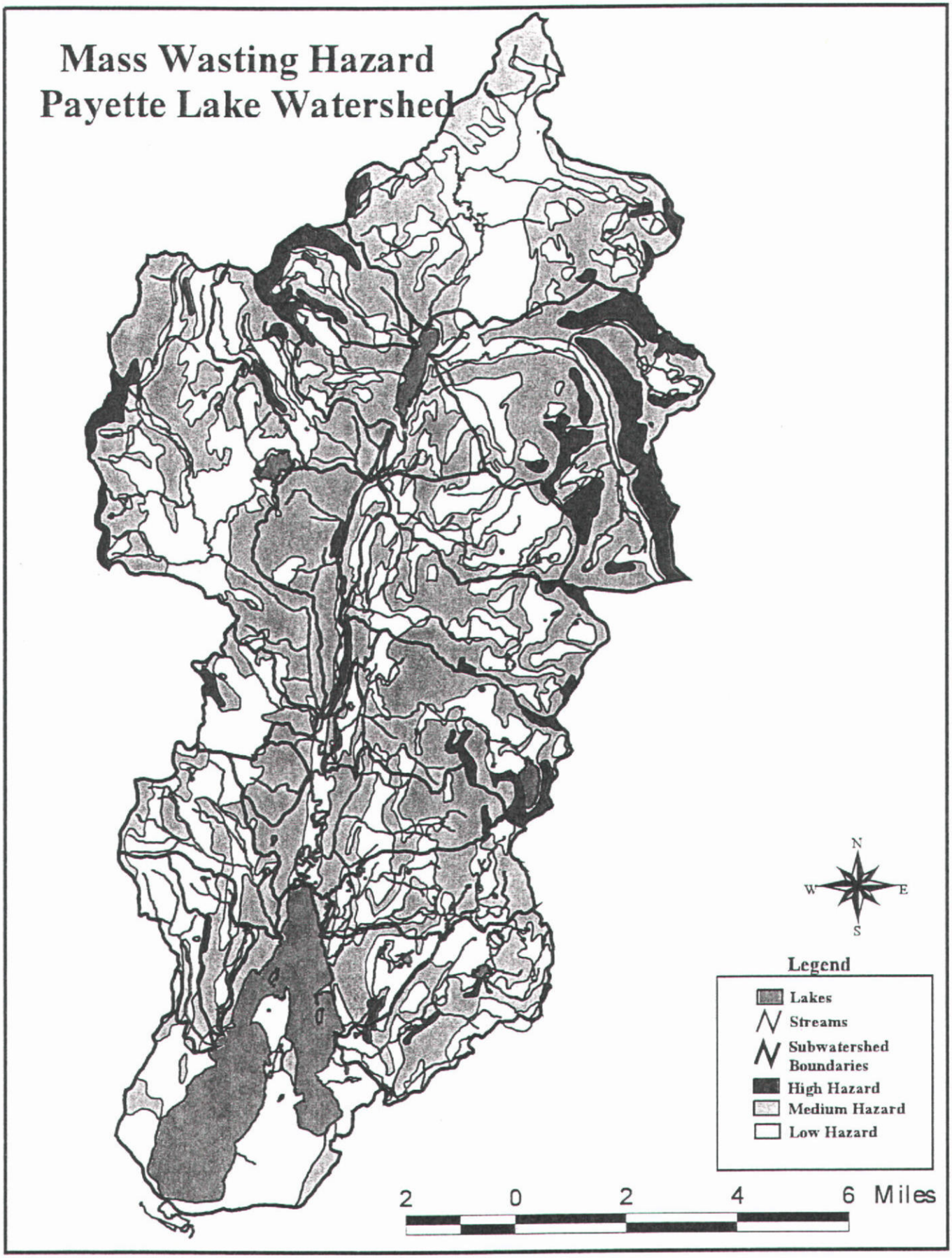


Figure 4-30. Habitat available to rainbow trout and spawning kokanee at various discharges in the upper North Fork Payette River, expressed as a percent of the total area of each study site. Vertical line in each chart represents recommended minimum discharge for that reach.

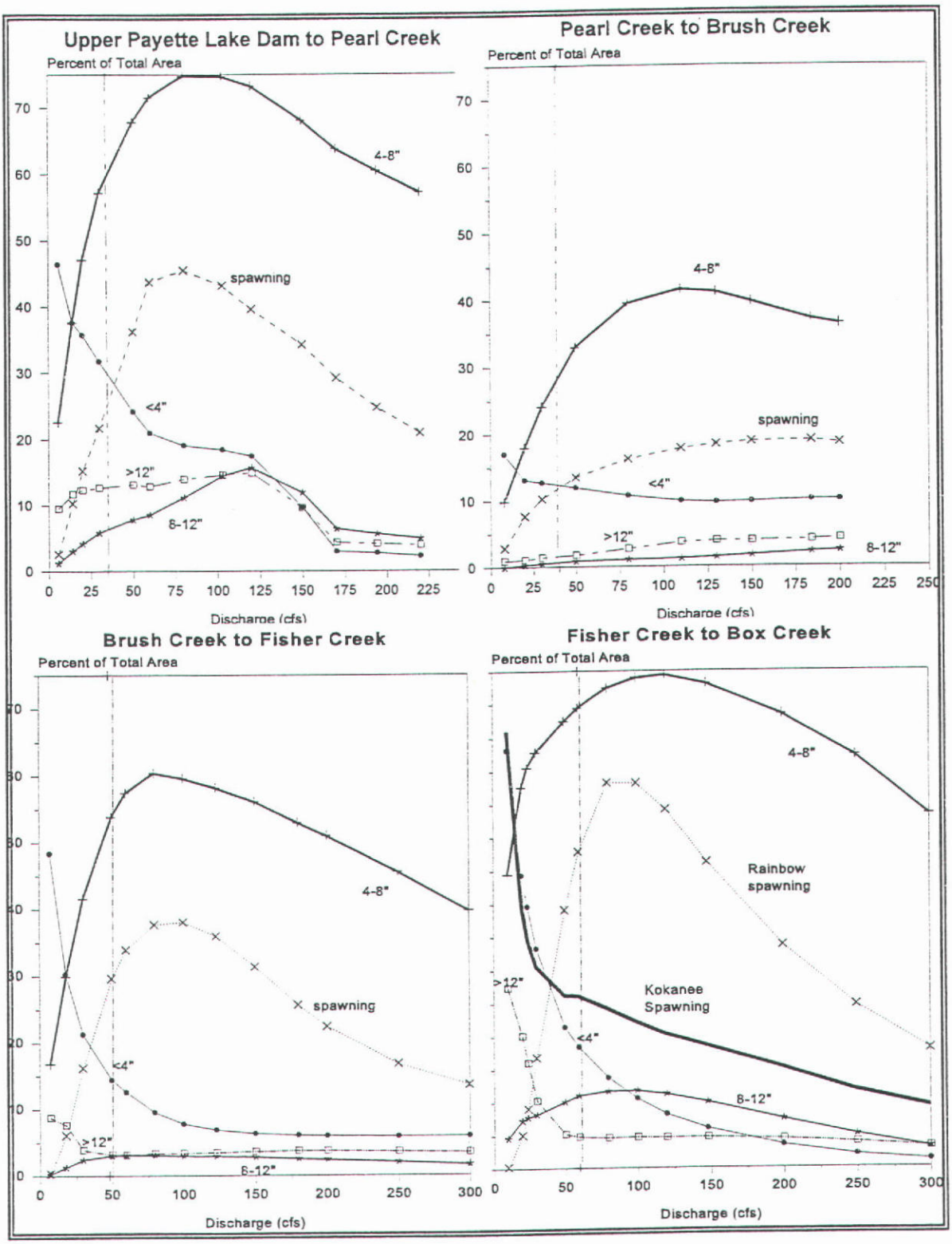


Figure 4-31. a.) Recommended summer discharge for mainstem N.F. Payette River, as measured at the USGS gauge below Fisher Creek, b.) Discharge relationship among all reaches of the river, c.) Summer water temperatures at USGS gauge, and d.) Densities of rainbow trout in study reaches.

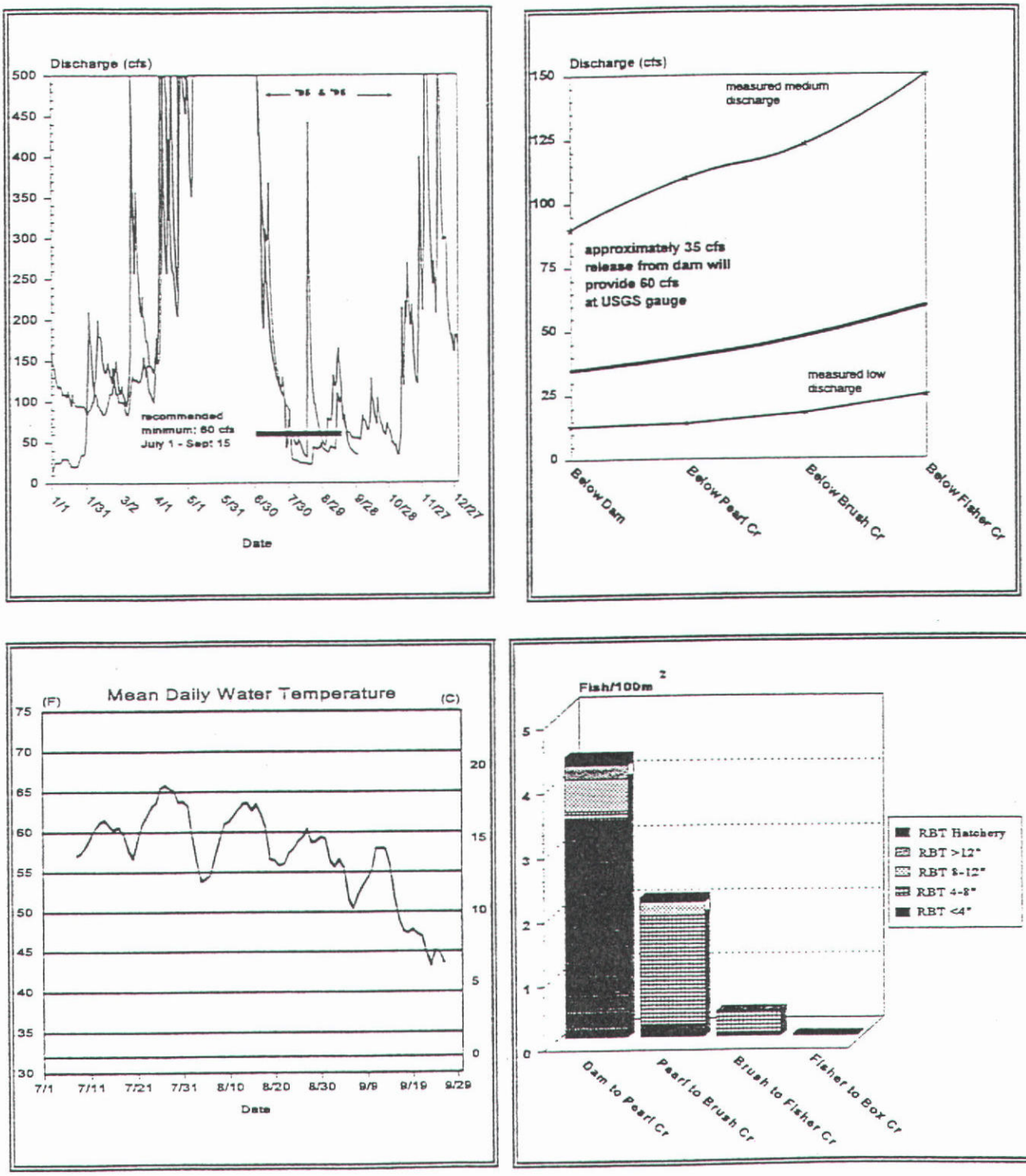
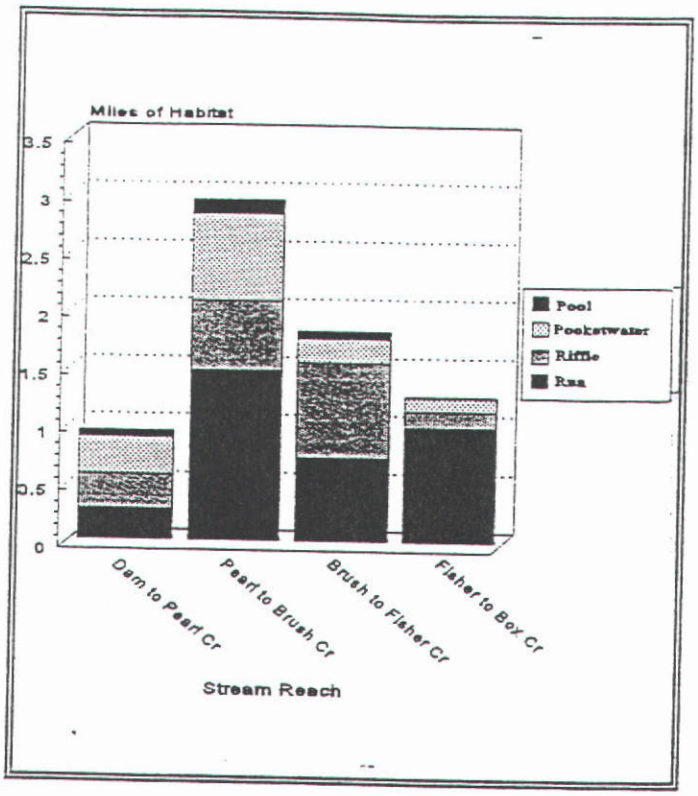


Figure 4-32. Quantity of habitat types in the upper North Fork Payette River.



Though no data were collected regarding riparian or instream cover, abundance of large woody debris in the river channel appears to be low. Fallen trees left in the river could increase pool abundance and depth, increase macro invertebrate production, provide velocity refuge for all trout life histories, and could provide sorting of sediment to provide spawning gravels (Hunter 1991).

4.8 Sediment Accumulation Rates and Nutrients

High quality sediment cores were successfully retrieved from Payette and Upper Payette Lakes during July of 1996. Duplicate cores were collected from each of the three target basins, with subsections from the best of each set further processed for 210Pb analysis. The spare cores were also subsectioned and archived for future consideration. All cores were subsectioned at one centimeter intervals through the first 30 cm and then at 2 cm intervals through the remainder of the strata.

4.8.1 Core Composition

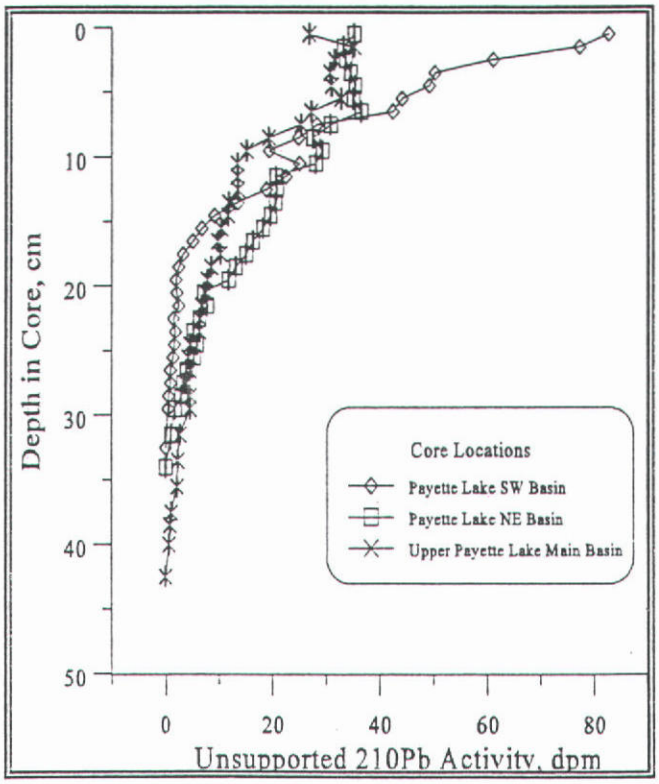
The three cores used for analyses varied in thickness from 70 cm (Main Basin, Upper Payette Lake: UPL), 98 cm (NE Basin Payette Lake: NEP) and 107 cm (SW Basin Payette Lake SWP). The excessive thickness of each core was necessary to insure that the entire period of 210Pb activity (160-180 years) was captured completely. The UPL core was visually unremarkable, grading from a flocculent surface material at the sediment/water interface, into a more densely packed fine mud at the bottom. This is a common change resulting from gravity compaction and dewatering. No significant coloration changes, sediment banding or other stratigraphic features were noted in the UPL core. There were no signs of surface disturbance or bioturbation in the core which could impact dating procedures.

By contrast, the NEP and SWP cores showed fined banding of sediment layers alternating in color between light brown and darker brown/black near the surface of each core. The banding persisted through the top 5-7 cm at a rate of 5-7 bands per centimeter and was most pronounced in the SWP core. The SWP core also showed signs of oxidized iron present in the surface layers. This is significant as iron and phosphorous cycling in lakes are intimately linked and directly related to water quality. The presence of oxidized (rust orange) iron at the surface of the SWP core indicates that iron has been cycling in the hypolimnion of that basin and that is readily available for release to the water column again. Since phosphorous is the most common co-precipitate of iron under changing redox conditions, phosphorous may also be stored in the surface sediment and available for recycling. Below the top 10 cm, no stratigraphic features were apparent in either the NEP or SWP cores. Each graded into denser material down through the core. There were no signs of surface disturbance or bioturbation in either core which could impact dating procedures.

4.8.2 Dating Results:

210Pb stratigraphies found in each core are depicted in Figure 4-33. All three cores showed similar ranges in 210Pb concentrations, which provides a good initial quality control check. Of the three, the SWP core shows the most classic decay curve, with 210Pb increasing at a relatively steady logarithmic rate from depth up to the surface. The extent of the detectable 210Pb concentrations ceased in each core within 30-45 cm of the surface. This indicates that a bicentennial record is contained within the top 0.5 m of each core and that the depth of penetration was sufficient in each instance to capture the appropriate record.

Figure 4-33. Observed 210Pb stratigraphies in each sediment core.



The raw 210Pb data were transformed into CRS model dates and are shown in Figure 4-34 (a). The first 10 cm of each core were deposited at an average linear rate of roughly one centimeter per year, yielding a satisfactorily high degree of temporal resolution. Cumulative dating error was also satisfactory, remaining below plus or minus 0.5 years (95% C.I.) through the top 20 cm of each core. The least precise dating interval reached plus or minus 5 years at the 120 years before present in the UPL core (<5% relative error). Relative to a range of other lakes and lake sediment cores, the three retrieved from UPL, SWP and NEP can be considered high quality and high resolution, meeting the data quality objectives of this study.

Figure 4-34. a.) CRS model dates and associated strata depth in core profile, b-d). CRS model dates and error estimates in the associated sediment accumulation rates for each core strata.

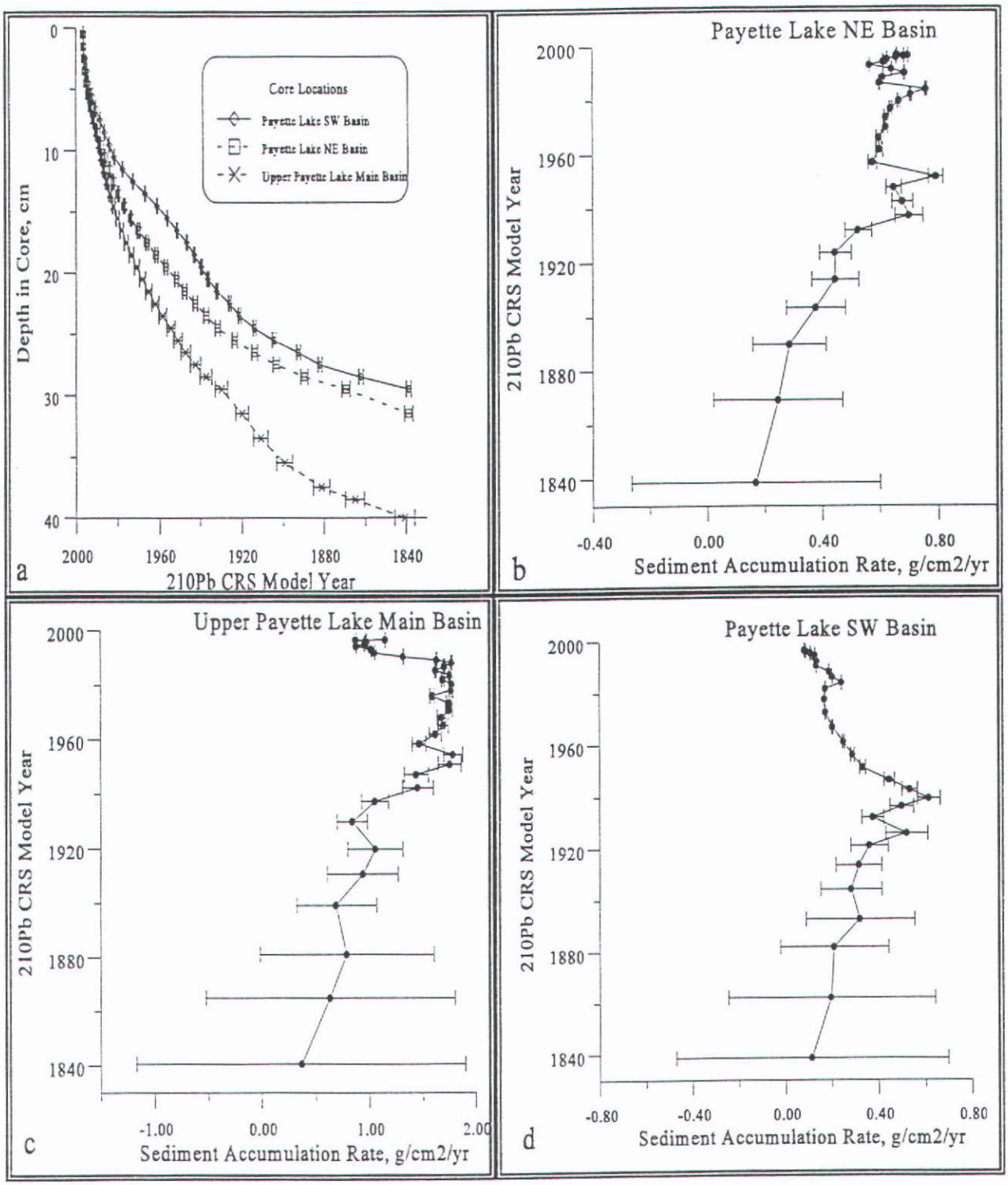
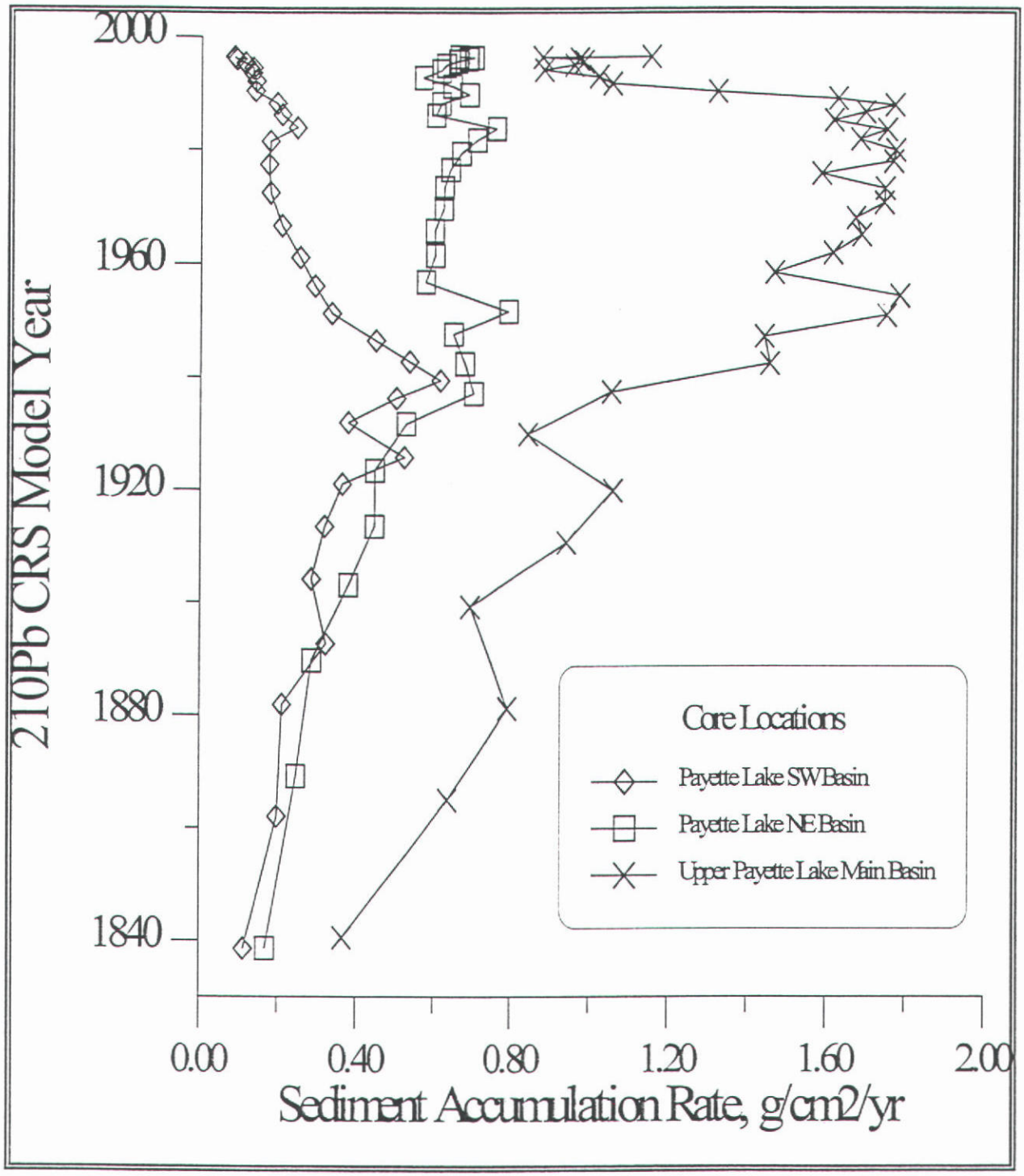


Figure 4-35. Comparison of SARs among sediment core sites in Upper and Big Payette Lake.



The observed changes in the sedimentation rates were not an anomaly related to concomitant changes in the annual runoff intensity as indicated by peak flow discharge volumes (Figure 4-36). Although direct discharge records are not available for the N.F. Payette River above Big Payette Lake, discharge records have been maintained at the Big Payette Lake outflow since 1910. Plotting the annual peak flows during spring runoff for the period of record shows that peak discharges from 1949 until the recent drought in 1987 were less variable (CV = 19.7%) and were roughly of equal magnitude compared to the preceding time span 1909-1948 (CV= 25.4). The corresponding sediment accumulation rates for Upper Payette Lake over this period clearly shows an increase in deposition after 1951 even though peakflows were less extreme (fewer high flow years) compared to the previous decades.

The events affecting the complicated patterns of SAR changes during the last 50-60 years are difficult to pinpoint in the continuum of further development and management of the basin. A significant influence amidst the changing landscape is the concerted effort to harness regional water resources through construction of dams; Upper Payette Lake (1929), Granite Lake (1932), Big Payette Lake (1944)[1] and others of unknown date (Blackwell Lake). While the exact construction regime is unknown, both Upper and Big Payette Lake were dammed during the period corresponding to the rapid changes in SARs (1930-1940).

Figure 4-36. Peak annual discharge as estimated by the Big Payette Lake outflows and corresponding sediment accumulation rates measured from Upper Payette Lake.

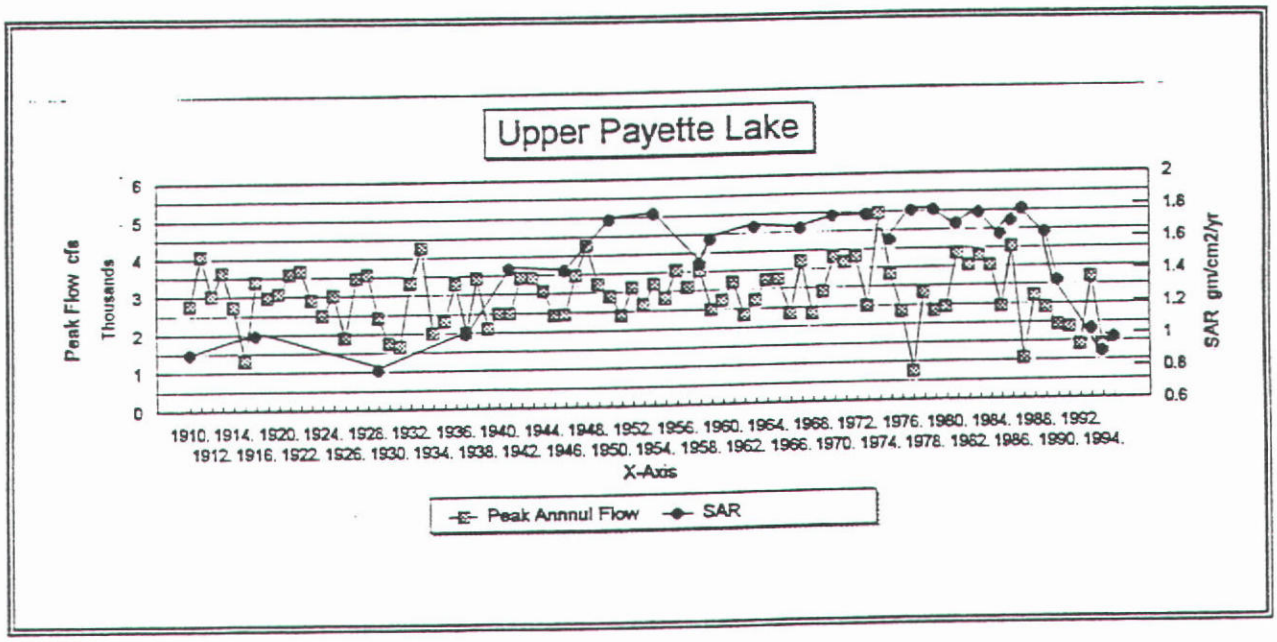


Figure 4-37. Profiles of total carbon (C), total nitrogen (TN), total phosphorus (TP) and iron (Fe) in sediments from Big Payette Lake. Concentrations in ug/g dry sediment weight.

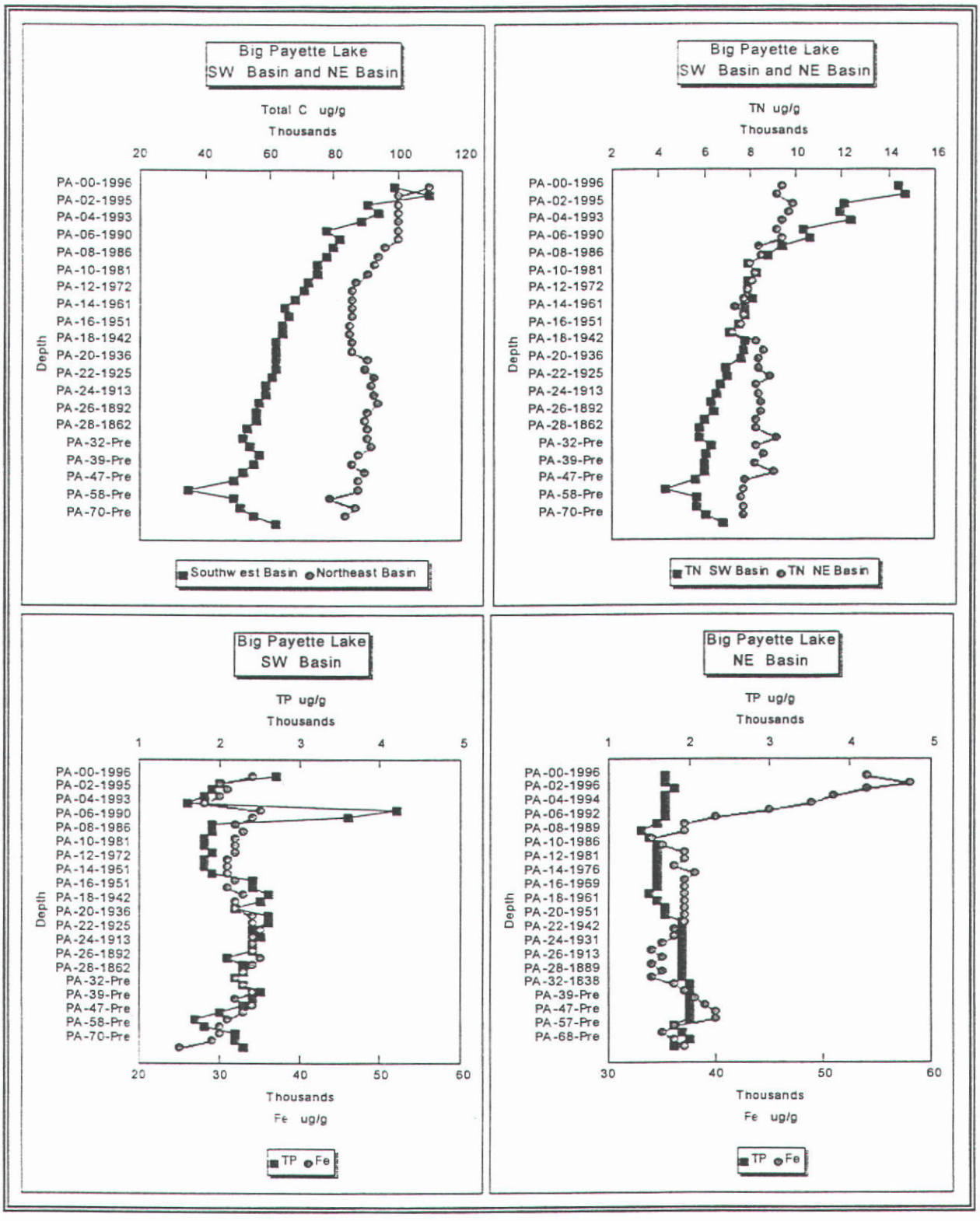
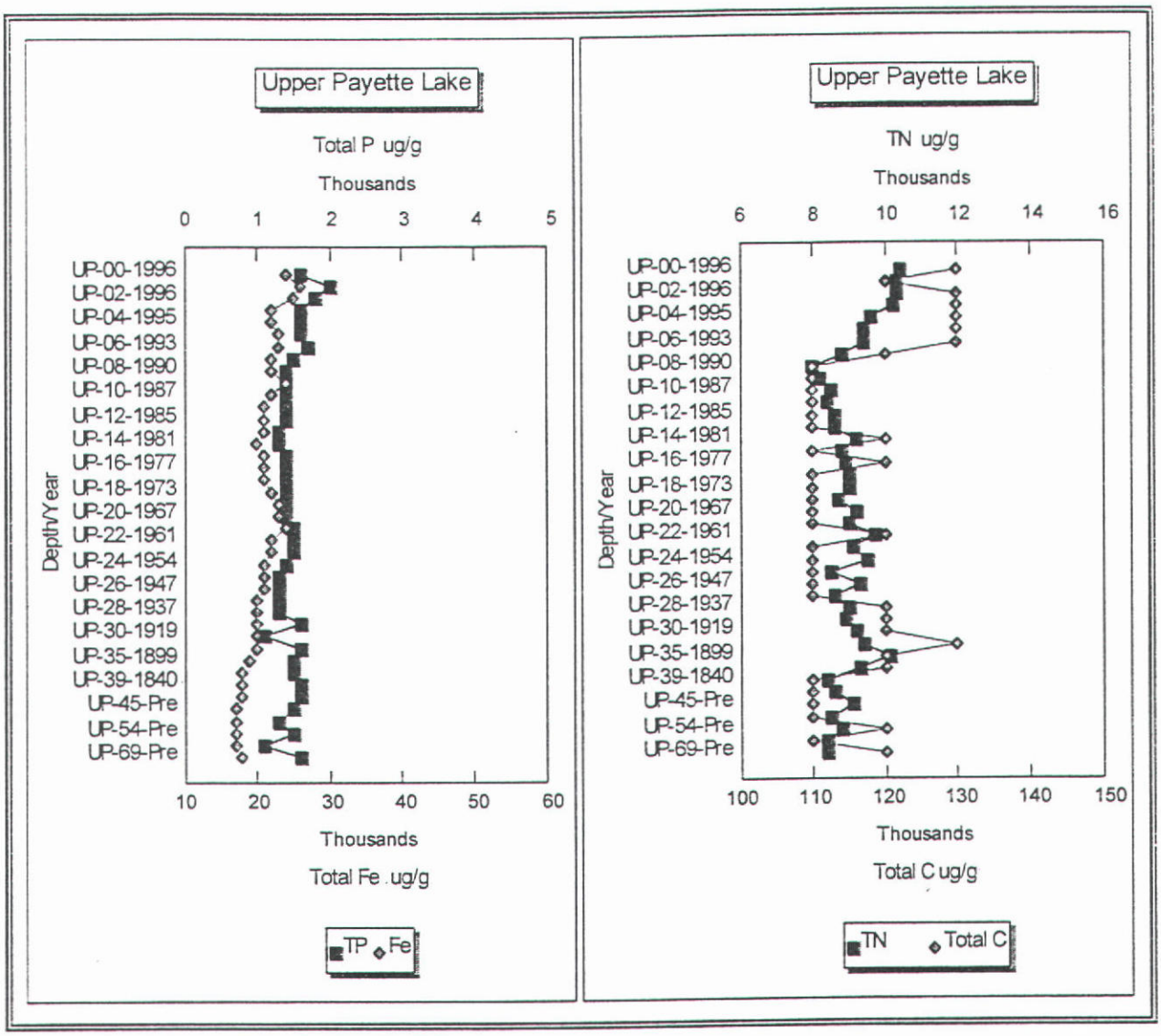


Figure 4-38. Profiles of total carbon, total phosphorus, iron and total nitrogen in sediments from Upper Payette Lake.



A comparison of the C:N and N:P ratios among the sites indicate subtle changes have occurred in the contribution of these nutrients within the SW basin over time (Figure 4-39). C:N ratios in the NE basin of Big Payette Lake vary between 10-12 throughout the core profile and do not exhibit any specific increasing or decreasing trend. Results indicate the relative contributions of carbon and nitrogen have remained relatively consistent. The pattern is somewhat similar for the C:N rations in the SW basin except for a general decline in the C:N ratio during the 1990's coinciding with the drought. Increasing ratios of N:P present at both sites suggest nitrogen export form the watershed has increased over time. This increase is most apparent in the SW basin

Figure 5-1. Lines of equal temperature, in degrees celsius, at stations 1-4 during selected months of 1995-1996.

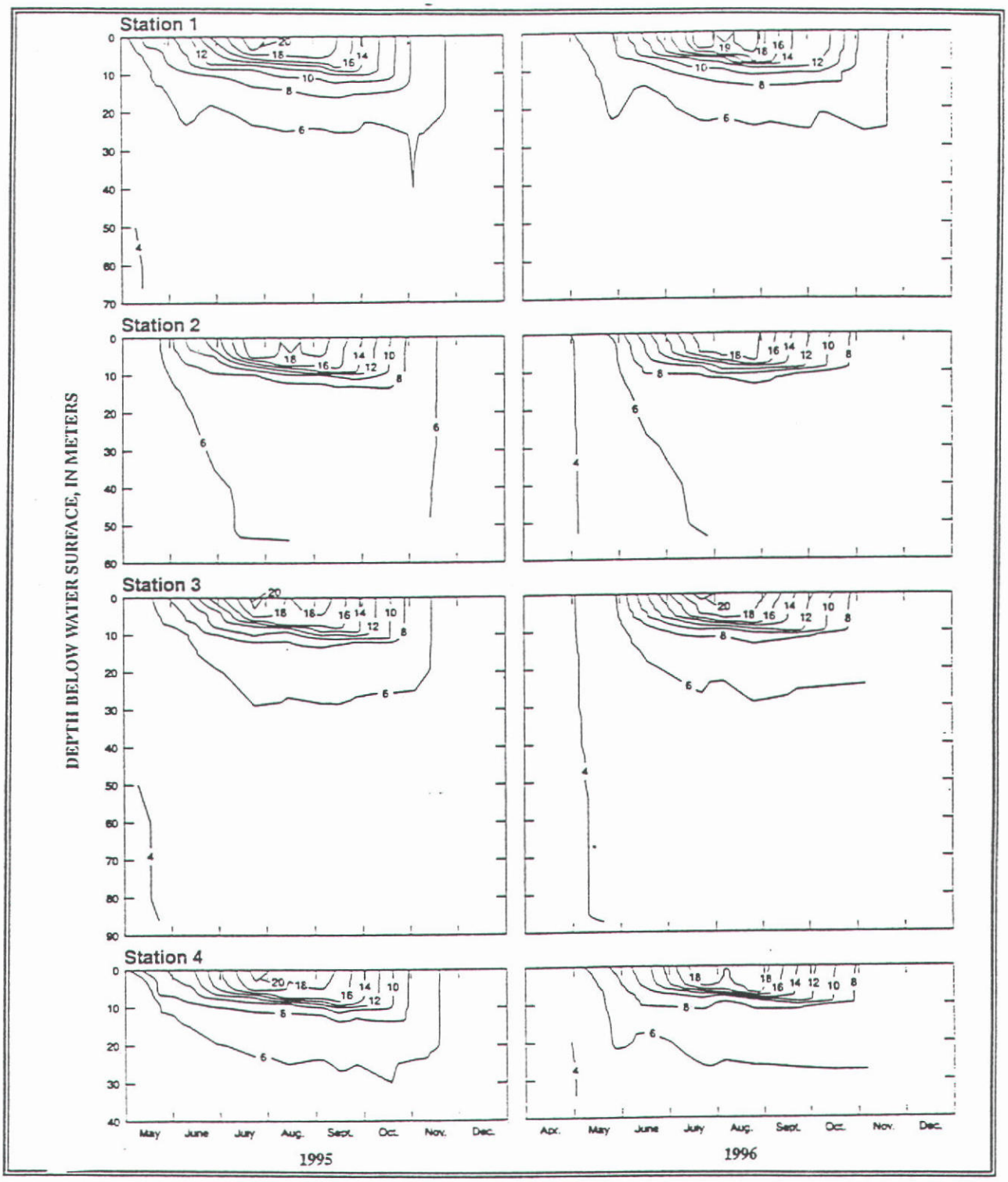


Figure 5-2. Depths of euphotic zone and secchi-disc transparency at stations 1-4 during 1995-1996.

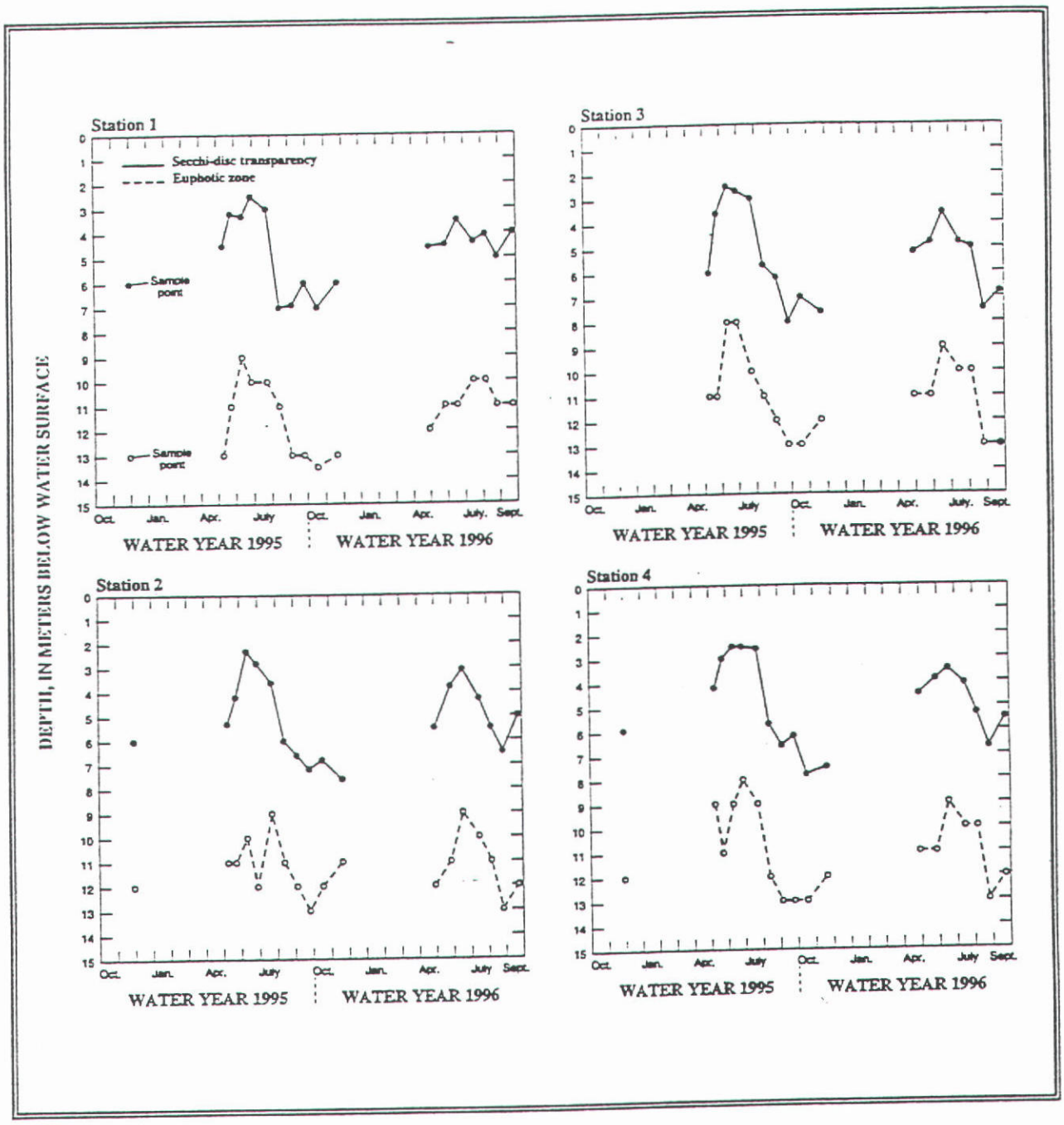


Figure 5-3. Lines of equal dissolved oxygen concentration, in milligrams per liter, at stations 1-4 during selected months of 1995-1996.

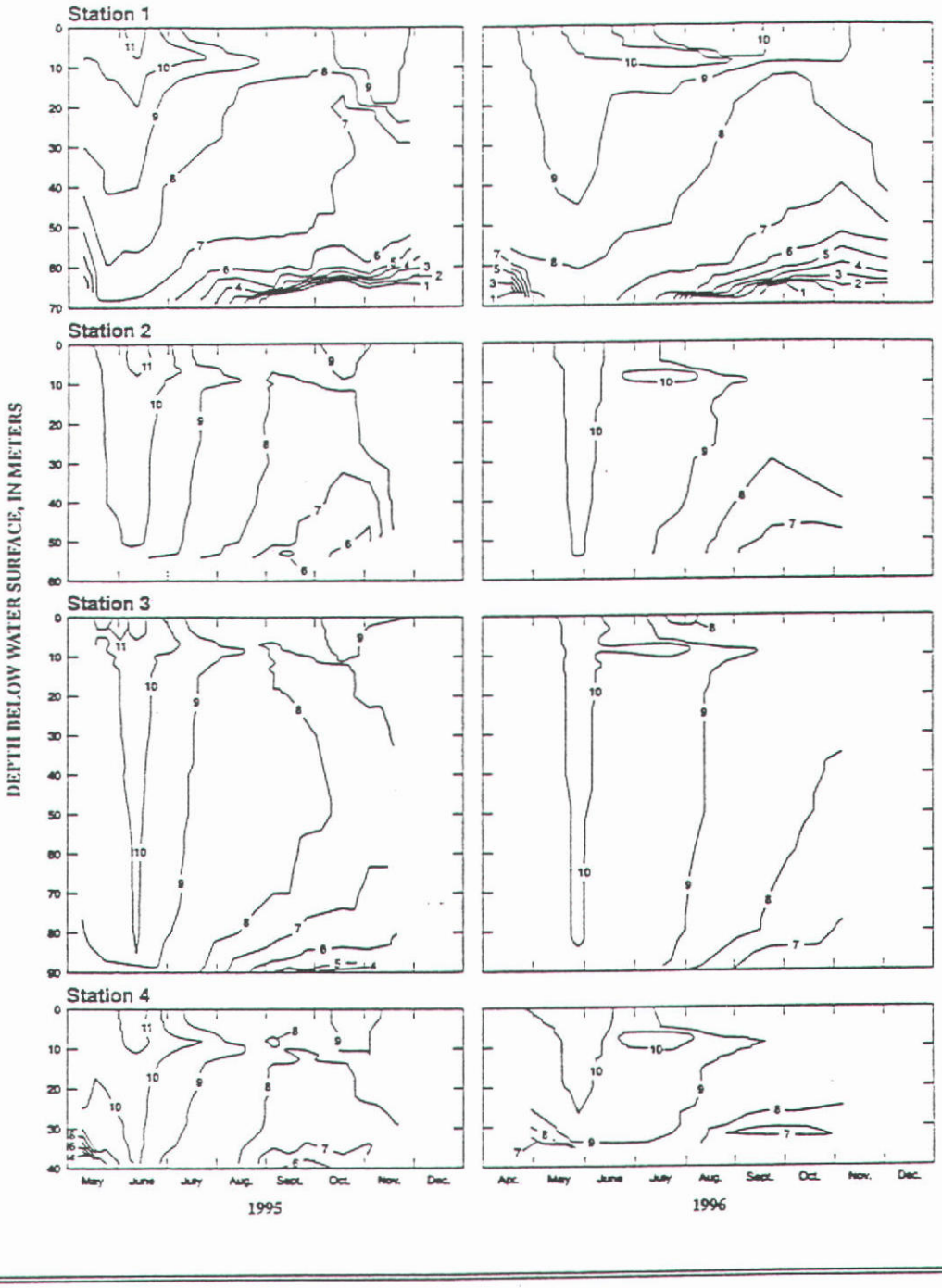


Figure 5-4. Lines of equal dissolved oxygen, as percent saturation, at stations 1-4 during selected months of 1995-1996.

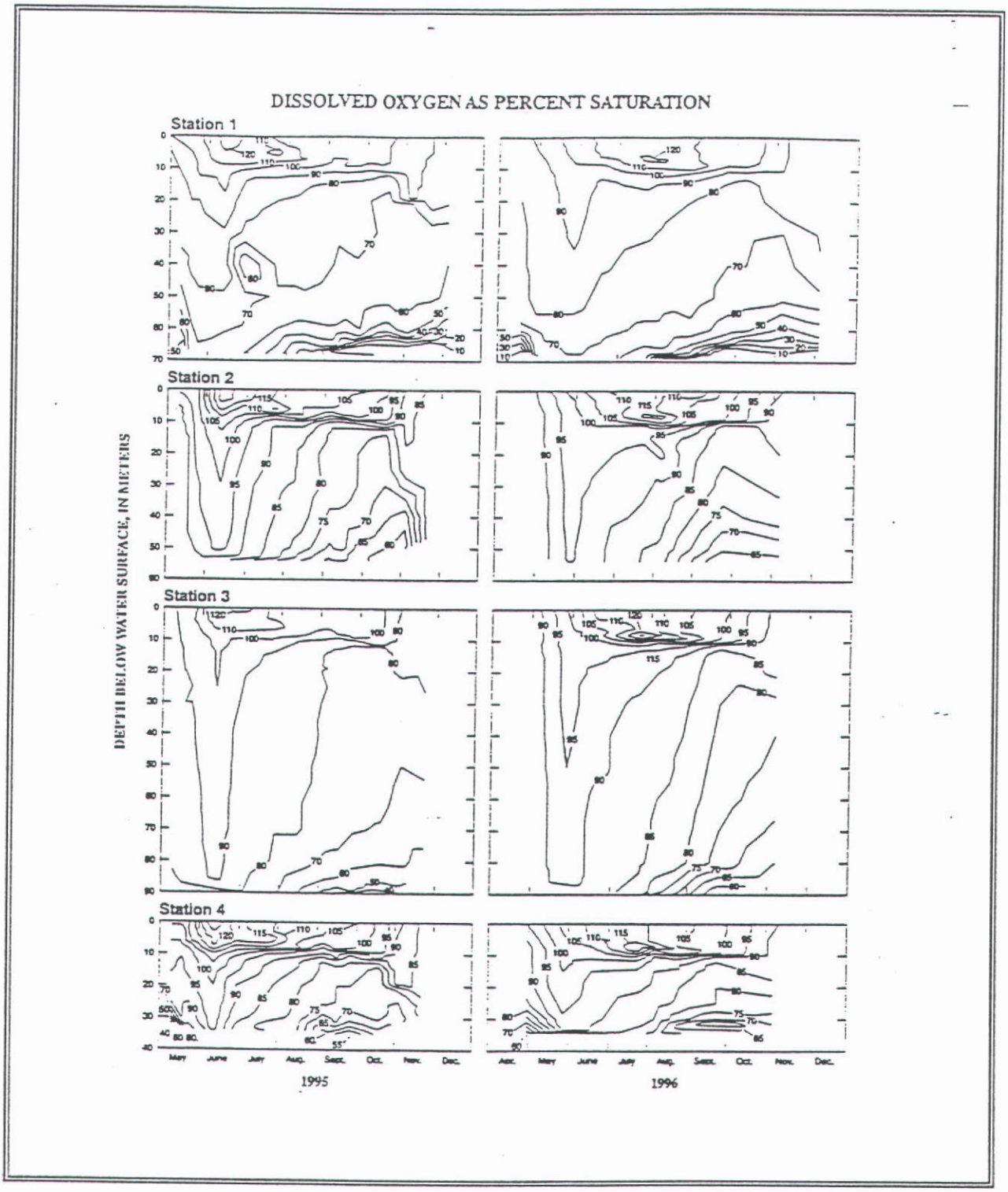


Figure 5-5. Concentrations of total phosphorus and dissolved orthophosphorus in the euphotic zone and lower hypolimnion at stations 1-4 during 1995 - 1996.

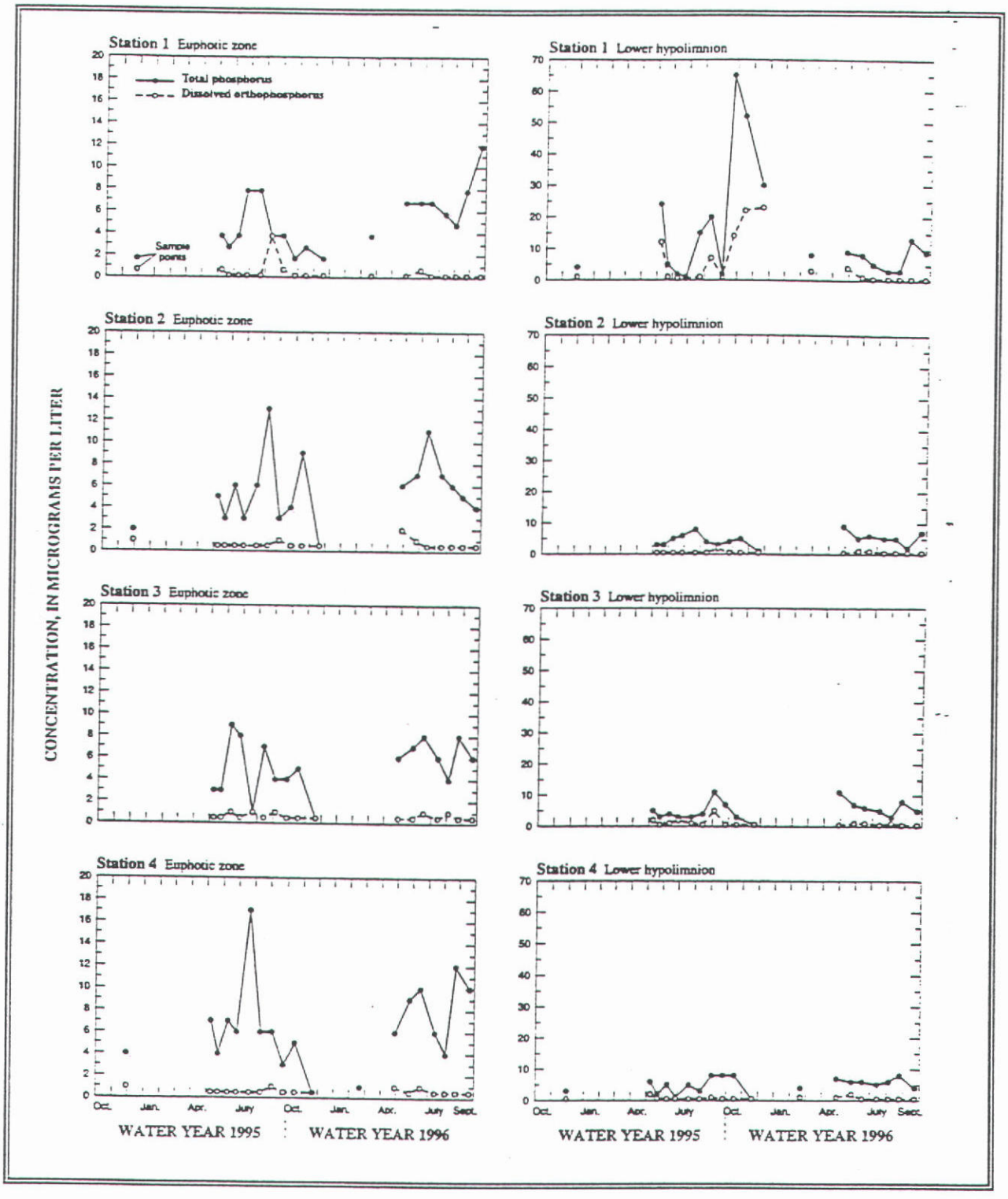


Figure 5-6. Concentrations of total nitrogen, dissolved inorganic nitrogen, and dissolved ammonia in the euphotic zone and lower hypolimnion at stations 1-4 during 1995-1996.

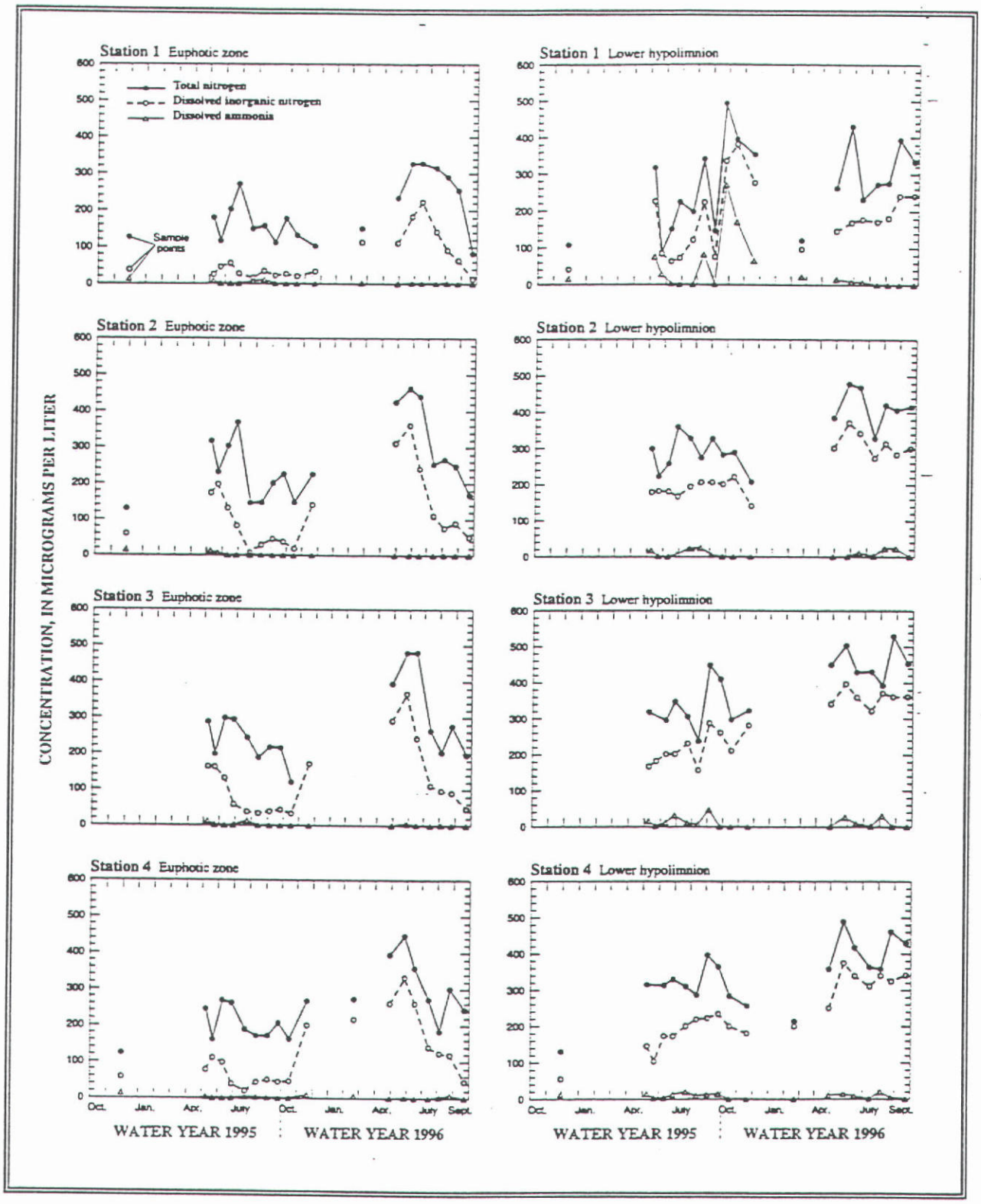
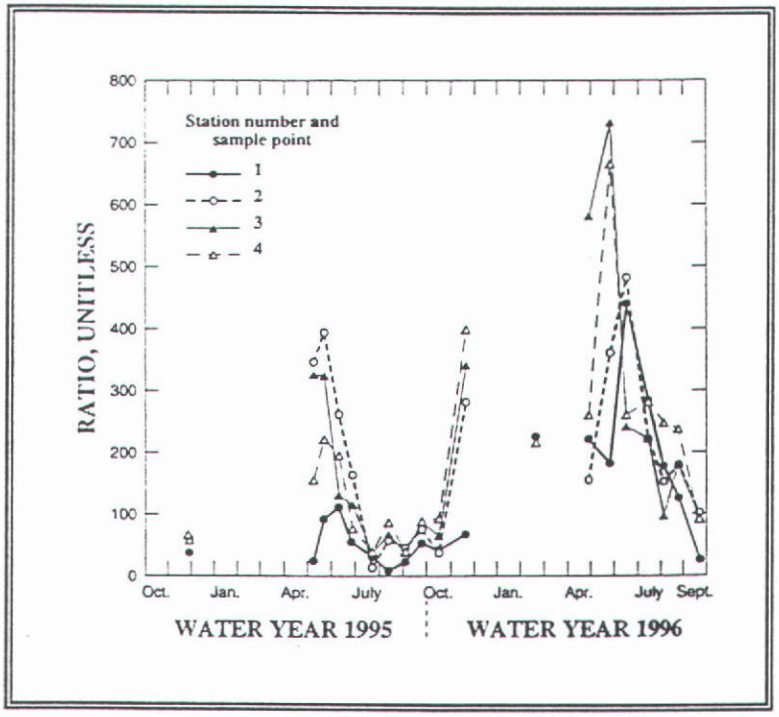


Figure 5-7. Dissolved inorganic nitrogen to dissolved orthophosphorus ratio at stations 1-4 during 1995-1996.



5.3.9 Chlorophyll-a

Chlorophyll-a is the primary photosynthetic pigment of phytoplankton and, as such, is used as an estimator of phytoplanktonic biomass. Median concentrations of chlorophyll-a at Payette Lake's four stations ranged from 1.6 to 2.4 ug/L during 1995 and from 0.8 to 1.3 ug/L during 1996 (Table 5-10). The 1995 median was highest at station 4, whereas the 1996 median was highest at station 1. The overall range in concentrations was from 0.2 to 5.2 ug/L with the largest concentration at station 1 in 1995 (table 10). Chlorophyll-a concentrations at the four stations had a distinct peak during June of 1995; temporal variation was more muted during 1996 (Figure 5-8).

5.3.10 Phytoplankton

Phytoplankton collected at the four stations during 1995-96 comprised five phyla (Chlorophyta, or green algae; Chrysophyta, or yellow-brown algae; Cryptophyta, or crytomonads; Cyanophyta, or blue-green algae; and Pyrrhophyta, or dinoflagellates), 44 genera, and 67 species (Table 5-11). The taxonomic composition was strongly dominated by the subphylum Bacillariophyceae, or diatoms. The Cyanophyta, represented by Anacystis marina and Chroococcus minimus, were a very minor component.

Lakewide, median density and biovolume for the 64 samples was 663 cells/ml and 384,000 um^3/ml, respectively. Among the four stations, median biovolume was highest at station 1 in both years (Table 5-10). Biovolume peaked in July of both years; only station 1 had a substantial secondary peak in the autumn of both years (Figure 5-9). Biovolume was dominated by one diatom, Tabellaria fenestrata, which, on average, contributed 52 percent of the lakewide biovolume.

Table 5-10. Medians and ranges of chlorophyll-a concentrations and phytoplankton biovolumes in samples from the euphotic zone at four limnetic stations, Payette Lake, 1995-1996.

Limnetic station	Chlorophyll-a concentration (μg/L)			Phytoplankton biovolume (μm^3/ml)		
	Median	Range	n	Median	Range	n
1995						
1	2.2	0.7-5.2	8	962,000	70,000-2,770,000	7
2	1.6	1.0-3.4	8	426,000	189,000-2,520,000	7
3	1.6	.7-5	8	420,000	97,100-2,820,000	7
4	2.4	.7-5	8	774,000	109,000-2,840,000	7
1996						
1	1.3	.5-2.1	10	556,000	313,000-1,890,000	9
2	1.0	.2-1.8	9	184,000	88,200-923,000	9
3	1.1	.3-1.5	8	189,000	81,900-1,700,000	9
4	.8	.3-1.3	10	230,000	76,600-2,340,000	9

Figure 5-8. Chlorophyll-a concentrations at stations 1-4 during 1995-1996.

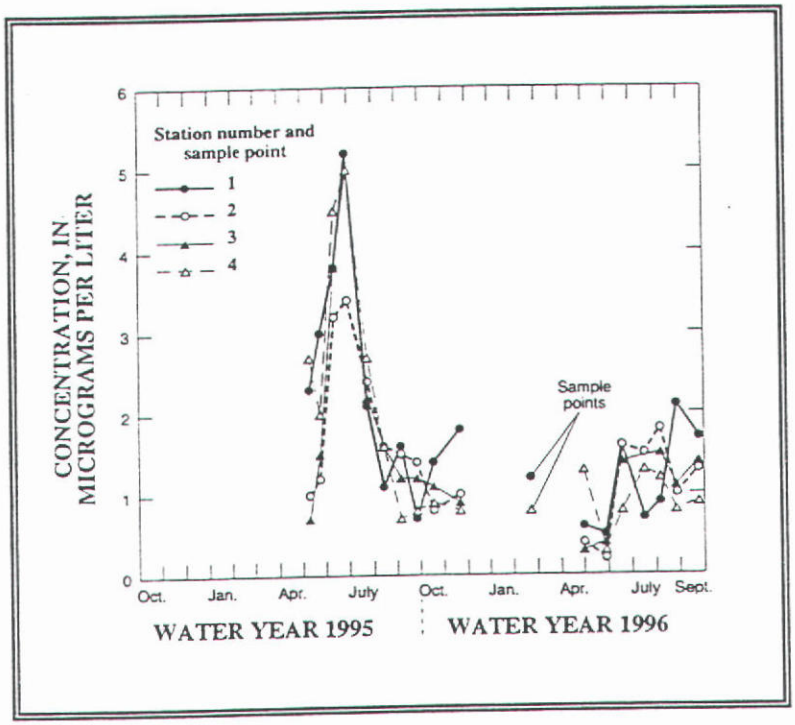
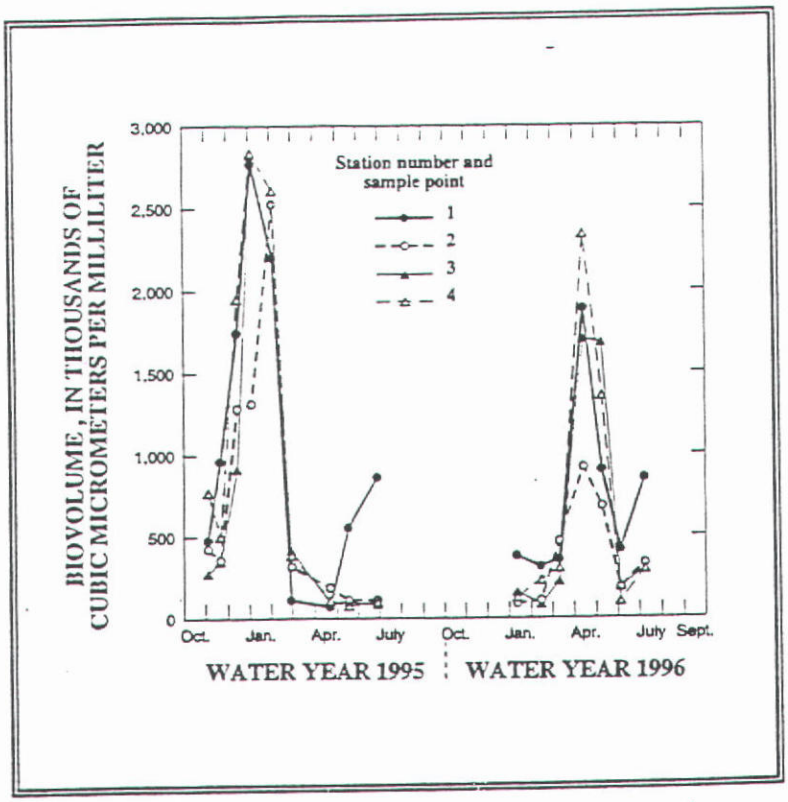


Figure 5-9. Phytoplankton biovolume at stations 1-4 during 1995-1996.



5.3.11 Trophic state

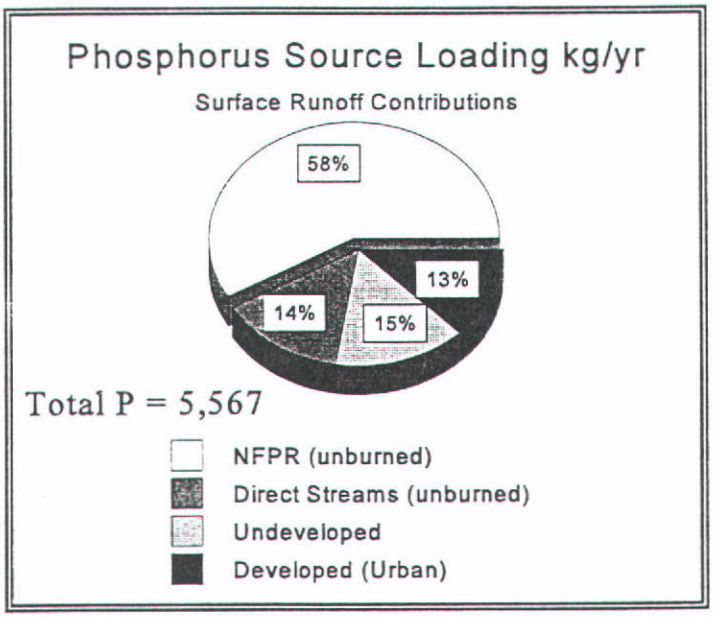
The biological productivity, or trophic state, of a lake is commonly categorized into one of three trophic states: oligotrophic, or low productivity; eutrophic, or high productivity; and mesotrophic, or moderate productivity. Numerous variables have been used as the basis for trophic-state classification; some of the most frequently encountered are total phosphorus, total nitrogen, chlorophyll-a, and secchi-disc transparency. These four variables were used by Ryding and Rast (1989) to develop an open-boundary trophic-state classification system which compensates for the overlap in classification that commonly occurs with a fixed-boundary system. Under the open-boundary system, a lake is considered correctly classified if three of the four classification variables are within two standard deviations of their geometric mean for the same trophic state.

Annual geometric means for euphotic-zone values of total phosphorus, total nitrogen, chlorophyll-a, and secchi-disc transparency were computed for Payette Lake for comparison to the open-boundary trophic-state classification system (Table 5-12). The lake was classified as oligotrophic in both years on the basis of total phosphorus, total nitrogen, and chlorophyll-a. On the basis of secchi-disc transparency, the lake was mesotrophic in both years.

Three earlier studies also classified the trophic state of Payette Lake. During the late 1970's, the lake was classified as oligotrophic on the basis of chemical and biological variables (Idaho Department of Health, 1970). The National Eutrophication Survey of 1975 classified the lake as early mesotrophic (U.S. Environmental Protection Agency, 1977). Falter (1984) used areal phosphorus loading as his basis for classifying the lake as mesotrophic in the early 1980's. These three studies indicate an increasing trend in trophic state; however, the trend may be misleading because the basis for trophic-state classification was not consistent among the three studies.

stormwater runoff were 10 to 100 times greater than typical streamflows, 10 to 15 times greater for nitrogen and 40 to 250 times greater for suspended sediments. Total loading of phosphorus and nitrogen from developed and undeveloped areas directly draining to the lake was estimated to be 700-800 kg TP and 3,000-3,500 kg TN during this study.

Figure 6.2 Source contributions of surface runoff nutrients to Big Payette Lake.



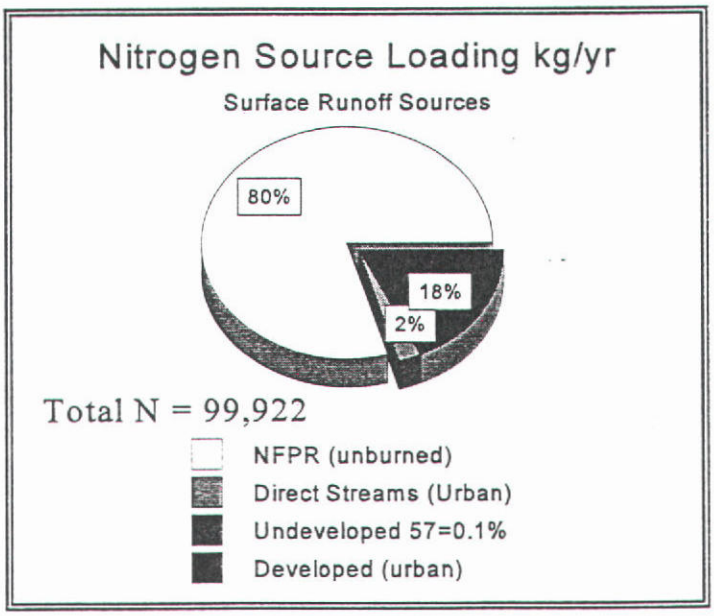


Figure 6-2 compares the phosphorus and nitrogen loading attributed to all the major sources of surface runoff entering Big Payette Lake after adjusting for the fire contributions. The percent contribution of phosphorus attributed to the N.F.Payette River was 58%, with 14% from other direct stream inputs (Fall Creek, Deadhorse Creek, Sylvan Creek, Wagon Bay Creek and Lemah Creek). The remaining land area directly draining to the lake includes developed and undeveloped lands around the lake perimeter. Of this land area, approximately 2,231 hectares of undeveloped land (5,514 acres) contributed 15% of the total phosphorus in runoff while 704 hectares (1,739 acres) of developed (urban) land contributed 14% of the total phosphorus in runoff. Thus, developed (urban) land around the lake perimeter contributed about three times the phosphorus load as undeveloped land. A breakdown of the nitrogen sources shows that the N.F. Payette River contributed the largest proportion of the load, accounting for 80%. Developed (urban) lands were the second largest source and accounted for 18% of the nitrogen loading through surface water runoff.

Recreation Survey

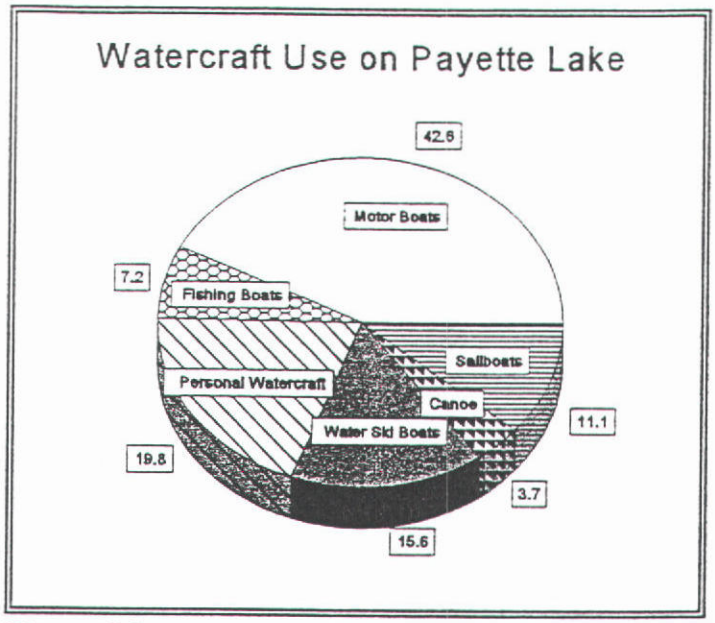


Figure 6-3

With the increased growth of population in Idaho, Payette Lake has become a recreational favorite due to its high water quality, large size, parks and other amenities. Boating use for general pleasure dominates recreational water use (Figure 6-3). On three separate dates, the number of boats on the lake surface exceeded 700 (including boats moored at docks and those in active use). Anglers spent an estimated 11,489 hours pursuing lake trout, kokanee, rainbow trout, and cutthroat trout. Kokanee were the most important species, in numbers, harvested from the lake. An analysis of the kokanee migration and recruitment showed that spawning kokanee run has been adequate to maintain lake population levels. Population numbers have actually increased since 1992 perhaps in response to increased lake productivity or other factors (less predation). Accordingly, the number of spawning kokanee utilizing the N.F. Payette River has increased.

A bacteria survey conducted on several popular camping sites within the watershed indicated surface contamination of streams was prevalent during summer months when recreational activity is greatest. The more undeveloped sites were most prone to soil disturbance and bacteria contamination.

Efforts by the State Department of Parks and Recreation have been made to better equip the primitive camping areas with sanitary facilities and designated parking facilities. Additional facilities are needed to reduce erosion and stabilize surrounding surface areas. As recreational demand increases, the more primitive sites will be prone to additional usage and could increase the potential for bacterial contamination and erosion.

North Fork Payette River Minimum Stream Flows

The IDFG conducted a survey of minimum stream flow requirements necessary to maintain and enhance fish habitat on the N.F. Payette River between Upper and Big Payette Lake. An Instream Flow Incremental Methodology (IFIM) was used to identify critical thresholds of streamflow for resident fish populations. These results indicated that existing low streamflows during late summer fell below levels needed to sustain adequate numbers of pools for fish. It was determined that a minimum baseflow of 60 cfs (as measured at the USGS gauge below Fisher Creek) was required in the mainstem river from July 1 to September 7. This flow rate provided an acceptable minimum quantity of water depth and

the southwest basin begins the thermal stratification period with an incomplete supply of dissolved oxygen with which to satisfy its hypolimnetic oxygen demands.

Figure 6-4. Relation of natural and human-related processes contributing to the loss of hypolimnetic oxygen in the southwest basin of Big Payette Lake.

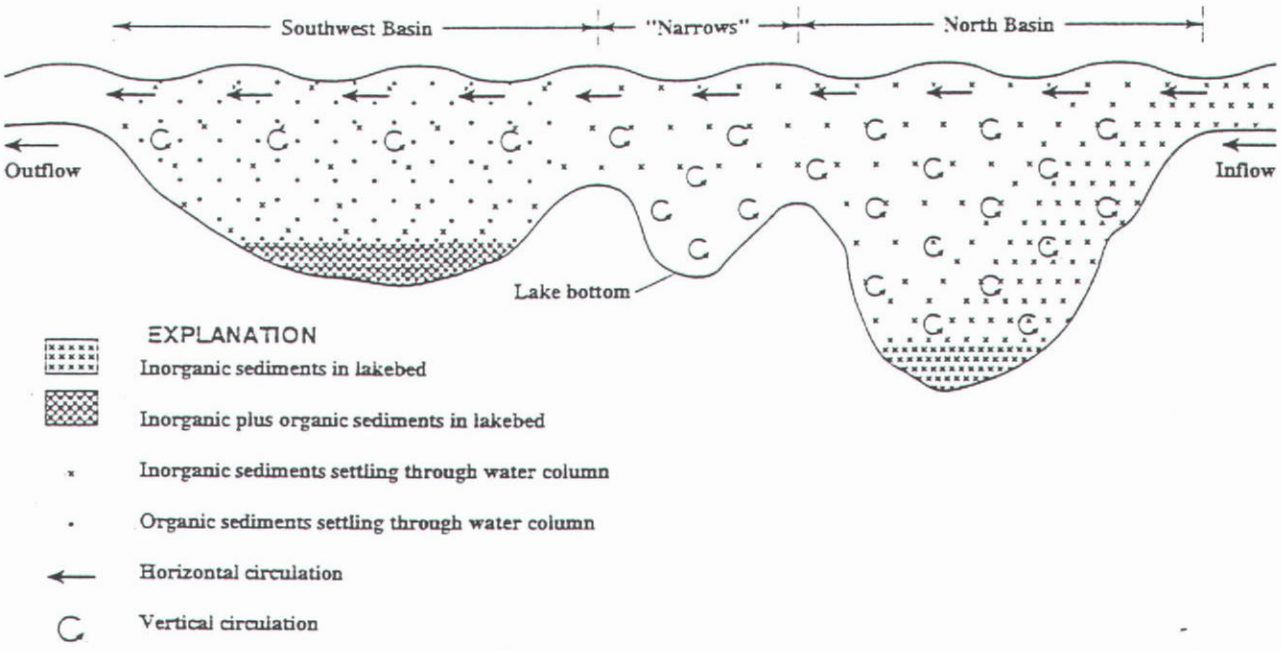
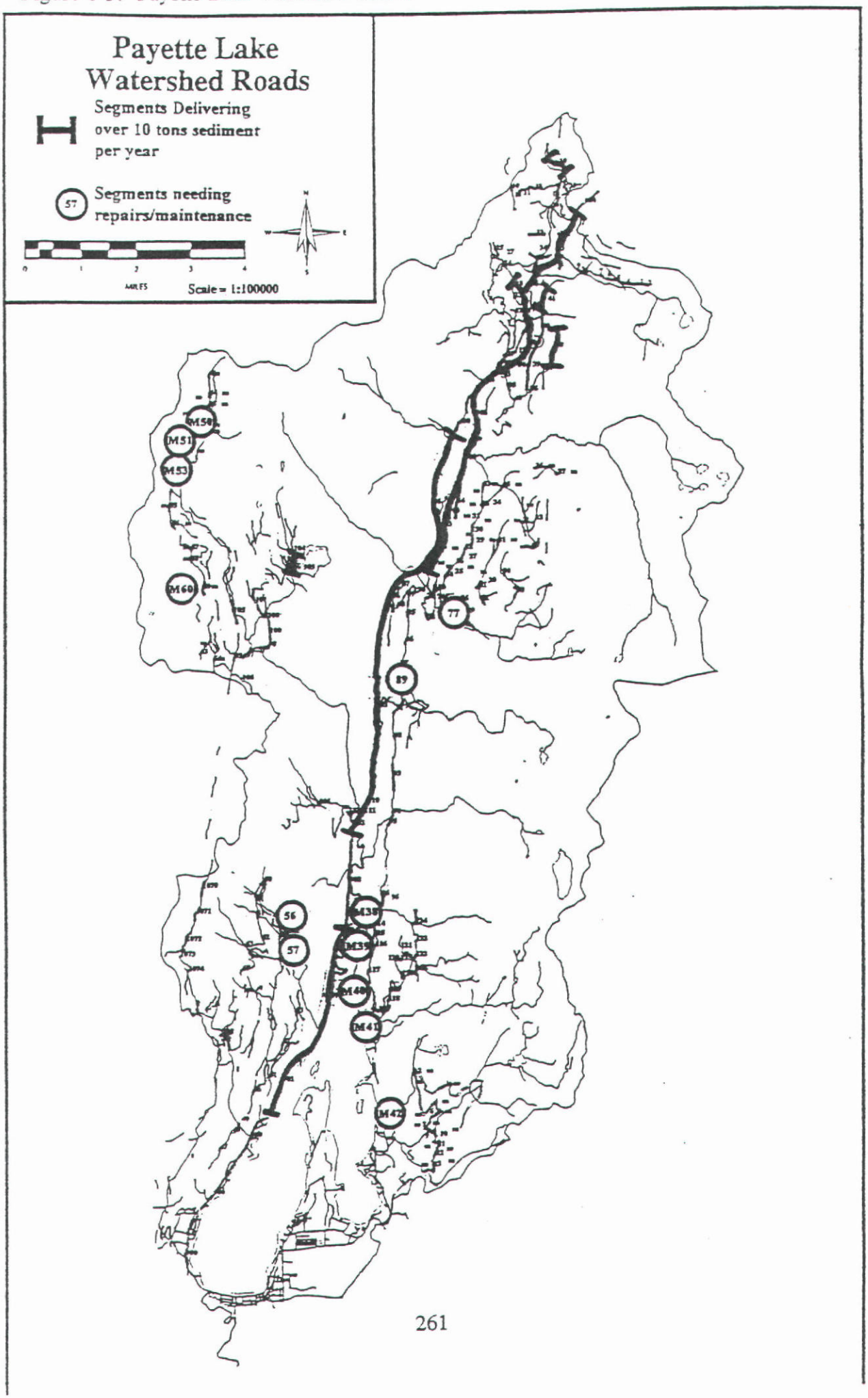
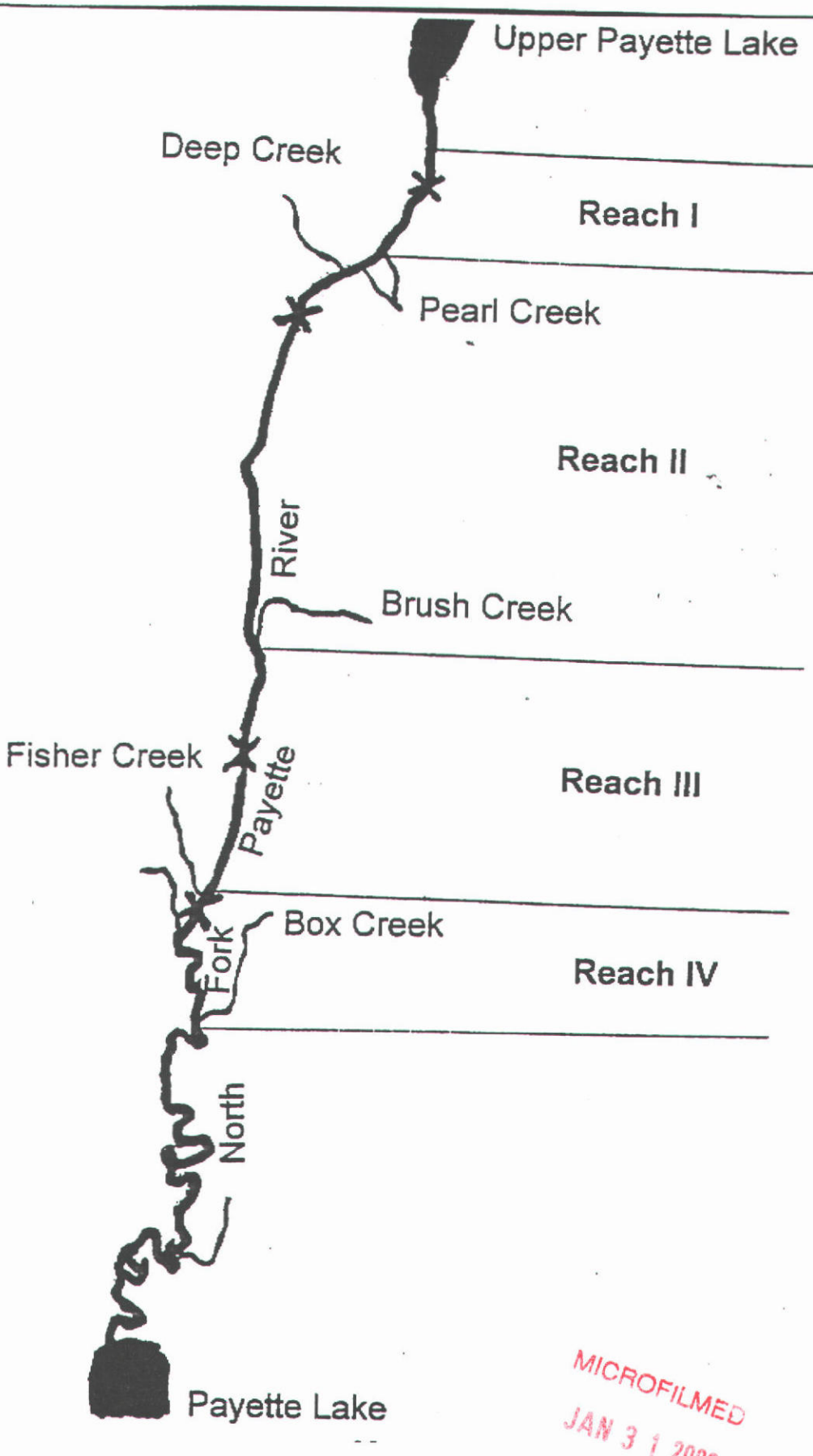


Figure 6-5. Payette Lake Watershed Roads



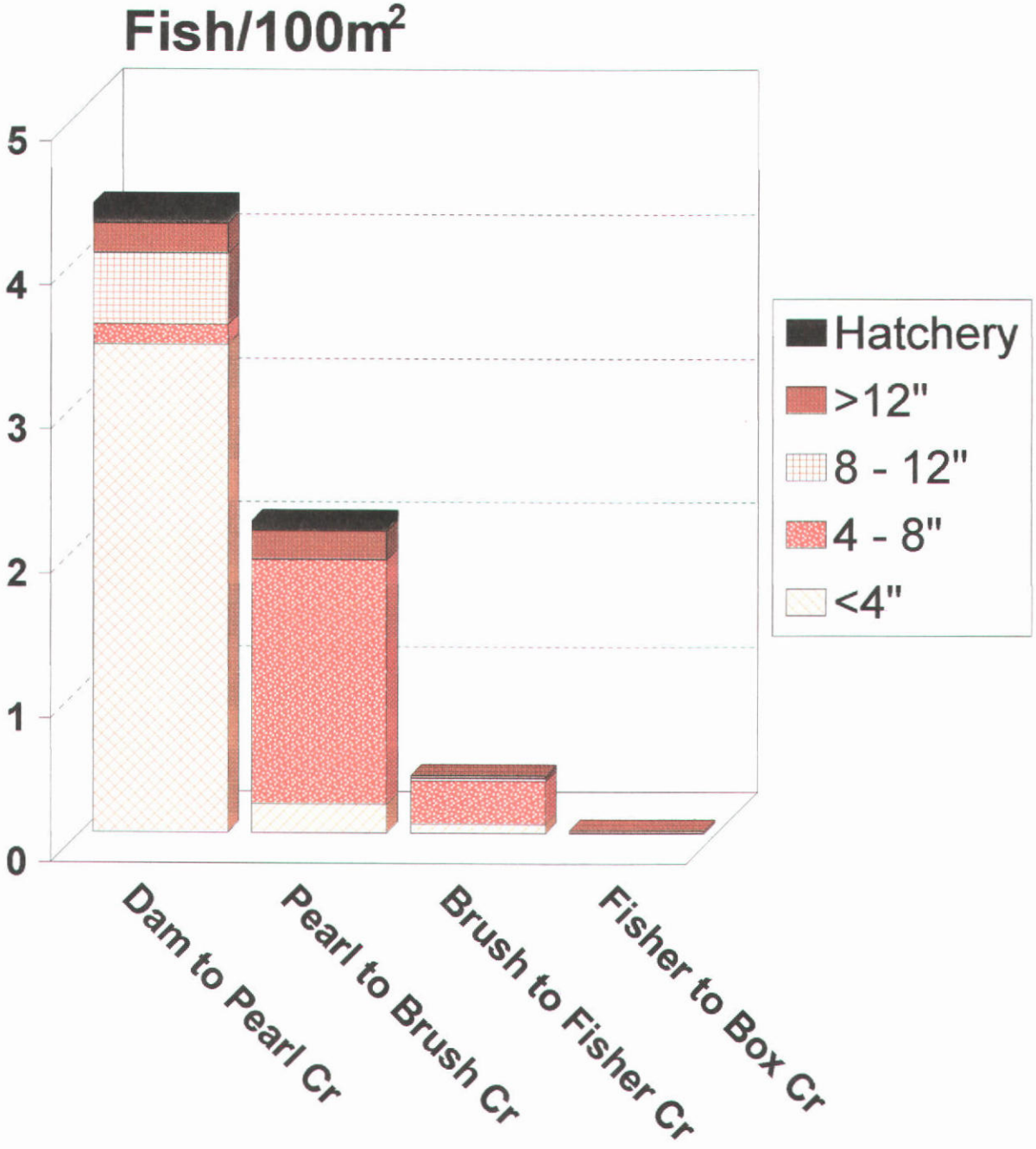


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Figure 2. Map of the upper North Fork Payette River with study reaches. Study sites are marked (X).

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Date Admitted 9-30-99

Rainbow Trout Abundance
1996 Snorkel Survey

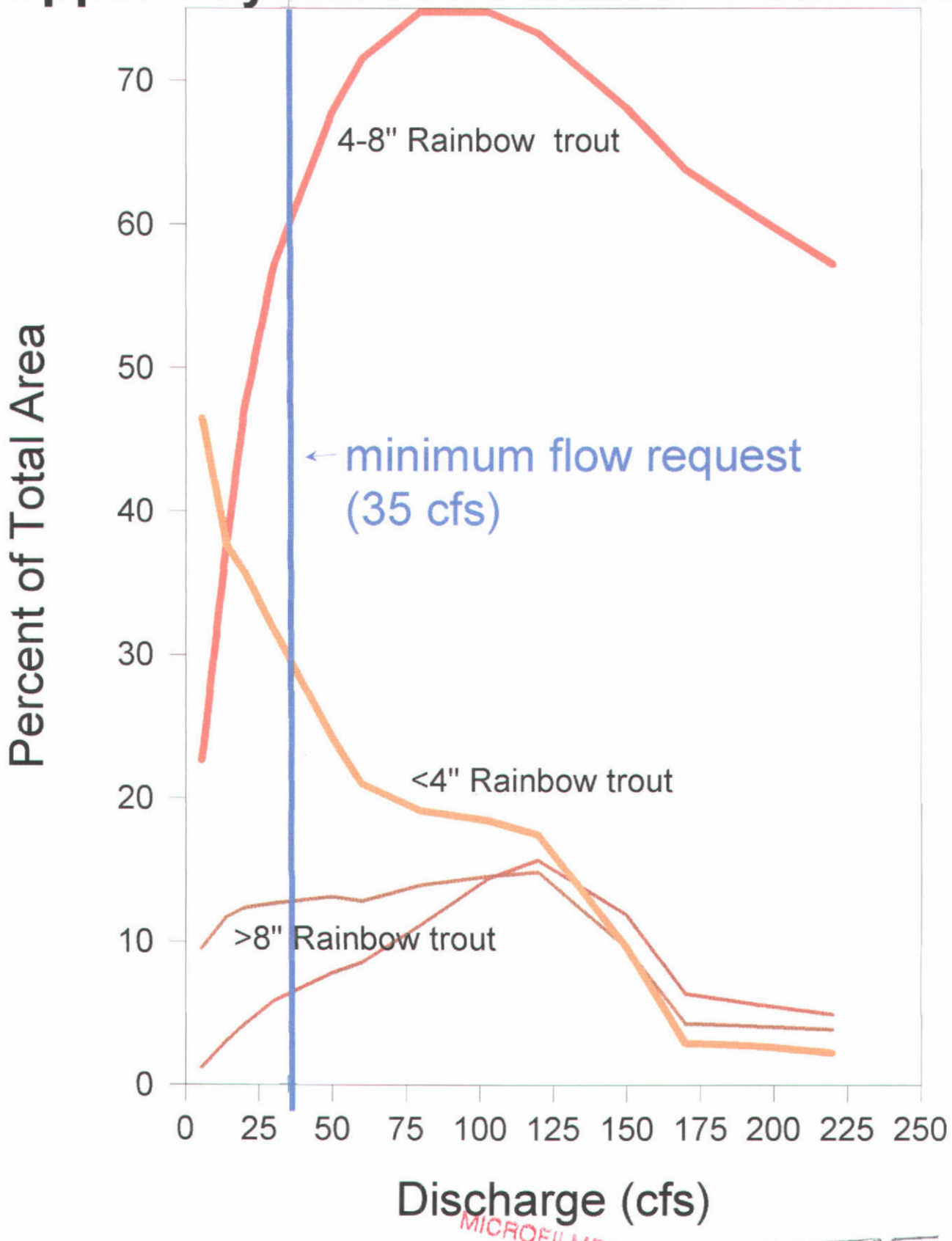


111 cfs at USGS gauge on July 24

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Date Admitted 9-30-99

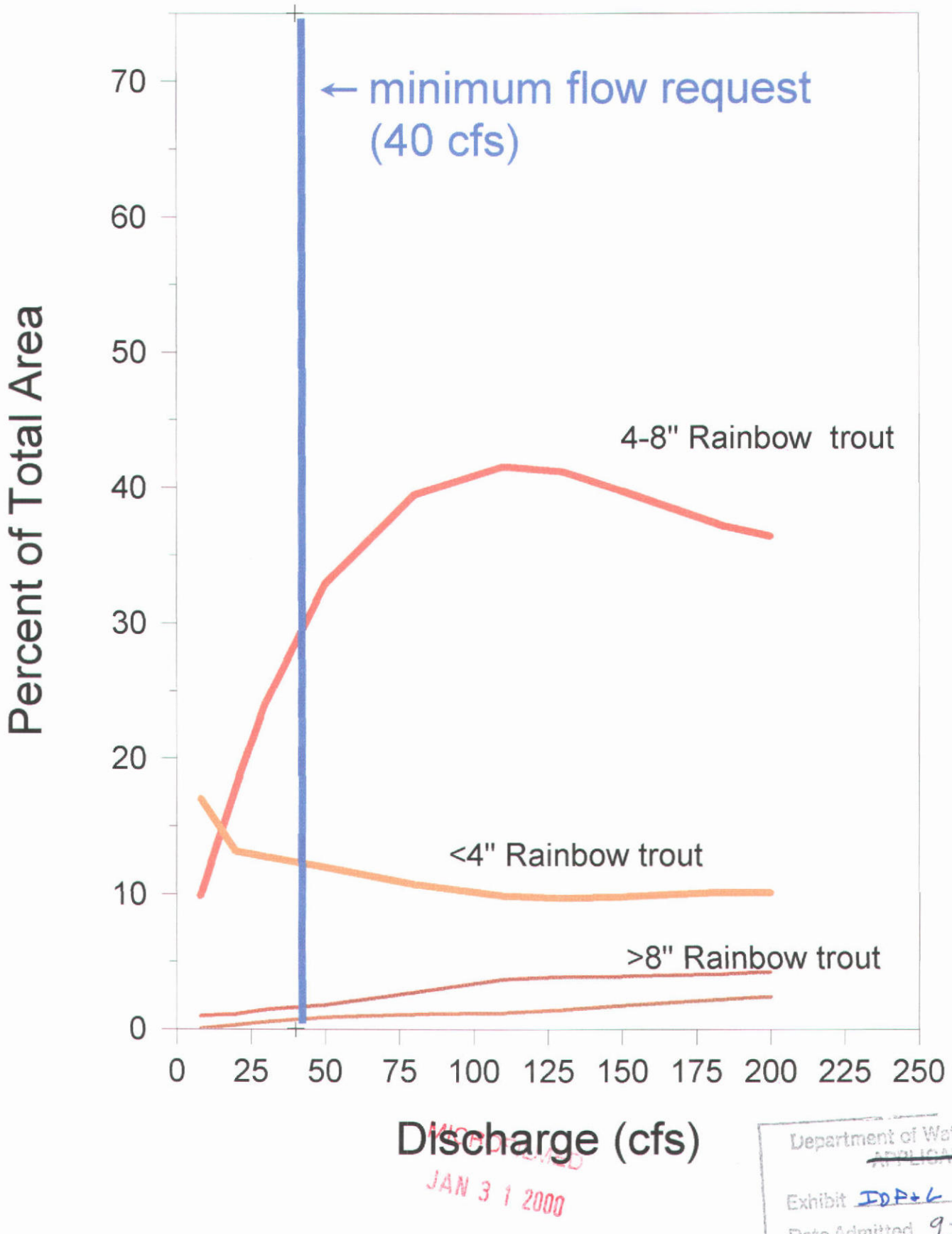
Upper Payette Lake Dam to Pearl Creek



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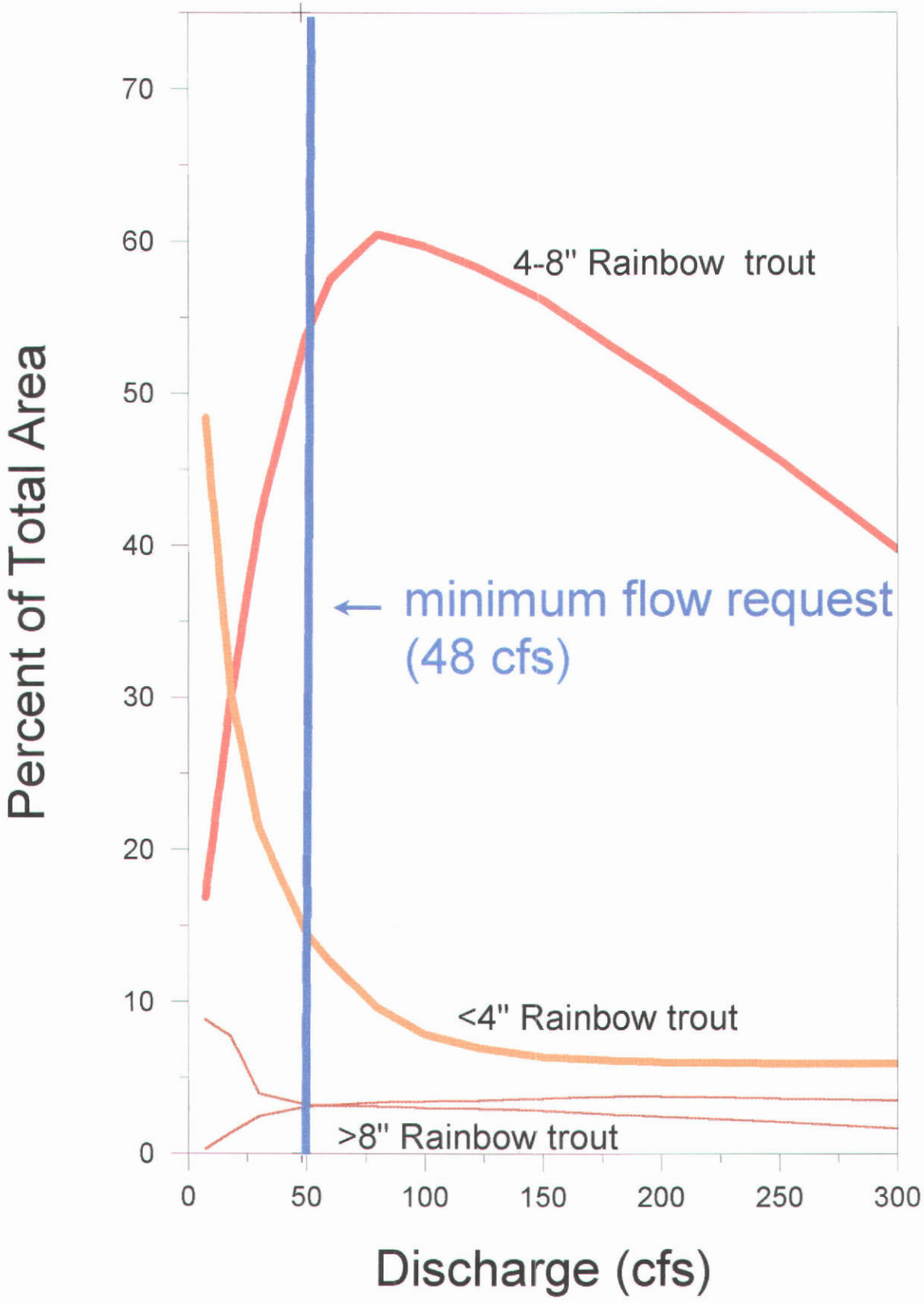
Pearl Creek to Brush Creek



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Date Admitted 9-30-99

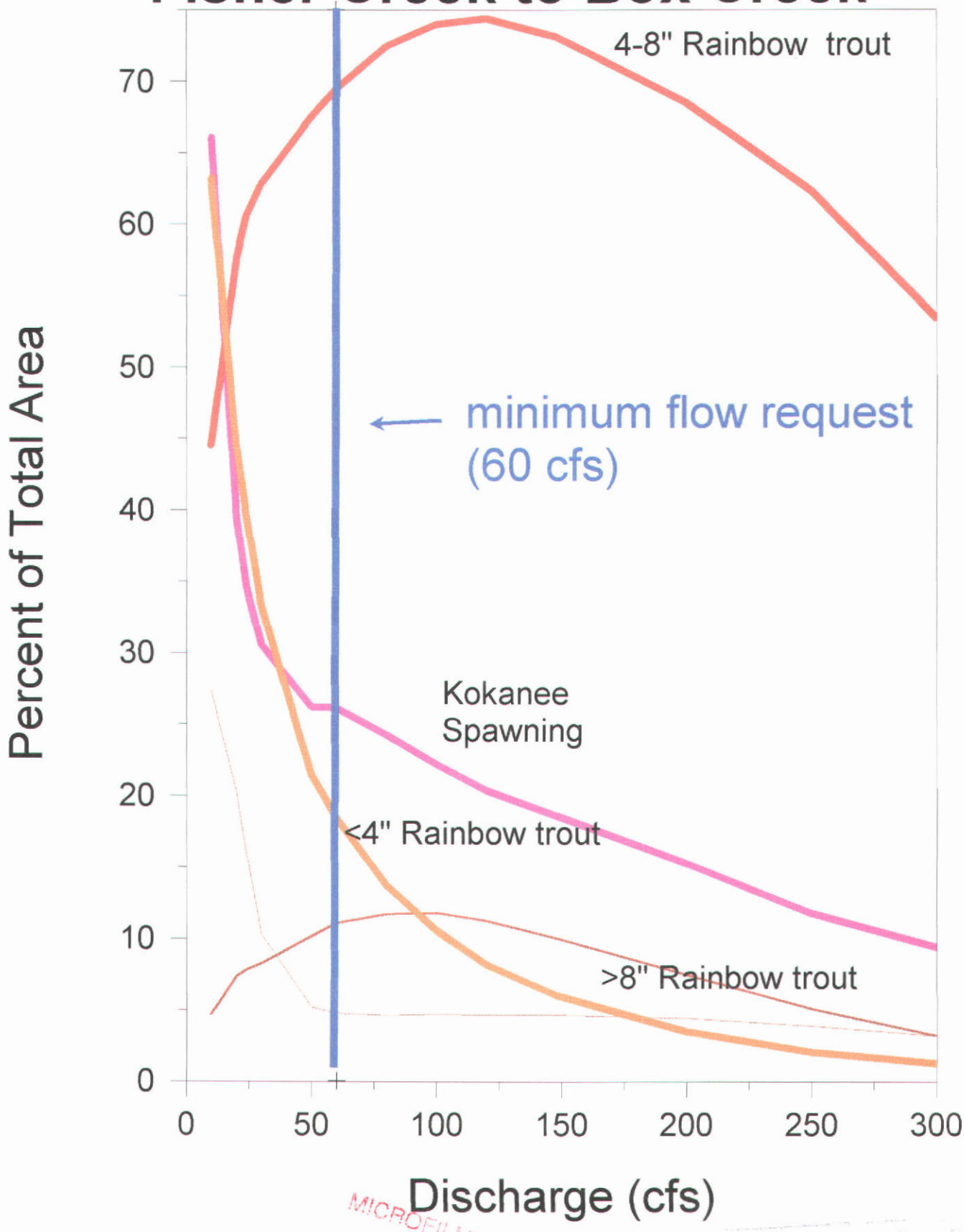
Brush Creek to Fisher Creek



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Date Admitted 9-30-99

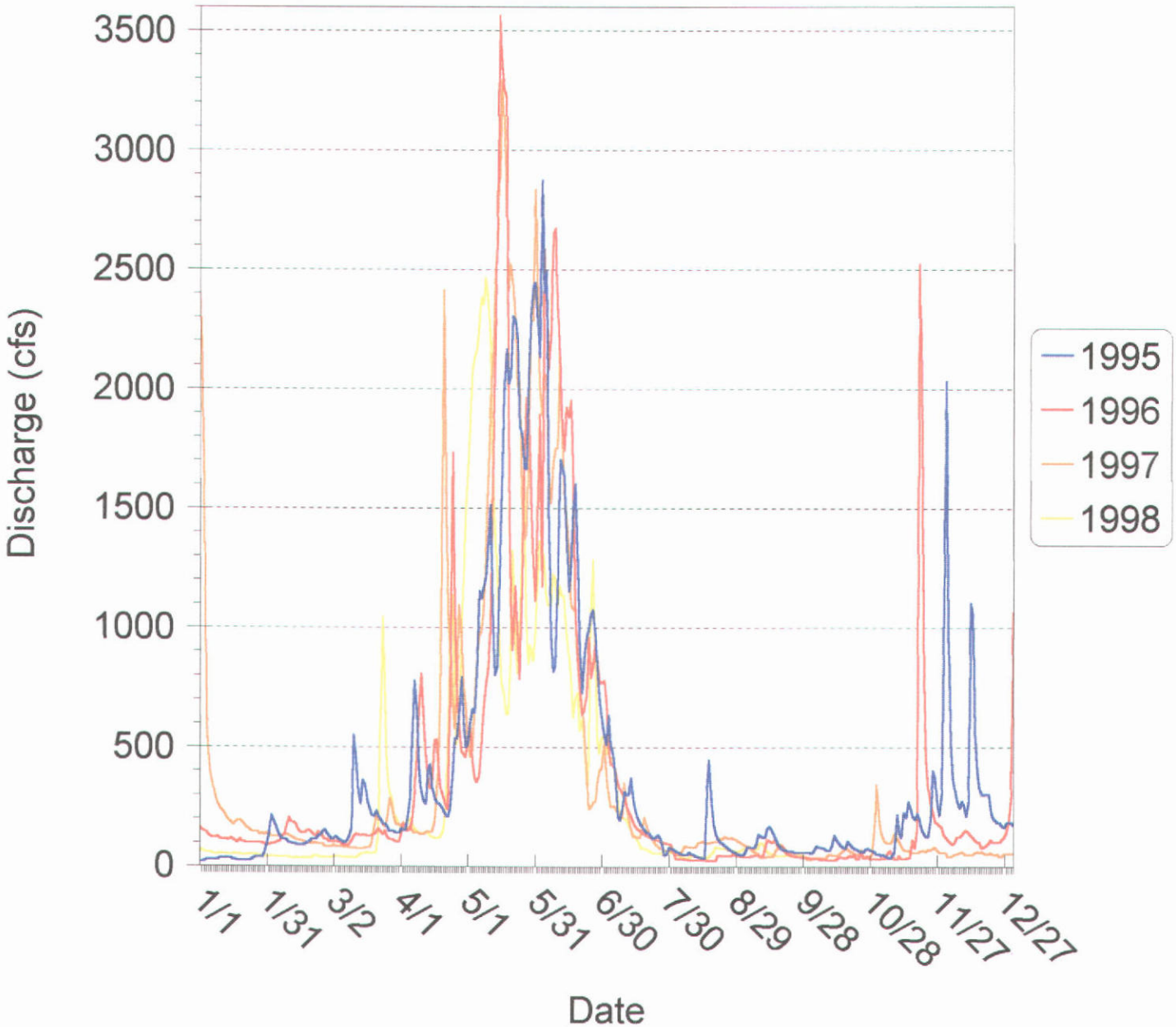
Fisher Creek to Box Creek



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Date Admitted 9-30-99

North Fork Payette River Discharge
USGS Gauging Station Below Fisher Creek

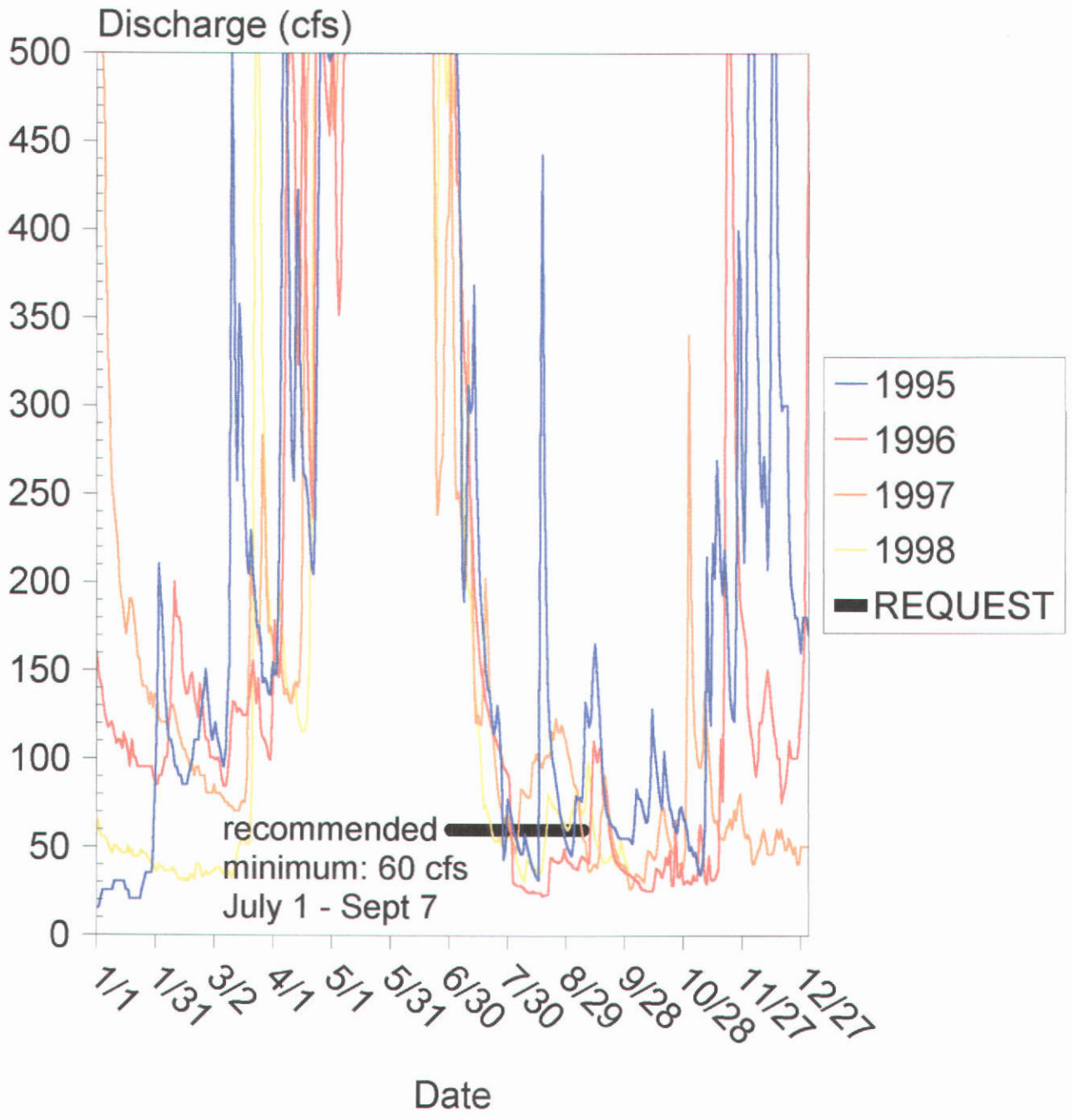


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Date Admitted 9-30-99

North Fork Payette River

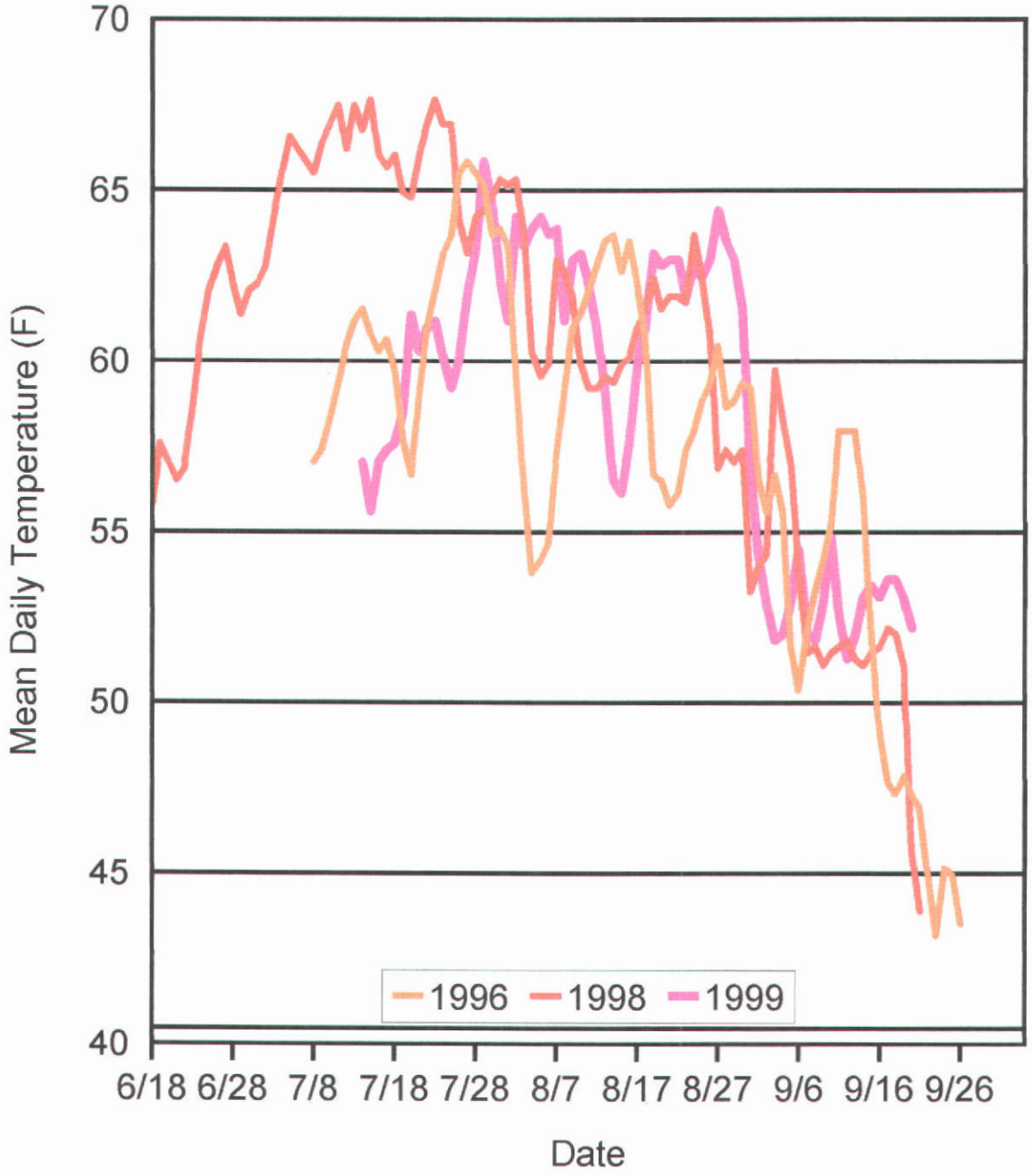
Recommended Summer Discharge at USGS Gauge below Fisher Creek



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JAN 3 1 2000

Department of Water Resources
Exhibit IDA+G 2(J)
Date Admitted 9-30-99

North Fork Payette River
Water Temperature



MICROFILMED
JAN 3 1 2000

Department of Water Resources
APPLICANT'S
Exhibit IDFG 2(k)
Date Admitted 9-30-99

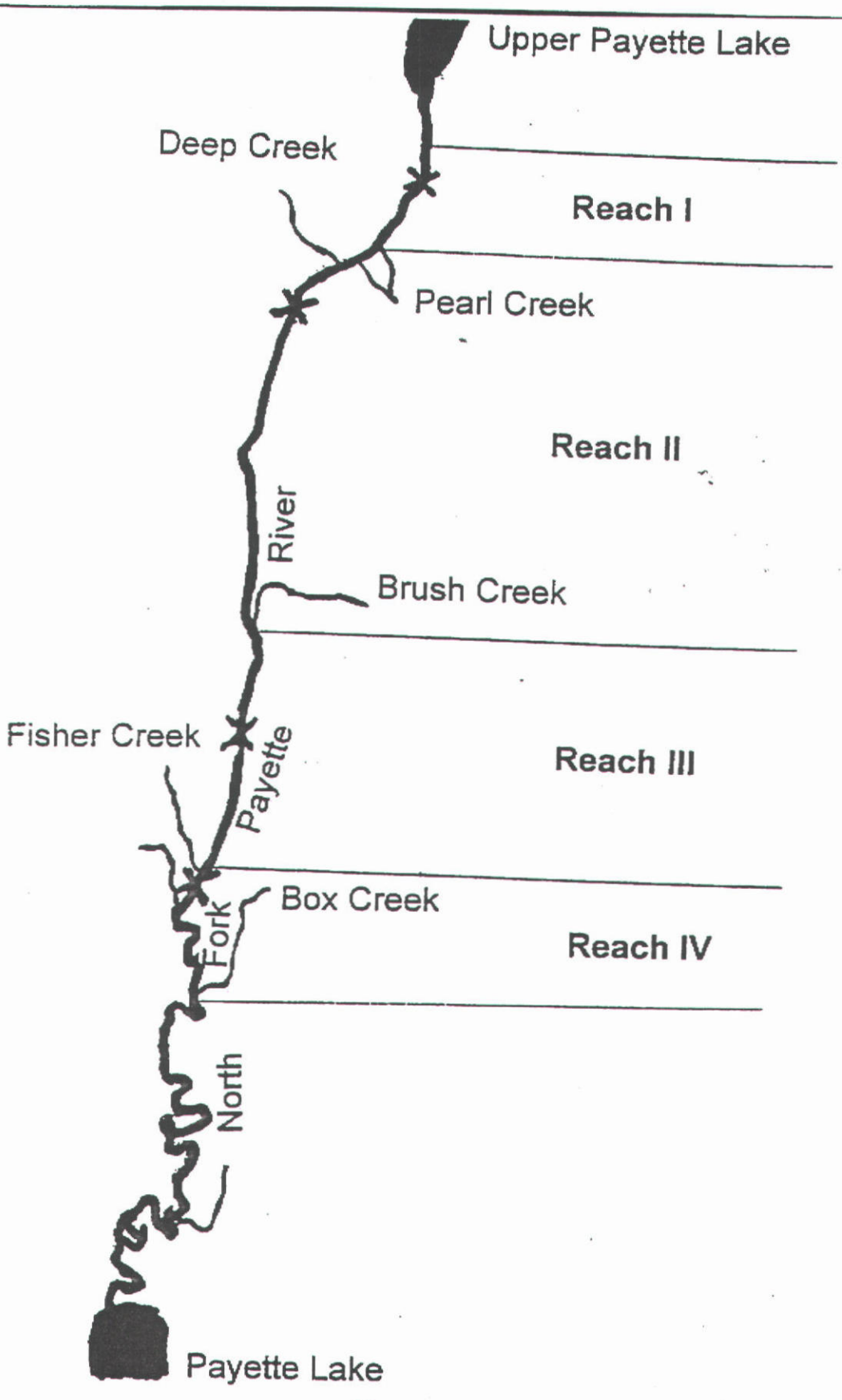


Figure 2. Map of the upper North Fork Payette River with study reaches. Study sites are marked (X).

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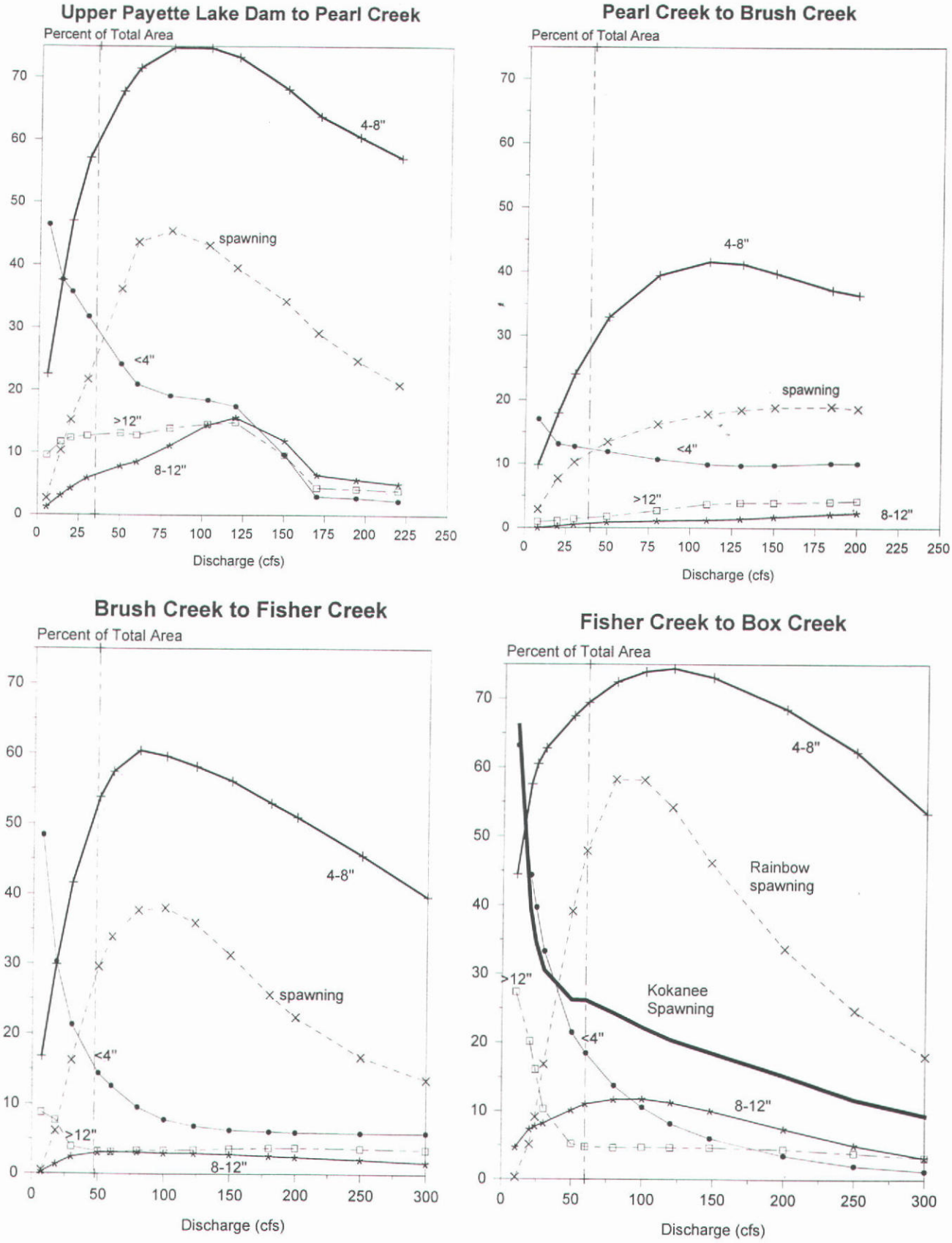


Figure 3. Habitat available to rainbow trout and spawning kokanee at various discharges in the upper North Fork Payette River, expressed as a percent of the total area of each study site. Vertical line in each chart represents recommended minimum discharge for that reach.

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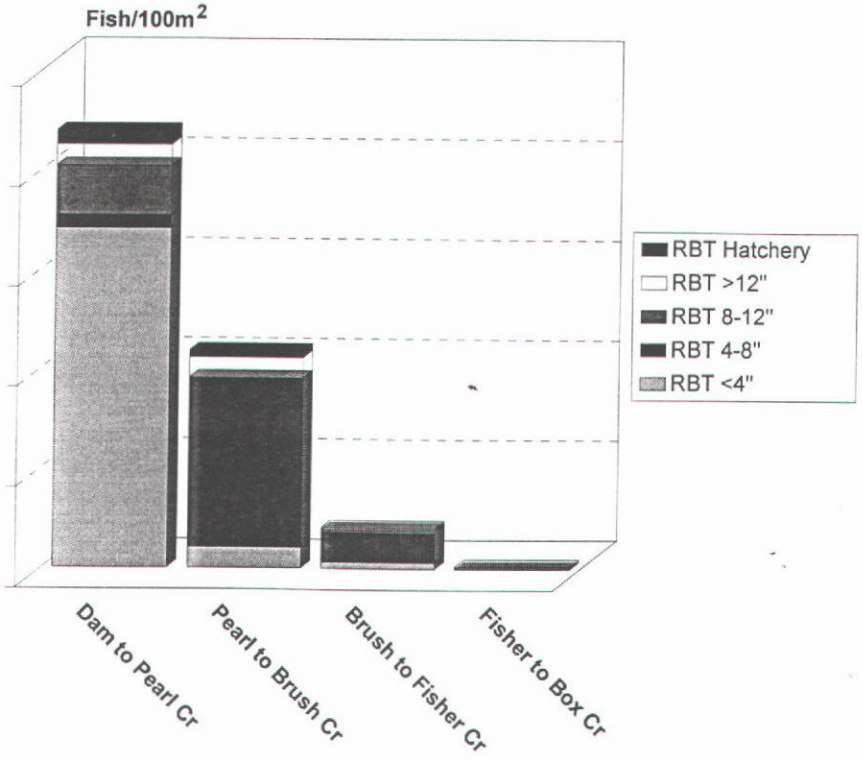


Figure 7. Densities of rainbow trout in study reaches of the upper North Fork Payette River, 1996

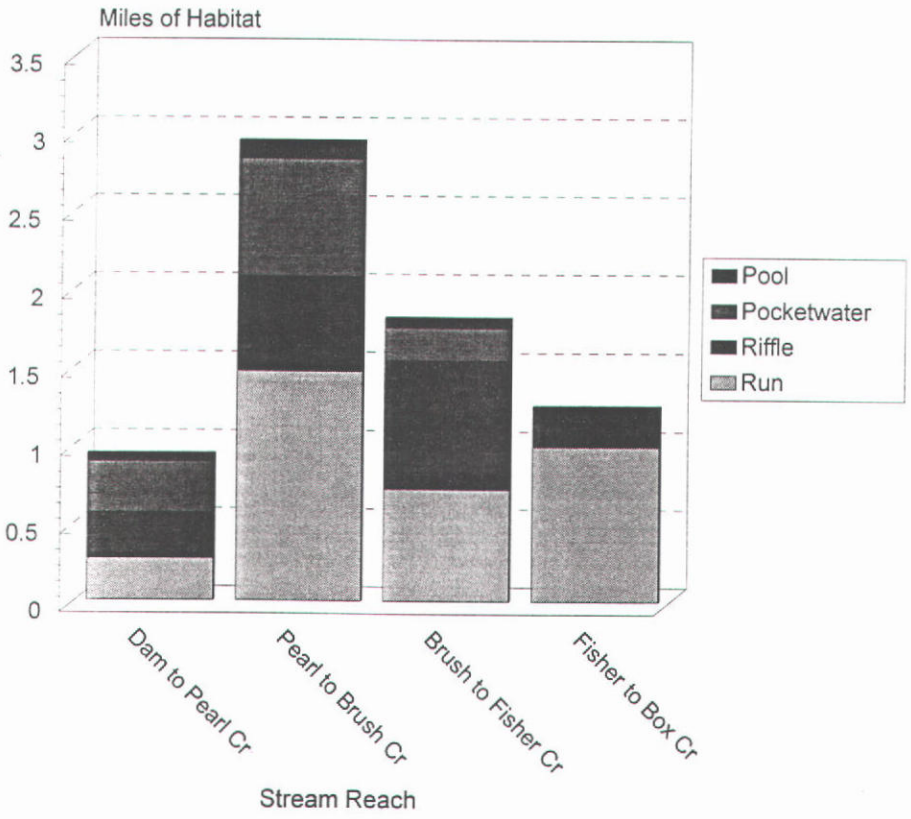
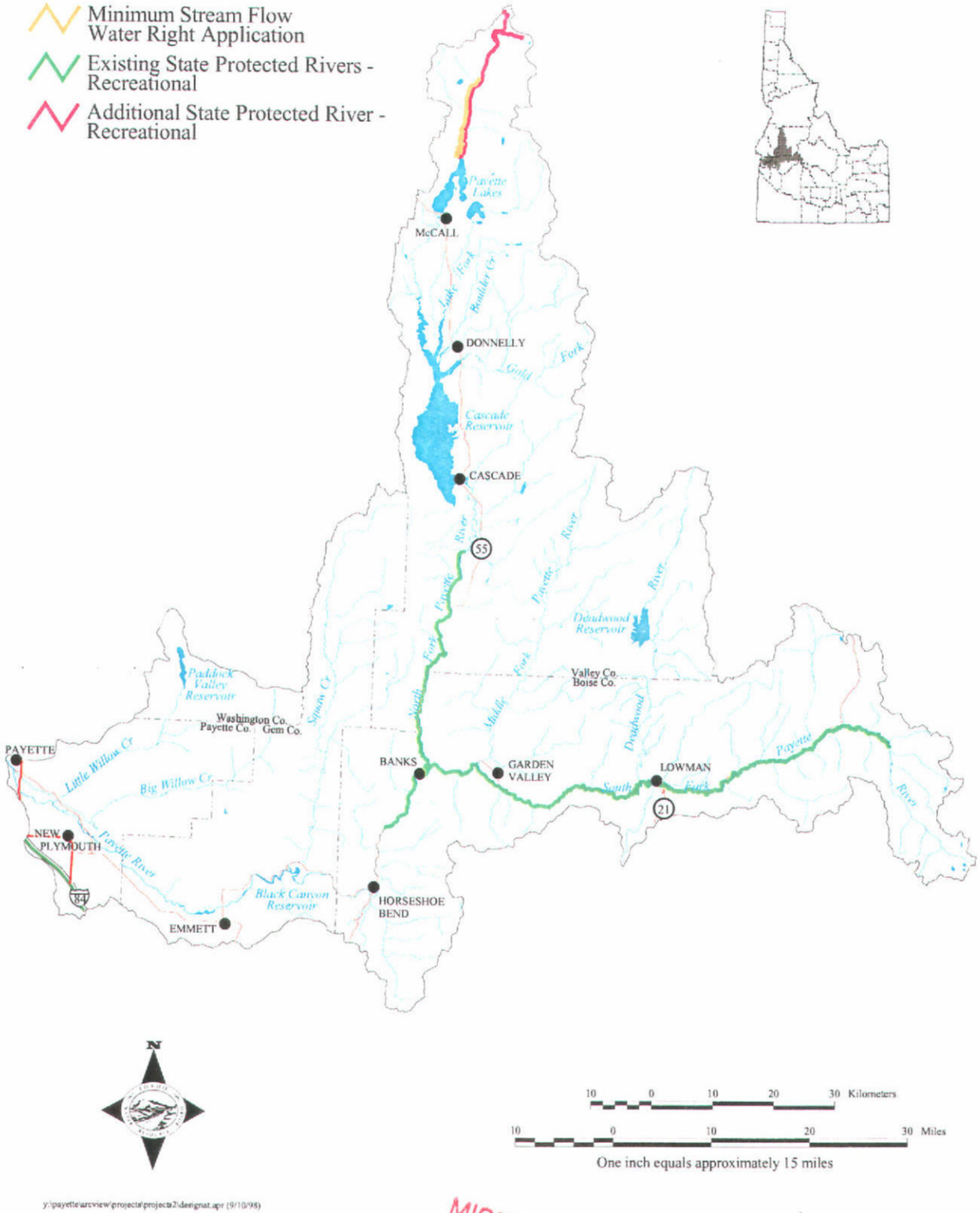


Figure 8. Quantity of habitat types in the upper North Fork Payette River.

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Map 27. Board Actions



y:\payette\arcview\projects\projects2\designat.apr (9/10/98)

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BEFORE THE DEPARTMENT OF WATER RESOURCES

OF THE STATE OF IDAHO

IN THE MATTER OF APPLICATION FOR PERMIT NO. 65-13894 IN THE NAME OF THE IDAHO WATER RESOURCE BOARD	)))))	**PRELIMINARY ORDER**

This matter having come before the Idaho Department of Water Resources (the "Department") and the Department having held a hearing in the matter, the hearing officer enters the following Findings of Fact, Conclusions of Law and Preliminary Order:

FINDINGS OF FACT

1. On July 16, 1999, the Idaho Water Resource Board ("Board or applicant") filed the above captioned application for permit with the Department of Water Resources ("Department") seeking to establish a minimum stream flow on the North Fork Payette River tributary to Big Payette Lake and the Payette River. The application was filed pursuant to Chapter 15, Title 42, Idaho Code. The reach is further described as follows:

Reach: Beginning at Upper Payette Lake dam and extending downstream a total of 6.8 miles to the Box Creek confluence, all located within Valley County and comprised of the following subreaches and flow rates:

Subreach A: 35 cubic feet per second ("cfs") from July 1 to September 7, beginning at Upper Payette Lake dam in the SE1/4NE1/4SE1/4 Section 36, T21N, R3E, B.M., and extending downstream 1.0 mile to the Pearl Creek confluence located in the SW1/4SW1/4NE1/4 Section 1, T20N, R3E, B.M.

Subreach B. 40 cfs from July 1 to September 7, beginning at the Pearl Creek confluence described above and extending downstream 2.8 miles to the Brush Creek confluence located in the SE1/4NW1/4NE1/4 Section 23, T20N, R3E, B M.

Subreach C: 48 cfs from July 1 to September 7, beginning at the Brush Creek confluence described above and extending downstream 1.8 miles to the Fisher Creek confluence located in the NW1/4SE1/4SW1/4 Section 26, T20N, R3E, B.M.

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Subreach D: 60 cfs from July 1 to September 7, beginning at the Fisher Creek confluence described above and extending downstream 1.2 miles to the Box Creek confluence located in the NW1/4SE1/4SW1/4 Section 35, T20N, R3E, B.M.

Uses sought in the application are to protect fisheries habitat including adequate flow for kokanee spawning, aquatic life in the stream reach and the water quality in Big Payette Lake. The period of use sought is from July 1 to September 7 each year. July 1 is approximately the time that natural discharge in the river decreases and September 7 is the date by which most kokanee spawning in the river is complete.

2. The Department provided notice of the application describing the proposed appropriation and setting the time and place for hearing on the application. Notice was published on September 16 and 23, 1999, in the Star News, McCall, Idaho; the Times News, Twin Falls, Idaho; the Lewiston Morning Tribune, Lewiston, Idaho; the Post Register, Idaho Falls, Idaho and the Idaho Statesman, Boise, Idaho.

3 On September 30, 1999, the Department conducted a public hearing in McCall, Idaho for the purpose of eliciting testimony regarding the application.

Parties appearing in a formal capacity at the hearing included the Idaho Water Resource Board, the Idaho Department of Fish and Game ("IDF&G"), Idaho Department of Lands and Kirk Hall for Payette Lake Water Quality Council ("PLWQC"). Chuck Davis for Trout Unlimited and David Simmonds for PLWQC testified as a public witnesses.

4. Exhibits offered and accepted as a part of the hearing record include the following:

a. Applicant's Exhibit A - Comprehensive State Water Plan - Payette River Basin - 1999

b. Applicant's Exhibit A-1 - Resolution of the Idaho Water Resource Board dated February 5, 1999 and five (5) pages from the Comprehensive State Water Plan - Payette River Basin - 1999

c. IDF&G Exhibit 1(a) thru 1(j) - Instream Flow Incremental Methodology

d. IDF&G Exhibit 2(a) thru 2(k) - Schematic diagrams, 1996 snorkel survey, area-discharge curves and hydrographs

e. IDF&G Exhibit 3 - Instream Flow Study and Recommendation for Minimum Summer Discharge in the Upper North Fork Payette River by

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Kimberly A. Apperson

f. Exhibit 4 - Transcript of select testimony before Larry F Weeks - October 29, 1997, PLWQC testimony and comments before the Payette Lake Water Quality Commission

g. Exhibit 5 - Big Payette Lake Management Plan - 1998

5. Fish & Game testified that there are game fish in North Fork Payette River including rainbow trout, cutthroat trout, mountain whitefish and kokanee

6. IDF&G has conducted a survey of minimum streamflow requirements necessary to maintain and enhance fish habitat on the reach applied for by the Board using an Instream Flow Incremental Methodology ("IFIM") to identify critical thresholds of streamflow for resident fish populations IFIM is a collection of computer models and procedures to predict habitat changes due to changes in flow and produces an estimate of the quality and quantity of available habitat based on changes in depth, velocity and channel index.

7. A minimum stream flow of 60 cfs (as measured at the USGS gauge below Fisher Creek) is required in the mainstem North Fork Payette River from July 1 to September 7 and will be met or exceeded 59% of the time. This rate of flow provides an acceptable minimum quantity of water depth and water pools for rainbow trout and spawning kokanee. This flow has been maintained by a discharge of 35 cfs from Upper Payette Lake in addition to the base flows provided by tributaries draining into the mainstem North Fork Payette River during the July 1 to September 7 period.

8. The requested minimum streamflow of 60 cfs is 46% of the observed mean flow for the July 1 to September 7 period and is desirable for fish spawning and the rearing of juvenile fish but is not the most ideal or most desirable flow.

9. The Lake Reservoir Company holds 3,000 acre feet of storage in Upper Payette Lake which is typically released in late summer to meet irrigation needs below Big Payette Lake. The rate of release of stored water from Upper Payette Lake is under the control of Lake Reservoir Company and will not be impaired by the minimum flows sought under this application.

10. All rights acquired under the application are for instream non-consumptive use and are subject to all vested water rights, permits or applications for permit having a date of priority earlier than July 16, 1999.

11. On February 5, 1999, the Board adopted a Comprehensive Water Plan for the Payette River Basin which was unanimously ratified by the 1999 Idaho Legislature.

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The plan provided that the Board would file this application with the Department.

12 All parties at the hearing supported the minimum stream flow application. There was no opposition to the approval of the application.

13. The Valley County Board of County Commissioners support the proposed minimum stream flow.

CONCLUSIONS OF LAW

1. Chapter 15, Title 42, Idaho Code, provides that stream flow preservation for the protection of fish and wildlife habitat, aquatic life, recreation, aesthetic beauty, navigation and water quality, when made pursuant to this statute, is in the public interest and is declared to be a beneficial use of such water.

2. The proposed minimum stream flows in the application will not interfere with any vested water right, permit, or application for permit having a priority date earlier than July 16, 1999 and can not be exercised to require the release of water stored in Upper Payette Lake by Lake Reservoir Company. The application, however, may prevent new water appropriations within and upstream from the minimum stream flow reach which would reduce the minimum flows.

3. The flow requested in the application is the minimum flow required to preserve the existing unique characteristics of the river for the public benefit, and is not the ideal or most desirable flows which could be utilized for those purposes.

4. The proposed minimum stream flows are in the public, as opposed to private, interest.

5. The minimum stream flows proposed by the application are necessary to protect fisheries habitat including kokanee spawning and aquatic life in the river reach.

6. The proposed minimum stream flows as approved in this order are generally capable of being maintained as the system now operates including releases from Upper Payette Lake by Lake Reservoir Company

7. The Department should approve the application with certain conditions and should issue a permit.

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JAN 31 2000

ORDER

IT IS, THEREFORE, HEREBY ORDERED That Application for Permit No. 65-13894 in the name of the Idaho Water Resource Board is **APPROVED** subject to the following conditions and limitations:

1. Use of water under the permit shall recognize and allow the continued beneficial diversion of water under any prior existing water right established by diversion and application of water to beneficial use or by an application, permit, or license on file or issued by the Director under provisions of Chapter 2, Title 42, Idaho Code, with a priority of water right earlier than July 16, 1999.

2. Use of water under the permit shall be non-consumptive.

3. Upon the future finding and order of the Director that gaging stations are required to maintain the approved minimum stream flow, the right holder shall permanently install and maintain gaging stations as specified by the Department.

4. The Director retains jurisdiction, as described below, to review and amend any and all parameters of this right. The Board, upon receiving a request, or upon its own initiative, may petition the Director for an amendment to the right. The petition must set forth any significant change in circumstances and evidence of the public interest supporting the proposed amendment. The Director will notify the general public and specific persons or known interested parties of the proposed change, and conduct a hearing for the purpose of determining whether the right should be amended in the public interest. The burden of proof at the hearing shall be upon the persons or parties seeking the amendment to establish that the amendment of the right would be in the public interest.

5. This minimum stream flow is for the protection of fisheries habitat including kokanee spawning, aquatic life in the river reach.

6. The river reach, subreaches and associated minimum stream flows hereby approved are described in Findings of Fact 1 and begin at the Upper Payette Lake dam in the SE1/4NE1/4SE1/4 Section 36, T21N, R3E, B.M. and extend downstream a total of 6.8 miles to the Box Creek confluence located in the NW1/4SE1/4SW1/4 Section 35, T20N, R3E, B.M., all in Valley County, Idaho.

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7. The minimum stream flows approved in this permit can not be exercised to require the release of water stored in Upper Payette Lake by Lake Reservoir Company.

8. The application hereby approved by the Director shall be submitted to the Idaho Legislature by the fifth day of the next regular legislative session and the Director's approval shall not become finally effective until approved by the legislature pursuant to provisions of Section 42-1503, Idaho Code.

9. Use of water under this right is subject to the control of the watermaster of Water District 65, Payette River and tributaries.

10. Proof of instream beneficial use of the minimum flow appropriated shall be submitted to the Department on or before **November 1, 2004**.

Dated this 23rd day of November, 1999.

L. GLEN SAXTON
Hearing Officer

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DEC 31 2000

CERTIFICATE OF MAILING

I DO HEREBY CERTIFY that on the 10th day of December, 1999, a true and correct copy of the foregoing **PRELIMINARY ORDER** was forwarded, by regular U.S. Mail, to the parties listed below:

Idaho Water Resource Board
PO Box 83720
Boise ID 83720-0098

Idaho Dept of Fish and Game
Attn Cindy Robertson
600 S Walnut
PO Box 25
Boise ID 83707-0025

Idaho Dept of Lands
PO Box 83720
Boise ID 83720-0050

Payette Lake Water Quality
Council
Attn Kirk Hall
PO Box T
McCall ID 83638

Julie L. Yarbrough

JULIE L. YARBROUGH, Administrative Assistant
Water Allocation Bureau

MICRO
2000

RECEIVED
SEP 2 2 1999
DEPARTMENT OF WATER RESOURCES

RECEIVED
JUL 2 0 1999
WATER RESOURCES
WESTERN REGION

FORM 202
1/96

Ident. No. 65-13894

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES
APPLICATION FOR PERMIT

To appropriate the public waters of the State of Idaho

RECEIVED
JUL 1 6 1999
Department of Water Resources

1. Name of Applicant State of Idaho IDAHO WATER RESOURCE BOARD Phone 208-327-7900 *
   Post Office address ~~1301 N. Orchard St, P.O. Box 83720,~~ Statehouse Boise, Idaho 83720-0098
2. Source of water supply North Fork Payette River which is a tributary of ~~Snake~~ Payette River
3. Location of point of diversion is SE 1/4 of NE 1/4 of SE 1/4, Govt. Lot — * Sec. 36 Township 21N Range 3E B.M. Valley County; additional points of diversion if any: see attachment (Beginning Point) (Ending Point) NWSESW S35 T20N R3E
4. Water will be used for the following purposes:

   Amount 35-60 cfs (cfs or acre-feet per annum) for instream flow purposes from July 1 to Sept. 7 (both dates inclusive)
   Amount _____ (cfs or acre-feet per annum) for see attachment purposes from _____ to _____ (both dates inclusive)
   Amount _____ (cfs or acre-feet per annum) for _____ purposes from _____ to _____ (both dates inclusive)
   Amount _____ (cfs or acre-feet per annum) for _____ purposes from _____ to _____ (both dates inclusive)
5. Total quantity to be appropriated is (a) 60 as measured below (cubic feet per second) and/or (b) _____ (acre feet per annum) Fisher Creek
6. Proposed diverting works:
   a. Description of ditches, flumes, pumps, headgates, etc. none
   b. Height of storage dam n/a feet; active reservoir capacity n/a acre-feet; total reservoir capacity n/a acre-feet; period of year when water will be diverted to storage: n/a to n/a inclusive.
   c. Proposed well diameter is n/a inches; proposed depth of well is n/a feet.
   d. Is ground water with a temperature of greater than 85°F being sought? n/a
   e. If well is already drilled, when? n/a; Drilling firm n/a;
      Well was drilled for (well owner) n/a
7. Time required for completion of works and application of water to proposed beneficial use is 5 years (*minimum 1 year*)
8. Description of proposed uses (*if irrigation only, go to item 9*):
   a. Hydropower; show total feet of head and proposed capacity if KW. _____
   b. Stockwatering; list number and kind of livestock. _____
   c. Municipal; show name of municipality. _____
   d. Domestic; show number of households. _____
   e. Other; describe fully. Instream flow for fisheries habitat, aquatic life and water quality (see item 16)

* Revisions per attached information & topographic maps & IDWR standards. -SL 8/19/99

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9. Description of place of use: n/a

a. If water is for irrigation, indicate acreage in each subdivision in the tabulation below.

b. If water is used for other purposes, place a symbol of the use (*example: D for Domestic*) in the corresponding place of use below. See instructions for standard symbols.

TWP	RGE	SEC	N E				N W				S W				S E				TOTALS
			NE	NW	SW	SE	NE	NW	SW	SE	NE	NW	SW	SE	NE	NW	SW	SE	

Total number of acres to be irrigated n/a

10. Describe any other water rights used for the same purposes as described above. n/a

11. a. Who owns the property at the point of diversion? n/a

b. Who owns the land to be irrigated or place of use? n/a

c. If the property is owned by a person other than the applicant, describe the arrangement enable the applicant to make this filing:

12. Remarks: see attachments

13. **MAP OF PROPOSED PROJECT ATTACHED** X Show clearly the proposed point of diversion, place of use, section number, township and range number.

BE IT KNOWN that the undersigned hereby makes this application for permit to appropriate the public waters of the State of Idaho as herein set forth.

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JAN 11 2005

Clarence A. Rass
(Applicant)

Received by [illegible] Date 7/14/99 Time 11:00 am Preliminary check by [illegible]
Fee $ Not applicable Receipted by — # — Date —
Publication prepared by [illegible] Date 9-8-99 Published in 1
Publication approved — Date —

ID Statesman — Times News —
Post Register — Star News —
Lewiston Trib —

ATTACHMENT TO APPLICATION FOR PERMIT
TO APPROPRIATE A MINIMUM STREAMFLOW
NORTH FORK PAYETTE RIVER

3. REACH DESCRIPTION. *Instream flow reach commences at Upper Payette Lake Dam in T21N R3E Sec. 36, SE1/4, NE1/4, SE1/4, B.M., Valley County; and extends downstream for a length of 6.8 miles to Box Creek confluence in T20N R3E Sec. 35, NW1/4, SE1/4, SW1/4, B.M., Valley County.*

4. ***Reach A:*** *35 cfs from July 1 to Sept. 7 beginning at Upper Payette Lake Dam in T21N R3E Sec. 36, SE1/4 NE1/4 SE1/4, B M., Valley County, and extends downstream for 1 mile to Pearl Creek confluence in T20N R3E Sec.1, SW1/4 SW1/4 NE1/4, B.M , Valley County.*

Reach B*: 40 cfs from July 1 to Sept. 7 beginning at Pearl Creek confluence in T20N R3E Sec.1, SW1/4 SW1/4 NE1/4, B.M., Valley County; and extends downstream for 2.8 miles to Brush Creek confluence in T20N R3E Sec. 23, SE1/4 NW1/4 NE1/4, B.M., Valley County.*

Reach C: *48 cfs from July 1 to Sept. 7 beginning at Brush Creek confluence in T20N R3E Sec. 23, SE1/4 NW1/4 NE1/4, B.M., Valley County; and extends downstream for 1.8 miles to Fisher Creek confluence in T20N R3E Sec. 26, NW1/4 SE1/4 SW1/4, B.M., Valley County.*

Reach D: *60 cfs from July 1 to Sept. 7 beginning at Fisher Creek confluence in T20N R3E Sec. 26, NW1/4, SE1/4, SW1/4, B.M., Valley County; and extends downstream for 1.2 miles to Box Creek confluence in T20N R3E Sec. 35, NW1/4 SE1/4 SW1/4, B.M., Valley County.*

14. Provide evidence that the appropriation will not interfere with any vested water right, permit or water right application of earlier date of priority.

This application is subordinate to all previously granted rights, or applications with earlier priority dates, and will not interfere with them. As a nonconsumptive instream use, this appropriation will have no impact on downstream appropriators, other than to help ensure water availability.

15. Provide evidence to show that the appropriation would be in the public interest as opposed to the private interest.

The appropriation is fully contained within a State Protected River, and will be held by the Idaho Water Resource Board in the public interest. The requested flows are nonconsumptive for instream purposes to support kokanee spawning, resident trout species and aquatic community, and water quality in Payette Lake.

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16 Provide evidence of justification that the appropriation is necessary for the purposes shown in Item 4

The purpose of the instream flow is to support kokanee spawning, maintain the resident trout fishery and aquatic community, and protect the water quality of Payette Lake. The Idaho Department of Fish and Game conducted a modeling study, using the Riverine Habitat Simulation Program, to model the relationship between flow and availability of fish habitat (Apperson, 1998; attached). This study established the flow parameters listed in this application (See Figures 3 and 5 of study).

17. Provide evidence that the minimum flow or lake level is minimum and not the ideal or most desirable flow or lake level

Ideal flow to maintain the best fishery habitat and water quality would be natural flows. The requested minimum stream flow of 60 cfs at Fisher Creek is 46 percent of the observed mean flow for the July 1 to September 7 period. [Note: The available period of record at the Fisher Creek gage (Oct 1994 to March 1999) was a period of above average flows. Flows were adjusted using a longer period of record at Lake Fork Jumbo Creek (USGS #13240000) to reflect a long-term average (1946-97).]

18 Provide evidence that the flow or lake level requested is capable of being maintained as evidenced by records of stream flows and water levels.

The flow duration curve calculated for this reach indicates the requested minimum stream flow of 60 cfs at Fisher Creek would be met or exceeded about 59 percent of the time. Storage water may comprise some of the flow during this period.

19 Describe the location of existing gaging stations that can be used in the administration of this appropriation.

Funding for the gage below Fisher Creek (USGS #13238322) is subject to cancellation each year, but is currently funded. Information from this gage will be used as long as it is funded.

The nearest downstream gage is North Fork Payette at McCall (USGS #13239000), located near the Payette Lake Outlet. Flows for the minimum stream flow reach can be calculated by using the outflows of Payette Lake and adjusting for storage as calculated for Water District 65 accounting of water rights.

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20. Do you intend to install additional gaging stations? Describe the locations.

Additional flow measurements would not be made unless required as a condition of approval.

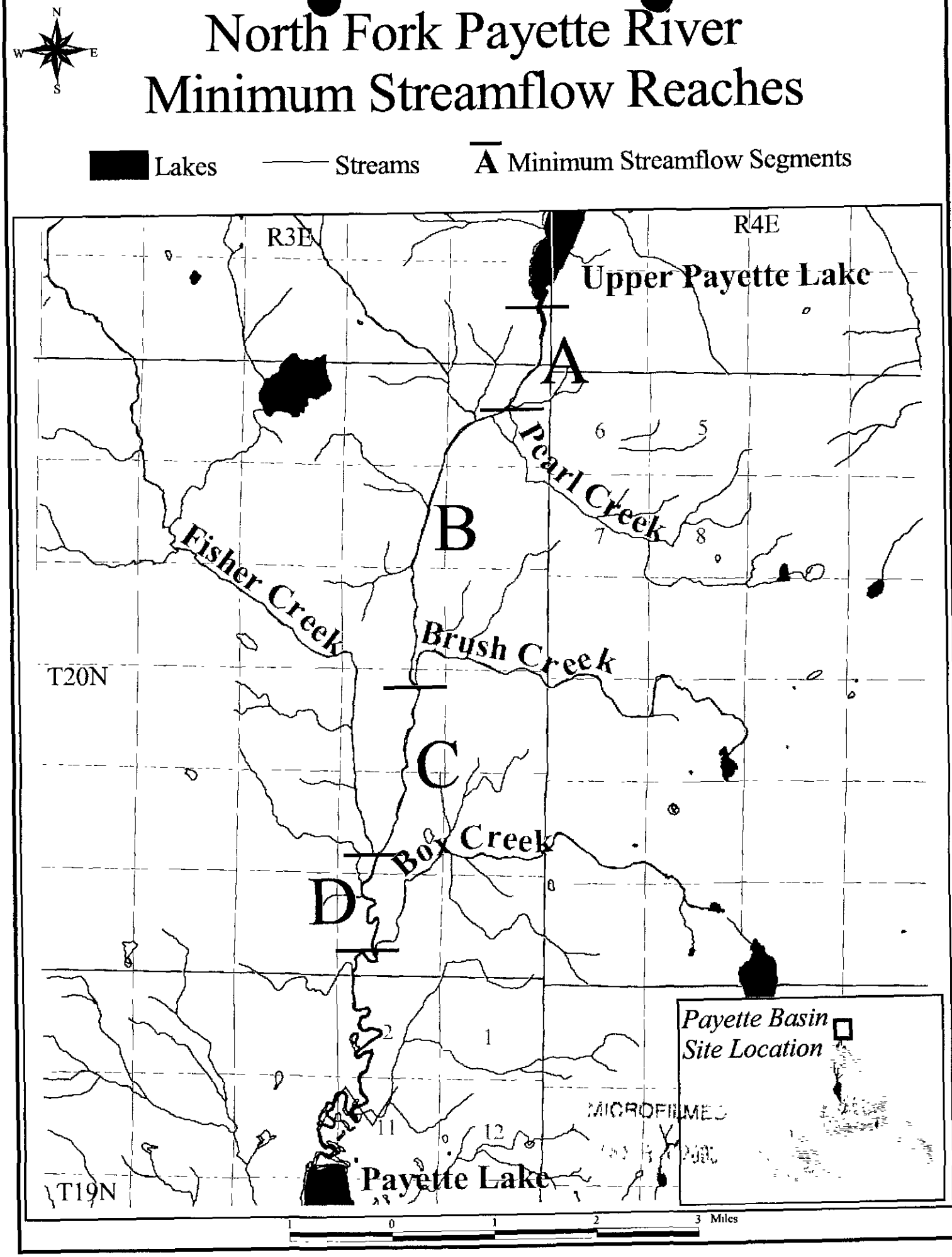
21 List any additional remarks to this minimum streamflow application

This minimum stream flow has received substantial public support. The Big Payette Lake Management Plan, prepared by the Big Payette Lake Water Quality Council and adopted by the Idaho legislature in 1998, recommended this minimum stream flow. Accordingly, the Board committed to pursuing the minimum stream flow in the Payette River Basin Comprehensive State Water Plan, adopted in February 1999 and unanimously ratified by the 1999 Idaho Legislature.

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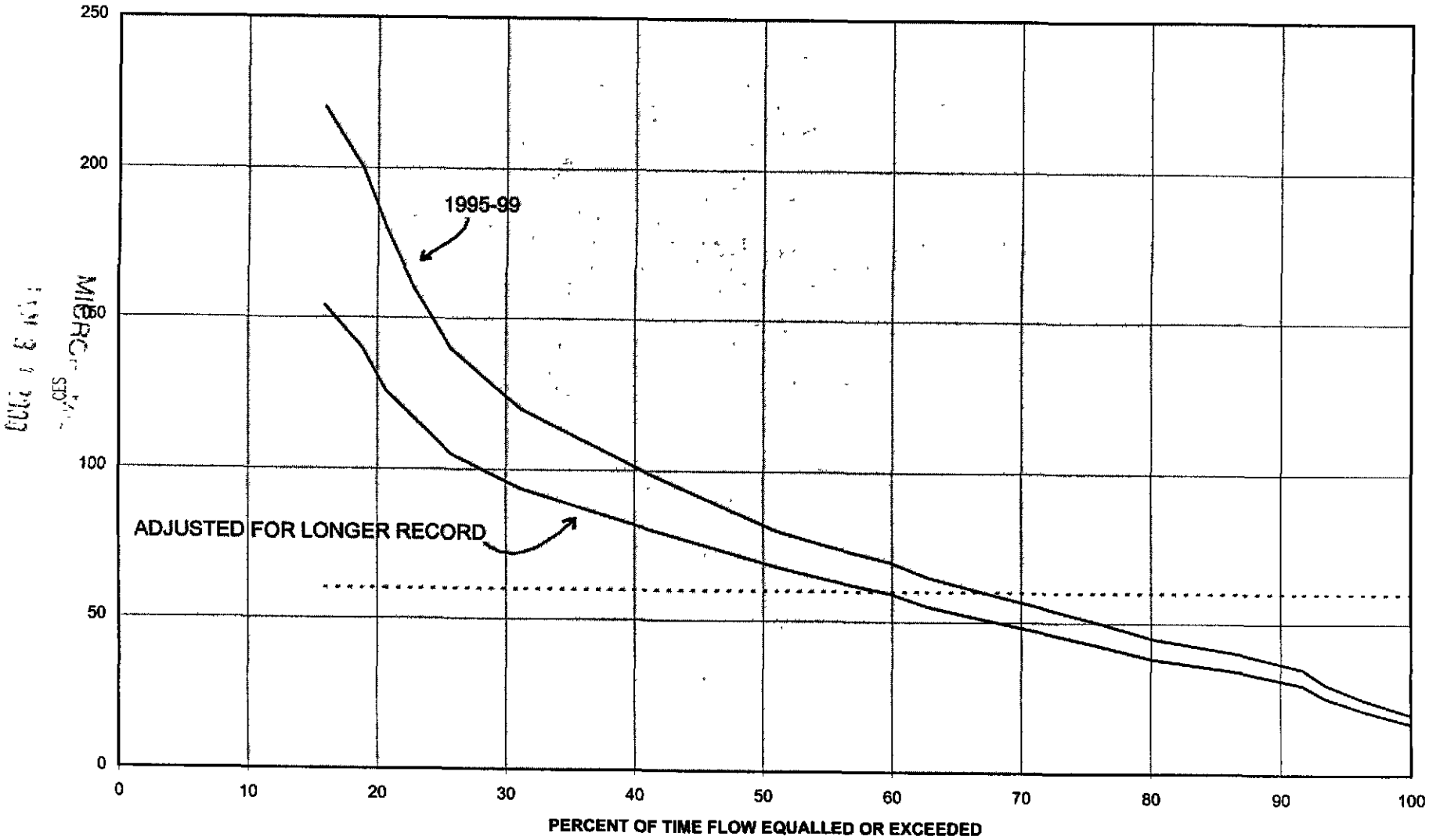
North Fork Payette River
Minimum Streamflow Reaches



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FLOW DURATIONS NORTH FORK PAYETTE RIVER BL FISHER CREEK

JULY 1 TO SEPTEMBER 7



S.36

Begin Point

T 21 N
T 20 N

A

S.1

Lake

Payette River

CREEK split to "North Fork" & FWNF confluence

Pearl

Creek

PAYETTE NATIONAL FOREST

North Fork Payette River

B

Fisher

Brush Creek

S.23

C

S.26

Box Creek

BOISE NATIONAL FOREST BOUNDARY

R3E

R4E

S.35

FORK

End 1 point

T 20 N

No gov't lots in relevant tracts
- SL
8/19/99

IDWR MAP confirms QQ sites

2'30"

IDNR topo

NOTICE OF MINIMUM STREAM FLOW HEARING

Notice is hereby given that on July 16, 1999, the Idaho Water Resource Board filed an application for permit with the Department of Water Resources (IDWR) to preserve a minimum streamflow for the protection of fish and wildlife habitat, aquatic life, and recreational values as follows:

Ident no·	65-13894
Source.	North Fork of Payette River tributary to Big Payette Lake and Payette River
Reach	6.8 miles beginning at the Upper Payette Lake dam and extending downstream to the Box Creek confluence, all located within Valley Co., and comprised of the following subbreaches and flow rates:
Subreach A	35 cfs from July 1 to Sept 7, beginning at Upper Payette Lake Dam in the SE¼NE¼SE¼, Section 36, T21N, R3E, B M., and extending downstream one mile to the Pearl Creek confluence in the SW¼SW¼ NE¼, Section 1, T20N, R3E, B M
Subreach B	40 cfs from July 1 to Sept 7, begining at the Pearl Creek confluence described above, and extending downstream for 2.8 miles to *the Brush Creek confluence*, located in the SE¼NW¼NE¼, Section 23, T20N, R3E, B.M.
Subreach C.	48 cfs from July 1 to Sept 7, beginning at the Brush Creek confluence described above, and extending downstream for 1 8 miles to the Fisher Creek confluence in the NW¼SE¼SW¼, Section 26, T20N, R3E, B.M.
Subreach D:	60 cfs from July 1 to Sept 7, beginning at the Fisher Creek confluence described above, and extending downstream 1 2 miles to the Box Creek confluence in the NW¼SE¼SW¼, Section 35, T20N, R3E, B M.

IDWR will hold a public hearing as required in Section 42-1503, Idaho Code, for the purpose of receiving evidence and testimony in regard to the application as follows:

Date and time:	September 30, 1999 at 3:00 pm and 7.00 pm

RECEIVED
SEP 29 1999
WATER RESOURCES
WESTERN REGION

RECEIVED
OCT 8 1999

ivit of Publication

OF IDAHO
Y OF TWIN FALLS } SS

No 32217

by Ruby Anderheath being first duly sworn upon oath, depose
ha[d] am Principal Clerk of the TIMES-NEWS, published daily, at
lls, Idaho, and do solemnly swear that a copy of the notice of advertisement, as per
attached, was published in the regular and entire issue of said newspaper, and not in any
nt thereof, for two consecutive weeks.
ing with the issue dated Sept 16, 1999,
g with the issue dated Sept 23, 1999.

And I do further certify that said newspaper is a consolidation, effective February 16, 1942, of the Idaho
nes, published theretofore daily except Sunday, and the Twin Falls News, published theretofore daily except
ith of which newspapers prior to consolidation had been published under said names in said city and county
y and uninterruptedly during a period of more than twelve consecutive months, and said TIMES-NEWS, since
idation, has been published as a daily newspaper except Saturday, until July 31, 1978, at which time said
began daily publication under said name in said city and county continuously and uninterruptedly
And I further certify that pursuant to Section 60-108 Idaho Code Thursday of each week has been designated
n which legal notice by law or by order of any court of competent jurisdiction within the state of Idaho, to be
eekly will be published, and that at the head of the editorial column of said combined newspapers, and in each
f, Thursday is announced as the day on which said legal notices will be published

IDAHO
OF TWIN FALLS

23rd day of Sept in the year of 1999, before me,

ublic, personally appeared Ruby Anderheath,
dentified to me to be the person whose name subscribed to the within instrument, and being by me first duly
lared that the statements therein are true, and acknowledged to me that he executed the same

Notary Public for Idaho
Residing at Twin Falls, Idaho.
My commission expires: 5-19-03

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JAN 3 1 2000

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SEP 2 7 1999

Publisher's Affidavit of Publication

STATE OF IDAHO } .ss

County of Valley

I, Carol J Wright, being duly sworn and say, I am the receptionist of The Star-News, a weekly newspaper published at McCall, in the County of Valley, State of Idaho; that said newspaper is in general circulation in the county of afore said and is a legal newspaper, that the PUBLIC NOTICE, a copy of which is enclosed hereto and is a part hereof, was published in said newspaper once a week for a period of two weeks in the regular and entire issue of every number there of during the period of time of publication, and was published in the newspaper proper and not in a supplement; and that publication of such notice began September 16, 1999 and ended September 23, 1999

Carol J. Wright

Subscribed and sworn before me this the 24th day of September, 1999.
STATE OF IDAHO

COUNTY OF VALLEY }

On this 24th day of September, in the year of 1999, before me, a Notary Public, personally appeared Carol J. Wright, known or identified to me to be the person whose name subscribed to the within instrument, and being by me first duly sworn, declared that the statements therein are true, and acknowledged to me that she executed the same.

TOM GROTE NOTARY PUBLIC STATE OF IDAHO

Tom Grote

Tom Grote
Notary Public for Idaho
Residing at McCall, Idaho
Commission Expires 1999

NOTICE OF MINIMUM STREAM FLOW HEARING

Notice is hereby given that on July 16, 1999, the Idaho Water Resource Board filed an application for permit with the Department of Water Resources (IDWR) to preserve a minimum streamflow for the protection of fish and wildlife habitat, aquatic life, and recreational values as follows:

Ident no: 65-13894

Source North Fork of Payette River tributary to Big Payette Lake and Payette River.

Reach: 6 8 miles beginning at the Upper Payette Lake dam and extending downstream to the Box Creek confluence, all located within Valley Co , and comprised of the following subreaches and flow rates

Subreach A: 35 cfs from July 1 to Sept 7, beginning at Upper Payette Lake Dam in the SE1/4 NE1/4SE 1/4 Section 36, T21N, R3E, B.M , and extending downstream one mile to the Pearl Creek confluence in the SW1/4 SW1/4 NE1/4, Section 1, T20N, R3E, B M.

Subreach B 40 cfs from July 1 to Sept 7, beginning at the Pearl Creek confluence described above, and extending downstream for 2 8 miles to the Brush Creek confluence, located in the SE1/4 NW1/4 NE1/4, Section 23, T20N, R3E, B.M.

Subreach C: 48 cfs from July 1 to Sept 7, beginning at the Brush Creek confluence described above, and extending downstream for 1 8 miles to the Fisher Creek confluence in the NW1/4SE1/4SW1/4, Section 26, T20N, R3E, B.M.

Subreach D: 60 cfs from July 1 to Sept 7, beginning at the Fisher Creek confluence described above, and extending downstream 1 2 miles to the Box Creek confluence in the NW1/4SE1/4SW1/4, Section 35, T20N, R3E, B M

IDWR will hold a public hearing as required in Section 42-1503, Idaho Code, for the purpose of receiving evidence and testimony in regard to the application as follows:

Date and time: September 30, 1999 at 3:00 pm and 7.00 pm

Place: McCall City Hall, American Legion Conference Rm.
216 Park Street
McCall, Idaho

The 3:00 pm hearing will be a formal hearing for presentation of evidence by full parties. Beginning at 7 00 pm, public witnesses may provide their comments in a less formal forum.

Any party who wishes to formally appear in the hearing for the purpose of presenting evidence and testimony or cross-examining witnesses should file a notice of appearance with the Director of IDWR, Statehouse Mail, Boise, Idaho 83720, Attn: L Glen Saxton, at least one (1) day prior to the hearing. Public witnesses are not required to file a notice of appearance. Informal written views and comments may also be submitted to IDWR prior to the hearing

The hearing will be conducted in a facility that meets the accessibility requirements of the Americans with Disabilities Act If you require special accommodations in order to attend, participate in or understand the hearing, please advise IDWR at least one (1) day prior to the hearing The hearing will be conducted by L. Glen Saxton, IDWR, P.O. Box 83720, Boise, ID 83720-0098, telephone (208) 327-7900.

If issued, this permit will be subject to all prior water rights

Karl J. Dreher
Director, IDWR
2tc9/23

The Idaho Statesman

P.O. Box 40, Boise, Idaho 83707-0040

LEGAL ADVERTISING PROOF OF PUBLICATION

Account #	DTI#	Identification	Amount
047628	118474	MINIMUM STREAM FLOW HEARING	$180.00

Ordered by	P O #	Rate	Run Dates
SUE TAYLOR		TT	SEPTEMBER 16, 23, 1999

IDAHO DEPARTMENT OF WATER RESOURCES, WEST
2735 AIRPORT WAY
BOISE, IDAHO 83705-5082

Number of Lines	
59 X 2	
Affidavit	Legal #
1	5010

RECEIVED
SEP 24 1999
WATER RESOURCES
WESTERN REGION

JANICE HILDRETH, being duly sworn, deposes and says That she is the Principal Clerk of *The Idaho Statesman,* a daily newspaper printed and published at Boise, Ada County, State of Idaho, and having a general circulation therein, and which said newspaper has been continuously and uninterruptedly published in said County during a period of twelve consecutive months prior to the first publication of the notice, a copy of which is attached hereto: that said notice was published in *The Idaho Statesman,* in conformity with Section 60-108, Idaho Code, as amended for TWO

[X] consecutive weekly [ ] single
[ ] consecutive daily [ ] odd skip
insertion(s)

beginning with the issue of: SEPTEMBER 16, 1999
and ending with the issue of: SEPTEMBER 23, 1999

Janice Hildreth

STATE OF IDAHO)
)ss
COUNTY OF ADA)

On this 23 day of SEPTEMBER in the year of 1999 before me, a Notary Public, personally appeared before me Janice Hildreth known or identified to me to be the person whose name subscribed to the within instrument, and being by me first duly sworn, declared that the statements therein are true, and acknowledged to me that she executed the same.

Angela M Newland

Notary Public for Idaho
Residing at Boise, Idaho
My Commission expires: 2/12/05

ANGELA M. NEWLAND NOTARY PUBLIC STATE OF IDAHO

MICROFILM
JAN 3 1 2000

RECEIVED
OCT 18 1999

LEGAL NOTICE
NOTICE OF MINIMUM STREAM FLOW HEARING

Notice is hereby given that on July 16, 1999, the Idaho Water Resource Board filed an application for permit with the Department of Water Resources (IDWR) to preserve a minimum streamflow for the protection of fish and wildlife habitat, aquatic life, and recreational values as follows:

Ident no:	65-13894
Source:	North Fork of Payette River tributary to Big Payette Lake and Payette River.
Reach.	6 8 miles beginning at the Upper Payette Lake dam and extending downstream to the Box Creek confluence, all located within Valley Co., and comprised of the following subreaches and flow rates:
Subreach A:	35 cfs from July 1 to Sept. 7, beginning at Upper Payette Lake Dam in the SE1/4NE1/4SE1/4, Section 36, T21N, R3E, B.M., and extending downstream one mile to the Pearl Creek confluence in the SW1/4SW1/4NE1/4, Section 1, T20N, R3E, B.M.
Subreach B:	40 cfs from July 1 to Sept. 7, beginning at the Pearl Creek confluence described above, and extending downstream for 2.8 miles to the Brush Creek confluence, located in the SE1/4NW1/4NE1/4, Section 23, T20N, R3E, B.M.
Subreach C:	48 cfs from July 1 to Sept. 7, beginning at the Brush Creek confluence described above, and extending downstream for 1.8 miles to the Fisher Creek confluence in the NW1/4SE1/4 SW1/4, Section 26, T20N, R3E, B M.
Subreach D:	60 cfs from July 1 to Sept. 7, beginning at the Fisher Creek confluence described above, and extending downstream 1.2 miles to the Box Creek confluence in the NW1/4SE1/4SW1/4, Section 35, T20N, R3E, B.M.

IDWR will hold a public hearing as required in Section 42-1503, Idaho Code, for the purpose of receiving evidence and testimony in regard to the application as follows:

Date and time.	September 30, 1999 at 3:00 p.m. and 7:00 p.m.
Place:	McCall City Hall, American Legion Conference Rm. 216 Park Street McCall, Idaho

The 3:00 p.m. hearing will be a formal hearing for presentation of evidence by full parties. Beginning at 7:00 p.m., public witnesses may provide their comments in a less formal forum.

Any party who wishes to formally appear in the hearing for the purpose of presenting evidence and testimony or cross-examining witnesses should file a notice of appearance with the Director of IDWR, Statehouse Mail, Boise, Idaho 83720, Attn: L. Glen Saxton, at *least one (1) day prior to the hearing.* Public witnesses are not required to file a notice of appearance. Informal written views and comments may also be submitted to IDWR prior to the hearing.

The hearing will be conducted in a facility that meets the accessibility requirements of the Americans with Disabilities Act. If you require special accommodations in order to attend, participate in or understanding the hearing, please advise IDWR at least one (1) day prior to the hearing. The hearing will be conducted by L. Glen Saxton, IDWR, PO Box 83720, Boise, Id 83720-0098, telephone 208/327-7900.

If issued, this permit will be subject to all prior water rights

Karl J. Dreher
Director, IDWR

Pub. Sept. 16,23, 1999 5010

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SEP 24 1999
WATER RESOURCES
WESTERN REGION

MICROFILM

RECEIVED
OCT 18 1999

TRIBUNE PUBLISHING COMPANY, INC.
The Lewiston Morning Tribune
505 C St., P.O.Box 957
Lewiston, Idaho 83501
(208) 743-9411

RECEIVED
SEP 27 1999
WATER RESOURCES
WESTERN REGION

LEGAL ADVERTISING INVOICE

Date 09/23/1999 INVOICE NO 211416

Account No. 964760

Description 211416NOTICE OF MINIMU

Times 2 Lines 52

Tab Lines

SOLD TO: DEPT OF WATER RESOURCES
2735 AIRPORT WAY
BOISE ID 83705

$ 156 00

NOTICE: This is an invoice of Purchase made by you. Statement will be rendered the first of the month.
Please Retain This Invoice as Your Statement Will Refer to Invoice by No. Only.

211416

NOTICE OF MINIMUM STREAM FLOW HEARING

Notice is hereby given that on July 16, 1999, the Idaho Water Resource Board filed an application for permit with the Department of Water Resources (IDWR) to preserve a minimum streamflow for the protection of fish and wildlife habitat, aquatic life, and recreational values as follows:

Indent no. 65-13894

Source: North Fork of Payette River tributary to Big Payette Lake and Payette River.

Reach: 6.8 miles beginning at the Upper Payette Lake dam and extending downstream to the Box Creek confluence, all located within Valley Co., and comprised of the following subreaches and flow rates:

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Subreach B: 40 cfs from July 1 to Sept 7, beginning at the Pearl Creek confluence described above, and extending downstream for 2.8 miles to the Brush Creek confluence, located in the SE1/4NW1/4NE1/4, Section 23, T20N, R3E, B M.

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IDWR will hold a public hearing as required in Section 42-1503, Idaho Code, for the purpose of receiving evidence and testimony in regard to the application as follows:

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Place McCall City Hall, American Legion Conference Rm 216 Park Street, McCall, Idaho

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If issued, this permit will be subject to all prior water rights.

Karl J. Dreher, Director, IDWR

Published: September 16th & 23rd, 1999.

AFFIDAVIT OF PUBLICATION

STATE OF IDAHO, ss.
County of Nez Perce

Karen Lewis, being duly sworn, deposes and says, I am the Legal Clerk of the Tribune Publishing Company, a corporation organized and existing under and by virtue of the laws of the State of Idaho, publishers of the LEWISTON MORNING TRIBUNE, a newspaper of general circulation published at Lewiston, Nez Perce County, Idaho; That the said Lewiston Morning Tribune is an established newspaper and has been published regularly and issued regularly at least once a day for more than 21 consecutive years next immediately preceding the first publication of this notice, and has been so published uninterrupted for said period, that the 211416NOTICE OF attached hereto and which is made a part of this affadavit was published in the said Lewiston Morning Tribune, 2 time(s). Publication being on 09/16, or once a WEEK for 2 consecutive WEEK, the first publication thereof being on the 09/16/1999, and the last publication thereof being on the 09/23/1999 and said 211416NOTICE OF was so published in the regular and entire issue of said newspaper and was not in a supplement thereof and was so published in every issue and number of the said paper, during the period and times of publication as set forth above.

Karen J Lewis

SUBSCRIBED AND SWORN BEFORE ME THIS THE 27

day of September 1999

Notary Public in and for the State of I
residing at Lewiston, therein
Commission Expires 7/1/03

Proof of Publication

RECEIVED
OCT 0 4 1999
WATER RESOURCES
WESTERN REGION

The Post Register

State of Idaho
County of Bonneville

I, S. Bob Bright or Robert Park, first being duly sworn, depose and say. That I am the Production Supervisor or Asst Prod Supervisor of The Post Company, a corporation of Idaho Falls, Bonneville County, Idaho, publishers of The Post Register, a newspaper of general circulation, published daily at Idaho Falls, Idaho, said Post Register being a consolidation of the Idaho Falls Times, established in the year 1890, The Idaho Register, established in the year 1880 and the Idaho Falls Post, established in 1903, such consolidation being made on the First day of November, 1931, and each of said newspapers have been published continuously and uninterruptedly, prior to consolidation, for more than twelve consecutive months and said Post Register having been published continuously and uninterruptedly from the date of such consolidation, up to and including the last publication of notice hereinafter referred to

That the notice, of which a copy is hereto attached and made a part of this affidavit, was published in said Post Register for two consecutive (days) weeks, first publication having been made on the 16th day of September, 1999, last publication having been made on the 23rd day of September, 1999, and that the said notice was published in the regular and entire issue of said paper on the respective dates of publication, and that such notice was published in the newspaper and not in a supplement

Robert Park

Subscribed and sworn to before me, this 29th day of September , 1999

Patricia O'Malley
Notary Public

My commission expires January 3.., 2003

RECEIVED
OCT 0 6 1999
Department of Water Resources

MICRO

NOTICE OF MINIMUM STREAM FLOW HEARING

Notice is hereby given that on July 16, 1999, the Idaho Water Resource Board filed an application for permit with the Department of Water Resources (IDWR) to preserve a minimum streamflow for the protection of fish and wildlife habitat, aquatic life, and recreational values as follows

Indent no: 65-13894

Source North Fork of Payette River tributary to Big Payette Lake and Payette River.

Reach 6 8 miles beginning at the Upper Payette Lake dam and extending downstream to the Box Creek confluence, all located within Valley Co., and comprised of the following subreaches and flow rates:

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IDWR will hold a public hearing as required in Section 42-1503, Idaho Code, for the purpose of receiving evidence and testimony in regard to the application as follows.

Date and time September 30, 1999 at 3:00 pm and 7:00 pm

Place. McCall City Hall, American Legion Conference Rm.
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If issued, this permit will be subject to all prior water rights

Karl J Dreher
Director, IDWR
Published: September 16, 23, 1999

RECEIVED
OCT 0 4 1999
WATER RESOURCES
WESTERN REGION

MICROFILMED
MAY 3 1 2000

Save for
potential
use in
2000 legislature

1-12-00

DRAFT c:\minflo.cr1 Jan 12, 2000 lgs

A CONCURRENT RESOLUTION
APPROVING APPLICATION TO APPROPRIATE WATER
FOR MINIMUM STREAMFLOW

Be It Resolved by the Legislature of the State of Idaho:

WHEREAS, the Idaho Water Resource Board may apply for a permit to appropriate unappropriated waters of any stream to establish a minimum streamflow; and

WHEREAS, under the provisions of Section 42-1503, Idaho Code, an approved application shall not become finally effective until affirmatively acted upon by the Legislature, except that if the Legislature fails to act prior to the end of the regular session to which the application was submitted, the application shall be considered approved; and

WHEREAS, on November 23, 1999, the Department of Water Resources approved the following application by issuing a Preliminary Order which became a Final Order authorizing the appropriation of water for minimum streamflow:

Ident. No: 65-13894

Source: North Fork Payette River Tributary to Big Payette Lake and Payette River

Reach: Beginning at Upper Payette Lake dam and extending downstream a total of 6.8 miles to the Box Creek confluence, all located within Valley County and comprised of the following subreaches and flow rates:

Subreach A: 35 cubic feet per second ("cfs") from July 1 to September 7, beginning at Upper Payette Lake dam in the SE1/4NE1/4SE1/4 Section 36, T21N, R3E, B.M., and extending downstream 1.0 mile to the Pearl Creek confluence located in the SW1/4SW1/4NE1/4 Section 1, T20N, R3E, B M.

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Subreach D: 60 cfs from July 1 to September 7, beginning at the Fisher Creek confluence described above and extending downstream 1.2 miles to the Box Creek confluence located in the NW1/4SE1/4SW1/4 Section 35, T20N, R3E, B.M.

Use: To protect fisheries habitat including kokanee spawning and aquatic life in the river reach.

NOW, THEREFORE, BE IT RESOLVED by the members of the Second Regular Session of the Fifty-fourth Idaho Legislature, the Senate and the House of Representatives concurring therein, that the same is hereby approved subject to the conditions and limitations contained in the Preliminary Order issued by the Department of Water Resources on November 23, 1999.

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, P.O. Box 83720, Boise, Idaho 83720-0098
Phone: (208) 327-7900 FAX: (208) 327-7866

January 10, 2000

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

Office of President Pro Tem
Idaho State Senate
Statehouse Mail
Boise, ID 83720

RE: APPLICATION FOR PERMIT NO. 65-13894 TO ESTABLISH A MINIMUM STREAM FLOW ON THE NORTH FORK PAYETTE RIVER

Dear Mr. President:

Enclosed for your consideration is a copy of the above referenced application for permit along with the preliminary order which concludes the administrative processing of the application. The preliminary order has become final without further department action, since there were no objections to the order.

As you are aware, Section 42-1503, Idaho Code, requires that the application be reviewed by the legislature. As defined by statute, an application "(i) shall not become finally effective until affirmatively acted upon by concurrent resolution of the Idaho Legislature; or (ii) except that if the legislature fails to act prior to the end of the regular session to which the application was submitted, the application shall be considered approved."

The 1999 legislature unanimously ratified the Comprehensive Water Plan for the Payette River Basin which provided that the Water Resource Board would file this application with the department. At the hearing I am required to conduct, there was no opposition to the establishment of this minimum stream flow.

This letter with its enclosures constitutes submittal of the application to the legislature for approval. Please advise if you would like further information or presentation on the nature of the application

Sincerely,

KARL J. DREHER
Director

Enclosures

c: Mike Nugent

MICROFILMED
JAN 3 1 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, P.O. Box 83720, Boise, Idaho 83720-0098
Phone: (208) 327-7900 FAX: (208) 327-7866

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

January 10, 2000

Bruce Newcomb
Speaker of the House
Statehouse Mail
Boise, ID 83720

RE: APPLICATION FOR PERMIT NO. 65-13894 TO ESTABLISH A MINIMUM STREAM FLOW ON THE NORTH FORK PAYETTE RIVER

Dear Representative Newcomb:

Enclosed for your consideration is a copy of the above referenced application for permit along with the preliminary order which concludes the administrative processing of the application. The preliminary order has become final without further department action, since there were no objections to the order.

As you are aware, Section 42-1503, Idaho Code, requires that the application be reviewed by the legislature. As defined by statute, an application "(i) shall not become finally effective until affirmatively acted upon by concurrent resolution of the Idaho Legislature; or (ii) except that if the legislature fails to act prior to the end of the regular session to which the application was submitted, the application shall be considered approved."

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Sincerely,

KARL J. DREHER
Director

MICROFILMED
JAN 3 1 2000

Enclosures

c: Mike Nugent

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, P.O. Box 83720, Boise, Idaho 83720-0098
Phone: (208) 327-7900 FAX: (208) 327-7866

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

December 10, 1999

RE: In the matter of Application for Permit No. 65-13894 in the name of Idaho Water Resource Board

Dear Interested Parties:

The accompanying order is a "**preliminary order**" issued by the department pursuant to section 67-5243, Idaho Code. It can and will become a final order without further action of the department unless a party petitions for reconsideration within fourteen (14) days after issuance as further described below:

PETITION FOR RECONSIDERATION

Any party may file a petition for reconsideration of a preliminary order with the hearing officer within fourteen (14) days of the service date of this order. The hearing officer will act on a petition for reconsideration within twenty-one (21) days of its receipt, or the petition will be considered denied by operation of law. See section 67-5243(3) Idaho Code.

EXCEPTIONS AND BRIEFS

Within twenty-one (21) days after (a) the service date of a preliminary order, (b) the service date of a denial of a petition for reconsideration from this preliminary order, or (c) the failure within twenty-one (21) days to grant or deny a petition for reconsideration from this preliminary order, any party may in writing support or take exceptions to any part of a preliminary order and may file briefs in support of the party's position on any issue in the proceeding to the Director. Otherwise, this preliminary order will become a final order of the agency.

If any party appeals or takes exceptions to this preliminary order, opposing parties shall have twenty-one (21) days to respond to any party's appeal. Written briefs in support of or taking exceptions to the preliminary order shall be filed with the Director. The Director retains the right to review the preliminary order on his own motion.

MICROFILMED
JUN 3 : 2000

ORAL ARGUMENT

If the Director grants a petition to review the preliminary order, the Director shall allow all parties an opportunity to file briefs in support of or taking exceptions to the preliminary order and may schedule oral argument in the matter before issuing a final order. If oral arguments are to be heard, the Director will within a reasonable time period notify each party of the place, date and hour for the argument of the case. Unless the Director orders otherwise, all oral arguments will be heard in Boise, Idaho.

CERTIFICATE OF SERVICE

All exceptions, briefs, requests for oral argument and any other matters filed with the Director in connection with the preliminary order shall be served on all other parties to the proceedings in accordance with Rules of Procedure 302 and 303

FINAL ORDER

The Director will issue a final order within fifty-six (56) days of receipt of the written briefs, oral argument or response to briefs, whichever is later, unless waived by the parties or for good cause shown. The Director may remand the matter for further evidentiary hearings if further factual development of the record is necessary before issuing a final order. The department will serve a copy of the final order on all parties of record.

Section 67-5246(5), Idaho Code, provides as follows:

> Unless a different date is stated in a final order, the order is effective fourteen (14) days after its issuance if a party has not filed a petition for reconsideration. If a party has filed a petition for reconsideration with the agency head, the final order becomes effective when:
>
> (a) the petition for reconsideration is disposed of; or
> (b) the petition is deemed denied because the agency head did not dispose of the petition within twenty-one(21) days.

APPEAL OF FINAL ORDER TO DISTRICT COURT

Pursuant to sections 67-5270 and 67-5272, Idaho Code, if this preliminary order becomes final, any party aggrieved by the final order or orders previously issued in this case may appeal the final order and all previously issued orders in this case to district court by filing a petition in the district court of the county in which

i. A hearing was held,
ii. The final agency action was taken,

MICROFILMED
JAN 31 2000

iii. The party seeking review of the order resides, or
iv. The real property or personal property that was the subject of the agency action is located.

The appeal must be filed within twenty-eight (28) days of this preliminary order becoming final. See section 67-5273, Idaho Code. The filing of an appeal to district court does not itself stay the effectiveness or enforcement of the order under appeal.

Sincerely,

L. Glen Saxton

L. GLEN SAXTON, Chief
Water Allocation Bureau

Enclosure

c: IDWR - Region

MICROFILMED

6 Ben Sarbon

Valley County Engineer

Valley County Courthouse/P.O. Box 737/Cascade, Idaho 83611
Phone (208) 382-4251

September 29, 1999

OCT 07 1999

RECEIVED

OCT 04 1999

WATER RESOURCES
WESTERN REGION

Gary Spackman
Idaho Department of Water Resources
Western Region
2735 Airport Way
Boise, ID 83705-5082

Re Application for Permit No 65-13894

Dear Gary,

The Board of County Commissioners for Valley County reviewed the application of the Idaho Water Resource Board for 60 cfs to sustain minimum instream flow in various reaches of the North Fork Payette River below Upper Lake from July 1 to September 7 annually. The Board asked that I relay their support for the proposal

Sincerely,

Leslie L Ankenman, P.E.
Valley County Engineer

LLA:sms

MICROFILMED

IDAHO FISH & GAME
600 South Walnut
P O. Box 25
Boise, Idaho 83707-0025

Dirk Kempthorne / Governor
Stephen P. Mealey / Director

September 28, 1999

Mr. Glen Saxton
Idaho Department of Water Resources
1301 North Orchard Street
Boise, ID 83706

RE: Minimum stream flow hearing—North Fork Payette River

Glen

Dear Mr. Saxton:

By this letter, Idaho Department of Fish and Game is filing notice of appearance for the above hearing to be held in McCall, ID on September 30, 1999. Department personnel will present evidence in support of the application. Please contact me at 334-2597 if you have any questions.

Sincerely,

Cindy Robertson

Cindy Robertson
Staff Fishery Biologist

Cc: Kim Apperson, McCall
Pete Ampe, AGO

RECEIVED
SEP 2 9 1999
Department of Water Resources

MICROFILMED

Saxton, Glen

From: Saxton, Glen
Sent: Tuesday, September 28, 1999 10.16 AM
To: 'Kirk & Betsy Hall'
Subject: RE' Hearing on NF Payette Minimum Streamflow

Dear Mr. Hall:

I will consider your E-mail message as a notice of appearance for the minimum streamflow hearing scheduled in McCall at 3.00 p m on September 30, 1999

Sincerely, L Glen Saxton
Hearing Officer

-----Original Message-----
From: Kirk & Betsy Hall [mailto:kbhall@cyberhighway.net]
Sent Tuesday, September 28, 1999 10 08 AM
To: 'gsaxton@idwr state id us'
Subject: Hearing on NF Payette Minimum Streamflow

Dear Mr Saxton

I have been requested by Peter Johnson, Chairman, Big Payette Lake Water Quality Council to appear representing the Council at the scheduled 3PM September 30, 1999 hearing on the requested minimum streamflows for a portion of the North Fork of the Payette River above Big Payette Lake.

Please accept this communication as a notice of appearance for the Big Payette Lake Water Quality Council The Council's mailing address is

Box T
McCall, ID 83638

I can be reached by replying to this message or by calling me at 634-4785 in McCall

Kirk Hall

MICRO

Saxton, Glen

From: Greegor, Dave
Sent: Friday, September 24, 1999 2:08 PM
To: Saxton, Glen
Subject: NF Payette hearing

Glen,
I got this in from Kirk Hall in McCall. Could you confirm back to him that this would work?
Dave Greegor

-----Original Message-----
From Kirk & Betsy Hall [mailto:kbhall@cyberhighway.net]
Sent Friday, September 24, 1999 11:23 AM
To 'Greegor, Dave'
Subject RE News Release 99-53

Dave

Thank you for the News release. I will be in Boise on Monday the 27th. I was planning on coming to the Water Resource Office and filling out a notice of appearance there. Will that work?

At the present time our plan is to have me represent the Council at the 3pm hearing and then have David Simonds, one of the Council members, appear at the evening hearing.

Kirk Hall

-----Original Message-----
From Greegor, Dave [SMTP:DGREEGOR@idwr.state.id.us]
Sent Monday, September 20, 1999 10:12 AM
To 'kbhall@cyberhighway net'
Subject FW: News Release 99-53

Kirk,
I got your phone message Thanks I sent the announcement surface mail Friday, and I will attach it now If you want to make a formal afternoon presentation, you need to send it to Glen Saxton (see bottom of announcement) by Sept 29. In the evening, you can simply show up, sign up and give a presentation, written and/or verbal. Much less formal.

Let me know if there is anything else I can do for you
Dave Greegor

>
>
> DICK LARSEN
> Public Information Officer
> Idaho Department of Water Resources
> (208) 327-7933 dlarsen@idwr.state.id.us
> Web Site www idwr state id.us/
>
>
> News Release
> IDAHO DEPARTMENT OF WATER RESOURCES
> 1301 N Orchard St , Boise, ID 83706 - TEL (208) 327-7900 FAX (208)
> 327-7866
> Internet Homepage http //www.idwr state id us/
>
> Release 99-53

MICRO
JAN 3 2000

>
>
> STATE SEEKS MINIMUM STREAM FLOW WATER RIGHT
> FOR NORTH FORK OF PAYETTE RIVER
>
> For Immediate Release
> For Media Information Contact
> Boise, Idaho - Sept 13, 1999
> Dick Larsen - (208) 327-7933
>
> The Idaho Water Resource Board wants to establish minimum summer
> stream flow levels on a 6.8 mile reach of the North Fork of the Payette
> River and has applied for a water right to do so, the Idaho Department of
> Water Resources said today.
> The Board says the minimum stream flows are needed to protect fish
> and wildlife habitat, aquatic life and recreational values on that segment
> of the North Fork Payette. A special public hearing on the application
> will be held by IDWR on September 30 at 3 00 p m and 7 00 p.m in McCall
> If granted, the right would carry a priority date of July 16, 1999 and
> would be junior to all prior water rights
> The minimum stream flows would cover a reach of the North Fork of
> the Payette that starts at the Upper Payette Lake dam and extends
> downstream to the confluence with Box Creek If approved, the water right
> would provide for minimum flows ranging from 35 to 60 cubic feet per
> Second (CFS) from July 1 to September 7 on four different sections of the
> 6 8 mile reach.
> The four sections and the minimum flows are
> * 35 CFS (15,709 gallons per minute) beginning at Upper Payette Lake
> Dam and extending one mile downstream to the confluence with Pearl Creek,
> * 40 CFS (17,953 gallons per minute) beginning at the Pearl Creek
> confluence and extending downstream for 2.8 miles to the confluence with
> Brush Creek;
> * 48 CFS (21,543 gallons per minute) beginning at the Brush Creek
> confluence and extending downstream for 1.8 miles to the confluence with
> Fisher Creek, and
> * 60 CFS (26,929 gallons per minute) beginning at the Fisher Creek
> confluence and extending downstream 1 2 miles to the confluence with Box
> Creek
> The hearing on September 30 will be divided into two parts. The 3 00 p m
> portion will be a formal hearing for presentation of evidence by full
> parties in the case Beginning at 7 00 p.m , public witnesses may provide
> their comments in a less formal forum. The hearing will be held in the
> American Legion Conference Room, at the McCall City Hall, 216 Park
> Street
> Any party who wants to formally appear in the hearing for the purpose of
> presenting evidence and testimony, or cross-examining witnesses should
> filed a notice of appearance with the hearing officer by September 29.
> Those notices should go to: Idaho Department of Water Resources, attn.
> Glen Saxton, 1301 N Orchard Street, Boise, ID 83706.
> The hearing will be conducted in a facility that meets the accessibility
> requirements of the Americans with Disabilities Act If you require
> special accommodations to attend, participate in or understand the
> hearing, please let Saxton know at least one day in advance so
> arrangements can be made
>
> -30-30-30-
>
>

MICRC

[illegible] 2000

Reed Gillespie Chapter
Trout Unlimited
P.O. Box 1 • McCall, Idaho 83638

RECEIVED
SEP 22 1999
Department of Water Resources

9/21/1999

Id. Dept. Water Resources
ATTN. Glen Saxton

Sir:

The Reed Gillespie Central Idaho Chapter of Trout Unlimited would like to request time to comment at the hearing Sept. 30 regarding water right application on the North Fork Payette.

Thank you.

Chuck Davis
President

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Form No. 202a.
9/98

RECEIVED
SEP 22 1999
Department of Water Resources

IDAHO DEPARTMENT OF WATER RESOURCES
APPROPRIATION APPLICATION ANALYSIS SHEET

INITIAL REVIEW BY: SL DATE: 9/10/99 APPLICATION: 65-13894

REQUIRED INFORMATION

- Name: (If applicant is a corporation or partnership, names and addresses for the director, officers, and other partners must be included.)
- Address:
- Source: (See USGS Quad for names of water sources)
- Point of Diversion: (10 acres for spring, lot & block descriptions for Subdivisions, local name)
- County:
- Quantity: (flow and/or volume)
- Period of use:
- Nature of proposed use: (Include description of use)
- Description of diverting works:
- Time required for beneficial use of water:
- Place of use or acres irrigated:
- Map: (show T, R, S, QQ &/or QQQ)
- Subdivision plat: (for > 1 home in restricted area. ≥ 5 homes in non-restricted area)
- Signature: (If applicant is corp., partnership, or municipality, title of signatory is required)
- N/A Correct fee paid

Gov't. Lots:
N P/D
P/U

N/A ADVERTISE REMARK(S)
(Reviewer identify which remarks)

N/A T FLAG CHANGED TO P FLAG

ADDITIONAL INFORMATION

YES	NO	
N/A for this use		Overlapping place of use: (Describe source & relationship to present application on next page.)
✓		Overlapping point of diversion.
	✓	Critical groundwater area:
	✓	Groundwater management area:
	✓	1992 moratorium:
✓		Surface water source, IDFG letter needed.
	✓	Bull trout impact area, IDFG letter needed ✓ Bull trout map shows "surveyed, not found"
		E-mail to SCA staff: (perennial stream, non-pump diversion &/or any mining).
		E-mail to Dam Safety staff: (for any storage)
		Mitigation plan: Check any that apply.
N/A		___ *immediate = acceptable plan required and submitted.*
		___ future = open areas, acceptance of condition of approval is in file.
		Send power requirement letter &/or fish farm requirement letter.
		Power residency affidavit:
		Diversion greater than 5 cfs or 500 af or irrigation greater than 200 acres: (If yes, attach Large Diversion supplementary analysis sheet.)
*		*REQUEST ADDITIONAL INFORMATION FROM THE APPLICANT

* Project doesn't lend itself to this analysis. Public interest criteria of this topic addressed within comment letters re I.C. 42-1503.

Date Requested ✓ Date Response Received ✓

PROCESSING APP. NO. 65-13894

YES	NO	
✓	___	In form for advertising:
✓	___	Statewide advertising: (>10 cfs &/or 1000 af)
N/A	___	Fee amount, receipt number and date recorded on application:

SEND COPIES TO: NOTE IF E-MAIL COMMENT LETTER USED.

← SENT 9/13 & 9/16 the only required reply is from Watermaster

YES	NO		YES	NO	
✓	___	I.D. Health & Welfare	✓	___	U.S. BLM
___	✓	I.D. District Health	✓	___	U.S. Forest Service
✓	___	I.D. Fish & Game	✓	___	Water Dist. # 65
✓	___	I.D. Lands	✓	___	Other SEE BELOW

FINAL REGIONAL PROCESSING REVIEW:

YES	NO	
___	___	Affidavit of publication received:
___	___	Application published correctly: If not, record action taken.
		_____
		_____
___	___	Publication dates and paper recorded on application:
___	___	Final date for protest 10-4-99
___	___	Protests received.
___	___	Recommendations attached:
___	___	Measuring device required:
___	___	Water delivered by water master? District #_____
___	___	Special conditions of approval or cover letter: _____
		_____
		_____
		_____
___	___	See below for additonal information

Recommended Date or Priority 7-16-1999

Recommended by: _____ Date: _____

ADDITIONAL INFORMATION:

"OTHER" Comment letters:

City of McCall, Valley Co. Board of Commissioners, ID Parks & Recreation, Bureau of Reclamation (attn. Gerald Gregg)

Overlap of P/D: Pt. of Beginning starts @ Upper Payette Lk Dam, which is P/D for Lake Reservoir Company's storage right 65-02918.

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SEP 2 2 1999
WATER RESOURCES
WESTERN REGION

01-99

State of Idaho
Department of Water Resources

RECOMMENDATION OF WATERMASTER

Application No: 65-13894

Applicant's Name: State of Idaho, Idaho Water Resource Board

Watermaster's Recommendation:

a) ___ I do not oppose approval of this application.

b) _X_ I do not oppose approval of this application if it is conditioned as follows: Under control of Watermaster for Water District No. 65

c) ___ I oppose approval of this application for the following reasons:

d) Additional Comment: State financial support for the operation and possible future improvements to the North Fork, Payette River USGS Gage below Fisher Creek is encouraged.

Dated this 17th day of September, 1999

Water District No. 65

Mark Limbaugh, Watermaster

Use reverse side of page if you need more space

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SEP 3 1 2003

State of Idaho
DEPARTMENT OF WATER RESOURCES
Western Region, 2735 Airport Way, Boise, Idaho 83705-5082 - (208) 334-2190
FAX (208) 334-2348

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

September 16, 1999

DEPT OF AGRICULTURE
FOREST SERVICE
324 25TH ST
OGDEN UT 84401

Re: Application for Permit No. 65-13894 in the Name of Idaho Water Resource Board

Dear Sir:

Enclosed is a copy of the above-referenced application for permit which may be of interest to your agency. Please review the application and submit any comments you may have.

Please note that a hearing for the application is scheduled for September 30, 1999. If you want to participate as a full party you should notify IDWR of your participation in writing no later than September 29, 1999.

If you have any questions regarding the application, please contact this office.

Sincerely,

Gary Spackman

Gary Spackman

GS:st

Encl.

CC: MICHAEL COLLETT
ID STATE COORDINATOR
USDA FOREST SERVICE
380 E PARK CENTER STE 330
BOISE ID 83706

MICROFILMED
JAN 3 1 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
Western Region, 2735 Airport Way, Boise, Idaho 83705-5082 - (208) 334-2190
FAX (208) 334-2348

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

September 16, 1999

ID DEPT OF HEALTH & WELFARE
DIV OF ENV QUALITY
BOISE REGIONAL OFFICE
PO BOX 83720
BOISE ID 83706

Re: Application for Permit No. 65-13894 in the Name of Idaho Water Resource Board

Dear Sir:

Enclosed is a copy of the above-referenced application for permit which may be of interest to your agency Please review the application and submit any comments you may have.

Please note that a hearing for the application is scheduled for September 30, 1999 If you want to participate as a full party you should notify IDWR of your participation in writing no later than September 29, 1999.

If you have any questions regarding the application, please contact this office

Sincerely,

Gary Spackman

Gary Spackman

GS:st

Encl.

MICROFILMED
JAN 3 1 2006

State of Idaho
DEPARTMENT OF WATER RESOURCES
Western Region, 2735 Airport Way, Boise, Idaho 83705-5082 - (208) 334-2190
FAX (208) 334-2348

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

September 16, 1999

GERALD GREGG
BUREAU OF RECLAMATION
SNAKE RIVER AREA OFFICE
214 BROADWAY
BOISE ID 83702

Re: Application for Water Right No. 65-13894 in the Name of Idaho Water Resource Board

Dear Interested Party:

Enclosed is a copy of the above-referenced application for permit which may be of interest to your agency. Please review the application and submit any comments you may have.

Please note that a hearing for the application is scheduled for September 30, 1999. If you want to participate as a full party you should notify IDWR of your participation in writing no later than September 29, 1999.

If you have any questions regarding the application, please contact this office.

Sincerely,

Gary Spackman

Gary Spackman

GS:st

Encl.

MICROFILMED
JAN 3 1 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
Western Region, 2735 Airport Way, Boise, Idaho 83705-5082 - (208) 334-2190
FAX (208) 334-2348

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

September 16, 1999

JON HAUPT
US BUREAU OF LAND MGMT
3948 DEVELOPMENT AVE
BOISE ID 83705

Re: Application for Permit No 65-13894 in the Name of Idaho Water Resource Board

Dear Sir:

Enclosed is a copy of the above-referenced application for permit which may be of interest to your agency. Please review the application and submit any comments you may have.

Please note that a hearing for the application is scheduled for September 30, 1999. If you want to participate as a full party you should notify IDWR of your participation in writing no later than September 29, 1999.

If you have any questions regarding the application, please contact this office

Sincerely,

Gary Spackman

Gary Spackman

GS:st

Encl.

MICROFILMED
JAN 3 1 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
Western Region, 2735 Airport Way, Boise, Idaho 83705-5082 - (208) 334-2190
FAX (208) 334-2348

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

September 16, 1999

ID DEPT OF LANDS
BUREAU OF NAVIGABLE WATERS
STATEHOUSE MAIL
BOISE ID 83720

Re: Application for Water Right No. 65-13894 in the Name of Idaho Water Resource Board

Dear Interested Party:

Enclosed is a copy of the above-referenced application for water right which may be of interest to your agency. Please review the application and submit any comments you may have.

Please note that a hearing for the application is scheduled for September 30, 1999 If you want to participate as a full party you should notify IDWR of your participation in writing no later than September 29, 1999.

Sincerely,

Gary Spackman

Gary Spackman

GS:st

Encl

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State of Idaho
DEPARTMENT OF WATER RESOURCES
Western Region, 2735 Airport Way, Boise, Idaho 83705-5082 - (208) 334-2190
FAX (208) 334-2348

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

September 16, 1999

ID DEPT OF PARKS & RECREATION
5657 WARM SPRINGS AVE
BOISE ID 83712-8752

Re: Application for Water Right No. 65-13894 in the Name of Idaho Water Resource Board

Dear Interested Party:

Enclosed is a copy of an application for minimum stream flow which may be of interest to your agency. Please review the application and submit any comments you may have.

Please note that a hearing for the application is scheduled for September 30, 1999. If you want to participate as a full party you should notify IDWR of your participation in writing no later than September 29, 1999.

Sincerely,

Gary Spackman

Gary Spackman

GS:st

Encl.

MICRO
SEP 2 1999

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, P.O. Box 83720, Boise, Idaho 83720-0098
Phone: (208) 327-7900 FAX: (208) 327-7866

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

September 14, 1999

RE: APPLICATION FOR PERMIT NO. 65-13894 TO ESTABLISH A MINIMUM STREAM FLOW ON THE NORTH FORK PAYETTE RIVER

Dear Interested Parties:

Enclosed is a copy of a legal notice which announces a planned public hearing in connection with the above referenced application to establish a minimum streamflow Hopefully the notice is clear and will provide sufficient information for you. A copy of the application is on file and available for review at the department's Western Regional office at 2735 Airport Way or at the department's State Office at 1301 N. Orchard St, both in Boise.

Please feel free to contact the department if you have questions or require additional information. My direct phone number in Boise is (208) 327-7955 and the phone number of the regional office is 334-2190.

Sincerely,

Copy

L. GLEN SAXTON, Chief
Water Allocation Bureau

Encl: 1

c: Attached Mailing List

Joe Jordan
Idaho Water Resource Board
2555 Glenvale Rd
Fruitvale ID 83620

Senator Laird Noh
3442 Addison Ave E
Kimberly ID 83341

Senator Judi Danielson
PO Box 528
Council ID 83612

Representative Twila Hornbeck
808 Lake
Grangeville ID 83530-1334

Representative Golden Linford
2120 W 4200 S
Rexburg ID 83440

Representative Christian Zimmerman
Box 121 Bogie Dr
Cascade ID 83611

MICRO

NOTICE OF MINIMUM STREAM FLOW HEARING

Notice is hereby given that on July 16, 1999, the Idaho Water Resource Board filed an application for permit with the Department of Water Resources (IDWR) to preserve a minimum streamflow for the protection of fish and wildlife habitat, aquatic life, and recreational values as follows:

Ident no:	65-13894
Source:	North Fork of Payette River tributary to Big Payette Lake and Payette River
Reach:	6.8 miles beginning at the Upper Payette Lake dam and extending downstream to the Box Creek confluence, all located within Valley Co., and comprised of the following subreaches and flow rates:
Subreach A:	35 cfs from July 1 to Sept 7, beginning at Upper Payette Lake Dam in the SE1/4NE1/4SE1/4, Section 36, T21N R3E, B.M., and extending downstream one mile to the Pearl Creek confluence in the SW1/4SW1/4NE1/4, Section 1, T20N, R3E, B.M.
Subreach B:	40 cfs from July 1 to Sept 7, beginning at the Pearl Creek confluence described above, and extending downstream for 2.8 miles to the Brush Creek confluence, located in the SE1/4NW1/4NE1/4, Section 23, T20N, R3E, B.M.
Subreach C:	48 cfs from July 1 to Sept 7, beginning at the Brush Creek confluence described above, and extending downstream for 1.8 miles to the Fisher Creek confluence in the NW1/4SE1/4SW1/4, Section 26, T20N, R3E, B.M.
Subreach D:	60 cfs from July 1 to Sept 7, beginning at the Fisher Creek confluence described above, and extending downstream 1.2 miles to the Box Creek confluence in the NW1/4SE1/4SW1/4, Section 35, T20N, R3E, B.M.

IDWR will hold a public hearing as required in Section 42-1503, Idaho Code, for the purpose of receiving evidence and testimony in regard to the application as follows:

Date and time:	September 30, 1999 at 3:00 pm and 7:00 pm
Place:	McCall City Hall, American Legion Conference Rm. 216 Park Street McCall, Idaho

The 3:00 pm hearing will be a formal hearing for presentation of evidence by full parties. Beginning at 7:00 pm, public witnesses may provide their comments in a less formal forum.

Any party who wishes to formally appear in the hearing for the purpose of presenting evidence and testimony or cross-examining witnesses should file a notice of appearance with the Director of IDWR, Statehouse Mail, Boise, Idaho 83720, Attn: L. Glen Saxton, at least one (1) day prior to the hearing. Public witnesses are not required

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JAN 3 1 2000

to file a notice of appearance. Informal written views and comments may also be submitted to IDWR prior to the hearing.

The hearing will be conducted in a facility that meets the accessibility requirements of the Americans with Disabilities Act. If you require special accommodations in order to attend, participate in or understand the hearing, please advise IDWR at least one (1) day prior to the hearing. The hearing will be conducted by L. Glen Saxton, IDWR, P.O. Box 83720, Boise, ID 83720-0098, telephone (208) 327-7900.

If issued, this permit will be subject to all prior water rights.

Karl J. Dreher
Director, IDWR

MICROFILMED
JAN 3 1 2000

Saxton, Glen

From: Larsen, Dick
Sent: Monday, September 13, 1999 3 12 PM
To: 'Argus Observer', 'Boise Weekly', 'Council Record', 'Garden Valley Idaho World'; 'Idaho Business Review'; 'Idaho Press Tribune', 'Idaho Statesman', 'Idaho World'; 'Long Valley Advocate'; 'McCall Star-News', 'Pat McCoy', 'Weiser Signal American'
Cc: 'Idaho Water Users Association', 'Mark Limbaugh', All IDWR Employees, IWRB Members; sclark@gov state id.us
Subject: News Release 99-53

The following news relese was issued today by the Idaho Department of Water Resources.

DICK LARSEN
Public Information Officer
Idaho Department of Water Resources
(208) 327-7933 dlarsen@idwr.state.id.us
Web Site www idwr state id us/

News Release

IDAHO DEPARTMENT OF WATER RESOURCES

1301 N. Orchard St., Boise, ID 83706 - TEL: (208) 327-7900 FAX: (208) 327-7866
Internet Homepage: http://www.idwr.state.id.us/

Release 99-53

STATE SEEKS MINIMUM STREAM FLOW WATER RIGHT FOR NORTH FORK OF PAYETTE RIVER

For Immediate Release
For Media Information Contact:
Boise, Idaho - Sept. 13, 1999
Dick Larsen - (208) 327-7933

The Idaho Water Resource Board wants to establish minimum summer stream flow levels on a 6.8 mile reach of the North Fork of the Payette River and has applied for a water right to do so, the Idaho Department of Water Resources said today.

The Board says the minimum stream flows are needed to protect fish and wildlife habitat, aquatic life and recreational values on that segment of the North Fork Payette. A special public hearing on the application will be held by IDWR on September 30 at 3:00 p.m. and 7:00 p.m. in McCall. If granted, the right would carry a priority date of July 16, 1999 and would be junior to all prior water rights.

The minimum stream flows would cover a reach of the North Fork of the Payette that starts at the Upper Payette Lake dam and extends downstream to the confluence with Box Creek If approved, the water right would provide for minimum flows ranging from 35 to 60 cubic feet per Second (CFS) from July 1 to September 7 on four different sections of the 6.8 mile reach.

The four sections and the minimum flows are:

- 35 CFS (15,709 gallons per minute) beginning at Upper Payette Lake Dam and extending one mile downstream to the confluence with Pearl Creek;

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- 40 CFS (17,953 gallons per minute) beginning at the Pearl Creek confluence and extending downstream for 2.8 miles to the confluence with Brush Creek;
- 48 CFS (21,543 gallons per minute) beginning at the Brush Creek confluence and extending downstream for 1.8 miles to the confluence with Fisher Creek; and
- 60 CFS (26,929 gallons per minute) beginning at the Fisher Creek confluence and extending downstream 1.2 miles to the confluence with Box Creek.

The hearing on September 30 will be divided into two parts. The 3:00 p.m. portion will be a formal hearing for presentation of evidence by full parties in the case. Beginning at 7:00 p.m., public witnesses may provide their comments in a less formal forum. The hearing will be held in the American Legion Conference Room, at the McCall City Hall, 216 Park Street.

Any party who wants to formally appear in the hearing for the purpose of presenting evidence and testimony, or cross-examining witnesses should filed a notice of appearance with the hearing officer by September 29. Those notices should go to: Idaho Department of Water Resources, attn: Glen Saxton, 1301 N. Orchard Street, Boise, ID 83706.

The hearing will be conducted in a facility that meets the accessibility requirements of the Americans with Disabilities Act. If you require special accommodations to attend, participate in or understand the hearing, please let Saxton know at least one day in advance so arrangements can be made.

-30-30-30-

MICROFILMED
SEP 21 '00

News Release

IDAHO DEPARTMENT OF WATER RESOURCES
1301 N. Orchard St., Boise, ID 83706 - TEL: (208) 327-7900 FAX: (208) 327-7866
Internet Homepage: http://www.idwr.state.id.us/

Release 99-53

STATE SEEKS MINIMUM STREAM FLOW WATER RIGHT FOR NORTH FORK OF PAYETTE RIVER

For Immediate Release
Boise, Idaho - Sept. 13, 1999

For Media Information Contact:
Dick Larsen - (208) 327-7933

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The four sections and the minimum flows are:

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- 48 CFS (21,543 gallons per minute) beginning at the Brush Creek confluence and extending downstream for 1.8 miles to the confluence with Fisher Creek; and
- 60 CFS (26,929 gallons per minute) beginning at the Fisher Creek confluence and extending downstream 1.2 miles to the confluence with Box Creek.

-more-more-

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The hearing on September 30 will be divided into two parts. The 3:00 p.m. portion will be a formal hearing for presentation of evidence by full parties in the case. Beginning at 7:00 p.m., public witnesses may provide their comments in a less formal forum. The hearing will be held in the American Legion Conference Room, at the McCall City Hall, 216 Park Street.

Any party who wants to formally appear in the hearing for the purpose of presenting evidence and testimony, or cross-examining witnesses should filed a notice of appearance with the hearing officer by September 29. Those notices should go to: Idaho Department of Water Resources, attn: Glen Saxton, 1301 N. Orchard Street, Boise, ID 83706.

The hearing will be conducted in a facility that meets the accessibility requirements of the Americans with Disabilities Act. If you require special accommodations to attend, participate in or understand the hearing, please let Saxton know at least one day in advance so arrangements can be made.

-30-30-30-

MICROFILMED

State of Idaho
DEPARTMENT OF WATER RESOURCES
Western Region, 2735 Airport Way, Boise, Idaho 83705-5082 - (208) 334-2190
FAX (208) 334-2348

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

September 13, 1999

SCOTT GRUNDER
STATE OF IDAHO
DEPT OF FISH & GAME
3101 S POWERLINE RD
NAMPA ID 83686

Re: Application for Permit No. 65-13894 in the Name of Idaho Water Resource Board

Dear Sir:

Enclosed is a copy of the above-referenced application for permit which may be of interest to your agency. Please review the application and submit any comments you may have.

Please note that a hearing for the application is scheduled for September 30, 1999. If you want to participate as a full party you should notify IDWR of your participation in writing no later than September 29, 1999.

If you have any questions regarding the application, please contact this office

Sincerely,

Gary Spackman

Gary Spackman

GS:st

Encl.

MICROFILMED
JAN 3 1 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
Western Region, 2735 Airport Way, Boise, Idaho 83705-5082 - (208) 334-2190
FAX (208) 334-2348

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

September 13, 1999

MARK LIMBAUGH
WATER DISTRICT 65
102 N MAIN
PAYETTE ID 83661

Re: Application for Permit No. 65-13894 in the Name of Idaho Water Resource Board

Dear Sir:

Enclosed is a copy of the above-referenced application for permit within your district. Also, enclosed is a form for your recommendation concerning this application for permit.

Please review the application and submit any comments you may have within two weeks. If you have any questions or need information, feel free to contact this office.

Sincerely,

Gary Spackman

GS:st

Encl.

MICROFILMED
NOV 3 1 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
Western Region, 2735 Airport Way, Boise, Idaho 83705-5082 - (208) 334-2190
FAX (208) 334-2348

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

September 13, 1999

CITY OF MCCALL
PO BOX 986
MCCALL ID 83638

Re: Application for Permit No 65-13894 in the Name of Idaho Water Resource Board

Dear Sir:

Enclosed is a copy of the above-referenced application for water right which may be of interest to you.

Please review the application and return any comments you might have before October 4, 1999.

Sincerely,

Gary Spackman

GS:st

Encl.

RECEIVED
SEP 3 1 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
Western Region, 2735 Airport Way, Boise, Idaho 83705-5082 - (208) 334-2190
FAX (208) 334-2348

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

September 13, 1999

VALLEY COUNTY BOARD OF COMMISSIONERS
219 N MAIN
CASCADE ID 83611

Re: Application for Permit No. 65-13894 in the Name of Idaho Water Resource Board

Dear Sir:

Enclosed is a copy of the above-referenced application for water right which may be of interest to you.

Please review the application and return any comments you might have before October 4, 1999.

Sincerely,

Gary Spackman

GS:st

Encl.

MICRO
1999

Lester, Steve

From: Spackman, Gary
Sent: Friday, September 10, 1999 8.37 AM
To: Lester, Steve
Cc: Spackman, Gary; Taylor, Sue
Subject: FW: MINIMUM STREAMFLOW HEARING - 65-13894

Steve,

I drafted the minimum stream flow notice and Sue sent it for publication statewide Will you follow up with Sue on these individual notices that need to be sent and apprise Glen that they have been mailed? Thanks

Gary

-----Original Message-----
From: Saxton, Glen
Sent: Thursday, September 09, 1999 3 49 PM
To: Spackman, Gary
Subject: MINIMUM STREAMFLOW HEARING - 65-13894

While recently reviewing provisions of Section 42-1503, Idaho Code, I note that the department is required to send a copy of an application for a minimum stream flow to Fish and Game, Health and Welfare, Parks and Rec and any other public entity likely to have an interest in the matter. Has this been done? If not please do soon. As far as "other public entities", several come to mind, i.e. the city of McCall, U.S. Forest Service, Department of Lands etc

Thanks for checking this out

42-1503

MICRO

State of Idaho
DEPARTMENT OF WATER RESOURCES
Western Region, 2735 Airport Way, Boise, Idaho 83705-5082 - (208) 334-2190
FAX (208) 334-2348

September 8, 1999

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

POST REGISTER
PO BOX 1800
IDAHO FALLS ID 83401

Dear Legal Dept.:

Enclosed you will find a legal notice which we wish to have published in your newspaper on the dates indicated. If you cannot publish the notice on the proposed dates, please contact us immediately.

An affidavit of publication must be submitted to the Department along with the publication bill. Your cooperation is appreciated.

Please send the affidavits of publication and publication billing to this office before **October 4, 1999.**

Sincerely,

Sue Taylor
Senior Secretary

Enc.

MICROFILMED
JAN 3 1 2003

State of Idaho
DEPARTMENT OF WATER RESOURCES
Western Region, 2735 Airport Way, Boise, Idaho 83705-5082 - (208) 334-2190
FAX (208) 334-2348

September 8, 1999

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

TIME NEWS
PO BOX 548
TWIN FALLS ID 83301

Dear Legal Dept.:

Enclosed you will find a legal notice which we wish to have published in your newspaper on the dates indicated. If you cannot publish the notice on the proposed dates, please contact us immediately.

An affidavit of publication must be submitted to the Department along with the publication bill. Your cooperation is appreciated.

Please send the affidavits of publication and publication billing to this office before **October 4, 1999.**

Sincerely,

Sue Taylor
Senior Secretary

Enc.

MICROFILMED
2003

State of Idaho
DEPARTMENT OF WATER RESOURCES
Western Region, 2735 Airport Way, Boise, Idaho 83705-5082 - (208) 334-2190
FAX (208) 334-2348

September 8, 1999

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

JANICE HILDRETH
ID STATESMAN
PO BOX 40
BOISE ID 83707

Dear Legal Dept.:

Enclosed you will find a legal notice which we wish to have published in your newspaper on the dates indicated. If you cannot publish the notice on the proposed dates, please contact us immediately.

An affidavit of publication must be submitted to the Department along with the publication bill. Your cooperation is appreciated.

Please send the affidavits of publication and publication billing to this office before **October 4, 1999.**

Sincerely,

Sue Taylor
Senior Secretary

Enc.

MICROFILMED
JUN 1 1 2008

State of Idaho
DEPARTMENT OF WATER RESOURCES
Western Region, 2735 Airport Way, Boise, Idaho 83705-5082 - (208) 334-2190
FAX (208) 334-2348

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

September 8, 1999

STAR NEWS
PO BOX 985
MCCALL ID 83638

Dear Legal Dept.:

Enclosed you will find a legal notice which we wish to have published in your newspaper on the dates indicated. If you cannot publish the notice on the proposed dates, please contact us immediately.

An affidavit of publication must be submitted to the Department along with the publication bill. Your cooperation is appreciated.

Please send the affidavits of publication and publication billing to this office before **October 4, 1999.**

Sincerely,

Sue Taylor
Senior Secretary

Enc.

MICROFILMED

State of Idaho
DEPARTMENT OF WATER RESOURCES
Western Region, 2735 Airport Way, Boise, Idaho 83705-5082 - (208) 334-2190
FAX (208) 334-2348

September 8, 1999

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

LEWISTON MORNING TRIBUNE
505 C, PO BOX 957
LEWISTON ID 83501

Dear Legal Dept.:

Enclosed you will find a legal notice which we wish to have published in your newspaper on the dates indicated. If you cannot publish the notice on the proposed dates, please contact us immediately.

An affidavit of publication must be submitted to the Department along with the publication bill. Your cooperation is appreciated.

Please send the affidavits of publication and publication billing to this office before **October 4, 1999.**

Sincerely,

Sue Taylor
Senior Secretary

Enc.

MICROFILMED

NOTICE OF MINIMUM STREAM FLOW HEARING

Notice is hereby given that on July 16, 1999, the Idaho Water Resource Board filed an application for permit with the Department of Water Resources (IDWR) to preserve a minimum streamflow for the protection of fish and wildlife habitat, aquatic life, and recreational values as follows:

Ident no:	65-13894
Source:	North Fork of Payette River tributary to Big Payette Lake and Payette River.
Reach:	6.8 miles beginning at the Upper Payette Lake dam and extending downstream to the Box Creek confluence, all located within Valley Co., and comprised of the following subreaches and flow rates:
Subreach A:	35 cfs from July 1 to Sept 7, beginning at Upper Payette Lake Dam in the SE1/4NE1/4SE1/4, Section 36, T21N, R3E, B.M., and extending downstream one mile to the Pearl Creek confluence in the SW1/4SW1/4NE1/4, Section 1, T20N, R3E, B.M.
Subreach B:	40 cfs from July 1 to Sept 7, beginning at the Pearl Creek confluence described above, and extending downstream for 2.8 miles to the Brush Creek confluence, located in the SE1/4NW1/4NE1/4, Section 23, T20N, R3E, B.M.
Subreach C:	48 cfs from July 1 to Sept 7, beginning at the Brush Creek confluence described above, and extending downstream for 1.8 miles to the Fisher Creek confluence in the NW1/4SE1/4SW1/4, Section 26, T20N, R3E, B.M.
Subreach D:	60 cfs from July 1 to Sept 7, beginning at the Fisher Creek confluence described above, and extending downstream 1.2 miles to the Box Creek confluence in the NW1/4SE1/4SW1/4, Section 35, T20N, R3E, B.M.

IDWR will hold a public hearing as required in Section 42-1503, Idaho Code, for the purpose of receiving evidence and testimony in regard to the application as follows:

Date and time:	September 30, 1999 at 3:00 pm and 7:00 pm
Place:	McCall City Hall, American Legion Conference Rm. 216 Park Street McCall, Idaho

The 3:00 pm hearing will be a formal hearing for presentation of evidence by full parties. Beginning at 7:00 pm, public witnesses may provide their comments in a less formal forum.

Any party who wishes to formally appear in the hearing for the purpose of presenting evidence and testimony or cross-examining witnesses should file a notice of appearance with the Director of IDWR, Statehouse Mail, Boise, Idaho 83720, Attn: L. Glen Saxton, at least one (1) day prior to the hearing. Public witnesses are not required

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to file a notice of appearance. Informal written views and comments may also be submitted to IDWR prior to the hearing.

The hearing will be conducted in a facility that meets the accessibility requirements of the Americans with Disabilities Act. If you require special accommodations in order to attend, participate in or understand the hearing, please advise IDWR at least one (1) day prior to the hearing. The hearing will be conducted by L. Glen Saxton, IDWR, P.O. Box 83720, Boise, ID 83720-0098, telephone (208) 327-7900.

If issued, this permit will be subject to all prior water rights.

Karl J. Dreher
Director, IDWR

CONVERSATION MEMORANDUM

DATE 8/26/99

FILE 65-13894

NAME OF PARTY Glen Saxton

EMPLOYEE FZ

RE: Hearing Scheduling

Working on contacting details so can include in legal notice.

tentative 9/29-30 3 pm & 7 pm

McColl

Will confirm before Reginn sends legal notice.

To Advertise -

1) See d'base Remarks, include in notice along w/ hearing details.
2) check d'entry to be sure correct.
3) statewide ads plus both valley w. papers.
4) Consider e ads

adv. program vs. word processing document - is 1 way better than another?

5) let Bill Graham know e adv. dates, protest deadline.

MICROFILMED

JAN 3 1 2000

Lester, Steve

From: Lester, Steve
Sent: Friday, August 20, 1999 4:47 PM
To: Saxton, Glen
Cc: Graham, Bill
Subject: IWRB Minimum Flow Appl. 65-13894

Glen:

Bill Graham forwarded a new appl. for instream flow @ N Fk Payette R. below Upper Payette Lake Dam. I talked to Bill about timing and he indicated that would be nice to present this to next legislative session.

Since the legal notice needs to include a hearing date, please advise how you would like to proceed. Deadlines on our end for sending notices to papers are as follows:

8/25 for first 1/2 Sept. publication

9/8 for second 1/2 Sept.

9/29 for first 1/2 Oct.

10/13 for second 1/2 Oct.

10/27 for first 1/2 Nov. ... etc.

Note that I will be gone Oct. 4-29 so will need to contact Gary during that time if necessary.

thanks,

Steve

MICROFILMED
1
JAN 2 1 2000

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, P.O. Box 83720, Boise, Idaho 83720-0098
Phone: (208) 327-7900 FAX: (208) 327-7866

DIRK KEMPTHORNE
GOVERNOR

KARL J. DREHER
DIRECTOR

MEMORANDUM

To: L. Glen Saxton

From: Karl J. Dreher

RE: APPOINTMENT AS HEARING OFFICER - PROCEDURE RULE 410

Date: September 14, 1999

You are hereby appointed as hearing officer and are authorized to represent the department as provided by IDAPA Rule 37 01.01410 (Procedure Rule 410) in the following matter:

IN THE MATTER OF APPLICATION FOR PERMIT NO. 65-13894 IN THE NAME OF THE IDAHO WATER RESOURCE BOARD

Date: September 30, 1999

Time: 3:00 p.m. and 7.00 p.m.

Location: American Legion Conference Room
McCall City Hall
216 Park Street
McCall, Idaho

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State of Idaho
Department of Water Resources

- ROSTER OF ATTENDANCE -

Pg. ____

RE: PUBLIC HEARING - IN THE MATTER OF APPLICATION FOR PERMIT NO. **65-13894** IN THE NAME OF THE IDAHO WATER RESOURCE BOARD

Date: September 30, 1999

Place: American Legion Conference Room
McCall City Hall
216 Park Street
McCall, Idaho

Do you wish to testify as a
Full party (show "**FP**")
or
Public witness (show "**PW**")
or
Not testify (Leave blank)

Name and Address	Representing	
** *Please Print* **		
Kimberly A Apperson	IDFG 555 Deinhard McCall	FP
Cindy Robertson	IDFG P.O. Box 25 Boise	FP
Peter Anderson	ID. Atty Gen. Box 83720 Boise	FP
Kirk Hall	PLWQC P.O Box T McCall	FP
Don Anderson	IDFG 555 Deinhard McCall	
Sheldon W. Keefer	IDL 555 Deinhard Ln McCall	
Chuck Davis	T.U. 1302 Ponderosa McCall	

MICROFILMED
JAN 1 1 2000

- ROSTER OF ATTENDANCE -

Pg. ____

Do you wish to testify as a
Full party (show "**FP**")
or
Public witness (show "**PW**")
or
Not testify (Leave blank)

Name and Address Representing

** *Please Print* **

Dennis M. Coyle IDPR

MICROFILMED

State of Idaho
Department of Water Resources

- ROSTER OF ATTENDANCE -

EVENING SESSION

RE: PUBLIC HEARING - IN THE MATTER OF APPLICATION FOR PERMIT NO. **65-13894** IN THE NAME OF THE IDAHO WATER RESOURCE BOARD

Date: September 30, 1999 - 7:00 p.m.

Place: American Legion Conference Room
McCall City Hall
216 Park Street
McCall, Idaho

Name and Address ** *Please Print* **	Representing	Do you wish to testify as a Public witness? (Yes or no)
Kimberly A Apperson	IDFG, McCall	[redacted]
Cindy Robertson	IDFG Boise	
Peter Anye	Idaho Hdq Coord Boise	
Don Anderson	IDFG McCall	
Dennis Coyle	IDPR McCall	
DAVID SIMMONDS	BPLWQC McCALL	YES

MICROFILMED

State of Idaho
Department of Water Resources

- ROSTER OF ATTENDANCE -

EVENING SESSION

RE: PUBLIC HEARING - IN THE MATTER OF APPLICATION FOR PERMIT NO. **65-13894** IN THE NAME OF THE IDAHO WATER RESOURCE BOARD

Date: September 30, 1999 - 7:00 p.m.

Place: American Legion Conference Room
McCall City Hall
216 Park Street
McCall, Idaho

Name and Address ** *Please Print* **	Representing	*Do you wish to testify as a Public witness?* (Yes or no)

MICROFILMED

STATE OF IDAHO
OFFICE OF THE ATTORNEY GENERAL
ALAN G LANCE

October 7, 1999

Glen Saxton
Idaho Department of Water Resources
1301 N. Orchard St.
Boise, ID 83706
Via Statehouse Mail

Re: Application for Permit No. 65-13894
(in the name of the Idaho Water Resources Board)

Dear Glen:

Enclosed for your file is a copy of the *Technical Report on the Water Quality of Big Payette Lake (December 1997)* which I requested you take notice of at the September 30, 1999, hearing in McCall, Idaho.

Thank you.

Sincerely,

PETER J. AMPE
Deputy Attorney General
Natural Resources Division

PJA/krj
Enclosure
L9278naa.doc

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Natural Resources Division
PO Box 83720, Boise, Idaho 83720-0010
Telephone (208) 334-2400, FAX (208) 334-2690
Located at 700 W Jefferson Street, Suite 210



Technical Report on the Water Quality of Big Payette Lake:

An Integrated Watershed and Lake Assessment,

Subtitled

(The Eutrophication Potential of Big Payette Lake)

December 1997

Division of Environmental Quality
Boise Regional Office
1445 N. Orchard
Boise, Idaho 83706
(208) 373-0550

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JAN 3 1 2000

Front Cover — Table of Contents Only



Technical Report on the Water Quality of Big Payette Lake:

An Integrated Watershed and Lake Assessment,

Subtitled

(The Eutrophication Potential of Big Payette Lake)

December 1997

Division of Environmental Quality
Boise Regional Office
1445 N. Orchard
Boise, Idaho 83706
(208) 373-0550

TECHNICAL REPORT ON THE WATER QUALITY OF BIG PAYETTE LAKE:

An Integrated Watershed and Lake Assessment,

Subtitled

(The Eutrophication Potential of Big Payette Lake)

Prepared by:

Payette Lake Technical Advisory Committee

Version Date: December 1, 1997

Division of Environmental Quality
Boise Regional Office
1445 N. Orchard Street
Boise, Idaho 83706
(208) 373-0550

MICROFILM

Acknowledgments:

Technical Study Coordinator:
Dewey Worth - Idaho Division of Environmental Quality

Principal Authors:

Surface Water Quantity and Quality-	Dewey Worth, IDEQ
Sediment Sources and Contributions-	Margaret Jenks, MJenks Consulting Kathy Dube, Harza Northwest, Inc
Boating/Creel and Recreation Survey-	Don Anderson, Idaho Department Fish and Game Dennis Coyle, Idaho Department Parks and Recreation
Stream Habitat Quality Assessment-	Ann Storrar, University of Idaho Mike Falter, University of Idaho
Minimum Stream Flows Assessment-	Kimberly Apperson, Idaho Department Fish and Game Cindy Robertson, Idaho Department Fish and Game
Lake Sediment Accumulation Rates-	Chad Gubala, Utah State University, Logan, UT Dewey Worth, IDEQ Joseph M. Eilers, E+S Environmental Chemistry, Corvallis, OR
Payette Lake Assessment-	Paul Woods - U.S. Geological Survey

Contributing Authors: General Background
Dewey Worth, IDEQ, Jim Fitzgerald, U.S. Forest Service, Don Anderson, IDFG
Peter Johnson, Chairman, Big Payette Lake Water Quality Council

Other Contributors and Acknowledgments:

This document is the product of efforts by many individuals from IDEQ monitoring staff (Don Lee, Joy Allison, Leslie Freeman and Mike Edmondson), U.S. Forest Service monitoring staff (John Rygh), and others. The Department of Lands and Idaho Fish and Game provided assistance in equipment for monitoring. Many additional individuals provided their support and expertise in the initial planning of this study and include members of the Technical Advisory Committee. Efforts of those above are greatly appreciated. Special appreciation is also extended to Kathy Hansen (IDEQ) for help in preparing this document Special acknowledgment to Walter Megahan, National Council of the Paper Industry for Air and Stream Improvement, for his review and assistance in the Sediment Erosion Study. Lastly, the Big Payette Lake Water Quality Council is recognized for their support and encouragement for initiating this study.

MICRO

EXECUTIVE SUMMARY

This Technical Report of the Big Payette Lake Water Quality Council (Council) is the first of two Council reports. By December of 1997 the second report, the Lake Management Plan, will define water quality in Big Payette Lake (Lake) and its watershed. These documents will constitute the Council's report to the Governor and the Legislature in accordance with the Big Payette Lake Water Quality Act, House Bill 153.

The Council's study has been a collaborative effort involving interested municipal, county, state and federal agencies and included private sector input. The Idaho Division of Environmental Quality has coordinated the study and assembled the multi-authored report. Lake studies were performed by the U.S. Geological Survey. All studies have been conducted with oversight by the Council's Technical Advisory Committee. Through its bi-monthly meetings the Council has also monitored progress and directed policy, consistent with its legislative authority.

The results of the Technical Report confirm that the water quality in the Lake has progressively deteriorated because eutrophication (the process by which nutrients pollute a lake) has commenced, especially in its southwest basin. Much of these nutrients flow into the Lake from tributaries, but some come from development along and behind the shoreline including marinas, docks and watercraft. The nutrient buildup has been large enough to create dissolved oxygen deficits (anoxia) in 1995 and 1996, a serious condition that may take years to reverse. These deficits have resulted from buildups over time of nutrients and oxygen demanding substances in the Lake's lakebed sediments.

The Technical Report findings point toward several categories of action that can preserve and enhance water quality and arrest the eutrophication of the Lake. These include:

- Storm water runoff controls on lands surrounding the Lake.
- Prudent Best Management Practices (BMPs) covering forest practices and road construction in the watershed.
- Criteria governing marinas, docks, watercraft, and pumpout stations.
- Rules controlling the development and management of campsites fronting on the Lake or a tributary.
- Citizen education of voluntary "stewardship ethics" to be practiced by parties recreating at the Lake and in the watershed.

At the request of the Council, the report initially identifies three Lake watershed specific water quality objectives which are defined by the following:

- Dissolved Oxygen - The dissolved oxygen objectives shall include the hypolimnion of Big Payette Lake and shall be measured in the lake's southwest basin at the following coordinates: 44 degrees 55 minutes 50 seconds North, 116 degrees 05 minutes 50 seconds West. Dissolved oxygen concentrations during June through September shall be equal to or greater than 6 milligrams per liter between the lake's surface and the 200 foot depth. Below the 200 foot depth and above 3 feet of the lakebed, the overall average dissolved oxygen concentration from June through September shall be greater than or equal to 3 milligrams per liter.

- Total Phosphorus - The median value of total phosphorus (TP) measured in the euphotic zone from May through September shall not exceed 6 milligrams per cubic meter.

- Chlorophyll-a - The median value of chlorophyll-a measured in the euphotic zone from May through September shall not exceed 3.0 milligrams per cubic meter.

The Council's recommendations to achieve these objectives will be set forth in the Lake Management Plan. It is the intent of the Council that these objectives will be achieved over time through recognition of their importance and prudent action by the community's economic interest including municipal, commercial, recreation, resource management, local residents and land owners. To establish these objectives the Technical Report has focused on evaluating the potential sources of nutrient pollution throughout the watershed of the Lake and the changes in water quality of the Lake itself. The watershed is approximately 75 percent U.S. Forest Land; 16 percent Idaho Endowment land; 3 percent private land; 1 percent City of McCall land, and; 5 percent Big Payette Lake.

The Lake is a favorite recreation spot for many Idaho residents as well as out-of-state visitors. Boating and fishing dominate recreational boats on the Lake - moored, docked or in active use (exclusive of jet skis). From May 1995 through June 1996, Anglers spent an estimated 11,489 hours fishing for lake, rainbow, and cutthroat trout as well as for kokanee, the most abundant fish in the Lake. Ponderosa State Park is a major camping, outdoor facility occupying the peninsula separating the southeast and southwest basins of the Lake. Camping at unimproved sites along watershed streams and lakes generates some nutrient and bacterial contamination.

Beneficial uses of the Lake include Domestic Water Supply, Agricultural Use, Cold Water Biota, Fish Habitat, and Recreation. The City of McCall and over 300 lake-side homes draw their entire domestic water supply from the Lake. The Lake Reservoir Company represents a group of irrigators holding 31,000 acre feet of water storage rights in the Lake. The Lake Reservoir Company regulates the Lake level in accordance with an agreement executed in 1924.

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The quantity and quality of runoff from the watershed retained in the Lake was studied during 1995 and 1996. Historical sediment accumulation rates within the Lake and the Upper Payette Lake were assessed. Supplemental gaging facilities were installed to provide additional data. Wildfires during the late summer and fall of 1994 burned about half of the entire watershed. Above normal runoffs in 1995 and 1996 (126 percent and 166 percent of normal), coupled with the accumulation of ash and disturbed soils in the burned areas, resulted in higher than usual transport of phosphorus and nitrogen nutrients as well as soil sediments.

Watershed Assessment: The technical study showed that estimates of phosphorus loading from the watershed in the post-burn 1995 runoff was much higher than the pre-burn loading, and dropped to near the pre-burn estimates during the 1996 runoff. Nitrogen loadings exceeded pre-burn levels by a factor of 2 to 3 during the 1995 and 1996 runoff. Sediment loadings also increased during these water years.

Sources of sediment entering streams were identified which included naturally high levels of sediment input from landslides and from erosion of forest soils. Roads were also identified as an important contributor of sediments to streams which in turn influence Upper and Big Payette Lakes. Road segments were identified where these inputs could be mitigated by changes in management or maintenance.

The habitats of twelve streams within the watershed were studied to assess habitat condition and quality. Data were compared with standards considered desirable for mountain streams. In general, this evaluation indicated a greater amount of fine sediments present in streams than desirable; acceptable levels of dissolved oxygen; somewhat higher water temperatures and stream width to depth ratios than desirable.

The study further disclosed relatively high concentrations of nutrients and bacterial pollutants in stormwater runoff from urban/residential areas around the Lake, particularly in the City of McCall. When compared to natural streams, concentrations of phosphorus in stormwater runoff were 10 to 100 times greater. Similarly, nitrogen concentrations in stormwater runoff were 10 to 15 times greater and contained suspended sediments that were 40 to 250 times greater than natural streams.

Upper Payette Lake was identified as an important collector of nutrients and sediments that could otherwise migrate through the North Fork Payette River into Big Payette Lake. This phenomenon indicates the importance of evaluating the quality and other characteristics of the upper lake, including the development of criteria for managed releases to protect both lakes and the intervening North Fork Payette River.

Payette Lake Assessment: Lake studies focused on monitoring and evaluating phosphorus and nitrogen inputs to the lake. Aquatic plant development along the shore was also studied together with an analysis of the nearshore water quality that may be influenced by lakeside development.

MICRO

Payette Lake is comprised of four major segments: the deepest northeast basin segment (North Beach to Lucks Point); the southeast basin segment (Lucks Point to Pilgrim Cove), the smallest central basin (Cougar Island and narrows); and the largest southwest basin segment (the narrows to the dam outlet).

The water quality of a healthy mountain lake is manifested by a suitable level of dissolved oxygen; the scarcity of nutrients that feed algae and other aquatic plant life; and water temperature sufficiently low to deter rapid aquatic plant growth while providing a desirable environment for fish species.

The study results indicate that, overall, the Lake was oligotrophic (low in nutrients and biological production) in 1995 and 1996, similar to previous assessments conducted in the mid 1970's. Despite this finding, however, the Lake has recently developed an absence of oxygen (anoxia) in the lower water column of the southwest basin that has not been previously documented. This condition was observed during about four months of summer and autumn each study year. Earlier data indicates that this condition is not directly related to the 1994 fire. The study suggests that this anoxic condition has been developing progressively over the years as nutrient loads have increased.

Phosphorus loading into the Lake during the study, estimated at about 6 tons per year after adjustment for the fire affects, was input primarily (58 percent) through inflows from the North Fork Payette River. The remainder comes almost equally from smaller streams flowing directly into the Lake; surface runoff from undeveloped land around the Lake (woodlands); and stormwater runoff from urban/residential development around the Lake. Comparisons with an earlier study of nutrient sources reveal that the relative magnitude of phosphorus input from the North Fork has decreased from 71 percent in 1982 to 58 percent in the current study. This indicates an increasing trend in nutrient inputs from near shore development and small tributaries draining into the Lake.

The observed oxygen deficit at depth in the southwest basin is larger than general nutrient conditions in the Lake would indicate. Some factors contributing to this condition are: local streams and the concentration of lake shore development around the southwest basin provide additional inputs of organic and other materials that accumulate on the lakebed and deplete oxygen; the basins considerable depth (some 200 feet) retards natural recirculation; the oxygen supply of the basin is finite in that oxygen levels are greatest when waters are well mixed in spring after ice-off and oxygen is not replenished during summertime thermal stratification.

A very significant finding of the near shore study was the suspected discovery of Eurasian Milfoil, a noxious aquatic weed, near the old mill site and the municipal boat ramp adjacent to the Sports Marina. Because of implications to the Lake and downstream interests, this condition warrants a prompt, ad hoc mitigation program.

MICRO

TABLE OF CONTENTS

Page

List of Figures i
List of Tables v

Chapter I

1.0 Introduction 1
1.1 Previous Environmental Studies 2
1.1.1 Watershed Studies 2
1.1.2 State Lands Planning Study 2
1.1.3 Parks and Recreation Study 2
1.1.4 Lake Studies 3
1.2 Technical Study Plan and Objectives 4
1.3 Overview of Study Components 6
1.3.1. Mass Balance Budget of Nutrients and Water Entering Big Payette Lake 7
1.3.2 Limnology 7
1.3.3 Nearshore Assessments 7
1.3.4 Watershed Assessments 8
1.3.5 Watershed Sediment Sources and Contributions 8
1.3.6 Sediment Accumulation Rates of Big Payette Lake and Upper Payette Lake . . 8
1.3.7 Recreational Impacts 8
1.3.8 Creel Survey and Boating Recreation 9

Chapter II

2.0 Watershed Description 10
2.1 General Description of Watershed 10
2.1.1 Lake 10
2.1.2 Watershed 10
2.2 Designated Uses and Benefits of the Watershed 12
2.3 Climate 12
2.4 Surface Hydrology - Watershed Delineation 12
2.5 Agricultural Water/Lake Regulation 16
2.6 Lithologic Units 17
2.7 Geography and Dominant Landform Association 23
2.8 Vegetation Cover 24
2.9 Management History 25
2.10 Fires 27
2.11 Fisheries and Wildlife 29
2.11.1 Lake Fishery 29
2.11.2 Watershed Fishery 30
2.11.3 Wildlife in the Watershed and Lake 32

MICROFILMED

Chapter III

3.0 Methods and Materials . . . 34
3.1 Lake Monitoring . . . 34
3.1.1 Hydrologic Budgets . . . 34
3.1.2 Nutrient Budgets . . . 37
3.1.3 Limnology . . . 39
Data Collection and Analysis . . . 39
Limnetic Zone . . . 39
Littoral Zone . . . 40
3.1.4 Nutrient Load/Lake Response Model . . . 43
3.2 Watershed Monitoring and Assessment . . . 44
3.2.1 Rationale for Selection of Sub-watershed Monitoring Sites . . . 44
3.2.2 Sub-watershed Water Quality and Stream Flow Monitoring . . . 45
Stream Flow Monitoring . . . 48
Monitoring Stormwater Runoff into Big Payette Lake . . . 48
Bacterial Monitoring Associated with Recreation Use . . . 49
Quality Assurance/Quality Control (QA/QC): Water Quality Samples . . . 53
3.3 Stream Habitat Quality . . . 53
3.3.1 Purpose and Objectives . . . 53
3.3.2 Data Acquisition . . . 54
3.3.3 Stream Habitat Assessment Methods . . . 57
3.3.4 Stream Habitat Parameters . . . 60
Large Woody Debris (LWD) . . . 60
Width/Depth Ratio . . . 61
Pools . . . 61
Pool/Riffle Ratio . . . 61
Substrate Composition . . . 62
Bank Stability . . . 62
Temperature . . . 63
Dissolved Oxygen (DO) . . . 64
3.3.5 Aquatic Organisms - Description, Significance and Limitations . . . 64
Macroinvertebrates . . . 64
Fish . . . 65
3.3.6 References for Stream Habitat Analysis . . . 66
3.3.7 Stream-bed Sediment Nutrient Enrichment Monitoring . . . 68
3.3.8 Channel Geometry Monitoring and Bank Stability . . . 70
3.4 Assessment of Watershed Sediment Contributions . . . 71
3.4.1 Background Sediment Yield . . . 71
Soil Creep . . . 71
Mass Wasting . . . 72
Fire . . . 73
3.4.2 Sediment Input from Land Management Activities . . . 74
Roads . . . 74
Timber Harvest . . . 77

MICRO

3.4.3 Relative Phosphorus Loading from Surface Erosion and Mass Wasting Sources . . . 78
3.5 Boating Recreation/Creel Survey Techniques . . . 80
3.6 Assessment of Sediment Accumulation Rates . . . 80
3.6.1 Sampling . . . 81
3.6.2 Sample Site Selection . . . 81
3.6.3 Stratigraphic Dating and Sediment Accumulation Rates . . . 82
3.6.4 Dating Confidence . . . 83
3.6.5 Nutrient Content Analysis . . . 83
3.7 Minimum Stream Flows . . . 83
3.7.1 Field Studies . . . 84
3.7.2 IFIM Simulations . . . 86

Chapter IV

4.0 Watershed Assessment - Results and Analysis/Quantity and Quality of Watershed Runoff . . . 87
4.1 Watershed Water Budgets . . . 87
4.1.1 Precipitation and Snow Pack Conditions . . . 87
4.1.2 Tributary Stream Flows and Water Budgets . . . 89
Upper Payette Lake Water Budget . . . 92
Mainstem North Fork Payette River Tributaries . . . 95
Big Payette Lake Tributaries . . . 96
4.2 Tributary Water Quality . . . 100
4.2.1 Physicochemical Data . . . 100
4.2.2 Watershed Nutrient and Sediment Contributions . . . 100
Upper Payette Lake Basin . . . 100
Mainstem North Fork Payette River Tributaries . . . 103
Tributaries to Big Payette Lake . . . 107
Fire, Nutrient and Sediment Relationships . . . 107
4.2.3 Summary of Tributary Water Quality and Watershed Mass Landings . . . 113
Future Loading Conditions . . . 122
4.2.4 Stream Sediment Enrichment . . . 122
4.2.5 Stream Temperature and Dissolved Oxygen Conditions . . . 126
4.3 Stormwater Monitoring of Developed Areas . . . 128
4.3.1 Loading Estimates from Developed Areas . . . 131
4.4 Watershed Sediment Sources and Contributions . . . 138
4.4.1 Background Sediment Input . . . 138
Soil Creep . . . 139
Mass Wasting . . . 139
Landslide Inventory . . . 140
Landslide Types and Sizes . . . 143
Lithologic Units Underlying Landslides . . . 147
Age and Reactivation of the Landslides . . . 147
Slope and Aspect of the Identified Landslides . . . 151
Delivery of Mass Wasting Debris to Streams . . . 151

MICROFILMED

4 4.2 Fire . . . 155
4 4.3 Sediment Input from Management Activities . . . 156
Roads . . . 156
Timber Harvest . . . 159
Management's Role in Producing Landslides . . . 161
4 4.4 Mass Wasting Triggering Mechanisms . . . 167
Mass Wasting Hazard . . . 167
Explanation of Hazard Ratings . . . 167
4.5 Stream Habitat Quality . . . 171
4.5.1 Description of Tables and Standards for Comparison . . . 171
4.5.2 Stream Habitat Data Synthesis . . . 171
Large Woody Debris (LWD) . . . 171
Width/Depth Ratio . . . 174
Pools . . . 175
Pool/Riffle Ratio . . . 176
Bank Stability . . . 176
Substrate Composition . . . 177
Temperature . . . 178
Aquatic Macroinvertebrates . . . 179
Fish . . . 182
4.6 Recreation Survey . . . 183
4.6.1 Bacteria Contamination . . . 183
4.6.2 Boating Recreation and Creel Survey . . . 185
4.6.3 Angler Use and Harvest Estimates . . . 185
4.6.4 Kokanee Migration and Recruitment . . . 185
4.7 Minimum Stream Flows Assessment . . . 186
4.7.1 Minimum Streamflow Analysis . . . 186
4.8 Sediment Accumulation Rates and Nutrients . . . 192
4.8.1 Core Composition . . . 192
4.8.2 Dating Results . . . 193
4.8.3 Sediment Accumulation Rates . . . 194
4.8.4 Nutrient Profiles . . . 198
4.8.5 Limnological and Ecological Implications . . . 203

Chapter V

5.0 Big Payette Lake Assessment . . . 204
5.1 Lake Hydrologic Budget . . . 204
5.2 Nutrient Budgets . . . 206
5.3 Limnology . . . 210
5.3.1 Water Temperature . . . 210
5.3.2 Water-column Transparency . . . 210
5.3.3 Specific Conductance . . . 214
5.3.4 pH . . . 214
5.3.5 Dissolved Oxygen . . . 214
5.3.6 Phosphorus . . . 217

MICROFILM

5.3.7 Nitrogen 219
5.3.8 Limiting Nutrient 223
5.3.9 Chlorophyll-a 224
5.3.10 Phytoplankton 224
5.3.11 Trophic State 227
5.3.12 Sediment Nutrients 228
5.4 Littoral Zone 229
5.4.1 Periphyton Production 229
Boat Docks 231
5.4.2 Aquatic Macrophytes 231
5.5 Fire Effects on Lake Water Quality 232
5.6 Nutrient Load/Lake Response Model 234
5.6.1 Model Description 234
5.6.2 Model Calibrations 235
Model Calibration and Verification 235
5.6.3 Simulation Results 237

Chapter VI

6.0 Summary Recommendations and Standards 243
6.1 Summary 243
6.1.1 Watershed Assessment 243
Quantity and Quality of Runoff 243
Sediment Sources and Contributions 246
Stream Habitat Quality 248
Recreation Survey 250
North Fork Payette River Minimum Stream Flows 250
Sediment Accumulation Rates in Upper and Big Payette Lake 251
6.1.2 Lake Assessment 252
6.2 Recommendations 255
6.2.1 Implementing Storm Water Controls for Water Quality Management 255
6.2.2 Recommendations to Reduce Management Caused Sediment Inputs 259
Surface Erosion 260
Mass Wasting 262
6.2.3 Monitoring and Trend Analysis 262
6.3 Recommended Standards for Water Quality Protection Specific to Big Payette Lake 263
6.3.1 Hypolimnetic Dissolved Oxygen Requirements 263
6.3.2 Nutrient and Chlorophyll Standards 264

Chapter VII

7.0 Bibliography 265

MICROFILMED
MAR 3 1 2005

List of Figures:

Figure 2-1 Location of Study Area

Figure 2-2 Major Land Ownership categories of the Payette Lake watershed

Figure 2-3 Streams and Lakes in the Payette Lake watershed

Figure 2-4 Payette Lake - Historical Hydrograph of Mean Daily Lake Surface Elevation for Period of Record to WY 1995

Figure 2-5 Major Rock Types of the Payette Lake watershed

Figure 2-6 Fire related tree mortality in the Payette Lake watershed

Figure 3-1 Relation of depth to lake surface area and volume for Payette Lake

Figure 3-2 Location of U.S.G.S. Discharge Monitoring Stations

Figure 3-3 Location of limnetic and littoral sampling stations

Figure 3-4 Watershed flow and water quality sample site locations

Figure 3-5 Site location map for stormwater runoff monitoring and recreation survey bacteria monitoring.

Figure 3-6 Stream habitat monitoring sites

Figure 3-7 Minimum Stream Flow Assessment Sites

Figure 4-1 Comparison of the precipitation amounts measured for water years 1994-1996 and the historical average (1961-1990) measured at Secesh Summit Snotel site.

Figure 4-2 Comparison of the first of month Snow Water Equivalent (SWE) from snowpack for water years 1994-1996 and the historical average (1961-1990) measured at Secesh Summit Snotel Site.

Figure 4-3 McCall Rainfall Amounts

Figure 4-4 Daily hydrographs representing seasonal runoff from tributary streams in the Upper Payette Lake drainage basin. Trend line estimated for missing data by interpolation.

Figure 4-5 Comparison of total monthly inflow and outflow estimates of water volume for Upper Payette Lake.

MICROFILM

Figure 4-6 Comparison of synoptic stream flow measurements taken in the Upper Payette Lake drainage basin and mainstem N.F. Payette tributaries.

Figure 4-7 Daily hydrograph representing seasonal runoff from tributary streams draining to Big Payette Lake.

Figure 4-8 Stream Conductivity and pH of burned and unburned watersheds

Figure 4-9 Total Phosphorus (TP) and Total Solids (TS) observed in samples from watersheds above Upper Payette Lake.

Figure 4-10 Inorganic nitrogen (DIN) and organic nitrogen (Org-N) observed in samples from watersheds above Upper Payette Lake.

Figure 4-11 Total Phosphorus (TP) and Total Solids (TS) observed in samples from watersheds tributary to the N.F. Payette River mainstem.

Figure 4-12 Inorganic nitrogen (DIN) and organic nitrogen (Org-N) observed in samples from watersheds draining to the N.F. Payette River mainstem.

Figure 4-13 Total Phosphorus (TP) and Total Solids (TS) observed in samples from watersheds tributary to Big Payette Lake.

Figure 4-14 Inorganic nitrogen (DIN) and organic nitrogen (Org-N) observed in samples from watersheds draining to Big Payette Lake.

Figure 4-15 Comparison of annual trends in Total Phosphorus (PP + Dis-P), particulate phosphorus (PP), dissolved inorganic phosphorus (Dis-P) and flow for burned flowing into Upper Payette Lake.

Figure 4-16 Linear regressions of particulate phosphorus (PP) on suspended sediment (SS) concentrations from Cougar Creek water quality samples.

Figure 4-17 Box plot comparisons summarizing nutrient and sediment data for combined water years 1995 and 1996.

Figure 4-18 Comparison of inflow and outflow concentrations of nutrients and suspended sediments for Upper Payette Lake.

Figure 4-19 Comparison of nutrient and sediment yields by unit area for monitored burned and unburned watersheds.

Figure 4-20 Phosphorus forms measured in streambed and streambank sediments

MICROFILMED

Figure 4-21 Temperature {C} and dissolved oxygen (mg/l) measured during synoptic sampling of watershed streams.

Figure 4-22 Total phosphorus (TP), inorganic nitrogen, organic nitrogen, total solids and suspended sediment concentrations measured and collected from developed areas.

Figure 4-23 Bacteria results from stormwater sample collections.

Figure 4-24 Total estimated pollutant loading by land use type for water year 1995.

Figure 4-25 Existing and possible landslides in the Payette Lake watershed

Figure 4-26 Road segments delivering sediments to streams in the Payette Lake watershed

Figure 4-27 Mass wasting hazard ratings for the Payette Lake watershed

Figure 4-28 Bacteria monitoring results from recreation use areas along the N.F. Payette River and lake shoreline

Figure 4-29 a.) N.F. Payette River kokanee spawning counts (1988-1996) and b.) mid water trawling estimates of age 1+ kokanee (1988-1996)

Figure 4-30 Habitat available to rainbow trout and spawning kokanee at various discharges in the upper N.F. Payette Rive, expressed as a percent of the total area of each study site

Figure 4-31 a.) Recommended summer discharge for mainstem N.F. Payette River, as measured at the USGS gauge below Fisher Creek, b.) Discharge relationship among all reaches of the rive, c.) Summer temperatures at USGS gauge, and Densities of rainbow trout in study reaches

Figure 4-32 Quantity of habitat types in the upper N.F. Payette River

Figure 4-33 Observed 210 Pb stratigraphies in each sediment core

Figure 4-34 a.) CRS model dates and associated strata depth in core profile, b-d.) CRS model dates and error estimates in the associated sediment accumulation rates for each core strata

Figure 4-35 Comparison of SARs among sediment core sites in Upper and Big Payette Lake

Figure 4-36 Peak annual discharge as estimated by Big Payette Lake outflows and corresponding sediment accumulation rates measured from Upper Payette Lake

MICROFILMED

Figure 4-37 Profiles of total carbon (C), total nitrogen (TN), total phosphorus (TP) and total iron (Fe) in sediments from Big Payette Lake

Figure 4-38 Profiles of total carbon, total phosphorus, total nitrogen and iron in sediments from Upper Payette Lake

Figure 4-39 Ratios of C:N and N:P in vertical sediment profiles from Upper and Big Payette Lake

Figure 5-1 Lines of equal temperature, in degrees celsius, at stations 1-4 during selected months of 1995 and 1996

Figure 5-2 Depths of euphotic zone and secchi disc transparency at stations 1-4 during 1995 and 1996

Figure 5-3 Lines of equal dissolved oxygen concentration, in mg/L, at stations 1-4 during selected months of 1995 and 1996

Figure 5-4 Lines of equal dissolved oxygen concentration, as percent saturation, at stations 1-4 during selected months of 1995 and 1996

Figure 5-5 Concentrations of total phosphorus and dissolved orthophosphorus in the euphotic zone and lower hypolimnion at stations 1-4 during 1995 and 1996

Figure 5-5 Concentrations of total nitrogen and dissolved inorganic nitrogen and ammonia in the euphotic zone and lower hypolimnion at stations 1-4 during 1995 and 1996

Figure 5-7 Dissolved inorganic nitrogen to dissolved orthophosphorus ratio at stations during 1995 and 1996

Figure 5-8 Chlorophyll-a concentrations at stations 1-4 during 1995 and 1996

Figure 5-9 Phytoplankton biovolume at stations 1-4 during 1995 and 1996

Figure 6-1 Comparison of the estimated phosphorus and nitrogen loading from watersheds before and after the 1994 fire

Figure 6-2 Source contributions of surface runoff nutrients to Big Payette Lake

Figure 6-3 Watercraft use on Big Payette Lake

Figure 6-4 Relation of natural and human related processes contributing to the loss of hypolimnetic oxygen in the southwest basin of Big Payette Lake

Figure 6-5 Payette Lake Watershed Roads

MICROFILMED

List of Tables:

Table 1-1 Member agencies and institutions supporting the Payette Lake Technical Advisory Committee.

Table 2-1 Sub-Basins and Subwatersheds in the Big Payette Lake drainage basin.

Table 2-2 Lithologic Units

Table 2-3 Sale acres of timber harvest by decade.

Table 3-1 Characteristics of the four segments of Big Payette Lake modeled by BATHTUB

Table 3-2 Watershed Nonpoint Source - Priority Stream Sites and Impact Characteristics

Table 3-3 Water Quality Parameters Monitored

Table 3-4 Stormwater Monitoring Sites and Drainage Basin Characteristics.

Table 3-5 Beneficial Use Reconnaissance Program Stream Habitat Quality Monitoring Sites

Table 3-6 Metrics used for Beneficial Use Attainability Survey

Table 3-7 Soil Chemistry Analysis Methods

Table 3-8 Basic fire erosion rates

Table 3-9 Basic Road Erosion Rate

Table 3-10 Road Gradient Factor

Table 3-11 Mitigation Factor

Table 3-12 Basic Soil Erosion Rate

Table 3-13 Road Tread Surfacing Factor

Table 3-14 Traffic Factor

Table 3-15 Cutslope and fillslope cover factor

Table 3-16 Road Component Delivery

Table 3-17 Basic Harvest Erosion Rate by Year after Harvest (tons/acre/year) from Reinig et. al. 1991.

MICROFILMED
MAR 3 1 2000

Table 4-1 Correlation matrix of synoptic stream flow measurements obtained during water years 1995 and 1996.

Table 4-2 Monthly cumulative flow (cf) estimates for streams flowing into Upper Payette Lake

Table 4-3 Radial gate openings and discharge volumes

Table 4-4 Monthly cumulative flow (cf) estimates for watersheds tributary to the mainstem North Fork Payette River.

Table 4-5 Monthly cumulative flow (cf) estimates for watersheds tributary to Big Payette Lake.

Table 4-6 Comparison of Average Total Phosphorus (TP), Particulate Phosphorus (PP) and the Percent of TP as PP (%) from watersheds in WY 1995 and 1996.

Table 4-7 Annual basin loading and subwatershed contributions for total phosphorus (TP), total nitrogen and suspended sediments (SS)

Table 4-8 Water, nutrient and suspended sediment budget for Upper Payette Lake.

Table 4-9 Estimate of future nutrient and sediment loadings from watersheds.

Table 4-10 Average concentration and standard error of nutrients, minerals and metals in streambed and streambank sediment samples

Table 4-11 Comparison of Fecal Coliform Bacteria concentrations in Urban McCall with results from the Nationwide Urban Runoff Program (NURP).

Table 4-12 Heavy metals concentrations measured in stormwater samples collected on September 14, 1996.

Table 4-13 Water Quality Characteristics of Runoff from Residential and Commercial Areas Based on Nationwide Urban Runoff Program (EPA, 1983).

Table 4-14 Urban drainage Basin characteristics for the City of McCall and surrounding area.

Table 4-15 Comparison of the calculated runoff coefficient by land use type and other literature values.

Table 4-16 Estimated pollutant yield (kg/ha) for developed areas around Big Payette Lake.

Table 4-17 Sediment Input from Soil Creep

MICROFILMED

Table 4-18 Number, percent of total, density and delivered sediment of landslides by subwatershed.

Table 4-19 Landslides by mass failure type.

Table 4-20 Landslides by size

Table 4-21 Landslides by lithologic unit

Table 4-22 Landslides identified by air photo year

Table 4-23 Recurrence interval of landslides

Table 4-24 Landslides by primary slope at and just below initiation point

Table 4-25 Landslides by aspect of initiation point

Table 4-26 Landslides by delivery to streams and lakes

Table 4-27 Sediment Input from Fire

Table 4-28 Average annual sediment input from roads

Table 4-29 Acres of timber harvest by decade

Table 4-30 Estimated surface erosion from harvest units (tons)

Table 4-31 Management activities and landslide production

Table 4-32 Payette Lake watershed stream habitat parameter summary

Table 5-1 Hydrologic budget associated with each budget component, 1995-1996

Table 5-2 Annual coefficients for unit runoff and nutrient export for three gauged inflow stations and one gauged outflow station, Payette Lake, 1995-1996

Table 5-3 Total phosphorus budget Payette Lake, 1995-1996

Table 5-4 Total nitrogen budget Payette Lake, 1995-1996

Table 5-5 Loads of nitrogen and phosphorus for WYs 1995 and 1996 at N.F. Payette River below Fisher Creek and N.F. Payette River at McCall

Table 5-6 Medians and ranges of secchi disc transparency and euphotic zone depth at four limnetic stations, Payette Lake, 1995-1996

MICROFILMED
JAN 3 1 2000

Table 5-7 Medians of total phosphorus and dissolved orthophosphorus from the euphotic zone and lower hypolimnion at four limnetic stations, Payette Lake, 1995-1996

Table 5-8 Medians of total nitrogen and dissolved inorganic nitrogen from the euphotic zone and lower hypolimnion at four limnetic stations, Payette Lake, 1995-1996

Table 5-9 Medians and ranges of ratios of dissolved inorganic nitrogen and dissolved orthophosphorus from the euphotic zone and lower hypolimnion at four limnetic stations, Payette Lake, 1995-1996

Table 5-10 Medians and ranges of chlorophyll-a and phytoplankton biovolumes in samples from the euphotic zone and lower hypolimnion at four limnetic stations, Payette Lake, 1995-1996

Table 5-11 Phytoplankton taxa at four limnetic stations, Payette Lake, 1995-1996

Table 5-12 Trophic state of Payette Lake during 1995-1996 based on annual geometric mean values for four limnological variables

Table 5-13 Concentrations of total phosphorus and total nitrogen in lakebed sediments at four limnetic stations, Payette Lake, July, 1996

Table 5-14 Periphyton production, as chlorophyll-a, at 19 littoral stations, Payette Lake, July-August, 1996

Table 5-15 Aquatic macrophyte taxa at 19 littoral stations, Payette, July, 1996

Table 5-16 Results of model calibration with 1996 data and model verification with 1995 data, Payette Lake

Table 5-17 Presence or absence of overlap in standard errors for observed and estimated values for five limnological variables for calibration and verification model runs, Payette Lake

Table 5-18 Simulation 1: Limnological response to estimated phosphorus and nitrogen loads delivered to Payette Lake prior to 1994 forest fires

Table 5-19 Simulation 2: Limnological response to increased phosphorus and nitrogen loads caused by forest fires in watershed areas not burned during the 1994 forest fires

Table 5-20 Simulation 3: Limnological response to 20 percent reduction in phosphorus and nitrogen loads from developed shoreline areas; comparison is to simulated response to pre-1994 forest fires (Simulation 1, Table 5-18)

MICROFILMED
JAN 3 1 2000

Table 5-21 Simulation 4: Limnological response to 20 percent reduction in phosphorus and nitrogen loads from watershed areas subjected to timber harvest activities; comparison is to simulated response to pre-1994 forest fires (Simulation 1, Table 5-18)

Table 5-22 Simulation 5: Limnological response to 20 percent reduction in phosphorus and nitrogen loads from developed shoreline areas and watershed areas subjected to timber harvest activities; comparison is to simulated response to pre-1994 forest fires (Simulation 1, Table 5-18)

Table 6-1 Summary of average annual sediment input from background and management sources delivered to streams and lakes

Table 6-2 Summary of average annual historical sediment input delivered to Upper Payette Lake and Big Payette Lake

Table 6-3 Comparison of key pollutant removal efficiencies using an array of stormwater runoff control techniques.

Table 6-4 Road erosion sites

MICROFILMED

Chapter I

1.0 Introduction

The Big Payette Lake Watershed project is a local citizen initiative to protect the high quality environment of Big Payette Lake and its contributing watershed. In support of this effort, the state legislature appointed a special council (Big Payette Lake Water Quality Act; HB. 153) of local citizens and granted it authority to conduct a comprehensive, scientifically based study of the lake and watershed, prepare a water quality management plan to protect the resource and encourage public participation in its implementation.

The Big Payette Lake Water Quality Council and the community of McCall, Idaho believe that a high level of water quality in the Big Payette Lake and its watershed must be preserved for drinking, swimming, fishing, wildlife and other aesthetic purposes while accommodating private, public and commercial activities to the extent prudent and practical and sustaining the economic viability of the area.

Although the lake is generally considered to be of high quality, continued population growth in the area and land use changes in the watershed have increased public concern that lake conditions could be degraded. The watershed is dominated by forest lands managed by the U.S. Forest Service and Idaho Department of Lands. The Idaho Forest Practices Act was passed in 1974 (revised 1992; Title 38, Chapter 13, Idaho Code) and recommends minimum forestry BMPs (Best Management Practices) required to protect state water quality. These regulations govern activities on Forest Service, private and State Lands. These regulations primarily attempt to control erosion of streams impacted by logging activity. Moreover, much of the logging activity on Forest Service land within the watershed took place prior to implementation of current BMPs.

Other issues include urban expansion of the city core and additional residential growth along the lake shoreline. Significant growth of the local economy is expected to continue based on current patterns of development and recreational usage. It is also anticipated that additional nutrient loading of the lake will increase at sporadic rates in response to increased disturbances within the watershed (land clearing, conversion to urban use, logging, etc.). Mitigation of these impacts will be required to maintain existing lake water quality. The quantity and quality of runoff associated with current land uses are largely unknown. In addition, the Department of Lands is responsible for management of undeveloped endowment lands scattered along the lake shoreline. The type and intensity of development on these lands could significantly affect nearshore water quality of the lake.

Attention has also been focused on an apparent decline in the water quality of the N.F. Payette River between Fisher Creek and Big Payette Lake. This section of the river was previously designated as a Stream Segment of Concern by Idaho Division of Environmental Quality (IDEQ, 1992). Increased recreational demands may also be contributing to changes in habitat quality.

More recently, a significant fire swept through the watershed in summer 1994. The long term impacts of this fire on the health and future condition of the watershed and that of Big Payette Lake have raised new concerns over future land management in the watershed.

1.1 Previous Environmental Studies

1.1.1 Watershed Studies

Despite a long history of management activities dating back to the 1900's and population growth in the Payette Lake watershed, there is very little scientific data relating these activities to watershed health. With the exception of activity related to isolated timber sales, information concerning the current status of the Payette Lake Watershed is lacking. Very few of the numerous tributaries flowing into the North Fork Payette River have been measured for flow rate or water quality to establish a baseline of existing conditions. Some historical data relevant to this study have been collected by the Forest Service and incorporated as part of the baseline information for the report.

Three assessments have been completed within the North Fork Payette River drainage: The Accelerated Englemann Spruce Harvest Environmental Impact Statement (USDA, 1991); the Blackwell Post-Fire Landscape Assessment (USDA, 1995a, working draft), and; the North Fork Payette Post-Fire Project (USDA, 1995b). The objective of the EIS was to identify alternatives to salvage insect- killed trees within Brush, Hendricks and Copet Creek drainages. The Post-Fire Landscape Assessment analyzed the effects of the Blackwell fire and identified a desired future condition for the watersheds. Finally the Post-Fire Project Assessment identified opportunities in timber harvest and restoration projects to begin implementation and changes toward the future conditions objectives. Portions of these documents have been used in this report.

1.1.2 State Lands Planning Study

The Idaho Department of Lands completed a draft Payette Lakes State Forest Land Use Plan (IDL, 1992). The purpose of this plan was to provide a guide for future development and use of 14,771 acres of State endowment lands near McCall. This land includes forest land for commercial timber and a significant amount of developed and undeveloped lands around the perimeter of Big Payette Lake. The plan intent was to consolidate management activities to better define future management objectives and determine the best use of undeveloped lands adjoining the lake shoreline.

1.1.3 Parks and Recreation Study

The Idaho Parks and Recreation Department completed a *General Development Plan for Ponderosa State Park* (Okerlund, 1994). This plan outlines conceptual development alternatives for the state park and adjoining lake front. Components include future development of recreation sites, protection of natural resources within the park and park expansion to include/improve the North Beach area of Big Payette Lake.

1.1.4 Lake Studies

One of the earliest references to Payette Lake's water quality was made in the 1890's in a report to the U.S. Fish Commission which noted the presence of sockeye salmon (Oncorhynchus nerka) and water-column transparency as much as 9 m (U.S. Forest Service, 1995a). By the late 1960's, water-quality concerns prompted the Idaho Department of Health (DH) to conduct studies on the effects of sewage disposal from nearshore dwellings around Payette Lake. A bacteriological survey conducted during 1964 found many unsatisfactory sewage-disposal systems in the nearshore area (Idaho Department of Health, 1970). A second, more intensive, study was conducted during 1967-69 to determine the extent of bacterial contamination, describe chemical conditions, and determine the general degree of eutrophication (the process by which excessive nutrient imports to a lake stimulate its biological productivity to levels that degrade water quality and thus impair some or all of the lake's beneficial uses). That study (Idaho Department of Health, 1970) found the lake to be oligotrophic (rich in oxygen at all depths), on the basis of chemical and biological variables, and to have obvious bacterial contamination in some nearshore areas. On the basis of these two studies, the Idaho Department of Health recommended a sewage-collection system be installed at Payette Lake to protect its oligotrophic (low in biological productivity) condition and to reduce the human health risks associated with bacterial contamination.

The U.S. Environmental Protection Agency (EPA) studied Payette Lake in 1975 as part of the National Eutrophication Survey (U.S. Environmental Protection Agency, 1977). Water quality analyses were indicative of excellent conditions and a trophic state of early mesotrophic (moderate biological productivity). This study was the first to estimate the lake's annual nutrient budget. Of the 4,100 kg of total phosphorus estimated to enter the lake during a year of average inflow, about 68 percent was delivered by the North Fork Payette River; nearshore sewage-disposal systems accounted for about 0.5 percent. For total nitrogen, the lake received about 198,000 kg, with 65.6 percent contributed by the North Fork Payette River and 0.3 percent from nearshore sewage-disposal systems.

A comprehensive limnological assessment of Payette Lake was conducted during 1981-82 in response to concerns over possible water-quality deterioration caused by lakeshore and watershed development and to monitor the water-quality impacts from construction of a gravity sewer line along the lake's shoreline (Falter and Mitchell, 1981; Falter, 1984). Concentrations of nutrients and chlorophyll were low in the open areas of the lake, but significant inputs of nutrients and bacteria were measured in nearshore areas, especially in the west and southeast basins. This was also the first study to measure dissolved-oxygen concentrations throughout the water column in the lake's deepest basins. At the southwest basin, dissolved-oxygen concentrations below the 60-m depth were about 4 mg/L in September, indicative of a substantial dissolved-oxygen deficit considering the lake's apparent trophic status with regard to phosphorus and chlorophyll.

Although this study estimated the lake's annual nutrient budget for 1982, it was not directly comparable to the 1975 nutrient budget because inflow during 1982 was 145 percent of the long-term average. Of the 14,000 kg of total phosphorus input to the lake in 1982, 71.4 percent

came for the North Fork Payette River and 1.7 percent came from nearshore sewage-disposal systems. About 87,300 kg of total nitrogen entered the lake in 1982; 42.7 percent came from the North Fork Payette River and 2 percent from nearshore sewage-disposal systems. Based on the lake's nutrient loadings and dissolved-oxygen deficit, the lake's trophic state was deemed mesotrophic.

Over the past decade, limnological data have been collected sporadically at Payette Lake by Idaho agencies such as the Idaho Department of Fish and Game (IDFG) and Idaho Division of Environmental Quality (DEQ); however, the scope of these efforts has been more limited than the 1975 and 1981-82 studies. Of interest are the dissolved-oxygen profiles collected on six occasions over 1992-93 by DEQ. The lowest dissolved-oxygen concentration, 2.8 mg/L, was measured at a depth of 71 m in the lake's west basin in late July, 1992 (D. Worth, Idaho Division of Environmental Quality, written commun., September, 1995).

These prior water-quality studies revealed that Payette Lake has undergone some degree of eutrophication on the basis of symptomatic evidence such as substantial dissolved-oxygen deficits and nutrient loadings. Although a sewage-collection system was completed in the mid-1980's, the reduction in the lake's overall nutrient budget was probably less than a few percent. The continuation of substantial dissolved-oxygen deficits into the early-1990's is evidence the lake is still undergoing eutrophication. Fishery data collected since the early-1980's also indicates the lake may be more biologically productive than in the past. In 1980 and 1988, the biomass of wild kokanee salmon was 0.18 and 0.24 kg/ha, respectively; whereas, from 1990 to 1995, biomass has steadily increased from 1.0 to 4.24 kg/ha (P. Janssen, Idaho Dept. of Fish and Game, written commun., February, 1996).

1.2 Technical Study Plan and Objectives

A Technical Advisory Committee (TAC) was established by the Big Payette Water Quality Council in November 1992 to develop the study scope and geographical extent. Due to the complexity of land and resource management issues, a technical study plan was developed in partnership with academic, state and federal agencies. Table 1.1 lists the member agencies participating as technical advisors in the plan formulation. The full Technical Advisory Committee, as identified in the Big Payette Lake Act, was responsible for final review of the study plan and scientific scrutiny of the technical reports. The technical study plan was presented to and approved by the Big Payette Lake Water Quality Council in McCall, Idaho (December 1993) and informally reviewed by appropriate Idaho Legislative Committees during the 1994 legislative session. Implementation of the technical study was a cooperative multi-agency effort between the Idaho Division of Environmental Quality, Idaho Department of Fish and Game, Idaho Department of Lands and the U.S. Forest Service, Payette National Forest.

Table 1-1. Member agencies and institutions supporting the Payette Lake Technical Advisory Committee.

Peter Johnson, Chairman Big Payette Lake Water Quality Council	Dr. Roy Mink University of Idaho
Robert Christensen Technical Advisory Committee	Don Anderson Idaho Fish & Game
Dewey Worth ID Division of Environmental Quality	Helen Bivens Lake Reservoir Company
Dave Detullio/Jim Woods Natural Resource Conservation Service	David Simmons Idaho Conservation League
Randy Phelan Natural Resource Conservation Service	Thomas Woodbury Idaho Conservation League
Dave Zimmer Bureau of Reclamation	David Blew Idaho Soil Conservation Commission
Ruth Schellbach Idaho Department of Water Resources	Tom Lance Idaho Soil Conservation Commission
Les Ankenman Valley County Engineer	Douglass Fitting Idaho Department of Lands
Dr. Paul Woods United States Geological Survey	Jeffrey Lappin Central District Health Department
Gerald Elson, Executive Director ID Association of Soil Conservation Service	Leigh Woodruff Idaho Operations Office - EPA
John Kwader Boise Cascade Cooperation	Glenn Logan/Shelby Brownfield Associated Earth Sciences
Ted Whiteman Payette Lakes Water & Sewer District	Tom Kerr Big Payette Lake Water Quality Council
Jim Fitzgerald Payette National Forest	Bill Petzak (succeeded by Sheldon Keifer) Idaho Department of Lands
Glenn Jacobsen Payette National Forest	Jackie DeClue, P.E. City of McCall
John Rygh Payette National Forest	Dieuwke Spencer, E.H.S., R.N. Central District Health Department
Dennis Coyle Idaho Parks & Recreation	

The technical study plan was designed to provide a coordinated assessment of the watershed conditions within the drainage basin and to determine the current trophic status of Big Payette Lake.

Specific objectives for the technical study were:

1. Develop ecological criteria that will preserve trophic status of Big Payette Lake as a drinking water supply and protect other designated beneficial uses.

2. Identify sources of nutrients that may contribute to eutrophication of Big Payette Lake based on potential risk that existing sources may degrade water quality.

3. Prioritize sub-watersheds based on their current contribution of nutrients. Determine the significance of change or intensity of land use and potential contributions of nutrient load.

4. Establish a maximum allowable limit of nutrient contributions for each sub-watershed such that trophic status of the lake will be preserved or enhanced.

5. Determine eutrophication response of Big Payette Lake through development of a nutrient response model to predict future trends based on changes in watershed land use.

Field monitoring would be conducted over two consecutive water years so that water, nutrient budgets and seasonal characteristics could be reasonably ascertained. A lake water quality model would be developed based on field monitoring to partition sources of nutrient loads and simulate lake responses based on future increases and reductions in the source loads. This analysis will be used to identify critical interactions of watershed runoff and expected lake capacity to assimilate these nutrients, develop load allocations to protect existing water quality and target specific sub-watersheds for improved implementation of best management practices (BMPs).

1.3 Overview of Study Components

Wildfires erupted within the study area during summer 1994 coinciding with the initiation of field studies. These fires occurred at the end of a prolonged drought cycle that coincided with an accumulation of ground fuels and standing dead spruce throughout the forest. The extent to which wildfires had modified the Payette National Forest landscape and potential transport of nutrients and water to Big Payette Lake was unknown at the time field studies were initiated.

A variety of field studies were utilized across different landscape scales to collect biotic and physical data. These results would be used to identify relationships between landscape

characteristics (geology, land use, management history) and current watershed conditions that affect quality of local streams and productivity of Big Payette Lake. Since recent fire effects would likely mask other environmental variables, this objective has been modified to include an assessment of fire impacts and related changes in water quality and quantity. To the extent possible, pre-burn conditions and related changes in water quality and quantity have been estimated. Overview of the major study components are summarized below.

1.3.1 Mass Balance Budget of Nutrients and Water Entering Big Payette Lake

Inflows to the Big Payette Lake have historically been estimated by the change in storage of Payette Lake and subtraction of the gaged outflows. The North Fork Payette River is the single largest river flowing into Big Payette Lake. Water quality data for inflows have been infrequently monitored by various agencies. Outflow water quality has also been infrequently monitored by the U.S. Geological Survey, Idaho Department of Environmental Quality and the Idaho Department of Fish and Game. The quantity and quality of ground water entering the lake is largely unknown, although some unpublished ground water quality data exists related to development of the Payette Lake central sewage collection system completed in 1980.

Inflows from the North Fork Payette River during the study period were continuously monitored with the installment of a U.S. Geological Survey surface water gaging station. Other tributaries surrounding the lake were monitored for flows using a combination of continuous recording devices and periodic site visits. Water quality was monitored in conjunction with flow measurements of tributary inflows and outflows. Meteorological data is currently measured at the McCall airport.

1.3.2 Limnology

The objective of this study component was to adapt an existing lake model developed by the U.S. Corps of Engineers (Bathtub) for use with Big Payette Lake. In-lake studies were initiated to provide background data concerning the amount and distribution of nutrients, exchange of water and nutrients among major basins within the lake and general productivity of the lake algal populations. This information was used by the model to make inferences about relationships between lake water quality and nutrient inputs. This component of the study was contracted to the U.S. Geological Survey.

1.3.3 Nearshore Assessments

Nearshore water quality, periphyton composition and growth, and littoral plant community development was monitored throughout the perimeter of the lake shoreline. The purpose of this assessment was to determine potential linkages between shoreline development and nearshore water quality. Monitoring stations were selected to represent the full range of existing shoreline development. This portion of the project was contracted to the U.S. Geological Survey.

1.3.4 Watershed Assessments

Monitoring objectives included an assessment of the nutrient and flow contribution of priority streams, stream stability and overall habitat condition as it relates to maintenance of fisheries and water quality. Information from this effort can be used to target specific sub-watersheds for implementation of Best Management Practices (BMPs) or other strategies to reduce nutrient and sediment loading.

A major focus of the watershed study was to characterize the quantity/quality of runoff from the watershed. Two approaches of study and evaluation were employed: 1) evaluating existing conditions attributed to non-point sources in a variety of major sub-watersheds draining to the mainstem of the NF Payette River above Big Payette Lake and other streams directly entering the lake, and 2) evaluation of urban stormwater quantity and quality directly entering the lake.

Stream habitat conditions were monitored using a combination of semi-quantitative habitat and bioassessment techniques. Field monitoring was conducted by Idaho Division of Environmental Quality, Payette National Forest and Idaho Department of Lands. Analysis of the data was contracted to the University of Idaho.

1.3.5 Watershed Sediment Sources and Contributions

Sediment sources and quantities attributed to the recent wildfire and forest management activities were estimated for National Forest and State managed forest lands within the watershed. Sediments attributed to the types of harvest activities, acreages and associated roads were estimated in conjunction with mass wasting (landslides). Field monitoring and analysis was contracted to private consultants.

1.3.6 Sediment Accumulation Rates of Big Payette Lake and Upper Payette Lake

The rate of sediment accumulation rates were determined by lead 210 dating of cores extracted from Big Payette Lake and Upper Payette Lake. Estimates of the rate of sedimentation were compared to past management activities and current estimates of sediment contributions. Field collections were conducted by the Idaho Division of Environmental Quality and Utah State University, Natural Systems Engineering.

1.3.7 Recreational Impacts

Sources of bacterial contamination were monitored in relation to recreation within the watershed and Big Payette Lake. Monitoring focused on high use areas and peak holiday seasons. Field collections were conducted by the Idaho Department of Fish and Game and Idaho State Parks.

1.3.8 Creel Survey and Boating Recreation

The Idaho Department of Fish and Game and Division of Environmental Quality jointly funded a creel census and boating recreation survey on Big Payette Lake. The purpose of this assessment was to determine current fishing activity and potential relationship to current lake water quality. Field monitoring and analysis was conducted by Idaho Department of Fish and Game.

Chapter II

2.0 Watershed Description

2.1 General Description of Watershed

2.1.1 Lake

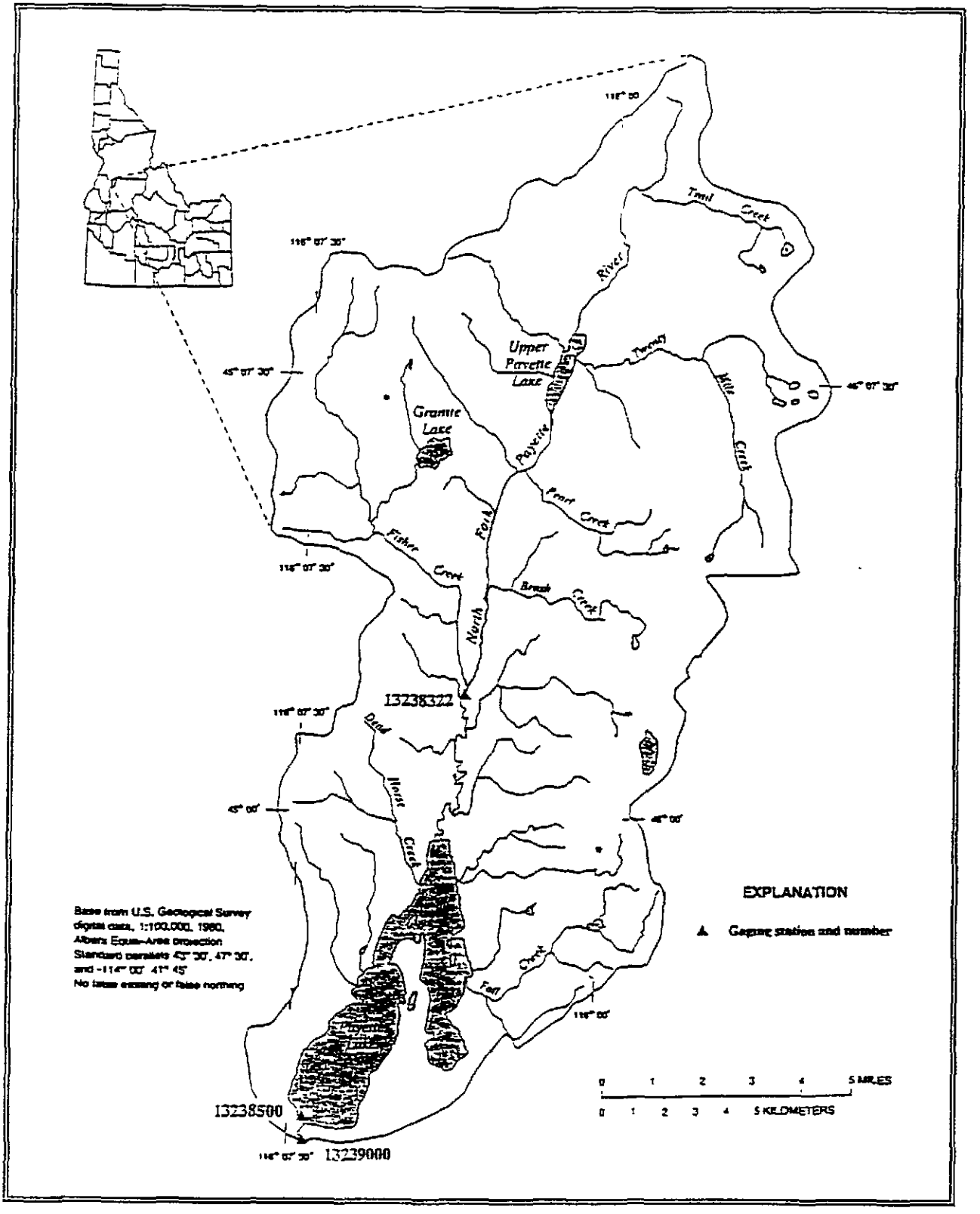
Payette Lake is a 2,023 hectare (5,000 acre) lake located on the Payette River (Figure 2-1) at river kilometer 121.3 (mile 75.4; lake outlet). Maximum lake depth is about 300 ft (see Figure 3.3 on page 39) (mean 103 ft) with a total volume of 500,137 ac-ft. Total volume of the lake is regulated by a spillway that allows lake surface elevation to vary 5-6 feet annually. Full pool is normally maintained July-September. The lake has a complex shoreline forming four distinct basins (Southwest Basin, Central Basin, North Basin and the Southeast Basin). Daily inflows to the lake are not measured but outflows are estimated by U.S. Geological Survey gaging station located downstream of the dam on the N.F. Payette River. Annual outflows are approximately 266,600 ac-ft. Although groundwater tables are high throughout the valley, the contribution of groundwater to the lake water budget is unknown.

Stratification of the lake occurs around mid summer and the lake remains stratified into December. Payette Lake has been classified as mesotrophic. Chlorophyll values during summer 1993, ranged from 0.5 - 2.5 μg/L (Worth, unpublished data). Water clarity generally exceeds 7 m in all basins. In addition, significant submerged macrophyte growth occurs within a narrow depth range along the lake shoreline. Organic loading of the lake has depressed dissolved oxygen levels in the lake hypolimnion during summer and winter. Continued organic loading could result in development of anoxic conditions and release of sediment stored nutrients and metals.

2.1.2 Watershed

The Big Payette Lake Watershed is approximately 373 km^2 (144 sq. miles; approximately 18 times larger than the lake). Topography of the watershed is mostly mountainous. Elevations range from 5,000 feet around McCall to 9000 feet in the Lick Creek Range. Soils are volcanic in origin and comprised of alluvium and glacial outwash characterized as highly weathered and decomposed. Drainage characteristics are poor to excessive depending on depth to water table and slope. Numerous small creeks flow into Payette Lake. The single largest inflow is N.F. Payette River. Land uses are predominately forest land (federal and state land) which supports commercial logging and extensive recreation. Other land uses are present within the basin but no information exists characterizing their acreage or importance in watershed hydrology and nutrient export. The City of McCall is situated at the south end of the lake [population 2,629 (1994)]. A significant influx of seasonal usage occurs during the summer (summer cottage use) and during the winter (winter sports).

Figure 2-1. Location of study area.



Land ownership (Figure 2-2) and/or regulation within the basin includes but is not limited to four major entities or units of government composed of the Payette National Forest (77,449 acres), state lands (16,184 acres), private (3,000 acres), and City of McCall (1,200 acres).

2.2 Designated Uses and Benefits of the Watershed

The Idaho Water Quality Standards and Wastewater Treatment Requirements designate beneficial uses for Payette Lake as: domestic water supply, cold water biota, salmonid spawning, and primary/secondary contact recreation. The Department of Parks and Recreation, and the City of McCall operate and maintain recreational access to the lake for a variety of uses (boating and fishing are the most popular). Facilities include one public boat ramp (operated by the city) and numerous picnic areas and camping sites associated with the state park. Aesthetic value of the pristine lake conditions make Payette Lake one of the primary destination points of interest. Much of the shoreline is currently undergoing conversion due to increased commercial development and home construction.

2.3 Climate

The climate in the Payette Lake Watershed is characterized by warm, drier summers and cold, wetter winter months. Average annual precipitation at McCall [elevation 1,532 m (5,026 ft.)] is 660 mm (26.4 in.). Precipitation increases with elevation, with up to 914 mm (36.5 in.) per year falling on the mountain peaks (USFS 1995). Precipitation falls as snow in the winter months, and a deep snowpack accumulates, particularly at higher elevations. Mean annual snowfall is 384 cm (153.6 in.). Snowmelt peaks in May and June. Annual evapotranspiration is 940 mm (37 in.) based on climatological data summarized by Myron Molnan and K.C.S. Kpordze (University of Idaho, written communication, 1992). Drought conditions persisted during the period 1987 to 1994. Average annual precipitation during this period was several inches below normal.

2.4 Surface Hydrology - Watershed Delineation

Surface hydrology in the Big Payette Lake drainage basin is dominated by the North Fork Payette River Basin extending from its headwaters near Secesh Summit located on the northern edge of the North Fork Payette River basin boundary to the outlet of the Big Payette Lake (Figure 2-3). Contributing to the mainstem flow of the N.F. Payette River are several tributaries comprised of variable size sub-watersheds (Figure 2-3). The basin is roughly separated into three main sections: 1) Upper Payette Lake basin comprised of the upper reach of the N.F. Payette River and associated tributaries; 2) mainstem N.F. Payette River and its associated tributaries, and; 3) direct drainage of sub-watersheds draining directly to Big Payette Lake. Additional smaller streams flow directly into Big Payette Lake (Table 2-1 and Figure 2-3).

In addition to the above streams, there are numerous high mountain lakes associated with strongly glaciated lands, which include landforms such as headwalls, rocky ridges, granite outcrops, and cirque basins. The majority of lakes lie within the cirque basins. Several larger lakes such as

Figure 2-2. Major land ownership categories of the Payette Lake watershed.

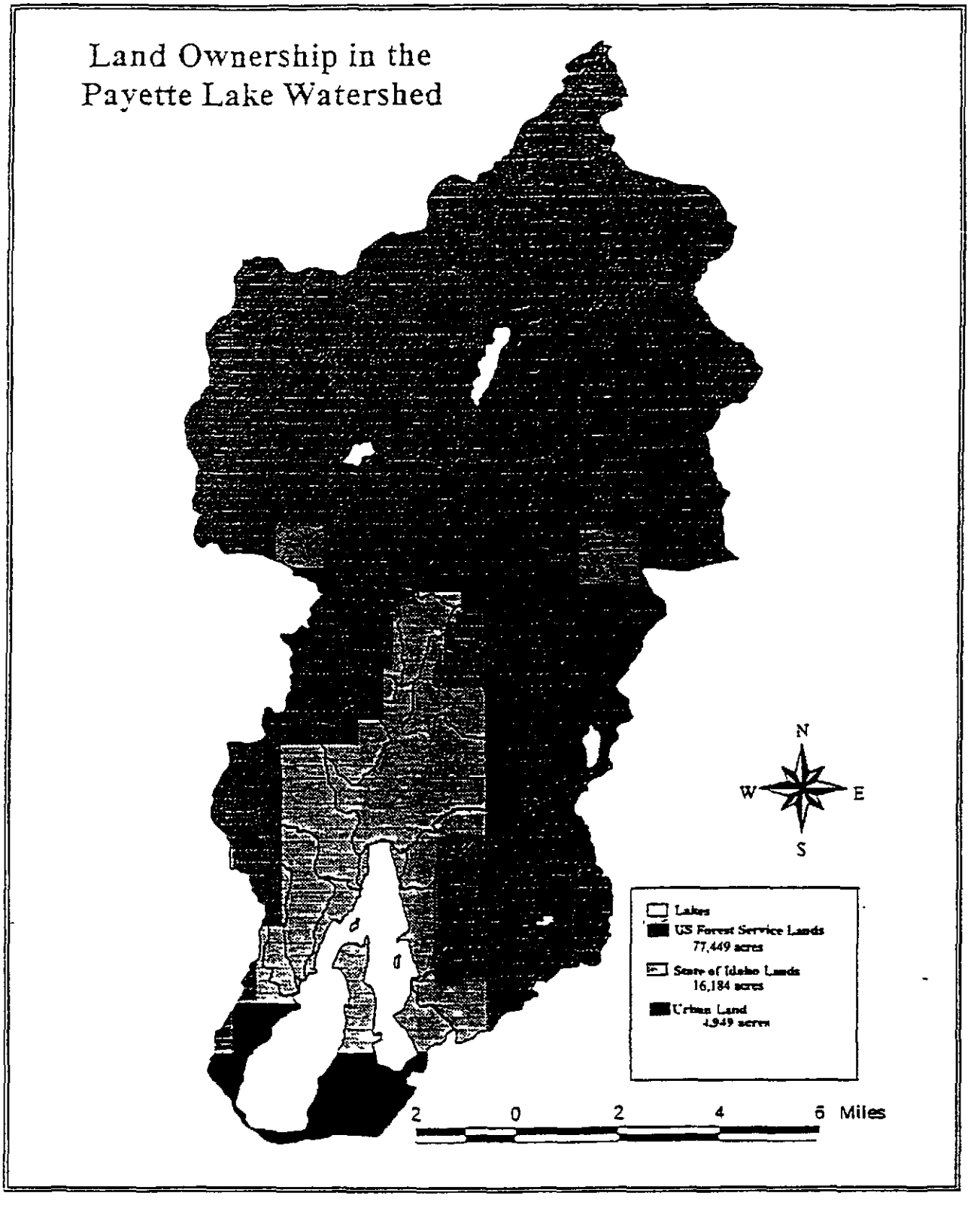
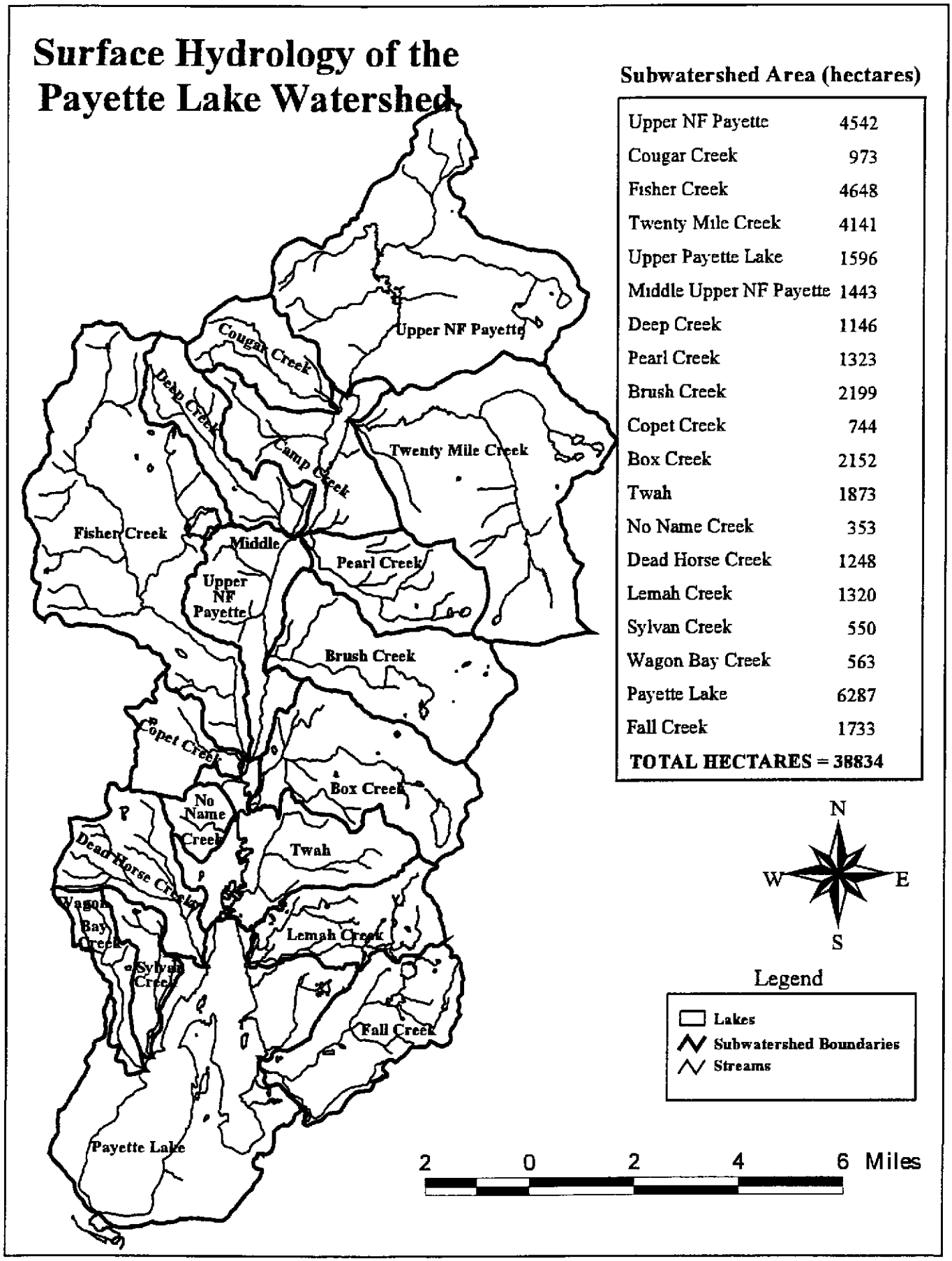


Figure 2-3 Streams and lakes in the subwatersheds of Paytte Lake watershed



Granite, Little Granite, Ellis, Squaw, and Upper Payette Lake lie in alluvial landforms. Blackwell Lake is located in Valley Train Land. These lands provide an effective buffer for sediment from upland slopes. Potential productivity for timber and herbaceous vegetation is moderate to high due to the deep soils and high water table associated with this landtype.

The Payette Lakes watershed topography and relative size of the sub-watersheds can be divided into two broad categories depending on whether the landforms are the result of ice sheet or valley glaciation. In general, the watershed ranges in elevation from a low of 1,524 m (5,000 ft.) at the outlet of Big Payette Lake, to a high of 2,768 m (9,081 ft.) at Storm Peak in the northeast corner of the watershed. Four sub-watersheds are in the 4,047 ha (9,996 ac.)-4,857 ha (11,996 ac.) range (Fisher and Twentymile Creeks, the Upper Payette River, and Payette Lake), but in general the rest of the subwatersheds are under 2,000 ha (4,940 ac.). The predominance of smaller watersheds is a reflection of the ice sheet erosion, with an undissected terrain draining to small streams that feed directly into the Payette River. The central part of the watershed, affected by ice sheet glaciation, has a subdued terrain with numerous small lakes and a disrupted drainage system. The general grain of the area is from north to south, with a distinctive north/south jointing pattern visible in aerial photographs. The ice erosion deepened this jointing pattern and the drainage generally follows a checkerboard-like pattern. The higher elevations in the watershed were affected by the valley glaciation. Creeks with the distinctive U-shaped valleys in their headwaters include Fisher, Twentymile, Cougar, and Trail. The upper elevation parts of other creeks, like Box Creek, had smaller valley glaciers that formed cirque valleys in the headward parts of the streams, but merged with the ice sheet at lower elevations.

Table 2-1. Sub-Basins and Subwatersheds in the Big Payette Lake drainage basin.

Upper Payette Lake Basin Tributaries		Mainstem NF Payette River Tributaries		Big Payette Lake Tributaries	
Subwatershed	hectares	Subwatershed	hectares	Subwatershed	hectares
Up Payette Lake	1,596	Deep Creek	1,146	Big Payette	6,287
Upper N.F.	4,542	Pearl Creek	1,323	Deadhorse	1,248
Cougar Creek	973	Middle Reach	1,443	Lemah Creek	1,320
Twentymile	4,141	Fisher Creek	4,648	Fall Creek	1,733
		Brush Creek	2,199	Wagon Bay	563
		Box Creek	2,152	Sylvan Creek	550
		Copet/No-name	1,097		
		Twah	1,873		
Sub-Basin Total	11,252	Sub-Basin	15,881	Sub-Basin	11,701

(1 hectare = 2.47 acres)

Some of the subwatersheds, such as Fisher Creek and Upper N.F. Payette River, have the potential for high water-yields and are poorly drained. resulting in many wet meadows and swamps in the upper portions of their watershed. The majority of landforms and stream gradients are fairly gentle. Tributaries draining the steeper side slopes, and the lower three miles of Fisher Creek are exceptions, with gradients from 10-25 percent. The mainstem of Fisher Creek and Lake Creek tend to be high gradient, large substrate channel types. Channel stability is good in those sections of the stream where substrate consists of boulders and rocks. Lower gradient channels are interspersed with finer bed and bank substrate, typical of depositional landforms.

2.5 Agricultural Water/Lake Regulation

In the early part of the twentieth century several irrigation associations - Lower Payette Ditch Company, Farmers Co-operative Irrigation Company, Emmett Irrigation District, Noble Ditch Company, Enterprise Ditch Company and Letha Irrigation Company - filed claims for water rights in Big Payette Lake, Granite Lake, Box Lake and the Upper Payette Lake. They formed the Lake Reservoir Company (Company), an Idaho Nonprofit Corporation, to represent their collective interests in the Big Payette Lake and its watershed.

About the same time the beaches around these lakes became popular due to their recreational and health benefits. To protect these recreational and health benefits, a group of area permanent and seasonal residents formed the Payette Lakes Protective Association (Association), also an Idaho non-profit corporation.

In November 1924, the Company and the Association signed an Agreement (Agreement). The Agreement included a high and low water mark and recognized the Company's storage rights to approximately 31,000 acre feet in Big Payette Lake (Lake) which were issued in 1924. That Agreement in part states that the Company..."draw off said stored waters so as to interfere as little as possible with the bathing beaches on the shores of said Lake, and ....so as not to interfere any more than is absolutely necessary with the natural fluctuation of said waters, that is, any more than is necessary to carry out the intents and purposes of the [Company] under its...permits".

Later in 1926 the Legislature enacted and the Governor signed into law Chapter 43, Title 67 Idaho Code (codified at 67-4301 et seq.) which established Big Payette Lake as a health resort and recreation place. In relevant part, the law provided that:

> "The Governor is hereby authorized and directed to appropriate in trust for the people of the state of Idaho all the unappropriated water of Big Payette Lake, or so much thereof as may be necessary to preserve said lake in its present condition. The preservation of said water in said lake for scenic beauty, health and recreation purposes necessary and desirable for all the inhabitants of the state is hereby declared to be a beneficial use of such water...the preservation of said lake in its present condition as a health resort and recreation place for the inhabitants of the state and said public use is hereby declared to be a more necessary use than the use of said lands as a storage reservoir for irrigation or power purposes."

In 1924, the Company's water rights were issued appropriating 31,000 acre feet of Lake water, thus the Company's appropriation pre-dates by two years the enactment of the 1926 statute which appropriated the remaining unappropriated water in Big Payette Lake.

In the early 1940's the Company, believing its members had rights under their irrigation permits to 50,000 acre feet in Big Payette Lake rather than 31,000 acre feet, challenged the high water restriction imposed by the Agreement. A lawsuit was filed in the Fourth District Court of the State of Idaho. District Judge Koelsch ruled that the Agreement was legally valid and enforceable. He also retained orders concerning the manner of storing, retarding, withdrawing, diverting, measuring and registering the waters of Big Payette Lake...". The Company appealed Judge Koelsch's ruling to the Idaho Supreme Court. The Supreme Court upheld Judge Koelsch by ruling in favor of the Association.

The Company owns the dam on the North Fork of the Payette River where the River leaves the Lake. The Company's water master controls the gates to the dam. The Company during average years has raised the water level in the Lake in mid July to the maximum allowed and thereafter retained it at that level for a few days depending upon snow depths and storm events. As the Company has withdrawn water, the water level in the Lake has dropped steadily through Labor Day but has remained high enough for general recreation, resort and related use. After Labor Day the water level is dropped to a minimum level sufficient to protect the dam from ice damage due to the Lake freezing over.

At the request of the Big Payette Lake Water Quality Council (created under Chapter 66, Title 39, Idaho Code), in 1996 the U.S. Geological Survey prepared a historical hydrograph titled, "Payette Lake - Historical Hydrograph of Mean Daily Lake Surface Elevation for Period of Record to 95 WY" (Figure 2-4). This hydrograph represents an historical average of how the Company has managed its affairs in accordance with the Agreement.

2.6 Lithologic Units

The Payette Lake watershed contains a complex set of lithologic, or rock, types. Within its boundaries are ancient sediments that have been metamorphosed by the large bodies of magma that later intruded much of central Idaho.

Figure 2-5 is a lithologic map that depicts the location of the various lithologies within the area. The map was compiled and generalized from geologic maps by Manducca (1988), Hamilton (1969), Lund (in press), and Othberg (1987). Table 2-2 lists the map symbol and name of each lithologic unit found within the watershed. The following text describes each lithologic unit.

Table 2-2. Lithologic units

Map Symbol	Lithologic Unit
ms	modern sediments, includes stream and glacial sediments
gt	glacial till, unsorted boulders to clay
gs	glacial sediments, sorted sand and clay
gr	granite, glaciated
gn	gneiss, glaciated
sch	schist, glaciated
bs	basalt, glaciated

Figure 2-4 Payette Lake - Historical Hydrograph of Mean Daily Lake Surface Elevation for Period of Record To 95 WY.

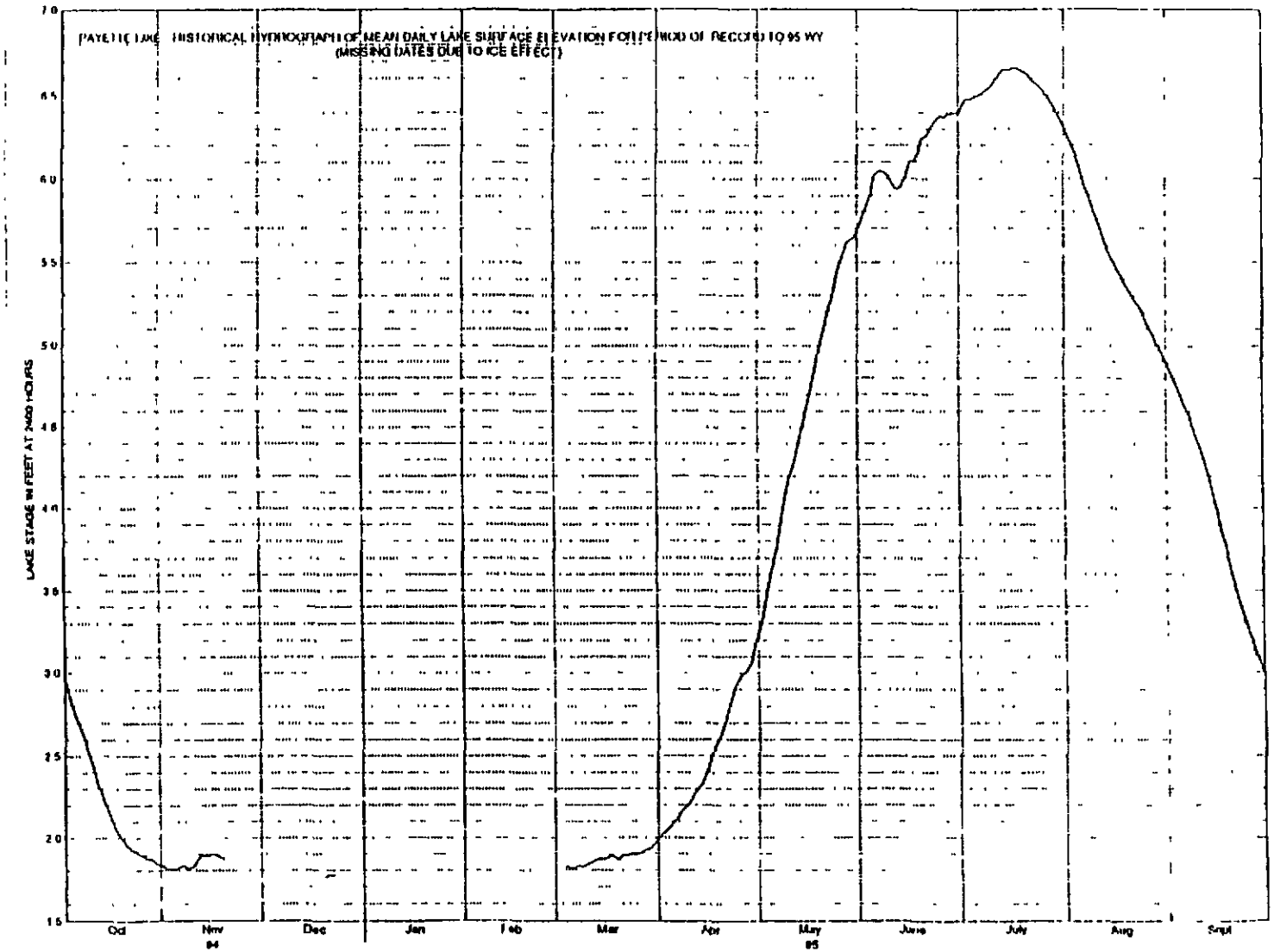
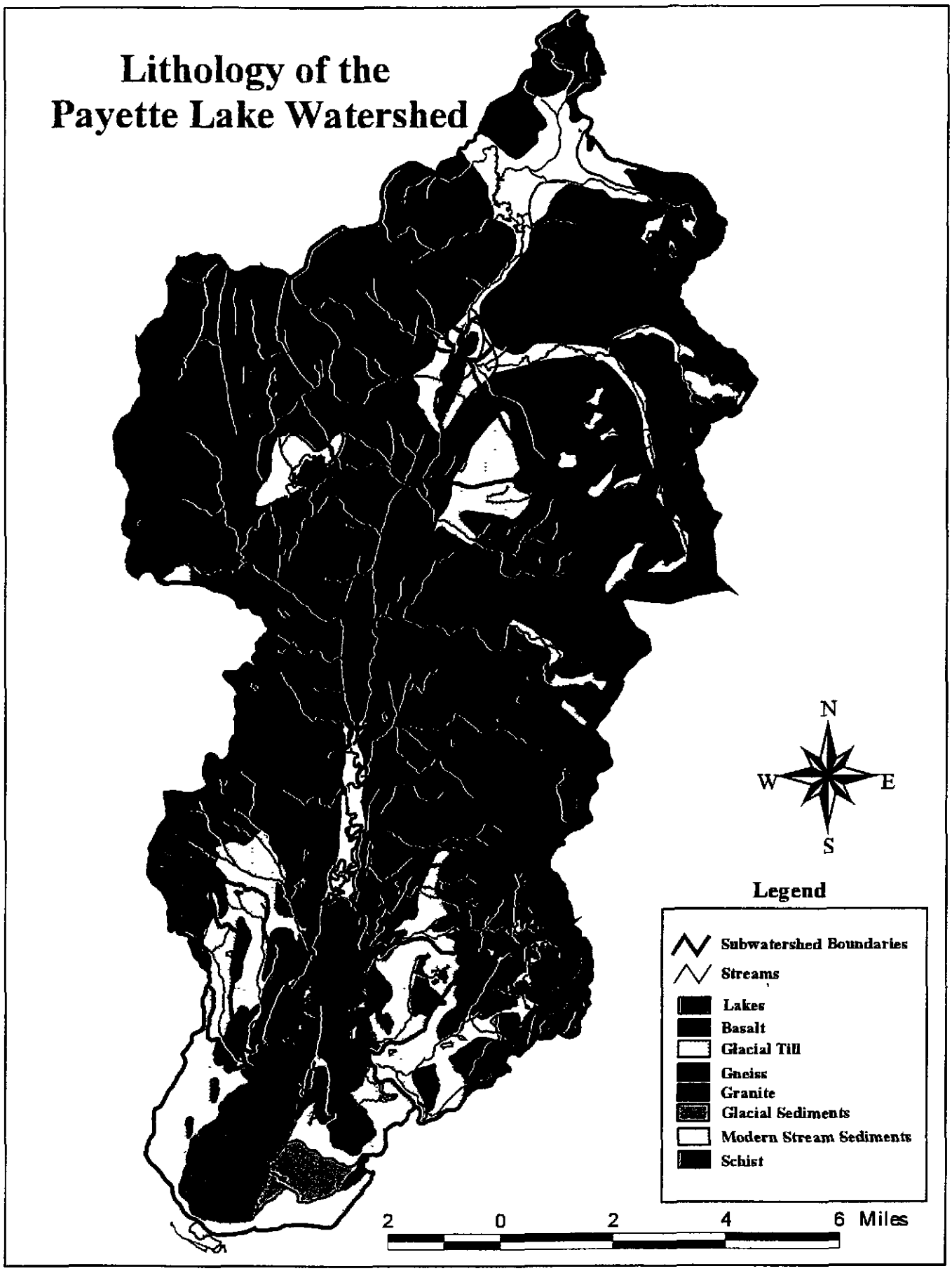


Figure 2 - 5 Major rock types of the Payette Lake watershed



The Payette Lake watershed lies on the western border of a granitic feature called the Idaho Batholith. This terrain covers large areas of central and northern Idaho, from the Clearwater River on the north to the Sawtooth Mountains on the south. The most recent and detailed geologic mapping of the watershed is by Cathryn A. Manducca (1988) and Karen Lund (in press).

In Manducca's dissertation, she divides this "western border zone" of the Batholith into three areas or terrains of similar rocks. From west to east, these terrains are the Hazard Creek, Little Goose Creek and Payette River Complexes. Each complex contains both granitic rocks of various kinds, and metamorphic rocks, mainly gneiss and schists. The granitic rocks are associated with the larger bodies of granite located to the east of the watershed. The metamorphic rocks are older sedimentary and volcanic rocks that were intruded by the granitic bodies/magma chambers. The majority of the Payette Lake watershed is underlain by the rocks of the Payette River Complex. As shown on Figure 2-5, most of the watershed is underlain by the granitic rocks [17,936 ha (44,301 ac.)]. Smaller areas of metamorphic gneiss [7,489 ha (18,497 ac.)] and schist [2,174 ha (5,369 ac.)] outcrop in north/south trending bodies on the eastern and western edges of the watershed (gneiss) and in the area north of Granite Lake (schist). In general the metamorphic rocks are layered, and include some small areas of quartzite and calc-silicate rocks. The granitic rocks have a salt and pepper look of dark and light minerals, and are unlayered.

After the granitic and metamorphic terrains were created, the area was inundated by the massive basalt flows (unit bs). These volcanic rocks presently occur only in one small part of the watershed, the arm of land that divides the two parts of Big Payette Lake and is the location of Ponderosa State Park. This area is an eastern remnant of much larger area underlain by thick and extensive basalt lava flows, called the Columbia River Basalt (C.B.). Covering most of central and eastern Washington, areas along the western border of the state of Idaho, and areas of northern and eastern Oregon, the flows are called flood basalt. They are voluminous with sequences of flows ranging up to 800 meters thick and encompassing a total volume of 300,000 cubic kilometers (Camp and others, 1982). In central Idaho, the basalt flows are part of what has been called the Weiser Embayment by geologists (Fitzgerald, 1982). Although some of the basalt flows in this area are part of the general C.B. units that erupted from a series of vents in northeastern Oregon, other units were erupted from two vents in the Weiser area. The flood basalt covered the topography like water filling a bathtub and disrupted the drainages. Since their eruption, the basalt sheets have been displaced by the faults that form the sides of Long Valley.

All of the rocks in the entire Payette Lake watershed have been severely affected and reshaped by glacial erosion during the ice age in the Pleistocene era. The glaciation occurred in two periods between 160,000-125,000 years ago and between 25,000-15,000 years ago. In the Payette Lake watershed the glaciation was of two types, ice sheet and valley glaciation. The valley glaciation formed the dramatic U-shaped stream valleys, called troughs, and the steep peaks and smaller cirque valleys found in the higher elevations of the watershed streams. Typical of this type of glaciation are the Twentymile Creek drainage, and the upper parts of the Fisher Creek drainage. Generally the cirque valleys contain small lakes, like Box Lake and the Twentymile Lakes. Small valley glaciers carved the cirque valleys and fed into the larger valley glaciers that filled the major stream valleys, like Twentymile Creek. These troughs were cut to lower

elevations than the tributary cirque valleys by the greater thickness and mass of the ice that filled the larger valleys. This action left the cirque valleys "hanging" above the level of the trough floors. The troughs have classic "U" shaped cross sections, with wide floors and steep (50% to >65%) walls.

The ice sheet glaciation affected the central part of the watershed. In this area a large sheet of ice completely covered the terrain, eroding the topography to its present low relief. In addition, it carved out the basins of Upper and Big Payette Lakes. Two types of lithologies that were deposited by the ice and stream melt waters are mapped on Figure 2-5. The glacial till (gt) deposits form the morainal material surrounding the smaller and larger lakes in the watershed. These sediments are basically unsorted, having a size range of particles that varies from clay to boulder. The glacial sediment deposits (gs) are the result of the streams of meltwater that resulted from the annual and final retreat of the glaciers. These units are well sorted and range in size from clay to sand, with a few cobble-sized pieces. Outcrops of these fine-grained sediments are confined to the area surrounding Big Payette Lake. The uncemented and unconsolidated nature of the glacial sediments, and their locations in the cirque valley and trough floors, mean that they are fairly easily eroded by surface erosion processes.

Both surface erosion potential and landslide hazard are enhanced by the steep nature of the glaciated trough and cirque valleys. The oversteepened nature of the trough valley walls lends itself to the creation of debris slides and snow avalanches. In addition, surface erosion processes in glacial terrains move sediments down from the valley walls at higher rates than those found in areas only affected by stream erosion. However, once the sediments reach the main stream channels, the flat nature of both the cirque and trough valley floors mean that the sediments do not necessarily move through the system at the same rates as similar sediments in unglaciated terrains. In this way, the trough valleys of the Payette Lake watershed have more capacity to store sediments than valleys in unglaciated terrains.

These characteristics of surface erosion and landslide potential are reversed in the parts of the watershed affected by the ice sheet glaciation. These areas now have fairly low relief terrains, with numerous small lakes. In addition, most of the soil and weathered rock have been stripped off by the erosive action of the glacier. Therefore, these areas have less material to be eroded by natural surface erosion processes.

The youngest lithologic unit is the modern stream sediments (ms) which are located in the bottoms of all the larger streams, such as the Payette River. It is composed of sediments that were deposited by the streams within their current or recent stream channels and floodplains. These sediments can range in size from silt to boulder, but in this watershed are predominantly sand, gravel, and cobble-sized, due to the source rock for much of the sediment, the granitic rocks. These sediments are uncemented and thus highly erodible during spring runoff and other flood events. They are generally moved around and transported within the stream channels.

2.7 Geography and Dominant Landform Associations

The geology and soils within the Big Payette Lake Watershed have a significant influence on the quantity, quality and timing of runoff generated from the landscape. The landscape within the watershed is grouped according to a landtype association used by the Forest Service based upon similarities in geomorphic processes, geologic rock types, soil complexes, stream types, lakes, and potential natural vegetation. General landscape characteristics in the drainages were classified into three geomorphic groupings of landtype associations summarized by the following:

Alpine Glaciated Lands: These lands include high-elevation mountain peaks and glacial valleys shaped by the scouring action of alpine glaciers. Harsh climatic conditions, steep slopes, fragile soils and extensive areas of exposed bedrock limit productivity and management opportunities. This geomorphic group is further subdivided into smaller landtype associations based on slope gradients and other common characteristics.

- Glacial Headlands (40-80 percent slope): Slopes greater than 60 percent are associated with rock outcrop escarpments and talus slopes below narrow ridges. Mean annual precipitation, dominated by snow, averages 35 to 50 inches, of which 50-90 percent is yielded as streamflow. Surface runoff is high due to the extensive areas of exposed bedrock and shallow soils. Soils have moderate-to-moderately-high hazard ratings for surface erosion, and a moderately high risk for debris slides and avalanches in steep drainage channels.

- Glacial Scoured Uplands and Cirque Basins (10 - 40 percent slope): These are ice-scoured upland plains and cirque basins with moderate slopes. Precipitation amounts, climatic conditions, and water yields are similar to the Glacial Headlands. Some cirque basins contain small lakes and adjacent areas of wet alluvial soils. Water yield is high, resulting in both surface runoff and infiltration into shallow and moderately deep soils. Dominant soils have moderate erosion hazard ratings and mass stability hazards are generally low.

- Glacial Trough Lands (40-70 percent slope): These are U-shaped valleys and trough walls (average slopes of 30 to 60 percent) formed by glaciers. Surfaces typically contain scattered debris and deposits from glacial erosion. Mean annual precipitation averages 25 to 50 inches, of which 25-45 percent is yielded as streamflow. Steeper valley side slopes (40 to 70 percent slope) are moderately dissected by parallel drainages that are subject to high surface runoff. Soils have moderate erosion hazard ratings, and there is a moderately low risk for debris slides and avalanches on these lands.

Periglacial Uplands and Mountain Slopes: These are gentle-to-moderately-steep slopes found between the strongly glaciated lands and lower-elevation fluvial lands. This geomorphic group has been formed by glaciation but surfaces have not been scoured by major ice currents. Slopes are relatively stable and contain rolling uplands and smooth mountain slopes averaging 15 to 40 percent. Mean annual precipitation averages 25 to 45 inches, of which 30-80 percent is yielded

as streamflow. Water yield is high, with most water returned to streams by subsurface flow. Soils have moderate erosion hazard ratings, and the risk for debris slides and avalanches is moderately low.

Depositional Lands: This geomorphic group is created by depositional processes originating from glacial, fluvial, or glacio-fluvial activity. These lands generally occupy gentle slope gradients in lowland positions with regard to surrounding landscapes, and nearly all are in close proximity to streams and water. These relatively stable lands contain two landtype associations:

- Moraines and Outwash Plains: These low, hilly landforms (0 to 20 percent slopes) comprise the valley bottoms and glacial trough floors where glacial deposits have accumulated on gentle slope gradients of 0 to 20 percent. Mean annual precipitation averages 25 to 50 inches based on elevation, of which less than 30 percent is yielded as streamflow. These lands provide effective buffering and storage capacity for water supply to perennial streams. The upper reaches of streams are stony and resistant to damage from high runoff, but the middle and lower reaches are more prone to damage from peak flows. Subalpine vegetation communities include stands of Engelmann spruce, subalpine fir, and lodgepole pine. Riparian community types are commonly found near alluvial lands and in small depression areas with high water tables. The inherent erosion hazard is moderately low to moderate, and there is low risk for mass movements.

- Alluvial Lands: These nearly level to gently sloping landforms (0 to 15 percent slope gradients) include valley bottomlands, floodplains, stream terraces, and alluvial fans along major drainageways and wet meadow basins. Mean annual precipitation averages 15 to 40 inches based on elevation, of which less than 30 percent is yielded as streamflow. Riparian community types are associated with high water tables and wet soils, whereas drier low-elevation sites commonly have shrub/grass communities. Their lowland positions are commonly associated with poorly drained soils, high water tables, and periodic flooding. The inherent erosion hazard is moderately low, and there is low risk for mass movements.

2.8 Vegetation Cover

Vegetation within the Payette Lake drainage basin is largely dominated by two major vegetation associations; Subalpine Fir and Grand Fir. These associations are the result of complex interactions between soil, climate, elevation and aspect that promote and delineate a specific vegetation composition. The Subalpine Fir Habitat Type is common in central Idaho at cool, moist high elevations on glaciated, periglacial and depositional landforms. Within the Subalpine Fir series, three principle stands of tree cover are prevalent and include lodgepole pine, Engelmann spruce and subalpine fir; whitebark pine, Douglas-fir and western larch can occur to a lesser extent. The understory can include huckleberry, mountain maple, spirea and beargrass. Due to adequate moisture, stand-replacing fires infrequently burn in these forests and trees are typically large. In many cases wind and insects cause more disturbance than fire. About 95%

of National Forest lands and 70% of state lands within the landscape contain this vegetation series. Prior to the 1994 fire, most of the land area within this vegetation type was in a late successional stage, which is characteristic for the long intervals between fire frequencies in this series.

The Grand Fir Habitat series is found in areas between the drier Douglas-fir zone and the cooler subalpine fir zone on glaciated, depositional and fluvial landforms. Most of this series occurs in the southern portion of the Big Payette Lake drainage within the State Lands management area and along the extensive southern aspect of Twentymile Creek. Ponderosa Pine, Douglas-fir, Lodgepole Pine, Engelmann spruce, Western Larch, and Aspen may be present depending on the successional stage. Understory species include Pinegrass, Spirea, Huckleberry, Beargrass and Mountain maple. Pre-fire assessments of growth stage suggest this series was also dominated by mature/overmature populations. A more detailed review of the vegetation types and fire series is described in the Blackwell Fire Assessment (USFS, 1995).

2.9 Management History

Timber management history within the watershed began 1914 to 1922 when a portable saw mill was established in Squaw Meadows (Upper North Fork Payette River) to manufacture railroad ties (USDA, 1966). Other incursions for timber harvest were not renewed until the later half of the century. Timber harvesting began in Fisher Creek sometime after 1947, Twentymile Creek beginning in 1968, Brush Creek in 1955, Pearl Creek in 1966, and Deep Creek in 1984 (USDA,1995a).

More recent timber management history within the Big Payette Lake drainage basin was assembled from historical aerial photography dating back to the early 1950's (see Management History Appendix Figures and Table 2-3). Effects of timber management prior to this period, although important, were not well documented. Moreover, due to recovery and regrowth, management activities preceding this period were not expected to be a dominant feature within the landscape and thus, less likely to be a source of surface erosion. A variety of harvest methods were employed throughout the past fifty year period. Early practices included liberal use of tractor clear cutting with skid trails. More recent methods have included use of helicopter, skyline and less frequent use of skid trails and clearcutting. The acres harvested increased substantially in the 1990's due to salvage sales of insect damaged trees (Table 2-3). Since its initial passage by the State Legislature in 1974, the Idaho Forest Practices Act has been instrumental in helping to reduce sediment inputs from timber harvest in the watershed. Insect infestation started in the late 1970's. At this time, the Department of Lands and U.S. Forest Service entomologists predicted most spruce trees over 12 inches DBH (diameter at breast height) would be killed by the insects (Spruce Bark Beetle)

Table 2-3. Sale acres of timber harvest by decade.

Subwatershed	Watershed Acres	1950's	1960's	1970's	1980's	1990's	Total
Box Creek	5,318	0	0	0	0	725	725
Brush Creek	5,434	171	9	0	23	461	664
Copet Creek	1,838	0	0	0	0	25	25
Cougar Creek	2,404	0	0	5	0	1	6
Dead Horse	3,084	0	0	0	232	373	605
Deep Creek	2,832	0	0	0	35	0	35
Fall Creek	4,282	0	0	0	263	44	307
Fisher Creek	11,485	512	148	925	231	852	2,668
Lemah Creek	3,262	0	0	0	0	585	585
Middle Upper NF	3,566	0	0	0	118	661	779
No Name Creek	872	0	0	0	0	4	4
Payette Lake	15,535	0	0	398	163	5	565
Pearl Creek	3,269	0	364	41	61	142	608
Sylvan Creek	1,359	0	0	94	279	60	432
Twah	4,628	0	0	0	5	1,355	1,360
Twentymile	10,232	0	284	165	335	196	980
Upper NF Payette	11,223	0	614	780	834	257	2,485
Upper Payette	3,944	0	63	387	138	237	826
Wagon Bay	1,391	0	0	94	6	0	100
Total	95,958	683	1,482	2,889	2,722	5,983	13,759

Grazing by sheep has also been supported within the rangelands and on lower gradient slopes in the watershed. Prior to the establishment of the Idaho National Forest (now the Payette National Forest) in 1908, livestock grazing was unregulated. Large bands of sheep were trailed into the area during this period, though the exact number of animals is unknown. The earliest grazing permit in the landscape was given in 1912 on the Pearl Creek and Twentymile allotments, and the first permitted use on State Lands occurred in the 1930's. Between 1912 and 1918, approximately 30,100 head of sheep were permitted to graze in the landscape. The Forest Service began monitoring and managing range conditions in the 1920's. Since that time, reductions in numbers, consolidations of allotments, and increased management have combined to improve range conditions. Currently, there are 4,600 head of sheep permitted in the landscape on both National Forest and State Lands.

Mining within the watershed has been limited. The sewer district had a sand pit and the county operated a sand and gravel pit for road improvements. The Warren Wagon road was initially built in the 1860's to access mines on the Salmon River drainage just north of the Upper Payette River drainage divide.

2.10 Fires

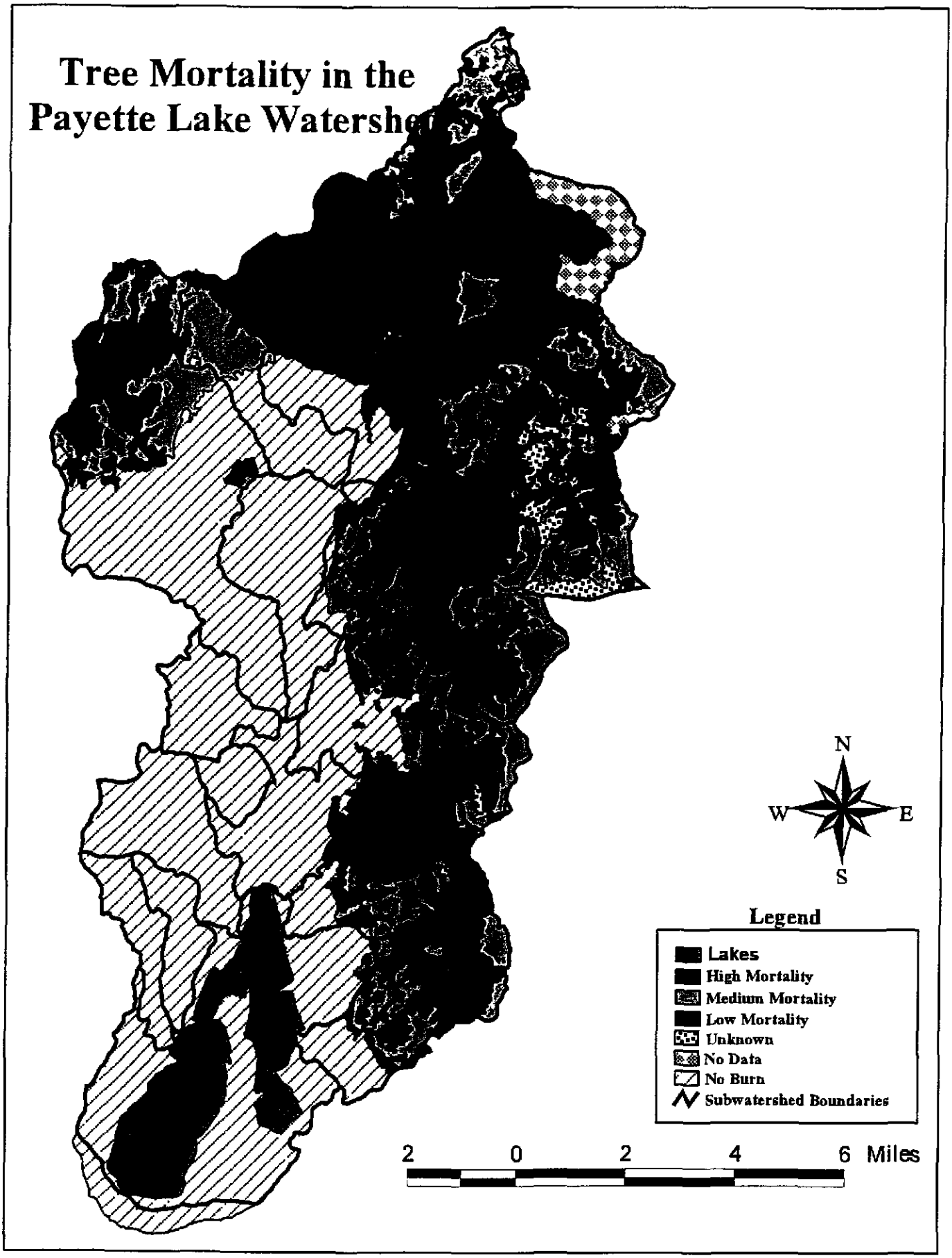
Forest records indicate that frequent fires have burned in Big Payette Lake drainage (History of Payette National Forest 1966). In 1910 and 1930 there were several large fires (Rothery 1940). An insect epidemic that peaked in 1930 (spruce budworm, spruce beetle, and lodgepole pine mountain pine beetle) probably provided the fuels for the 1930 fires. The fires of 1994 were preceded by a Forest-wide spruce beetle epidemic that killed thousands of trees from 1985-1989. About 27 million board feet of this spruce mortality was salvage logged from 1,600 acres. Before effective fire suppression began in the 1940's, fires created large patches of young trees and left small patches of mature trees unburned. Human activity such as logging and fire suppression may currently be influencing vegetative patterns.

Although the Forest Service concluded that the wildfires in 1994 were within the historic range of variation for the subalpine fir habitat type prevalent in the region, these fires affected the sizes of vegetative patches, the composition and structure of stands, and the future potential of both fire hazard and insect disturbance. Over one-half (52%) of the landscape acres (including state and private land) within the Big Payette Lake drainage basin were burned [19,544 ha (48,273 ac.)]. Natural fire breaks and different burn intensities, however, created a mosaic of islands of unburned vegetation patches from 50 to 700 acres in size. Re-sprouting forbs and grasses were already observed by the fall of 1994, and much of the herbaceous layer had recovered by spring of 1995.

Tree mortality by fire was estimated and separated into three classes (Figure 2-6), depending on the number of dead trees at the time surveys were conducted, plus those projected to die within the next five years. High mortality designations represent areas where the expected number of trees killed by fire ranged from 70-100% mortality [11,753 ha (29,029 ac.)]; moderate varied from 30-70% mortality [5,181 ha (12,797 ac.)]; and low designations were those of less than 30% [2,602 ha (6,426 ac.)]. Patches of green trees exist within both the high and moderate mortality areas. Large patches of high and moderate mortality areas were created, while the low mortality burns were smaller in size. The extremely large amount of high mortality in the northern portion of the landscape was a result of a "blow-up" where the Blackwell and Corral Fires merged within the Upper Payette Lake basin due to heavy fuels of dead trees.

Intensity (heat generated by the fire) can affect both the structure and composition of vegetation by eliminating seed sources and by increasing competition for space and nutrients by more opportunistic species. In the subalpine series, the acres of mature/overmature trees has been dramatically reduced from about 80% to 45%. Conversely, the number of seedling, sapling and pole class trees is expected to increase from 5% to around 40%. Spruce/fir stands at the higher elevations could take as long as one hundred years to establish trees. A large portion of the high and moderate intensity burn acres are expected to reseed back to lodgepole pine due to reduced numbers of spruce and subalpine fir seed trees.

Figure 2-6 Fire related tree mortality in the Payette Lake watershed



The grand fir series is not expected to experience significant change in structure and composition due to lower tree mortality. The mature/overmature age class has been reduced by about 10%; the immature class reduced by 5%; the seedling, sapling, pole age trees will increase by 5%. Pioneer species, such as Ponderosa Pine, Western Larch, Douglas Fir, and Lodgepole Pine, will slowly seed in the high mortality areas and the larger openings within the moderately burned areas.

Additional damage by fire and insects may further alter the balance in forest health and cycling of nutrients. Dead snags and fallen timber has created increased amounts of standing and ground fuel loads. Risk of rapid rates of fire spread in previously burned areas will likely be minimal in the near future due to the removal of fine fuels, which are low in areas that experienced high and moderate severity ground fires. A potential for fire exists in areas of spruce and fir where low mortality, accumulation of fine fuels and snags exist. The remaining green stands of mature/overmature spruce and fir are also vulnerable to ignition. Increased insect activity can be expected within the burn area for the next 2 to 5 years. Fire-stressed trees are frequently attacked by insects and provide suitable habitat for insect brood survival.

2.11 Fisheries and Wildlife

2.11.1 Lake Fishery

Payette Lake has a long history of providing important fishery benefits. The earliest records documented a subsistence fishery on both big(sockeye salmon) and small(kokanee) redfish in 1894. Evermann, 1896, reported 25,000 sockeye salmon being captured at Lardo, Idaho and another 75,000 Payette Lake-bound sockeye were harvested at the mouth of Gold Fork. Early settlers salted these fish for year long consumption. The fish from Payette Lake played an important role in settling the McCall/Cascade area.

The sockeye salmon run was blocked by the construction of Black Canyon Dam in the 1920's, but the fresh water kokanee population persisted, providing much of the fishing opportunity to the present. The Idaho Department of Fish and Game has intermittently stocked kokanee but most of the kokanee result from natural spawning on the lake's shoreline and in the North Fork Payette River above the lake. The IDFG introduced lake trout (mackinaw) in the late 1950's and cutthroat trout in 1988. These three fish species require cold, clean, clear water with high dissolved oxygen content. The cold infertile water of Payette Lake favors kokanee, lake trout and cutthroat over other species, that is why these fish were chosen to be the base for fishing in the lake. In fact, the number of fish caught would probably improve if Payette Lake had more nutrients, but the fish community would have to change. Rainbow trout, yellow perch, brook trout, suckers and squawfish would displace the colder water species. Importantly, the water clarity and color would also change as the nutrients stimulate algae growth. The IDFG senses that this is not what is desired of Payette Lake and the existing and future fisheries management planning accommodates the high value of nonfishing recreation while preserving fishing opportunities on coldwater fish species.

2.11.2 Watershed Fishery

The watershed to Payette Lake includes some very interesting and valuable fisheries. The N.F.Payette River not only provides clean water to Payette Lake, but it also provides the gravel needed for kokanee, rainbow and cutthroat spawning and incubation. The N.F.Payette River also supports rearing populations of rainbow and cutthroat trout. Adult rainbows ascend the river for spawning and sporadically during the summer to take advantage of aquatic insect hatches. Plants of hatchery rainbow trout support a popular trout fishery throughout the summer.

Fishing, camping, hiking, ORV use, canoeing and swimming are common activities for recreationists using the N.F.Payette River above Payette Lake. Planting fish improves fishing success and stimulates angler use of the watershed. Recreationists can negatively effect water quality through inappropriate activities. The impacts might include littering, improper human waste disposal, trampling streambanks and spilling household or automotive materials. These impacts are lessened by programs that educated recreationists that their activities can damage the resources that they are there to enjoy. Signs, brochures, campground programs, and personal contacts by natural resource workers are effective methods to reduce impacts from recreational use of the watershed.

Streamflow

In many ways, the flows in the N.F.Payette River effect the health of the fish populations and the quality of water in Payette Lake. Idaho Code 42-1501 declares minimum flow to be a beneficial use for the protection of fish and wildlife habitat, aquatic life, recreation, aesthetic beauty, transportation and navigation values, and water quality. IDFG personnel measured stream flows and other habitat parameters on transects within three river reaches representative of the river's habitat types. Instream Flow Incremental Methodology and Physical Habitat Simulation System were used to quantify the amount of potential fish habitat available for each life history stage of salmonids that occur in the upper N. F. Payette River (Trihey and Wegner, 1981). This method is designed to demonstrate the impact of incremental changes in stream flow on fish habitat (Fig. 4-32). It will be used to identify and pursue streamflows that will continue to support the beneficial uses. Other analyses can compare flows and the other uses.

The tributaries of the N.F. Payette River support naturally reproducing populations of rainbow, cutthroat and brook trout. A myriad of alpine lakes dot the watershed. Blackwell Lake and Brush Lake are managed for trophy fishing experiences using a 20-inch minimum size limit to allow the fish to attain larger sizes. Alpine lakes provide excellent fishing and have the highest "approval" rating among anglers for any fishing opportunity in the state (Reid, IDFG.1989). Pearl Lake, Box Lake and Twenty-mile Lakes are also very popular.

Upper Payette Lake and Granite Lake are manmade reservoirs covering natural lakes. Both contain complex fish communities of non-game and gamefish species. Both are liberally augmented with hatchery rainbow trout. Both lakes have recently received introductions of splake, a brook trout X lake trout hybrid.

Current Program and Future Plans

The current fishery program in Payette Lake is based on naturally produced kokanee, natural and hatchery-enhanced lake trout, introduced and hatchery-augmented cutthroat, and natural and stocked rainbow trout.

Kokanee are, and will continue to be, the major species supporting sport fishing on Payette Lake. They not only provide 73.1% of the total harvest, they also provide the prey base for the lake trout. The IDFG annually monitors the kokanee population using mid-water trawling techniques and by counting the number of adult fish in the spawning run. Mid-water trawling techniques are described in detail in Grunder (1990) and Bowles et al. (1986,1987). In general the mid-water trawl is a long funnel shaped net with a ten foot square mouth. This net is pulled through the water at various depths. The number of kokanee caught in the net is directly proportional to the total number of fish in the lake. The number of kokanee caught in the trawl is then expanded to give an estimate of the total kokanee population in the lake.

The kokanee spawning run is enumerated by walking the entire stretch of the N.F. Payette River that is utilized by spawning fish and counting all live fish. This count is made every three to four days until the number of fish counted begins to decrease. The peak count is then multiplied by a correction factor of 1.73 (Frost 1994).

Since 1992 kokanee population estimates have increased. From 1988 to 1996 the age 1+ population estimate has increased from <2000 to 132,000 fish (Figure 2.3).

There has also been a dramatic increase in the number of spawning kokanee in the N.F. Payette River. Between 1988 and 1996, we counted 14,500 to 60,707 adult kokanee (Figure 2.4). These values should produce good fishing for kokanee and an adequate prey base for the lake trout. Angling success is not as high as is desired, but the trend appears upward in 1995 and 1996.

Lake trout provide a trophy component to the Payette Lake fishery. Lake trout fishing on Payette Lake is excellent when compared to other lakes nationwide. In the 1988 samples, more than ½ of the fish exceeded 15 pounds. This species was introduced in 1955, intermittent hatchery plants continued until 1985. Fishing pressure on lake trout has been relatively low, until recent years. This allowed a large, "old growth" population to establish in the lake. Beginning in the mid-1990's, angler interest and participation increased. Signs of over harvest of large fish (>30") became apparent when we compared 1988 data to 1994-1995 data. Public opinion favored maintaining/restoring the large fish to the population. A trophy regulation was implemented in January 1996, requiring release of all lake trout under 36" and allowing only 1 fish per day. Population sampling also showed very few juvenile lake trout to be present, suggesting limited reproduction or poor early survival. 1000 fin-clipped, 9-inch lake trout will be stocked in the spring of 1997. These fish will be tracked for several years to determine the need for future stocking.

Westslope cutthroat trout were introduced in 1988. Initially they were scatter planted around the perimeter of the lake. Additionally, fry/fingerlings were stocked in many of the N.F. Payette River tributaries, and stocked 9-10" yearlings in the N.F Payette River between Payette Lake and Upper Payette Lake.

In 1991, a net pen rearing operation was begun in the lake near Sports Marina. This is a community project with the Reed Gillespie Central Idaho Chapter of Trout Unlimited (TU) being the lead partner. The City of McCall owns the walkway/dock. The IDFG provides the fish, technical assistance and much of the feeding and stocking labor. The McCall Chamber of Commerce supports the program and plans to help on an as needed basis. Several other organizations helped with the construction of the facility.

Cutthroat provide a limited but increasingly important component to the fishery. Cutthroat are shoreline oriented, as opposed to the deep water habits of kokanee and lake trout, thereby giving shore-based or small boat anglers a target species suited to their fishing techniques. A return to scatter planting yearling cutthroat and conversion of the net pens to rainbow trout rearing is planned beginning in 1997.

Rainbow trout provide 15.3% of the total catch from Payette Lake. Of which, 72.5% are from natural origin and 27.5% are from hatchery stocking. Scatter planting 5,000, 9-11" rainbows occurs each year, targeting planting sites with good angler access to encourage good return-to-the-creel. Natural rainbows enter the lake from spawning and early rearing areas in the N.F. Payette River and its tributaries. Some natural rainbows contribute to angler catches in the N.F.Payette River. We are in the process of evaluating a segment of the N.F.Payette River for quality fishing management, but early indications suggest that protective regulations would not affect a significant response in the population. Quality management would likely displace traditional bait anglers.

2.11.3 Wildlife In The Watershed and Lake

The Payette Lake watershed contains a variety of wildlife habitats, and therefore, supports a variety of wildlife species. The watershed lies in Game Management Unit 24 which is an important hunting unit. It has general archery and rifle hunts for both elk and deer, as well as a popular controlled muzzleloader elk hunt. Black bear, mountain lions and snowshoe hares can also be taken during open seasons. Fox and other furbearers (including beaver, mink, marten, and muskrat) are available to trappers. River otter and fisher live in the watershed, but are protected from hunting or trapping. Predatory mammals include the coyote, skunk, and weasel. Many nongame mammals inhabit the N.F. Payette River drainage, these include pine squirrels, flying squirrels, ground squirrels, chipmunks, pika, hoary marmots, and various mice, voles and wood rats.

Several migratory waterfowl nest in or migrate through the watershed. Major nesters are Canada geese, mallard ducks, wood ducks, mergansers, green-wing and cinnamon teal. Snow geese and trumpeter swans are regular visitors.

Many raptors use the watershed. Bald eagles nest in the vicinity and regularly hunt the lake and heavily utilize the kokanee during their spawning run. The same is true for osprey. Red-tailed, Swainson's, Ferruginous, and rough-legged hawks are common. Peregrine falcon are occasionally reported. Kestrel, Sharp-shinned hawks, and Goshawks are relatively common. Great horned, great gray, boreal, saw wet, and screech owls inhabit the watershed.

Shorebirds and other water-oriented birds frequent the area. These include sandhill cranes, great blue herons, sandpipers, kingfishers, and dippers. Many neotropical birds rely on the area's habitat for much of their life. These bird species range from hummingbirds to thrushes. Several woodpeckers benefit from the old growth forest in the McCall area, the largest is the pileated woodpecker. Crows, ravens, vultures and magpies help to clean the area of carrion. Blue grouse, ruffed grouse and spruce grouse support popular hunting seasons.

Mammals that use Payette Lake directly include river otters, mink, muskrats and beavers. The latter two species can, at times, become bothersome to humans when they burrow into Styrofoam dock logs or chew down ornamental trees. The IDFG offers advice to property owners on how to reduce or prevent damage.

As mentioned earlier, bald eagles and osprey depend on the lake's fish population for important food sources. Western grebe and Canada geese use the lake during the parts of the year when the lake is ice-free. As with the beaver, Canada geese are viewed by landowners and visitors either as a wonderful wildlife amenity or a destructive nuisance. The IDFG has monitored the goose population since 1994 and found a stable population of 225-250 geese. The goal is to maintain the population at about this level. If the population increases dramatically, then a trapping and relocation program will be initiated. The IDFG offers technical advice to help reduce "goose problems" on docks and lawns.

Phosphorus loading from waterfowl was estimated for the Cascade Reservoir Water Quality Management Plan (1991). From that evaluation, the Payette Lake goose population is estimated to contribute from 65.57 to 72.85 kilograms of phosphorus per year.

Most of the wildlife species mentioned in the previous section also frequent the shoreline of Payette Lake.

Chapter III

3.0 Methods and Materials

3.1 Lake Monitoring

3.1.1 Hydrologic Budget

The budgets accounted for the mass of water entering and leaving the lake via pathways such as streamflow, precipitation, evaporation, and change in lake storage. Such data were important components of the nutrient load/lake response model and were also used to compute nutrient budgets for the lake. Hydrologic budgets were computed with the following equation (quantities in cubic hectometers):

$$R = GTI + UTI + DSR + P - E - SWGO - MW - CS, \quad (1)$$

where

R is the residual;
GTI is gaged tributary flow;
UTI is ungaged tributary flow;
DSR is direct surface runoff;
P is precipitation to the lake surface;
E is evaporation from the lake surface;
SWGO is gaged surface-water outflow;
MW is municipal water withdrawal;
CS is change in lake storage.

Gaged surface-water inflows were measured at the USGS gaging station 13238322, North Fork Payette River below Fisher Creek, and at DEQ gaging stations at Dead Horse Creek and Fall Creek (Fig. 3-2). Gaged surface-water outflow was measured at the USGS gaging station 13239000, North Fork Payette River at McCall (Fig. 3-2). Discharge at the two USGS gaging stations was determined from continuous monitoring of stage (water-surface elevation) and periodic measurements of streamflow using methods described in Buchanan and Somers (1968, 1969), Carter and Davidian (1968), Kennedy (1983, 1984), and Riggs (1968). Discharge was determined by DEQ at its two gaging stations by relating periodic streamflow measurements to a stage-discharge curve.

Ungaged tributary inflows were estimated by DEQ by multiplying drainage-basin area by a unit-runoff coefficient determined at a nearby gaged surface-water inflow station, either Dead Horse or Fall Creek. Unit-runoff coefficients for these two creeks were determined by dividing annual discharge, in cubic hectometers, by drainage-basin area, in square kilometers (Table 3-1).

Direct surface runoff was estimated by DEQ using methods described in Schueler (1987), who estimated runoff by relating precipitation, infiltration, percent of impervious surfaces and soil moisture storage.

Precipitation to the lake surface was determined by multiplying lake surface area by the precipitation recorded during water years 1995 (0.83 m) and 1996 (0.73 m) at the National Weather Service station in McCall. Evaporation from the lake surface was estimated by multiplying lake-surface area by an annual evaporation rate of 0.76 m. The evaporation rate was derived from a map of annual free-water-surface evaporation in Idaho (Myron Molnau and K.C.S. Kpordze, University of Idaho, written commun., 1992). The change in lake storage was determined with a combination of lake stage data collected at USGS station 13238500, Payette Lake at McCall, and area and volume curves (Fig. 3-1) generated by this study. An evaluation of ground-water flux for Payette Lake was beyond the scope of this study.

Figure 3-1. Relation of depth to lake surface area and volume for Payette Lake.

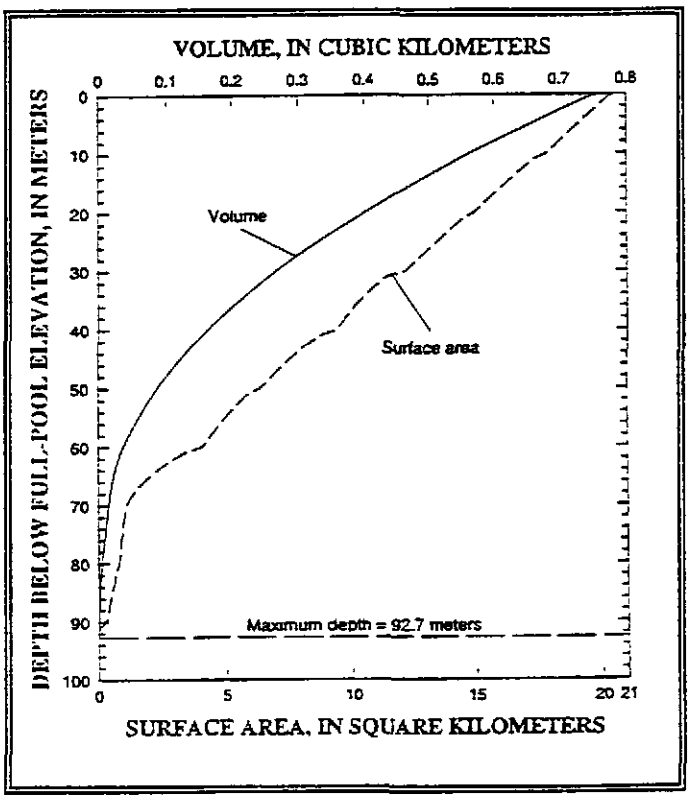
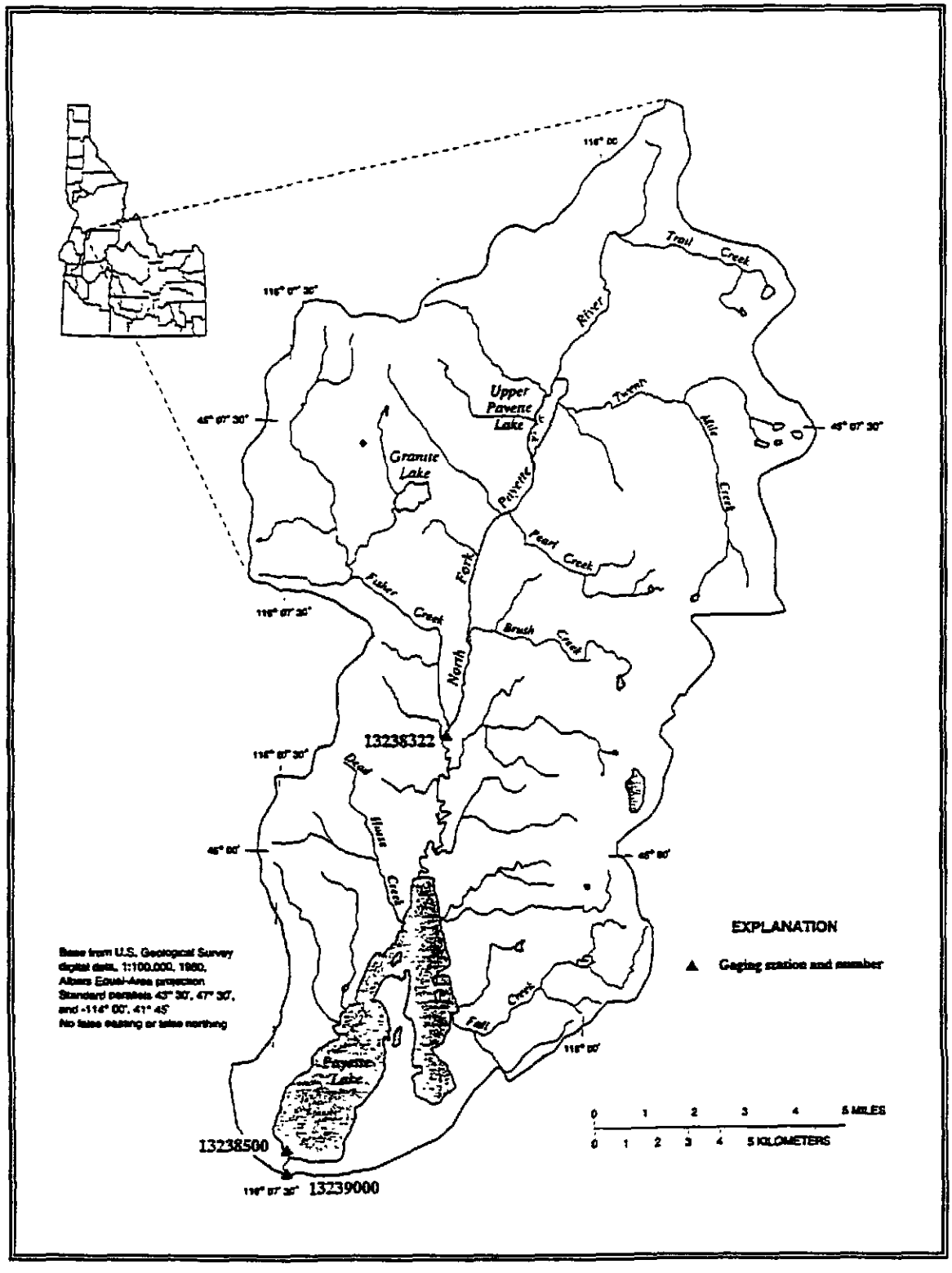


Figure 3-2. Location of U.S. Geological Discharge Monitoring Stations.



The residual for the hydrologic budget was computed as the difference between inflow and outflow minus change in lake storage. The residual included the errors associated with all budget components and unmeasured components such as ground-water flux and bank-storage flux.

The error associated with the hydrologic budget was computed with methods described by Winter (1981) and Brown (1987). The error associated with each budget component was computed with the following equation (Brown, 1987):

$$E = [(P^2)\ (C^2)]^{0.5}, \quad (2)$$

where

E is total standard error associated with budget component C;

P is percent error used to determine budget component C; and C is value of budget component.

Percent error for each budget component was adapted from Winter (1981). Assignment of percent error to each budget component was as follows: gaged surface-water inflow and outflow and change in lake storage, 7.5 percent; precipitation, 15 percent; other components, 25 percent. The propagation of error for the hydrologic budget was computed with the following equation (Brown, 1987):

$$OE = [(E_1)^2 + E_2)^2 + \ldots + (E_n)^2]^{0.5}, \quad (3)$$

where

OE is overall standard error associated with hydrologic budget, in cubic hectometers; and
En is total standard error associated with each budget component.

3.1.2 Nutrient Budgets

The budgets were calculated by multiplying the hydrologic quantities in equation 1 by their associated nutrient concentrations.

The nutrient loads associated by the lake's primary inlet and outlet tributaries (USGS gaging stations 13238322 and 13239000) were determined with nutrient concentration data collected concurrent with streamflow measurements. Nutrient samples were collected over a wide range of discharges using standardized USGS cross-sectional, depth-integrating methods (Edwards and Glysson, 1988). The samples were analyzed for total concentrations of phosphorus, orthophosphorus, organic plus ammonia nitrogen, nitrite plus nitrate, and ammonia at the USGS National Water Quality Laboratory using low-level detection limit methods described by Fishman and Friedman (1989) and quality assurance/quality control procedures as described by Pritt and Raese (1995). Approximately ten percent of the nutrient samples were submitted as duplicates or blanks for quality assurance purposes as described by Friedman and Erdmann (1982).

Nutrient loads from ungaged surface-water inflows were estimated by multiplying drainage area, in square kilometers, by a nutrient-export coefficient, in kilograms per square kilometer. The nutrient-export coefficients were derived from nutrient load data collected by DEQ's watershed-monitoring program. A coefficient is computed by dividing the annual nutrient load, in kilograms, by the drainage basin area, in square kilometers.

Nonpoint-source nutrient loads from residential and commercial areas were estimated as described in the Stormwater Monitoring of Developed Areas (Section 4.3). The annual nutrient load was calculated with equations that combine precipitation, percent impervious area, drainage area, and national, flow-weighted concentrations of total phosphorus or total nitrogen.

Atmospheric input of nutrients to the lake's surface was estimated with data from the National Atmospheric Deposition Program's monitoring station at Smiths Ferry. The annual areal deposition rates, in kilograms per square kilometer, were multiplied by lake surface area, in square kilometers, to determine the annual load to Payette Lake. The nutrient load associated with the annual change in lake storage was determined by multiplying that volume, in cubic hectometers, by the mean annual concentration of nutrients, in micrograms per liter, in the epilimnion of limnetic station 1.

The residual for each nutrient budget was computed as the difference between the inflow and outflow of nutrients minus the nutrient load associated with the change in lake storage. The residual contains the errors associated with all budget components and unmeasured components such as ground-water flux.

Errors associated with each component of a nutrient budget were computed using errors in the hydrologic budget and errors in the collection and analysis of nutrient concentration data. Assignment of percent error to each concentration in a nutrient budget was as follows: gaged inflows and outflow and lake storage change, 15 percent; ungaged inflows and precipitation, 30 percent. Total error for each budget component was computed with the following equation (Brown, 1987):

$$E = [[(E_c)^2(Q)^2] + [(E_q)^2(C)^2]]^{0.5}, \quad (4)$$

where

E is total standard error associated with a nutrient budget component, in kilograms;
Ec is standard error associated with a nutrient concentration, in micrograms per liter;
Q is quantity of water, in cubic hectometers;
Eq is standard error associated with quantity of water, in cubic hectometers; and
C is nutrient concentration, in micrograms per liter.
Overall error for each nutrient budget was computed with the following equation (Brown, 1987):

$$OE = [(E_1)^2 + (E_2)^2 + \ldots + (E_n)^2]^{0.5}, \quad (5)$$

where

OE is overall standard error associated with nutrient budget, in kilograms; and
En is total standard error associated with each budget component.

3.1.3 Limnology

Data Collection and Analysis

The physical, chemical, and biological functions of a lake are important factors in determining its susceptibility to eutrophication. The nutrient load/lake response model used to assess eutrophication in Payette Lake required a large amount of limnological data in order to simulate the lake's response to changes in nutrient loadings. Collection of limnological data at the lake was conducted in both the limnetic zone and the littoral zone.

Limnetic Zone

Four limnetic stations (Fig. 3-3) were sampled from October 1994 through September 1996. Each station represented an important limnetic zone. Station 1 monitored the large volume of water contained in the lake's southwest basin and was nearest to the lake's outlet. Station 2 monitored the small basin that connected the southwest and northern basins. Station 3 monitored the northern basin which was the deepest and was nearest the lake's primary tributary. Station 4 monitored the southeastern basin which was the shallowest and most hydrologically isolated from the primary tributary.

Sampling at the four limnetic stations typically occurred tri-weekly during May through October; one winter trip occurred in February, 1996 when the lake was ice-covered. A profile of photosynthetically-active radiation (PAR) was made with a spherical quantum sensor and planar deck-cell sensor in order to determine the euphotic-zone depth and compute an extinction coefficient. The euphotic zone is defined as that part of the water column in which in situ PAR is equal to or greater than 1 percent of the PAR incident upon the lake surface. Water-column transparency was then measured with a 20-cm-diameter secchi disc for later correlation with the PAR data. A full-depth profile of water temperature, specific conductance, pH, and dissolved-oxygen concentration and percent saturation was then made with a multi-parameter water-quality profiling instrument (Hydrolab Surveyor II).

A nonmetallic water-sampling bottle was used to obtain three samples: euphotic-zone composite, mid-depth, and 1 m above the lake bottom. Each water sample was analyzed for concentrations of total phosphorus and ammonia plus organic nitrogen and dissolved ammonia, nitrite plus nitrate and orthophosphorus. The euphotic-zone composite was also used for chlorophyll-a and phytoplankton analyses. The chlorophyll-a sample was obtained by filtering 500 ml of sample

water through a pre-rinsed glass-fiber filter (Whatman GF/F) which was then immediately frozen until analysis. The phytoplankton sample was preserved with Lugol's solution. Nutrient samples were analyzed at the USGS National Water Quality Laboratory using low-level detection limit methods as described by Fishman and Friedman (1989) and quality assurance/quality control procedures as described by Pritt and Raese (1995). Approximately ten percent of the nutrient samples were submitted as duplicates or blanks for quality assurance purposes as described by Friedman and Erdmann (1982). Chlorophyll-a was analyzed according to Britton and Greeson (1989) using high performance liquid chromatography. Aquatic Analysts of Portland, Oregon evaluated the phytoplankton samples for taxonomic composition, density, biomass, and diversity indices.

During July, 1996 the surficial lakebed sediments at the four limnetic stations were sampled using a stainless-steel Ponar dredge. Each sample was analyzed for total phosphorus and nitrogen using methods described by Fishman and Friedman (1989).

Littoral Zone

Nutrient and chlorophyll samples were taken from the 1-m depth at 25 littoral stations (Fig. 3-3) during August-September, 1995 to aid in selection of stations to monitor periphyton production. Sampling protocol paralleled that used for limnetic sampling. During July-August, 1996, 20 of the 25 littoral stations were equipped with artificial substrates to monitor periphyton production in relation to nearshore influences. Artificial substrates were chosen, instead of natural substrates, to reduce the number of environmental variables used for the statistical evaluation. The substrates were placed on July 23-24, were incubated in situ for about 30 days, and then were retrieved on August 20-21.

Each artificial substrate consisted on a 5-cm-diameter unglazed ceramic ball affixed with adhesive to a 0.5-m-long rigid plastic shaft. At each station, three substrates were held vertically by a concrete-filled, plastic bucket. The bucket was placed on the lakebed such that the ceramic balls were about 2 m beneath the lake surface and about 0.5 m above the lakebed. This design and placement reduced the potential losses of periphyton due to benthic-invertebrate grazing and wave-induced sloughing. The amount of PAR received by each station during the incubation was computed so periphyton growth, quantified as chlorophyll-a, could be normalized to PAR. A LiCor solar monitor (model LI-1776) located on the southeast shore of Payette Lake recorded the hourly input of PAR. The amount of shading by the horizon and nearby structures and vegetation was quantified at each station using a solar pathfinder instrument. This allowed adjustment of the incubation PAR data to account for differences in incident PAR at each station. Finally, the PAR received during incubation at each station's substrates was computed with the following equation:

$PAR_z = PAR_t(e^{-nz})PS$, (6).

where

PAR_z is PAR input to artificial substrate during incubation, in Einsteins per square meter;
PAR_t is PAR input to lake surface during incubation, in Einsteins per square meter;
e is base of natural logarithms, unitless;
n is extinction coefficient of nearest littoral station, per meter;
z is depth of artificial substrate, in meters; and
PS is decimal percent of station shaded.

Immediately following retrieval, the periphyton attached to a ceramic ball was brushed gently into a 500-ml plastic jar containing 200 ml of lake water. The periphyton-lake water sample was homogenized in a blender and then three subsamples were withdrawn for filtration. The filters (Whitman GO/F glass-fiber) were frozen immediately. The chlorophyll-a analyses were performed by the author using a Turner Designs fluorometer (model 10-005R) and the methods described by Koenings and others (1987). Two replicate analyses were run on the supernatant derived from an acetone extraction of each chlorophyll-a-bearing filter. The amount of chlorophyll-a associated with the periphyton on each ceramic ball was computed with the following equation:

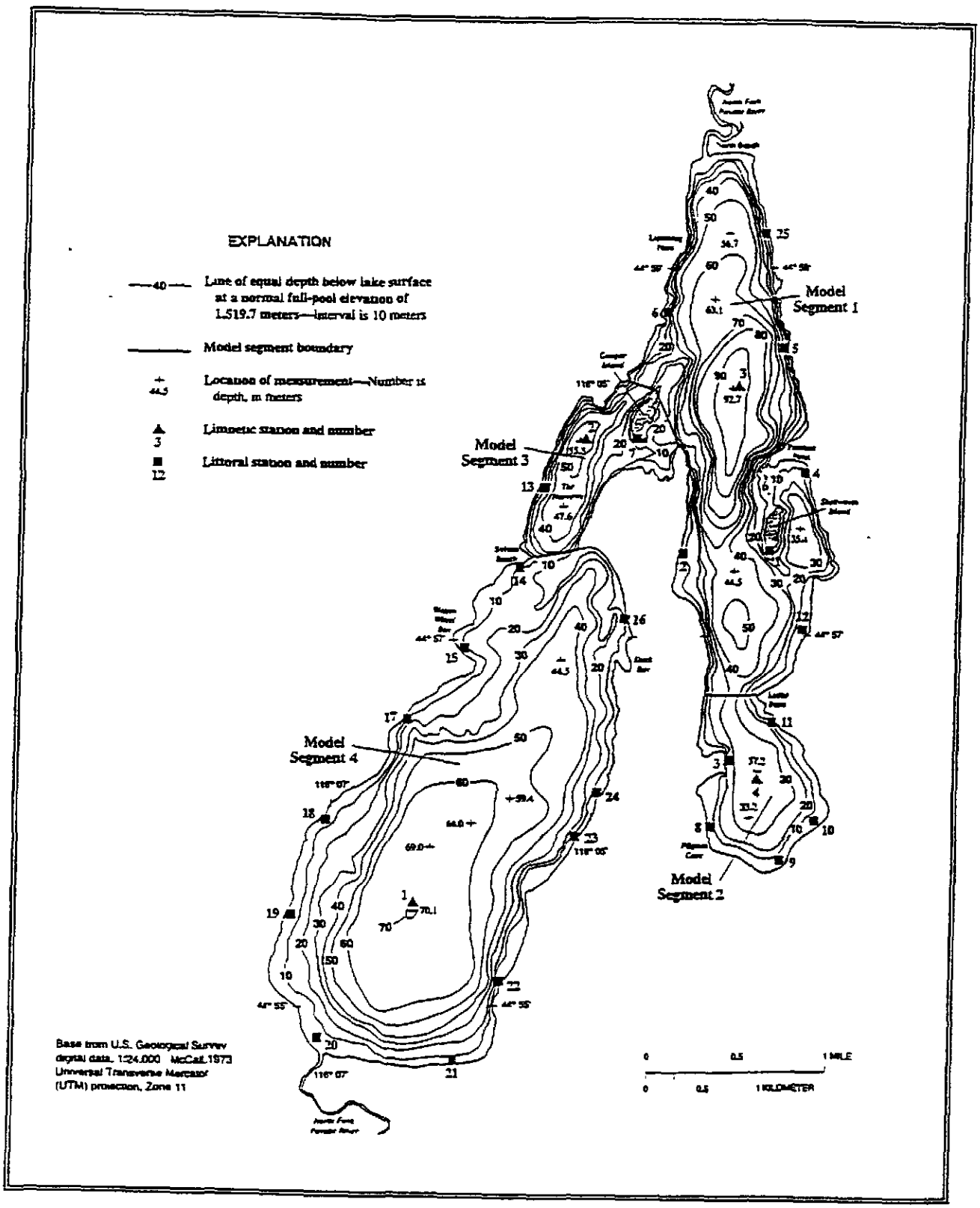
$B_{chl} = [(C)(V_e)(V_t/V_f)(CF)] / A$, (7)

where

B_{chl} is periphyton biomass, as chlorophyll-a , on artificial substrate, in milligrams per square meter;
C is concentration of chlorophyll-a in extract, in micrograms per liter;
V_e is volume of extract, in liters;
V_t is volume of periphyton-lake water sample, in liters;
V_f is volume of periphyton-lake water sample filtered, in liters;
CF is factor to convert micrograms to milligrams; and
A is area of artificial substrate, in square meters.

During July, 1996, the 20 littoral stations equipped with artificial substrates were surveyed for occurrence and taxonomic composition of aquatic macrophytes. The taxonomic work was performed on-site by a botanist with the U.S. Bureau of Land Management.

Figure 3-3. Locations of limnetic and littoral sampling stations.



3.1.4 Nutrient Load/Lake Response Model

Model Description: The empirical nutrient load/lake response model (Walker, 1996) applied to Payette Lake provided a mathematical method for simulating the lake's limnological responses to alterations in water and nutrient loads delivered to the lake from various sources. The model combined data on the lake's morphometrics, hydrologic and nutrient budgets, and limnological characteristics in order to simulate the following eutrophication-related variables: concentrations of total phosphorus, total nitrogen, and chlorophyll-a; secchi-disc transparency, and hypolimnetic dissolved-oxygen deficit.

Three programs, FLUX, PROFILE, and BATHTUB, compose the model. The FLUX program quantifies tributary loads of water and nutrients using a variety of calculation methods. The PROFILE program generates statistical summaries of water-quality conditions in the water body within a temporal and spatial context. The BATHTUB program applies nutrient-balance and eutrophication-response models within a spatially segmented hydraulic framework that accounts for advection, diffusion, and sedimentation. BATHTUB is a highly evolved version of empirical lake-eutrophication models, and incorporates additional variables to account for important process such a nonlinear nutrient-sedimentation kinetics, inflow nutrient partitioning, seasonal and spatial variations, and algal growth limitation by factors such as phosphorus, nitrogen, light, and flushing rate. If error estimates are provided for input variables, BATHTUB can express output variables in probabilistic terms. An important feature of BATHTUB is the ability for modeling linked segments of the lake to account for spatial variations in water quality.

Table 3-1. Characteristics of the four segments of Payette Lake modeled by BATHTUB.

[km^2, square kilometer, cubic kilometers, m, meters]

	Segment (Fig. 3-3)			
Characteristics and units	1	2	3	4
Surface area, km^2	6.51	1.69	1.37	10.9
Volume, km^3	.279	.035	.038	.402
Mean depth, m	42.9	20.7	27.7	36.9
maximum depth, m	92.7	37.2	55.5	70.1
Segment weight[1]	.32	.08	.07	.53
Important tributary Inflow source	North Fork Payette River	None	None	None
Outflow routed to segment number	3	1	4	Outlet
Limnetic station For segment	3	4	2	1

[1] Based on surface area of segment divided by surface area of lake.

Segment boundaries can be selected on the basis of factors such as lake morphometry, important sources of water and nutrients, and lake hydrodynamics.

Payette Lake was divided into four segments (Fig. 3-3); each segment's characteristics are listed in Table 3-1. Segment 1 is the deep, northeastern basin; it covers 6.5 km2 and contains 0.28 km3. This segment receives the lake's primary inflow from the North Fork Payette River. Segment 2 is the southeastern basin which covers 1.7 km2 and contains 0.04 km3. This segment is the most hydrologically isolated from the primary inflow and is furthest from the lake's outflow. Segment 3 is the smallest basin and connects the northeastern and southwestern basins. This segment covers 1.4 km2 and contains 0.04 km3. Segment 4 is the southwestern basin and contains the lake's outlet into the North Fork Payette River. This segment has the largest area and volume, 10.9 km2 and 0.4 km3.

Water-quality characteristics for each segment were input to BATHTUB. The characteristics were computed with PROFILE using data from the four limnetic stations. Excepting the metalimnetic and hypolimnetic dissolved-oxygen deficits, the characteristics represented mean annual values for the euphotic zone for water years 1995 and 1996. The euphotic zone was the primary focus for modeling because most of the empirical relations used by BATHTUB were derived from studies of euphotic zones.

The hydrologic and nutrient budgets were the source of water and nutrient loads input to BATHTUB. Each segment received water and nutrient loads from the subbasins draining into it. If a subbasin contributed to more than one segment its water and nutrient load was apportioned between the segments.

3.2 Watershed Monitoring and Assessment

There are no permitted point source discharges of pollutants directly entering streams or lakes within the Big Payette Lake Watershed. Consequently, watershed monitoring was limited to evaluation of non-point source runoff associated with the local land uses (Figure 2-2). Sub-watersheds above Big Payette Lake were assessed to determine relative importance of the drainage areas, landscape type, management history and fisheries habitat quality as these factors influence the incremental and aggregate quantity and quality of flow in the North Fork Payette River. Other diffuse land use impacts were also evaluated in and around the recreation and urbanized areas of the watershed adjacent to Big Payette Lake.

3.2.1 Rationale for Selection of Sub-watershed Monitoring Sites

Prior to initiating the study, existing data collected by DEQ, Idaho Fish and Game and the Payette National Forest were reviewed by the Payette Lake Technical Advisory Working Committee. Sub-watersheds for monitoring were prioritized based on factors such as intensity of past management activity, anticipated future uses, fire history and general conditions of stream habitat

quality. Historic changes in stream channel alteration were additionally considered as an important reference concerning the long term stability of sub-watershed stream conditions. These factors provided some relative estimate of how the potential cumulative stability (or instability) of the local watersheds may influence biotic and abiotic processes of the local streams.

Figure 3-4 identifies the priority sub-watersheds, streams and sample site locations selected for non-point source monitoring above Big Payette Lake. A total of 8 sub-watersheds were selected that cover a range of relative impacts based on intensity of previous logging activity, percent of equivalent clear-cut, recreational use and recent fire damage (Table 3-2). An additional monitoring site (sample site 4; Table 3-2) was selected at the outflow of Upper Payette Lake to ascertain whether this lake effectively reduces export of nutrients and sediment from the upstream watersheds. Water quality and flow samples were also monitored at the USGS gauging station on the N.F. Payette River below the confluence of Fisher Creek. Although this site was principally used to estimate the N.F. Payette River bulk nutrient loads and water volume to Big Payette Lake, nutrient loads from unmonitored sub-watersheds such as Brush Creek and adjoining lands along the river mainstem were estimated by difference.

3.2.2 Sub-watershed Water Quality and Stream Flow Monitoring

Quantity and quality of runoff reflecting non-point source land uses was monitored at roughly 2 week intervals during spring snow-melt and approximately monthly during the remainder of the year. This information was used to identify the relative rank and importance of the sub-watersheds relative to the cumulative contribution of flows and nutrients to the North Fork Payette River.

Samples for nutrients and solids were collected by two methods; either as 1) flow weighted collection of samples using automated ISCO water sampling devices or 2) as channel cross-composite, depth integrated grab samples using a DH-48 sampler and plastic churn splitter to composite grab samples. Samples for nutrient analysis and solids (sediment) analysis were stored in plastic cubitainers on ice and returned to the Idaho State laboratory for analysis within 24 hours.

Table 3-3 lists the parameters analyzed in water samples and analytical methods. Total phosphorus and nitrogen species were analyzed from unfiltered samples. Dissolved nutrients (dissolved ortho-phosphate) are determined by filtering samples through a 0.45 um filter. Disposable filters will be used for filtering samples in the field. A separate new filter was used for each sample site. Physicochemical parameters were measured in-situ using a Model H-20 Hydrolab. Probes were submerged in the center of the stream channel and allowed to equilibrate for 15 minutes prior to recording results. A manual of field protocols was developed and followed in the collection and handling of samples (Worth, 1995).

Figure 3 - 4 Watershed flow and water quality sampling sites

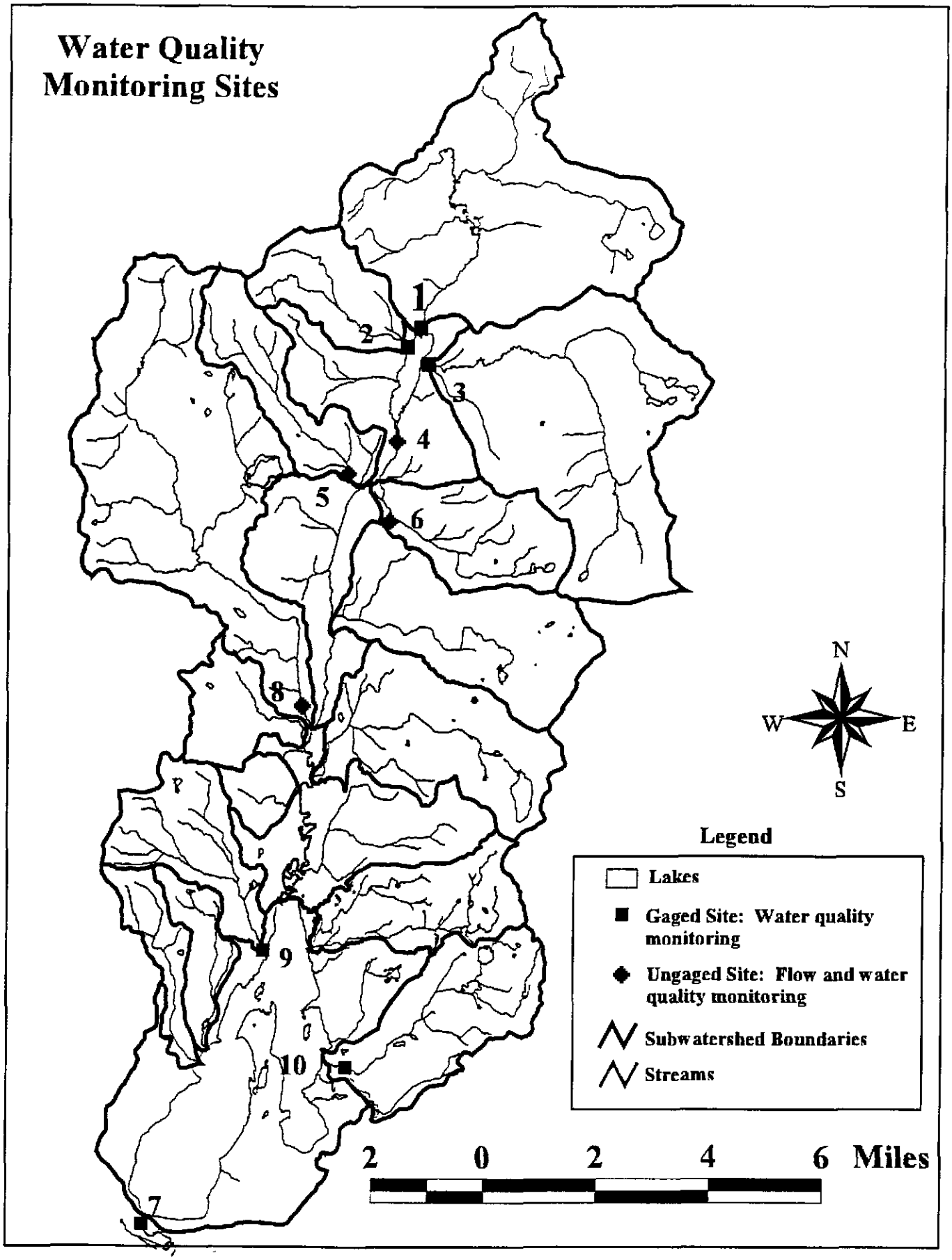


Table 3-2. Watershed Non-Point Source - Priority Stream Sites and Impact Characteristics.

Site #	Watershed Name	Acres	Type of Impact
1	NF Payette River above Upper Payette Lake	11,223	- Timber harvest - Burn impact NE of lake, 80% of watershed burned
2	Cougar Creek	2,404	- No harvest - 73% of watershed burned
3	Twentymile Creek	10,232	- Minor timber harvest - 82% of watershed burned
4	NF Payette River Outflow Upper Payette Lake		- Lake retention
5	Deep Creek	2,827	- No harvest - 30% burned
6	Pearl Creek	3,271	- Timber harvest - 95% of watershed burned
7	NF Payette River (USGS Gauge Site)	12,942	- Includes upstream inputs
8	Fisher Creek	11,519	- Timber harvest - 20% burned
9	Dead Horse Creek	3,086	- Timber harvest - Un-burned
10	Fall Creek	4,235	- Timber harvest - 50% burned

Automated sampling sites (ISCO) were programmed to composite discrete collections of water samples according to measured quantities of stream volume (see calibration of flows below). Samples were removed at two week intervals and analyzed for total phosphorus, total nitrogen and sediments following the same methods outlined in Table 3-3.

Suspended sediment concentrations in runoff was determined as the difference in weight of aliquots of unfiltered and filtered (0.45 um) stream samples after evaporation (105°C) to dryness.

Stream Flow Monitoring

Instantaneous stream flows (cfs) were measured during each water quality sampling event. Flows were measured through a known cross-section area of a stream channel using Marsh/McBirney digital flow meters. For water depths of less than 2 feet, estimates of water velocity were made using the six tenths estimate (0.6) of the average stream depth from water surface. At water depths greater than 4 feet, estimates of water velocity were made using the 2 point method (velocity is the average of measurements taken at 0.2 and 0.8 of the depth from water surface). Under very high flow conditions when stream wading was not possible, a bridge board was used to obtain estimates of flow velocity.

Continuous surface water flows were additionally monitored at Upper Payette Lake Inflow (N.F. Payette River), Cougar Creek, Twentymile Creek, Fall Creek and Dead Horse Creek by installing ISCO flow meters (model 4230-bubbler) and recording devices in open stream channels. Computed channel flows were corrected to channel stage height using direct open channel calibration of flows obtained from routine flow measurements using Marsh/McBirney flow velocity meters. A stage calibration was calculated for each automated site and used to correct estimated flows between measured sampling events.

Monitoring Stormwater Runoff into Big Payette Lake

Stormwater inflows from urban runoff within the city of McCall were monitored using the ISCO automated samplers and through grab samples during individual storm events. Figure 3-5 identifies the major storm sewers draining to Big Payette Lake and monitoring sites. Sites were selected based on accessibility for sample collection and representation of the surrounding land use intensity and type (Table 3-4).

Automated samplers (ISCO) were installed in two stormwater collection systems located in the downtown core area (Art Roberts Park and Public Boat Marina, Figure 3-5). Flow weighted samples were composited at these sites based on storm runoff volume.

Routine stormwater analysis included measures of nutrient concentrations (total and dissolved) and solids. Analytical procedures for grab samples were identical to those outlined for stream monitoring in Table 3-3. Automated composite samples were only analyzed for total constituents.

Bacteria contamination (fecal coliform and fecal streptococcus) in stormwater runoff were measured from grab samples collected during individual storm events. Samples were collected from culvert discharge in plastic 500 ml bottles fixed with sodium thiosulfate. All samples were stored on ice and transported to the Idaho State Lab (Boise) within 24 hours after collection.

Table 3-3. Water Quality Parameters Monitored.

Parameters	STORET#	MDL[1]-Units	Methods
NO_2+NO_3 as N	00631	0.005 mg/L	EPA Method 353.2 Methods
NH_4 as N, Total	00610	0.005 mg/L	EPA Method 350.1
TKN	00625	0.05 mg/L	EPA Method 351.2
Tot. Phosphorus	00665	0.005 mg/L	EPA Method 365.4 (Semi automated block digester)
Ortho-Phos.	00671	0.001 mg/L	EPA 365.2
Suspended Sediment	80154	<2 mg/L	EPA 160.2
Total Solids			
Chloride	00940	<0.9 mg/L	EPA Method 325.3
Flow	00060	.01 cfs	Electronic measurement for instantaneous flow measurement
Temperature	00010	.01 °C	Point and continuous
Oxygen, Diss.	00300	.01 mg/L	DO meter
Specific Conductivity	00095	.001 umhos	Conductivity meter
pH	00403	.01 SU	pH meter
[1] = Minimum Detection Limits			

Bacterial Monitoring Associated with Recreation Use

Bacteria samples were collected from selected streams and/or beach areas to measure total and fecal coliform contamination associated with concentrated recreational use areas (Figure 3-5). Samples sites were located upstream and downstream of concentrated use areas along active use areas on the N.F. Payette River between the National Forest Boundary and Big Payette Lake. Sites included an undesignated campground at the forest boundary, the Fisher Creek campground and Indian Campground. Samples for surface water contamination along beaches were collected at the water surface within 1.0 meters of the beach, upstream and downstream of the beach use areas. These sites included the North Beach, Lucks Point, Firemans Cove, the boat docks at Ponderosa State Park and a high use area between Deadhorse Creek and the North Beach. All sites were sampled before and after major holidays during the summer recreation season (July 4 and Labor Day) when density of recreational use was expected to be greatest. Methods of collection were identical to those described above.

Table 3-4. Stormwater Monitoring Sites and Drainage Basin Characteristics.

Basin No.	Size (ha)	General Characteristics	Monitoring Site Description
1	200	Located north of downtown McCall and includes entrance to Ponderosa State Park. Approximately 50% of basin lies within McCall city limits. Drainage gradient is to the lake. The drainage conveyance consists of open ditches and overland flow (down gradient contour discharge).	Not monitored.
2	253	Located north of downtown McCall and borders the eastern shore of Big Payette Lake southwest basin. Major feature includes City golf course (western end of basin). Approximately 35% of basin in city limits. Approximately 60% of basin is woodland with very low residential density. Drainage gradient is to the lake. Drainage conveyance is through a prominent open ditch with numerous smaller feeder ditches. Land surface cover predominately open spaces and small percentage impervious cover.	• Open ditch at intersection of Agate St and Davis Ave. Discharge to lake approximately 1,000 ft west.
3	69	Located just north of downtown McCall and borders the eastern shore of Big Payette Lake southwest basin Significant growth areas include the Old Mill site (residential/multi-unit and single family) and railroad right-of-way (commercial). Land surface includes impervious and vegetated coverings. Drainage gradient is to the lake. Drainage conveyance includes mostly shallow open ditches.	• Subsurface drainage pipe (4") discharging to lake at Mill Park Development.
4	105	Drainage basin located partially within the downtown McCall and borders the eastern shore of Big Payette lake southwest basin. Major features include the Marina (west side of basin) and railroad right-of-way. Drainage gradient is to the lake. Drainage conveyance includes numerous open ditches and enclosed CMP/concrete pipe as water is routed through the more developed areas along the west side of the basin (downtown area). High flows are common during spring snowmelt. Land surface cover consists of woodland on the east side of the basin and increasing impervious cover to the west near the lake.	• Concrete collection box next to Marina; discharge outfall at lake shoreline approximately 30 ft west of collection box.

Figure 3 - 5 Bacteria and stormwater monitoring sites in the Payette Lake watershed

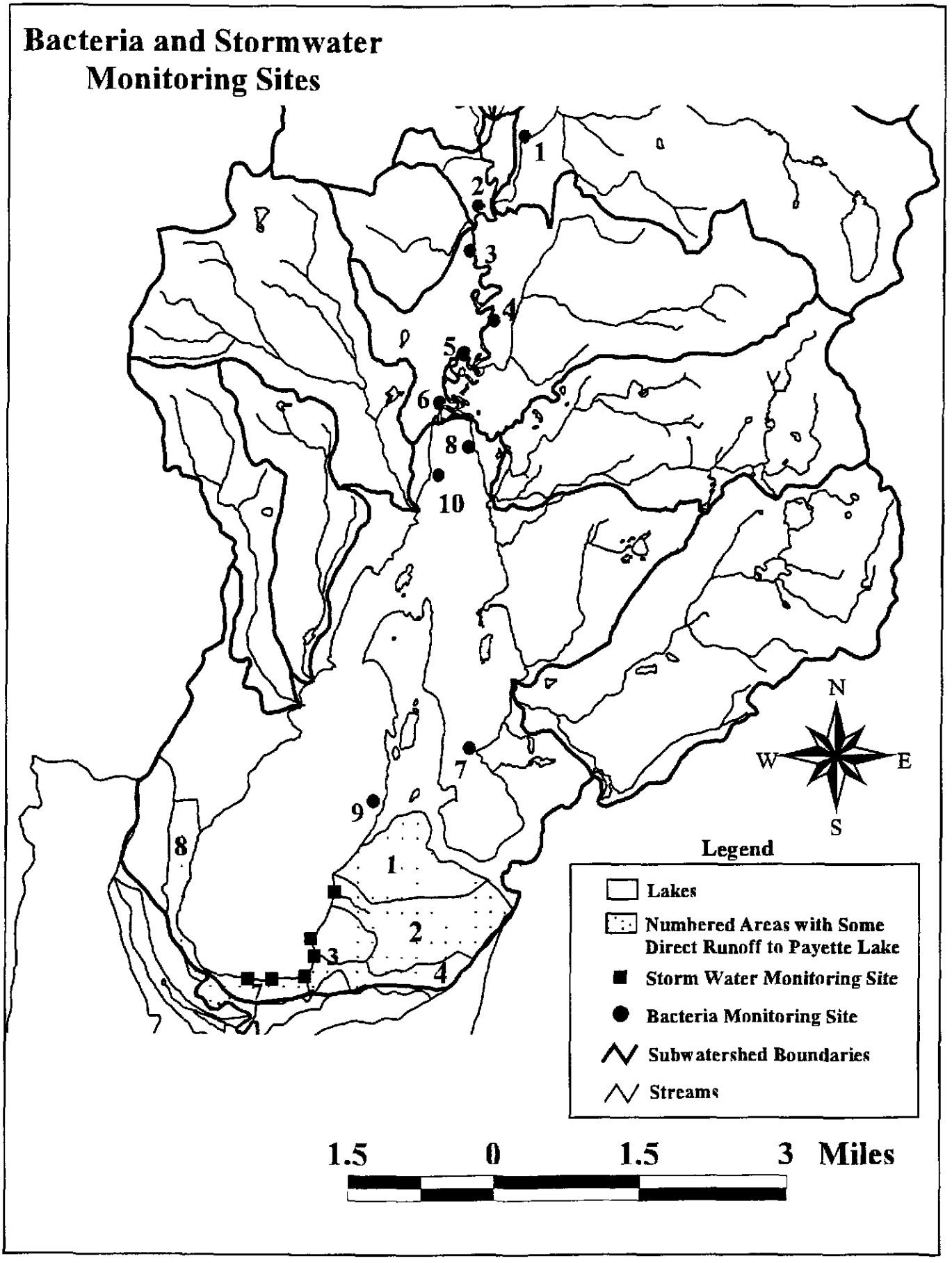


Table 3-4 continued. Stormwater Monitoring Sites and Drainage Basin Characteristics.

Basin No.	Size hectares	General Characteristics	Monitoring Site Description
5	56	Basin discharges to N.F. Payette River	Not monitored.
6	116	Basin discharges to N.F. Payette River.	Not monitored.
7	81	Drainage basin is located partially within the McCall downtown area and borders the south shoreline of Big Payette Lake southwest basin. Downtown core is located on the est side of the basin. Drainage gradient is fragmented with runoff flowing to the lake and the N.F. Payette River. Major features include significant drainage of State Highway 55 fronting the lake and high density commercial development in the downtown core. Drainage conveyance includes numerous open ditches which route water through a maze of piped storm drains in the downtown area and smaller piped collections systems to the west. Land surface cover varies from a high percentage of impervious cover in the downtown to low density residential to the west.	• Legacy Park discharge at concrete pipe below an just east of the Restaurant complex. • Concrete collection box and skimmer at Art Roberts Park. Discharge to lake Approximately 300 ft to the north. • Concrete collection box at Paul's Grocery Store. Discharge to lake approximately 300 ft north. • Concrete pipe at end of driveway north of Mission St-Hwy 55 intersection. Culvert discharge at lake shoreline on west side of condo bldg. • Concrete collection box on north side Hwy. 55 and State St intersection. Discharge to lake approximately 300 ft north.
8	93	Located on the west side of Big Payette Lake southwest basin. Major features are the Warren Wagon Road drainage, and the North Shore Lodge Resort. The northern portion of this basin is mostly sparse cabins and woodland. Commercial zoning abuts the city limits to the south with a large percentage of impervious surface. Drainage gradient is mostly to the lake. Drainage conveyance is minimal ditching and mostly overland flow (down gradient discharge). Some storm drain piping exists in the southern portion of the basin discharging to N.F. Payette River.	Not monitored.
9	220	Basin discharges to N.F. Payette River.	Not monitored.
10	96	Basin discharges to N.F. Payette River.	Not monitored.
11	261	Basin discharges to N.F. Payette River.	Not monitored.
12	1608	Basin discharges to N.F. Payette River.	Not monitored.
13	583	Basin discharges to N.F. Payette River.	Not monitored.

(1 hectare = 2.47 acres)

Quality Assurance/Quality Control (QA/QC): Water Quality Samples

All grab samples collected for water quality analysis were fixed in the field at the time of collection by advanced addition of the appropriate preservative to each sample bottle. For automated sample collections, samples were removed from the storage container at two week intervals. All samples were stored on ice and transported to the Idaho state lab for analysis.

Addition of spikes and sample results from specified stations were used for assessment of field and laboratory techniques. Duplicate samples were collected and used to determine media variability. Overall precision of the sampling and analytical methods was evaluated by analyzing duplicate samples collected at the same time and location. Duplicate samples were collected on every sampling date in which stream grab samples were collected. Average relative range and average coefficient variation were within acceptable margins of error.

Two types of spiked samples were used to determine laboratory accuracy and precision and potential degradation of samples stored on-site between intervals of sample retrieval. One set of samples was spiked at the beginning of each two week interval of automated sample collection. These spikes remained inside the automated sampler and were removed with the following batch of samples submitted for analysis. Analysis of these spikes provided an estimate of the change in recovery due to on-site holding conditions. A second set of containers were spiked at the time of sample retrieval and submitted for analysis with remaining samples. These results were used to determine percent recovery and average percent recovery.

Blank samples were used to determine laboratory equipment accuracy and precision and to assess sample handling errors and biases. Blank samples were submitted with each sample batch and treated as samples collected from the field, duplicating handling, storage, and transportation methods.

Physical-chemical parameters were measured in-situ using a Hydrolab Model-20 electronic meter for determination of dissolved oxygen, pH, conductivity and temperature. Various probes were maintained as recommended by the manufacture and calibrated according to specifications prior to each day of sample collection. Calibration logs were also maintained to record errors and trends in equipment operation.

3.3 Stream Habitat Quality

3.3.1 Purpose and Objectives

This study evaluates the stream habitat conditions in the Payette Lake Watershed (PLWS) for the technical report from which the Payette Lake management plan will be developed. Data from 1993-1996 was analyzed to determine the quality of stream habitat and ability to support aquatic biota.

Objectives for this analysis were to:

1. Compile existing data on the PLWS from federal and state agencies;
2. Characterize and compare stream channel habitat and water quality conditions (excluding nutrients) in subwatersheds;
3. Determine the macroinvertebrate species composition and abundance of the PLWS and subwatersheds;
4. Relate current stream habitat conditions to adjacent land use, and natural events;
5. Develop recommendations for continued stream habitat monitoring in the PLWS.

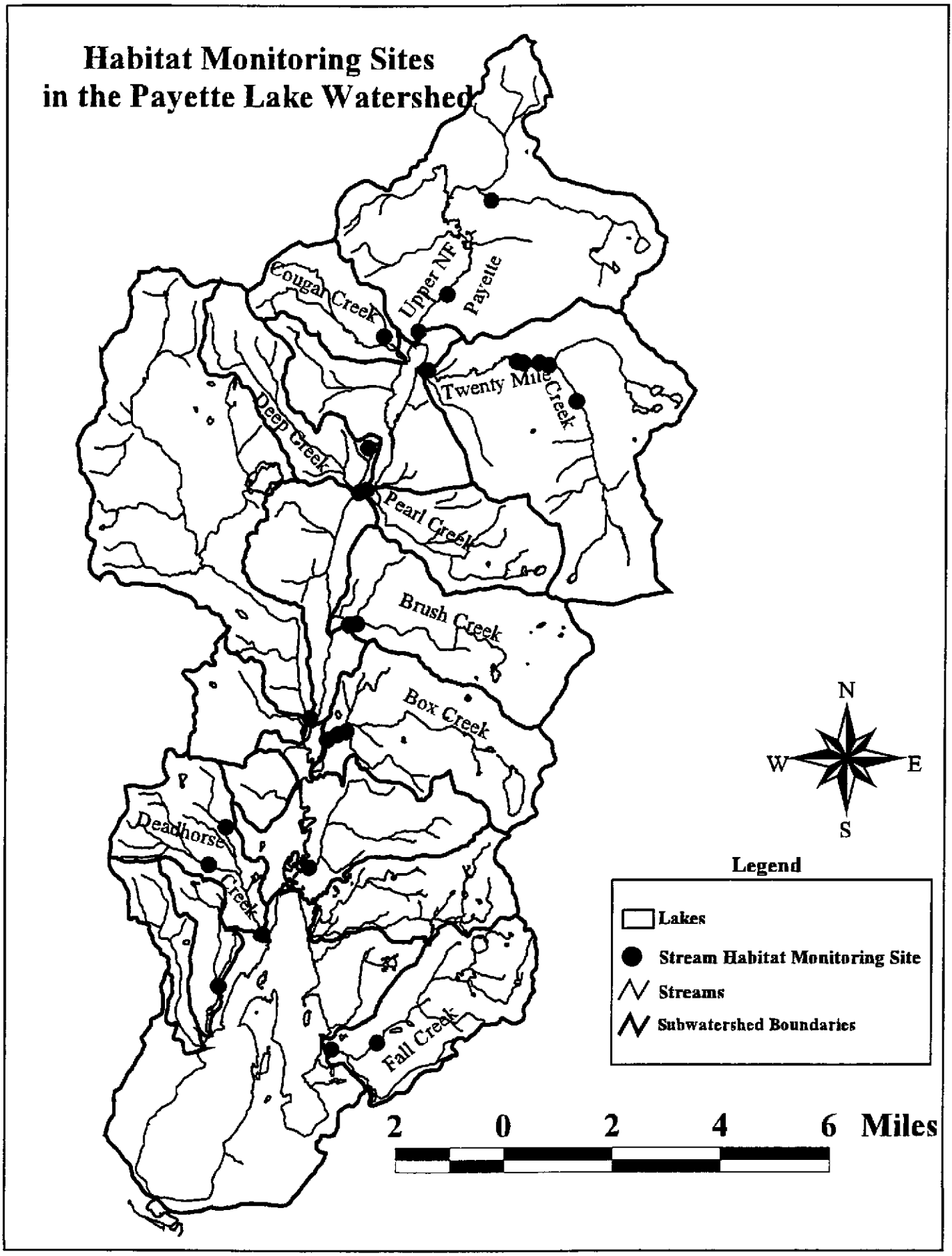
3.3.2 Data Acquisition

Conditions related to stream habitat quality, stability and the functional support of key biological species were evaluated using four different protocols but with somewhat comparable measures of overall habitat complexity, hydrologic function and biological sensitivity. Field investigations were initiated at different but overlapping time periods resulting from the individual management needs by the U.S. Forest Service, Idaho Division of Environmental Quality, Idaho Department of Fish and Game, and the Idaho Department of Lands. The four protocols used were R1-R4 Riparian Assessment Protocol, the Beneficial Use Reconnaissance Protocol (BURP), Stream Reach Inventory and Channel Stability Evaluation, and the Cumulative Watershed Effects protocol. (Site locations are identified in Figure 3-6 and Table 3-5).

Table 3-5. Beneficial Use Reconnaissance Program Stream Habitat Quality Monitoring Sites.

Watershed/Stream	Year	Site Latitude-Longitude	Stream Length	Method	Channel Type
Cougar Ck	94	44°08'22"-116°01'44"	Lower	BURP	B
	95	Unknown	Upper	BURP	A
20Mile Ck	94	45°08'00"-115°58'10"	Middle	BURP	C
	94	45°08'03"-115°58'49"	Lower	BURP	C
	95	45°07'23"-115°57'20"	Upper	BURP	C
	95	45°08'00"-115°58'10"	Middle	BURP	C
	95	45°08'03"-115°58'49"	Lower	BURP	C
Upper NF	94	45°09'06"-116°00'13"		BURP	B
Payette R	94	45°08'26"-116°00'50"		BURP	A
	94	45°06'45"-116°01'53"		BURP	C
Deep Ck	95	45°05'61"-116°02'10"	Upper	BURP	C
	95	45°05'59"-116°02'21"	Lower	BURP	A
Pearl Ck	95	45°05'06"-116°00'51"	Upper	BURP	?
	95	45°05'58"-116°01'54"	Lower	BURP	A
Box Ck	94	45°02'02"-116°03'03"	Middle	BURP	B
	94	45°02'09"-116°02'43"	Lower	BURP	C
	95	45°02'13"-116°01'57"	Upper	BURP	B
	95	45°02'02"-116°03'03"	Middle	BURP	B
	95	45°02'07"-116°02'44"	Lower	BURP	B
Brush Ck	94	45°03'52"-116°02'32"	Upper	BURP	A
	95	45°03'55"-116°01'30"	Lower	BURP	A
Deadhorse	94	45°00'09"-116°05'52"	Upper	BURP	B
	95	44°58'50"-116°04'32"	Lower	BURP	A
Fall Ck	94	44°55'00"-116°00'30"	Middle	BURP	B
	94	44°57'05"-116°03'15"	Lower	BURP	B
	95	44°57'10"-116°02'03"	Upper	BURP	B
	95	44°55'00"-116°00'30"	Middle	BURP	B
	95	44°57'17"-116°03'13"	Lower	BURP	B/C
Trail Ck	95	45°10'36"-115°59'13"	Upper	BURP	B
Fisher Ck	93	45°02'22"-116°03'35"	Lower	BURP	No Rosgen
	93	45°04'33"-116°05'56"	Upper	BURP	No Rosgen
	95	45°02'18"-116°03'31"	Lower	BURP	B
	95	45°04'53"-116°05'57"	Upper	BURP	C
Landing Ck	94	45°00'42"-116°05'25"		BURP	C
	95	44°58'06"-116°05'39"		BURP	C
	95	45°00'39"-116°05'27"	Upper	BURP	B

Figure 3 - 6 Stream habitat monitoring sites in the Payette Lake watershed



3.3.3 Stream Habitat Assessment Methods

1. Payette National Forest Region 1 / Region 4 (Northern Region/Intermountain Region) Fish Habitat Inventory (1995, Overton et al.).

This stream inventory procedure was initially developed in 1990 by the Forest Service's Intermountain and Northern Regions and the Intermountain Research Station. It is designed to describe and quantify fish and fish habitat characteristics for a given area by determining salmonid fish species composition, distribution and relative abundance; describing and quantifying fish habitat structure; and linking fish species and their life stages to habitat structure. The inventory is conducted at base flow usually by a two-person crew comprised of a "recorder" who records the data and an "observer" who classifies the habitat types and measures the variables. Prior to field work, extensive information is collected from maps and references and recorded on a "Header Form". Included in this information is reach type, reach boundaries and descriptions, gradient, elevations, Rosgen channel type, Ecoregion classifications, geology , and stream identity codes. The field data collected is extensive and includes *in part*: habitat type (run, glide, riffles and pools) ; habitat unit average width, length, and depth (including maximum); number and depth of pocket pools; pool crest depth, percent surface fines, substrate composition (Wolman Pebble Count Procedure), bank length, bank stability, bank undercut, quantities of large woody debris, and temperature. Fish population data is obtained by snorkeling counts of the total number of fish within given habitat units. Commonly a 20 percent sampling frequency is used for pool and riffle habitats. Training and quality control are also emphasized in the R1/R4 methodology. Payette National Forest R1/R4 data from 5 Payette Lake Watershed streams are analyzed in this report.

2. Idaho Division of Environmental Quality Beneficial Use Reconnaissance Project (BURP) (1996, IDEQ).

The BURP protocol is a modification of the Environmental Protection Agency Rapid Bioassessment Protocol used to evaluate stream conditions, stability and beneficial use support status (Robinson and Minshall, 1992). A combination of metrics were used to provide quantitative and qualitative measures of stream conditions and associated biological communities.

BURP monitoring sites are located in each of the priority streams upstream of the water quality monitoring stations (Figure 3-6). Several streams were sampled in summer 1994 just prior to closure of the Payette National Forest due to fires. Selected portions of each stream reach are classified according to the Rosgen stream classification system (Rosgen, 1993). Table 3-6 lists the various metrics that are obtained from each sample site. Monitoring is conducted during low flow conditions (September) when streams can be readily observed by wading. Low flow conditions also reflect the period in which sediment deposition from erosion, stream temperatures and other surrogate measures of environmental stressors are greatest.

Table 3-6. Metrics used for Beneficial Use Attainability Survey.

Parameter	Method/ Definition	Level of Intensity
Flow	Harrelson et al. 1994	one measurement per site, set interval method
Width/Depth	Bauer and Burton 1993. pg. 86	measure wetted and bankfull conditions at 3 riffles; record X-sectional depth a minimum of 10 times
Shade	Bauer and Burton 1993 pg. 68	measure with a densiometer at three riffles; use habitat types and lengths to weight calculations for stream reach shade calculations
Bank Stability	Bauer and Burton 1993. pg. 98	longitudinal (total stream reach length) for both stream banks
Substrate	Wolman 1954	at three riffles; a minimum of 50 counts per riffle; set interval method
Habitat Types	Meehan 1991	longitudinal; classify as pool, glide, run, riffle
Pool Complexity	Bauer and Burton 1993. pg. 119	measurements taken in a minimum of 3 pools, length, max width, max depth and depth at pool tailout
Large Organic Debris	Platts et al. 1987. pg. 83	LOD > 10 cm diameter and >1 m in length; within bankfull zone of influence (applicable only in forested situations)
Stream Channel Classification	Rosgen 1994	to letter classification only (A,B,C, etc.)
Habitat Assessment	Hayslip 1993	follow habitat assessment protocol
Temperature	Franson 1992	instantaneous temperature measurements
Photopoints		photographs upstream and downstream at lower end of each reach; record directions in which photographs are taken
GPS	Trimble 1995	collect uncorrected (raw) data
Macroinvertebrates	Clark and Maret 1993	Hess sampler, w/500 μm mesh at three riffles (n=3); samples preserved and stored separately in the field; lab personnel composite the three samples, count and identify the first 500 individuals; Surber or kick net samplers used if conditions do not permit use of a Hess sampler
Fish	Modified from Chandler et al. 1993	collect fish in the study reach or an equivalent length of stream which includes all habitat types encountered in the study reach; collect, count, and voucher specimens (6 individuals if possible) for each species; measure total length of all salmonids

The BURP methodology involves collecting data on stream habitat parameters in relatively short reaches, commonly 100 meters, or 20 X stream width. These reaches are chosen to be representative of the entire stream segment being assessed. For this reason, the determination of habitat quality and comparisons of biotic data between study streams and reference conditions is greatly affected by site selections and whether the survey site accurately represents the conditions within the entire stream. Consequently, sample reaches should be both comparable between streams and representative of the entire stream segment being assessed.

Multiple measures are taken of most core parameters which include: flow, width / depth, canopy closure (shade), bank stability, substrate composition, habitat types, pool complexity (determined by evaluating 5 separate variables), large organic debris, stream channel classification, habitat assessment (determined by rating 12 criteria), and temperature. In addition, Macroinvertebrates are collected at each site, and fish are sampled by electroshocking. Crews receive training in field techniques and are supervised to ensure quality control. The habitat assessment and pool quality criteria are included in the *Stream Habitat and Parameter Interpretation, Standards and References* section of this report. BURP data from 11 Payette Lake Watershed streams (21 sites) is analyzed in this report.

3. Stream Reach Inventory and Channel Stability Evaluation. A Watershed Management Procedure (1978, Pfankuch).

This procedure was developed to measure and evaluate the resistive capacity of mountain stream channels to the detachment of bed and bank materials and to provide information about the capacity of streams to adjust and recover from changes in flow and increases in sediment production. The inventory utilizes maps, aerial photos, and field professional observations and measurements. The condition of the upper stream banks, lower stream banks, and channel bottom is evaluated by rating a total of 15 parameters including: slope, mass wasting potential, large woody debris, bank vegetation, channel capacity, bank obstructions and rock content, bank cutting and deposition, rock angularity, substrate brightness, particle embeddedness, scouring and deposition, and presence of aquatic vegetation. This methodology is commonly used by hydrologists and was utilized by the Payette National Forest to evaluate streams in the Payette Lake Watershed. See field inventory sheet included in *Stream Habitat and Parameter Interpretation, Standards and References* section of this report for parameter evaluation criteria.

4. Forest Practices Cumulative Watershed Effects Process for Idaho. (1995, Idaho Department of Lands).

This methodology combines field measurements with professional judgement to examine watershed processes in order to: 1) determine the hazards inherent in the watershed from erosion, increased water temperature, or nutrient accumulation; 2) evaluate the current stream condition; and 3) evaluate the current watershed condition. For each condition analyzed, rating criteria are provided. The Box Creek Subwatershed was analyzed using this process and results are summarized in the Stream Habitat Quality Appendix Tables; Box Creek Data Summary.

3.3.4 Stream Habitat Parameters-- Description and Limitations

Selection of monitoring parameters is based on designated uses, management activities and cost (MacDonald et al. 1991). Habitats for aquatic species are products of geology and soils, topography, vegetation, climate, and hydrology of a watershed (Meehan 1991). Meehan (1991) states that for the most part, these watershed characteristics remain fairly constant, and so does the productivity of the aquatic habitats. Any changes in these conditions can bring about changes in habitats that may greatly affect aquatic populations. Such changes may be caused by human activities such as logging, road construction, livestock grazing, and mining, or by natural events such as floods, mass soil movements, wind, and fire.

Stream parameters reviewed below are those used in this report to formulate conclusions regarding ecosystem functioning in the Payette Lake Watershed. Data was collected using different methodologies by the agencies.

Large Woody Debris (LWD)

a. Description of Data: The amount of large woody debris in stream channels is evaluated in both the BURP and R1/R4 methodologies. If both methodologies are reported for a given stream, the R1/R4 values are used for analysis as they represent a greater percent of the stream. In the BURP method, all LWD greater than 10 cm. in diameter and 1 meter in length is counted within each stream reach (IDEQ 1996). Diameters and lengths are not recorded, however, and the wood count is not delineated into numbers of pieces as single, aggregates, and root wads, making the BURP LOD count not comparable to Overton's (1995) natural conditions database. The R1/R4 methodology (Overton 1995) counts all LWD within bankfull width, measuring or estimating diameters and lengths, broken into three categories: 1) Single piece - must be 3 meters in length or two-thirds the wetted stream width (whichever is smaller) and 0.1 m in diameter one-third of the way up from the base. Smaller pieces are easily flushed through the system and are not retained. 2) Aggregate - a group of two or more pieces. The total number of pieces is estimated. For comparison to Overton's natural condition streams, aggregates count as one piece. 3) Root wads - attached to logs less than 3 meters in length. Volume of LWD was calculated for streams to facilitate comparison to INFISH standards. Aggregate volume was included in overall volume, calculated as 0.1 m x 1 m.

b. Limitations: Difficulties are encountered when trying to quantify and count large woody debris due to subjectivity and the visibility of pieces buried in aggregates, submerged in substrate and hidden by vegetation. Overton (1995) states that there is a high range of natural variability and sampling error appears to be high.

Width/Depth Ratio:

a. Description of Data: The R1/R4 methodology calculates a width to depth ratio for each habitat unit based on the mean wetted width and depth. The data summary tables for each subwatershed list the mean width and mean depth for the total habitat units in the reach. The mean width/depth shown in the table is the mean of all the width to depth ratios. The BURP data summaries also include the wetted width to depth ratio, and bankfull width and depth (width and depth at maximum flow), are provided as well.

b. Limitations: Definitions of channel width and depth varies in our data base, with the R1/R4 method using the wetted channel, and BURP using bankfull. Use of geomorphic indicators such as bankfull tend to be subjective and major runoff events can alter the channel cross-section making identification of bankfull features questionable. In addition one stream of uniform depth and width may have insignificant amounts of fish rearing habitat, yet another with the same average width to depth ratio may have shallow riffles interspersed with deep pools and overhanging banks which may provide abundant rearing habitat (Beschta and Platts 1986).

Pools

a. Description of Data: The R1 R4 methodology uses main channel pools to determine pool frequency, excluding pocket pools and side channel pools. Step pool complexes are counted as one pool. Inventories are conducted at base flows to maintain consistency of measurements, as changes in flow affect all pool measurements except residual depth (Overton et al. 1995). In the BURP methodology pool complexity is evaluated. Residual depth, pool length, substrate, overhead cover, submerged cover, and bank cover are measured. See Stream Habitat Quality Interpretation Standards and References Appendix Tables; Pool Quality Index, for ratings of these parameters. Due to the limited sampling area of the BURP methodology, the number of pools per 1.6 kilometer (one mile) was not calculated.

b. Limitations: The change from pools to runs or glides is one point on a continuum leaving the dimensions of a pool a matter of professional judgement. In larger streams with deeper pools, direct measurements are difficult and estimates may be necessary. Pool depth, pool area, and pool volume are all flow dependent, thus comparisons between surveys should consider the discharge at the time of data collection. In the PLWS study, all streams were analyzed with the R1/ R4 and BURP methodologies at base flow conditions to maintain consistency of measurements.

Pool/Riffle Ratio

a. Description of Data: This ratio was calculated by dividing the length of pool habitats by the length of riffle habitats in both the BURP and R1/R4 methodologies. Interpretations of this ratio were made from the R1/R4 data when available because these surveys covered a larger percentage of the stream. In the Stream Habitat Quality Appendix Tables; Data Summary, the BURP pool / riffle ratios were calculated for the reach length surveyed .and in addition, rated as part of the Habitat Quality Assessment Summary Appendix Tables, ranging from optimal to poor.

b. Limitations: The common interpretation is that a ratio of 1 is optimal. Platts (1974) found the highest salmonid fish standing crops in the South Fork Salmon River drainage were in stream reaches with a pool-riffle ratio of 0.4 - 1. However, streams with high pool-riffle ratios have been shown to be high producers of salmonids (Platts et al. 1983). In some high gradient streams, riffles and pools may be difficult to discern, and are replaced by cascades and pocket waters (IDEQ 1996). MacDonald et al. (1991) state that habitat unit surveys may be relatively insensitive to land use practices. A small amount of sediment may significantly alter the bed material or residual pool volume, but not alter the size of or ratio among different habitat units.

Substrate Composition

a. Description of Data: The R1/R4 Fish habitat Inventory technique and the BURP methodology both utilize the Wolman Pebble Count procedure to determine substrate composition, however, the techniques categorize the particle size classes somewhat differently. For the analysis in this report, " fine sediment" refers to particle sizes less than 6 mm. If both methodologies are reported for a given stream, the R1/R4 values for mean percent substrate composition is used for analysis, as it represents a greater percentage of the stream. The BURP data for this parameter represents one Wolman Pebble Count in the reach, while the R1/R4 data averages multiple counts representing a 20 percent sampling of pools and 10 percent sampling of low gradient riffles. In addition, the percent surface fines (< 6 mm) was visually estimated in the R1/R4 methodology in pool tails and low gradient riffles, and beginning in 1995, a 49-Intersection Grid technique was used by the Payette National Forest to assess some habitat units for fine sediment (6 mm). Bottom substrate (percent fines <6.35 mm) is also evaluated by ocular estimation in the BURP Habitat Assessment Summary. The dominant particle size determined by the Wolman Pebble Count is represented in bold and referred to as the "D50" in the Habitat Quality Appendix Summary Data Tables. The "D50" particle size occurs in the size class where 50 percent of the substrate particles have a diameter less than the D50 diameter. A decrease in the D50 size is generally interpreted as an adverse effect

b. Limitations: While the Wolman Pebble Count is useful for characterizing the substrate overall, it is not the preferred technique for fine sediment analysis, due to individual sampling biases. In this analysis, data from all the sampling techniques utilized (including ocular estimates and the 49-intersection grid technique)are evaluated to draw conclusions.

Bank Stability

a. Description of Data: In the R1/R4 methodology, stable banks (vegetated and unvegetated) are estimated as a percentage of the total bank length (left and right banks) for each habitat type at the steepest portion of the bank between bankfull and the existing water level. According to Overton et al. (1995) stable streambanks show no evidence of active erosion, breakdown, tension cracking, or shearing. Undercut banks are considered stable until tension fractures show on the ground surface at back of the undercut. The BURP methodology follows the approach of Platts et al. (1983) including measuring and proportioning banks into four stability classes: mostly

covered and stable (non erosional), mostly covered and unstable (vulnerable), mostly uncovered and stable (vulnerable), and mostly uncovered and unstable (erosional). The streambank is envisioned as that part of the channel which would be most susceptible to erosion during high water; therefore it represents the steeper-sloped sides of the stream channel. Banks are considered unstable if they show indications of breakdown, slumping or false bank, fracture, and steepness over 80 degrees with erosion. See Section III B, Streambank Stability for definitions and discussion of protocol.

b. Limitations: Some limitations related to assessing the degree of bank stability include: the lack of accuracy and precision involved in visual estimates, the inability to identify specific causes of instability, varying sensitivity of stream reaches, and the difficulty of separating natural and management impacts. According to Platts, (1981) grazing has the most direct and obvious impact on bank stability, and this may mask other impacts (MacDonald et al. 1991). Discharge and sediment yield tend to be controlled by upslope processes, so the linkage to bank stability is not immediately obvious, however, bank stability may be most useful as a quick indicator of shift in the equilibrium of the stream system (MacDonald et al. 1991).

Temperature

a. Description of Data: Stream temperatures in the PLWS were analyzed using thermograph records from the Payette National Forest, Idaho Department of Fish and Game, and Idaho Division of Environmental Quality. Bimonthly temperatures (IDEQ) were evaluated if thermograph records were unavailable. Temperatures in this database include 1993, 1994, 1995, and 1996 data. In general, temperatures from 1994 are highest due to low flows and drought conditions. Temperatures were evaluated in terms of total number of days exceeding 13°C and 15°C, and the number of days exceeding these temperatures during the approximate fall spawning interval of August 20 - September 20. Temperatures in this range exceed INFISH (1995), IDEQ (1996), and biological standards (Bjornn and Reiser 1991) discussed in Section III B. No temperature data was available for Brush Creek, Dead Horse Creek, and Landing Creek.

b. Limitations: Thermographs provide a continuous record of temperature variability, and are a useful approach for assessing thermal suitability of streams for aquatic species. According to MacDonald et al. (1991), the additive nature of temperature increases and the likely importance of sublethal effects suggest that monitoring is needed when 1) the potential exists for large changes of water temperature due to management activities, 2) water temperatures are already in the upper range of acceptable temperatures, and 3) there is potential for significant temperature increases due to the additive effects of smaller increases. Temperature effects also need to be distinguished from open canopy effects including: increased light, increased nutrients, greater primary productivity, and amounts of large woody debris (MacDonald et al. 1991).

Dissolved Oxygen (DO)

a. Description of Data: Dissolved oxygen levels (mg/L) in the PLWS streams were obtained bimonthly by IDEQ at designated water quality sites. Records (2/15/95- 7/30/96) were available for the following streams: North Fork Payette River, Fisher Creek, Pearl Creek, Deep Creek, Twentymile Creek, and Cougar Creek.

b. Limitations: Fish can modify spawning site conditions in the redd building process, and monitoring sites should be carefully selected to represent the actual DO levels eggs will experience (Chapman 1988).

3.3.5 Aquatic Organisms

Macroinvertebrates

a. Description of Data: Macroinvertebrates are collected as part of the BURP methods from three separate riffles per site and combined as one sample, using a modified Hess stream bottom sampler with 0.5 mm mesh. The first 500 individuals are counted and identified to species. Seven metrics are calculated for the IDEQ (1996) Macroinvertebrate Biotic Index (MBI) including: percent EPT, Hilsenhoff Biotic Index (HBI), percent scrapers, percent dominance, EPT Index, Taxa Richness, and the Shannon-Weiner Diversity Index. Each metric measures a different component of community structure and a different range of sensitivity to pollution stress. The IDEQ MBI is calculated based on these metric values compared to the Northern Rockies Ecoregion reference standards representing the best conditions for this region (DEQ, 1996). The Northern Rockies Ecoregion individual metric values are presented in the Section III A, data tables for comparison with the PLWS stream values and the MBI value is given for each site. The IDEQ MBI is used to determine the level of macroinvertebrate assemblage impairment. See Stream Habitat Quality Appendix Table; Parameter Interpretation Standards and References, for interpretations of this value.

The macroinvertebrate data was also evaluated using Plafkin's (1989) Rapid Bioassessment Protocols approach for the seven metrics listed above. According to Plafkin (1989) metrics based on standard taxa richness and EPT indices (% EPT. EPT index, and taxa richness), differences of 10-20% are considered nominal, thus a value within 80% of the reference condition would be considered non-impaired for that metric. For this analysis, the best condition value obtained for the metrics within the PLWS, as well as the Northern Rockies Ecoregion values are used as references for comparison. Northern Rockies Ecoregion values are generally considered to be high (pers. comm. F. Rabe) and should not be weighted as heavily as the regional reference. Box Creek (Sites 1 and 3) had the highest PLWS values for these metrics are used for the PLWS regional reference. Percent dominance is evaluated based on percent contribution, not percent comparability to a reference site, with < 20 % dominance considered optimal (Plafkin 1989). The HBI score is evaluated as a ratio of the reference site to study site x 100, with greater than 85% considered optimal (Plafkin 1989). Shannon's H' Diversity Index and percent scrapers rate

as optimal if values are within 80% of the reference site value. Section III B describes the significance and interpretation of the metrics.

All sites evaluated in the PLWS fall within 1st through 3rd order streams, with the exception of two 4th order sites on the North Fork Payette River. First through third order streams as viewed in the river continuum concept (Vannote et al.1980) are heavily canopied, light-limited heterotrophic systems with rocky substrates. Dominant macroinvertebrate species in lower order streams include shredders and collectors, with a smaller percentage of grazers and predators (Ward 1992).

b. Limitations: Disadvantages of monitoring macroinvertebrates include a relatively high degree of variability within or between sites, local or regional variations in the sensitivity of given organisms to stress, and the need for specialized taxonomic expertise (MacDonald et al. 1991). Sampling should be replicated at sites and stratified by habitat type due to variability with depth, current speed, and substrate character. The BURP macroinvertebrate samples were obtained at base flows (late July-August), however, flows differed between years which could contribute to variability, and samples were combined at sites, thus they are not replicates. Sampling variability may also result from the sampling device operations, physical features of the habitat, laboratory sorting procedures, and biological features of the study population (Platts et al. 1983).

Fish

a. Description of Data: The status of the fish population in the PLWS was determined by Idaho Division of Environmental Quality electrofishing catch per unit effort records, and snorkeling surveys conducted by Idaho Department of Fish and Game, and the Payette National Forest. The BURP electrofishing technique consists of one upstream pass without block nets, identifying and measuring all fish. In streams of a given size and with the same sampling method and efficiency of effort, poorer sites are expected to yield fewer individuals than sites of higher quality (Karr et. al.1986). Snorkeling surveys conducted for the Payette National Forest by L& H Aquatic Research (Twentymile Creek, NF Payette River, and Trail Creek) consisted of a 20% sampling frequency of slow habitat types and a 10% sampling of fast water units. Fish were identified by species, number and size class.

b. Limitations: Sampling of fish populations must be done accurately because freshwater fish have wide fluctuations in year-class strength, and sampling techniques have different advantages and disadvantages. Snorkeling is useful in streams with low conductivity, however more secretive fish may avoid detection. In general, snorkeling allows a true estimate of fish populations only for certain species under favorable conditions (Platts et al. 1983). Electrofishing may be affected by stream conductivity, temperature, depth, and clarity of water.

3.3.6 References for Stream Habitat Analysis

Standards were compiled from the literature and state and federal agencies to provide a basis from which to interpret the available stream data. In many cases more than one standard is presented for a parameter. The resources used as references for standard conditions are detailed below.

Overton, C.K., et al. 1995. User's guide to fish habitat: descriptions that represent natural conditions in the Salmon River Basin, Idaho, USDA Forest Service General Technical Report INT-GTR-322. Ogden, Utah, U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 142 p.

Overton (1995) describes the physical features of stream channels that represent natural conditions for fish habitat within the Salmon River Basin in Idaho. "Natural conditions" refers to the structure and patterns of streams that have not been substantially influenced by human disturbances. Data for this guide was collected at four scales, including watershed, channel reach type, habitat type, and habitat type attribute. Streams were evaluated at base flow conditions using the R1/R4 Fish and Fish Habitat Standard Inventory Procedure. Summary statistics were calculated for bank stability, bank undercut, width-to-depth ratio, width-to-maximum-depth ratio, surface fines, water temperature, large woody debris frequency, and pool frequency. Large woody debris and pool frequency are summarized by stream size classes. This guide was used as a reference for comparison with five Payette Lake Subwatershed streams inventoried with the R1/R4 technique. The comparisons were made with relatively un-impacted streams with similar geology (plutonic), Rosgen channel types (A, B, or C), and widths.

USDA Forest Service. 1995. Inland native fish strategy environmental assessment. Interim strategies for managing fish-producing watersheds in eastern Oregon and Washington, Idaho, Western Montana, and portions of Nevada.

This strategy provides interim direction for National Forests and US Fish and Wildlife Service agencies to protect habitat and populations of resident native fish outside of anadromous fish habitat in eastern Oregon, eastern Washington, Idaho, western Montana, and portions of Nevada. Riparian management objectives, standards and guidelines, and monitoring guidelines are presented. The riparian management objectives are described as good indicators of ecosystem health and delineate the desired conditions for fish habitat by habitat feature and interim objectives. Desired conditions are described for pool frequency, water temperature, large woody debris, bank stability, lower bank angle, and width/depth ratio; and were listed for reference to Payette Lake Watershed streams when applicable.

Bjornn, T.C. and Reiser, D.W. 1991. Habitat requirements of salmonids in streams. Influences of forest and rangeland management on salmonid fishes and their habitats. W. Meehan editor. American Fisheries Society Special Publication 19:83-138.

Bjornn and Reiser present optimum and limiting values for the range of habitat conditions for each life stage for various species of fish. Ranges of temperatures, water velocities, depths, cover, and substrates preferred by salmonids, trout, and char are presented. This source was used to provide a basis for comparison for temperature, dissolved oxygen, and substrate quality for meeting life history requirements of resident fish species in the Payette Lake Watershed.

MacDonald, L.H.; Smart, A.W.; Wissmar, R.C. 1991. Monitoring guidelines to evaluate the effects of forestry activities on streams in the Pacific Northwest and Alaska. EPA 910/9-91-001. Seattle, Washington: U.S. Environmental Protection Agency and University of Washington. 166 p.

This document provides information for designing water quality monitoring projects and selecting monitoring parameters. Part I discusses the regulatory mechanisms for nonpoint source pollution and defines seven types of monitoring. Part II is a technical review of the six categories of parameters: physical and chemical constituents, flow, sediment, channel characteristics, riparian, and aquatic organisms. Each parameter is discussed in seven sub-sections: definition, relation to designated uses, response to management activities, measurement concepts, standards, current uses, and assessment. This reference was useful for evaluating some of the monitoring techniques used in the Payette Lake Watershed, and for providing standards for some parameters in the Payette Lake Watershed Data Base.

Idaho Division of Environmental Quality. 1996. Water body assessment guidance. A stream to standards process. Prepared for State of Idaho, Watershed Monitoring and Analysis Bureau. 109 p.

This document presents guidelines for assessing data collected by the Beneficial Use Reconnaissance Project (BURP), and other sources. BURP objectives are to determine beneficial use attainability, and beneficial use status for streams in Idaho. Aquatic life beneficial use is the most sensitive of all the beneficial uses a water body can have. This guide is based on interpretation of *Idaho's Water Quality Standards and Wastewater Treatment Requirements*, and includes cold water biota general criteria for stream parameters. This reference presented State of Idaho standards for dissolved oxygen, temperature, and macroinvertebrate community structure for comparison with Payette Lake Watershed data.

Plafkin, J.L.; Barbour, M.T.; Porter, K.D.; Gross, S.K.; Hughs, R.M. 1989. Rapid bioassessment protocols for use in streams and rivers. Benthic macroinvertebrates and fish. U.S. Environmental Protection Agency, EPA/444/4-89-001.

The purpose of this document was to provide states with a practical technical reference for conducting cost-effective biological assessments of lotic systems. Three macroinvertebrate and two fish protocols are presented which advocate an integrated assessment, comparing habitat and biological measures with defined reference conditions. This reference was useful for interpreting the macroinvertebrate data collected in BURP.

Platts, W.S.; Megahan, W.F. Minshall, G.W. 1983. Methods for evaluating stream, riparian. and biotic conditions. Gen. Tech. Rep. INT-138. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 70 p.

This report discusses some of the environmental parameters that best measure and describe conditions existing in aquatic ecosystems. Standard techniques are presented for measuring the aquatic, riparian, and biotic attributes; and the precision and accuracy of these measurements is discussed. This reference was useful for assessing the macroinvertebrate community structure on the Payette Lake Watershed as well as for providing a basis to evaluate and interpret stream habitat parameters including pool quality, pool / riffle ratios, and bank stability.

3.3.7 Stream-bed Sediment Nutrient Enrichment Monitoring

Stream channels can store significant amounts of fine sediments depending on the channel morphology, roughness and slope. Fine sediments, in addition to impacting fish habitat, have a strong affinity for nutrients, particularly phosphorus, and may accumulate additional nutrients through other bio-geochemical processes and effect the bioavailability of sediment bound nutrients (Taylor and Kumishi, 1971; Bostrom, et al, 1988). The nutrient status of fine sediments stored in streams was determined for each priority sub-watershed. Samples were collected in conjunction with the BURP stream assessments. Due to presence of gravels or very coarse sands, core samples were not obtained from all sites.

Submerged soils in streams were collected with a PVC core driven into the substrate to a depth of approximately 150 mm. Samples were collected from the center of the stream channel and at the wetted edge depending on the substrate conditions. The intact soil core was placed into a single plastic bag and labeled. If distinct soil horizons were present, each horizon was measured for depth of horizon, separated into an individual bag and labeled accordingly.

Analysis of soils from stream beds included estimates of the percent sand, silt and clay present in each core using the hydrometer method. This analysis was contracted to the University of Idaho analytical services laboratory. Other soil characteristics analyzed included the following:

> Bulk density - Dry bulk density were be computed from percent dry weights of the soil sub-sample, wet weight and volume of the original core. Percent dry weights and water content were calculated from soil wet and dry weights. Bulk densities are expressed as g dry weight/cm^3 of soil for each core volume.
>
> Soil pH - Soil pH was measured using a 10 g wet weight of soil sub-sample mixed with 20 ml deionized water. This soil/water mixture was allowed to settle and pH obtained from the liquid after 10 minutes

Table 3-7. Lists the chemical constituents analyzed from each stream-bed core. Estimates of labile and non-labile fractions of phosphorus were determined by a modification as described.

Table 3-7. Soil Chemistry Analysis Methods

Parameter	Sample Source	Method
Extractable Inorganic N	Wet/Dry Soil	Known sample extracted with 1M KCL solution (1:100 soil to extractant on a soil dry basis), shaken for 1 hour, centrifuged for 15 minutes at 5,000 rpm and then filtered (0.45 um pore membrane filter). Filtered extract analyzed for ammonium -N using an automated salicylate nitroprusside method 351.2 (EPA, 1983).
HCL Extractable P	Dry Soil	5.0 g of dry soil extracted with 25 ml of 1M HCL for three hours, filtered (0.45 um pore membrane filter) and analyzed for SRP using method 365.1 (EPA, 1983) and total P using block digestion and automated ascorbic acid method 365.4 (EPA, 1983). HCL-P_i represents the Ca bound P fraction.
HCL Extractable Cations	Dry Soil	1M HCL extract prepared as in HCL extractable P and analyzed for Ca, Mg, Fe, and Al using inductively coupled argon plasma (ICAP) spectrometry method 200.7 (EPA, 1983).
Bicarbonate Extractable P	Wet/Dry Soil	1 g dry weight equivalent of wet soil extracted with 25 ml of 0.5M $NaHCO_3$ solution (pH=8.5), shaken for 30 minutes, soil suspension filtered (0.45 um pore membrane filter) and analyzed for soluble reactive P (SRP) and total P. A sub-sample of the extract (10 ml) is digested using a potassium persulfate digestion method 4500-P (APHA), 1989). Digested volume is analyzed using automated ascorbic acid method 365.1 (EPA, 1983). P fractions will be reported as P^i (inorganic P or soluble reactive P) and P_o (organic P).
Total P	Dry Soil	1.0 g dried weight combusted at 550^0 C for 4 hours in a muffle furnace. Ash residue dissolved in 20 ml of 6M HCL, then heated to evaporate to dryness. Residue redissolved in 2.25 ml 6M HCL, heated again and filtered (Whitman #42 filter) and brought to 50 ml volume and analyzed for total P using automated ascorbic acid method 365.4 (EPA, 1983).
Total N	Dry Soil	Finely ground (100 mesh) samples analyzed for total N and C using a Leco CHN 600 Combustion Autoanalyzer.

3.3.8 Channel Geometry Monitoring and Bank Stability

Changes in channel cross-section profile were measured annually to determine inter-annual differences in accretion and deposition processes. These measures provided an estimate of the amount of stream bank material eroded or re-deposited from upstream erosion. A cross-section profile of each stream channel and floodplain was determined for representative channel types monitored under the BURP protocols. In most cases, at least two channel sites were measured for each stream reach. Channel types were classified using the Rosgen Stream Classification system.

Complete protocols for the channel measurements are listed in Worth (1995). Briefly, transects crossing perpendicular to the channel were established at roughly 10, 20, 50, 70, 80, 100 meters downstream from a selected stream section. Channel cross sections were measured for the wetted width (WW) of the stream channel at equally spaced intervals by dividing the WW by 14 (at least 14 measurements were obtained). The bank full width was also measured together with measures of bank angle for both banks (angle in degrees deviation from horizontal) and the length and angle of bank undercut.

Bank stability was additionally measured throughout the entire reach of stream segment monitored. A minimum 100 m length of channel including both banks was documented by visual observations. Stability was estimated based on the linear meters of stream bank characterized according to the following criteria:

Covered & Stable (non-erosional) - more than 50% of bank surfaces are covered by vegetation in rigorous condition or covered by armored materials (large rocks). Stream banks appear stable and no evidence of cutting, breakdown, shearing or slumping.

Covered & Unstable (vulnerable) - over 50% of bank surfaces are covered by vegetation in rigorous condition or covered by armored materials (large rocks). Streambanks appear unstable with evidence of breakdown, cracking, sloughing, cutting or slumping. Recent evidence of erosion is typified by vertical or near vertical banks with little or no regrowth.

Uncovered & Stable (vulnerable) - less than 50% of streambank surfaces are covered with vegetation in vigorous condition or covered by armored materials. Stream banks appear stable and no evidence of cutting, breakdown, shearing or slumping. Banks may be bare but they appear to be holding together and are not vertical.

Uncovered & Unstable (eroding) - less than 50% of banks are covered by vegetation in vigorous condition or by armored materials. Streambanks appear unstable with evidence of breakdown, cracking, sloughing, cutting or slumping. Recent evidence of erosion is typified by vertical or near vertical banks with little or no regrowth.

3.4 Assessment of Watershed Sediment Contributions

The volume of sediment reaching aquatic systems as a result of soil creep, mass wasting, fire, roads, and harvest activities was calculated for the Payette Lake watershed. Calculations were based on observations made during field visits on October 11-16, 1996; aerial photographs of the watershed; Geographic Information System (GIS) databases of streams, roads, and past harvest; and watershed information supplied by the US Forest Service.

3.4.1 Background Sediment Yield

The major processes moving sediment downslope and into streams in the undisturbed portions of the Payette Lake basin include soil creep, mass wasting, and surface erosion on burned, unvegetated hillsides. Soil creep is the slow downslope movement of soil resulting from gravitational forces and during discussions between DEQ, the Payette National Forest and the consultants was believed to include soil movement resulting from biological activities such as animal burrowing and soil attached to roots of fallen trees. Mass wasting was observed to be an important delivery process in the steep valley sidewalls in portions of the glaciated uplands in the watershed. A large fire (Corral-Blackwell fire), covering half of the watershed occurred in 1994. Fires can remove vegetation protecting the soil and result in increased surface erosion and mass wasting.

Soil Creep

The sediment yield from soil creep was estimated using the following formula:

> Annual Sediment Yield from Soil Creep = Length of Stream Channel * 2 banks* Average Soil Depth * Average Creep Rate

The length of channel was obtained from the GIS stream database. An average soil depth of 2 feet and an average creep rate of 0.06 inches/yr (1.5 mm/year) was used (Washington Forest Practices Board 1994). Stream channel length was multiplied by 2 to account for creep from both sides of the stream. The calculated soil creep was multiplied by 1.4 to account for the bulk density of soil/rock along stream banks and convert the volumetric creep estimate to tons. The bulk density value chosen is an average of lower density, thinner upper soil horizons and the higher density, thicker lower soil horizons.

In order to provide an alternate estimate of background sediment production, rates measured in undisturbed drainages of similar geology were used. A value of 25 tons/sq. mi/yr was multiplied by the area of each subbasin (Walt Megahan, pers. comm. 1997). This estimate, however, may be biased due to inclusion of multiple sediment sources (surface erosion, channel erosion, and mass wasting) in a single collective estimate. Mass wasting contributions in this study are calculated as a separate addition to the total sediment sources. Thus, estimation of background erosion contributions using the undisturbed erosion coefficient may slightly overestimate natural background sediment totals when tabulated with mass wasting contributions.

Mass Wasting

In consultation with DEQ personnel, Forest Service employees, Idaho Department of Lands representatives and other individuals knowledgeable about mass wasting processes in central Idaho, the analysts agreed to use a modified form of the mass wasting analysis procedures outlined in the Washington State Watershed Analysis methodology, version 3.0 (Washington Forest Practices Board, 1994). This methodology uses the underlying characteristics of the watershed to determine landscape areas that have produced landslides in the past and that have the potential to produce landslides in the future. It is a qualitative approach, which emphasizes analyzing the actual landslide history of the watershed in combination with the underlying general characteristics of the landscape (i.e., its slope, aspect, lithologic types and landscape evolution).

The method assumes that slopes and rock types that have failed in the past are more likely to fail again in the future. It uses three kinds of information: an analysis of historical aerial photographs to create a landslide inventory, research into the nature and susceptibility of the lithologies underlying the located landslides, and a geomorphic analysis of the characteristics of the watershed's slopes that have produced landslides in the past. All of this information allows the analyst to create a rating system that is used to delineate areas in the watershed that are more likely to produce landslides in the future. In addition, the inventory includes information about whether or not a particular landslide delivered sediment to a stream or body of water, and about the quantity of material that it may have removed and transported to the stream. Because it is a qualitative analysis, this approach does not attempt to predict a reliability level for the hazard rating system it develops. Instead, the analyst defines the confidence level for the various kinds of information that he/she develops and uses in the analysis.

Three methods were used to analyze the mass wasting in the Payette Lake watershed: aerial photo analysis, field investigations, and watershed slope analysis. Five sets of aerial photographs, taken in 1946, 1969, 1976, 1987, and 1995, were examined to track the history of the mass wasting features in the watershed. The 1946 set of photographs are black and white and did not provide full coverage of the entire watershed. Therefore, the landslides in areas that were not covered by the 1946 photos may have been present in 1946, but they were actually inventoried off of the 1969 photos. The mass failures first recognized in the 1949 or 1969 photos could have occurred any time before the photos were taken Therefore, they may be either "ancient" in the sense of having occurred and reactivated within the recent geological past, or "historical", having occurred within more recent time preceding 1946. It is not possible to interpret from photos the exact age of a particular landslide, other than by noting its presence or absence in a particular photo set.

Field identification and verification of the mapped mass failures was undertaken from October 9-16, 1996. The work included checking and investigating active and recent landslides identified from aerial photo analysis, and identifying landslides and mass failures that were not visible on the aerial photographs.

The analysis of the watershed slopes was undertaken with the aid of a slope map generated by the GIS analyst, an analysis of the slope aspect from the topographic maps, and identification of

specific landforms from the aerial photographs. These three types analysis were then compared with each other and combined with the landslide inventory map and lithologic map to find areas that are more susceptible to mass wasting.

While the GIS slope map is used as the basis for some of the landslide hazard mapping in the watershed, it should be noted that the slope map has some limitations. The density of the data points used to create the map means that small areas of high slope located within larger areas of lower slope may not be shown. Instead, they are generalized into the lower slope categories. The glacial nature of this watershed means that it contains a larger number of these high slope "pockets" than the more typical fluvially dissected terrain. This fact is important, because these pocket areas are more susceptible to mass wasting. Thus, it appears that some debris slides formed within lower slope terrain, when in fact they are probably located within one of these high slope pockets that does not show up in the mapping of the lower slope terrain. Managers working in these areas should note the locations of these landslides and take the same sorts of precautions as suggested for the mapped high landslide hazard areas.

Fire

The Corral-Blackwell fires burned over half of the Payette Lake watershed during the summer of 1994. Based on observations made during field work in the watershed, the following assumptions were made to calculate the input of sediment from the 1994 fires:

(1) Any sediment eroded from burned areas did not reach streams unless the riparian vegetation was burned (defined as moderate or high intensity burn on USFS stream surveys or showing up as brown or black vegetation in the 1995 color aerial photographs of the basin).

(2) In areas where riparian vegetation was burned, the hillside area that could contribute eroded sediment to that stream segment was delineated based on USGS topographic maps. Burn intensity was determined from USFS burn intensity maps for each area.

(3) Fire erosion rates for low or moderate intensity fires as defined in the BOISED sediment erosion/delivery model were used (Table 3-8).

Table 3-8. Basic fire erosion rates (in tons/square mile/year). Adapted from Reinig et al. (1991).

Year Since Fire	Low Intensity Burn	Moderate Intensity Burn
1 (1995)	110	275
2 (1996)	24	60
3 (1997)	5	13
4 (1998)	1	3

Total estimated sediment input from the 4 years following the Corral-Blackwell fires was thus calculated as:

Sediment Input from Fire (tons) = Basic Fire Erosion Rate X Geologic Erosion Factor X Area Contributing to Stream Reach

Geologic Erosion Factor = Factor for each landtype (Reinig et al. 1991)

3.4.2 Sediment Input from Land Management Activities

Roads

Erosion from roads in the basin was estimated using road erosion rates from the BOISED manual (Reinig et al. 1991) applied to road segments that contribute to streams in the basin. Approximately 80 percent of the total miles of open forest roads in the basin were surveyed during October, 1996. Information on the road tread, cutslope, fillslope, ditch, and delivery of road runoff to a stream were recorded for each road segment that delivered to a stream. Each of these delivering segments was also marked on a map. After returning from the road survey, these delivering segments were transferred to a base map for entry into the GIS system. Delivering segments were also delineated on the map for non-surveyed roads in the basin at locations where these roads crossed streams. Average tread width, surfacing, cutslope and fillslope cover, and delivery rates were assigned to non-inventoried roads based on observations of the roads in the basin.

Roads within the town of McCall were not included in the survey. Erosion from these roads is accounted for in stormwater runoff measurements made by Idaho Division of Environmental Quality.

Road erosion rates were calculated as follows. Factors used are defined below and in Tables 3-9 through 3-11.

Average Sediment Input from Roads (tons/yr) = Basic Road Erosion Rate X Geologic Erosion Factor X Road Gradient Factor X Mitigation Factor X Delivery Factor X Road Prism Width X Segment Length

Geologic Erosion Factor = Erosion factor for each landtype (varies from 0.5 to 1.3 depending on landtype/soil erodability)
Road Prism Width = average total width of cutslope, ditch, tread, and fillslope
Segment Length = length of road that delivers sediment to a stream
Delivery Factor = percent of road drainage that reaches creek (estimated in field)

Table 3-9. Basic Road Erosion Rate.

Road Use	Traffic Type	Erosion Rate* (tons/sq mi/yr)
Heavy	Main haul road or highway	7,000
Moderate	Secondary road	6,000
Light	Less than 5 vehicles/day	5,000
None	Closed to traffic	1,250

* Erosion rates for existing roads were used to calculate long-term average annual road erosion rates for comparison with other sediment sources. A newly constructed or heavily reconstructed road will have a much (2-5 times) higher erosion rate for the first 3-4 years following construction (Megahan, 1974).

Table 3-10. Road Gradient Factor

Road Slope	Factor
0-5%	0.5
5-10%	1.0
over 10%	1.5

Table 3-11. Mitigation Factor

Tread Composition	Factor
Asphalt	0.05
Gravel	0.2
Native	1.0

In addition to estimates of surface erosion from the road prism, sections of road with rills or gullies that delivered to streams were also noted. The dimensions of the gullies (average width, depth, and length) were estimated in the field so a volume of eroded sediment could be calculated.

An alternate estimate of road surface erosion rates was calculated using procedures and empirical relationships from the Washington Department of Natural Resources Watershed Analysis Manual (Washington Forest Practices Board 1994). This method uses erosion rates and mitigation factors compiled from road research throughout the Pacific Northwest. While the erosion rates are derived from areas farther away from Payette Lake than the BOISED method rates, the Washington method has the advantage of applying much more site-specific information from the road survey to calculations of erosion from that particular road segment. Thus, while the BOISED method may more closely represent total volumes of sediment coming from road segments in the basin, the Washington method allows road managers to determine more accurately which road segments and which road prism components are supplying the most sediment to streams in the basin.

The average annual volume of sediment delivered to a stream system at each stream crossing was calculated based on the following formulas:

Total Sediment Delivered from each Road Segment (in tons/year) = Tread + Cutslope + Fillslope + Gully Erosion

Tread = Basic Erosion Rate x Tread Surfacing Factor x Traffic Factor x Segment Length x Road Width x Delivery Factor

Cutslope = Basic Erosion Rate x Cutslope Cover Factor x Segment Length x Cutslope Height x Delivery Factor

Fillslope = Basic Erosion Rate x Fillslope Cover Factor x Fillslope Segment Length x Fillslope Height x Delivery Factor

Values for each factor in the equations were obtained from information collected during the road inventory. These values were linked to lookup tables to calculate total sediment delivered from each road segment (based on WDNR 1994). Tables 3-12 through 3-15 show the values that were used. Parent material for each road segment was assigned based on observations of the road cut.

Table 3-12. Basic Soil Erosion Rate.

Parent Material	Basic Erosion Rates (tons/acre/year)
alluvium	30
sandy till	30
silty till	60
granite	30
gneiss	30

Table 3-13. Road Tread Surfacing Factor.

Surface Type	Surface Factor
Asphalt	0.05
Gravel	0.2
Native	1.0

Table 3-14. Traffic Factor

Road Use	Traffic Factor
Heavy	5
Moderate	2
Light	1
None	0.02

Table 3-15. Cutslope and fillslope cover Factor

Percent Vegetation or Rock	Cover Factor
100	0.1023
90	0.1500
80	0.2003
70	0.2540
60	0.3116
50	0.3742
40	0.4433
30	0.5222
20	0.6155
10	0.7700
0	1.0000

The delivery of sediment from each of the road prism components was determined based on the road drainage configuration (Table 3-16) and the delivery of road runoff as noted in the field for each segments (directly to a stream channel - 100 percent delivery; within 200 feet of a stream - 10 percent delivery; or to the forest floor - no delivery).

Table 3-16. Road Component Delivery.

Length of Road Component Delivering			
Road Drainage	Tread	Cutslope	Fillslope
Insloped	All	All	Length noted in field
Outsloped	Equal to length of fillslope	Equal to length of fillslope	Length noted in field
Crowned	Half width for total length	All	Length noted in field

Timber Harvest

An evaluation of the potential for surface erosion from harvest practices in the basin was made based on observations from aerial photographs and field checking of individual harvest units for erosion. Maps of past harvest were obtained from the GIS database. Selected recent harvest units were observed during the field visit to determine if erosion was occurring and reaching waterways. The type of erosion (sheet erosion, gullying, rilling) was noted in each unit as well as whether the eroded sediment was delivered to a stream or body of water.

Observations on the ground and on aerial photographs showed that minimal sediment from timber harvesting or skid trails in recently harvested units was reaching creeks. Stream buffers and erosion control measures on skid trails (e.g. water bars) were effective at protecting waterways. The only potential for sediment to reach creeks was if skid trails or ground disturbance occurred close to creeks. The following equation was used to estimate sediment reaching waterways from timber harvest activities:

> Sediment Input from Harvest (tons) = Basic Harvest Erosion Rate X Stream Length within Harvest Units X 2 banks X 50 feet on each bank

Basic harvest erosion rates were taken from the BOISED manual, and vary by type of harvest (clearcut, partial cut) and tree skidding method (tractor, skyline, cable, helicopter). The rates also decline each year following harvest as vegetation regrows in harvested areas and erosion decreases (Table 3-17). Stream lengths within harvest units were obtained from the GIS database. The assumption that sediment produced from 50 feet on each side of the creek reached the creek is a maximum assumption. The little research measuring surface erosion transport distances in harvest units that has been performed suggests 30 foot buffers are effective at trapping sediment (Walt Megahan, pers. comm.,1997). Field observations in the Payette Lake watershed indicated eroded sediment movement varied with small-scale topography, vegetation, and obstructions within each unit.

Total sediment input from harvest was divided by the period of harvest records (1950-1995) to yield an average annual sediment input (tons/yr) from harvest in the basin for comparison with other sediment sources.

Table 3-17. Basic Harvest Erosion Rate by Year after Harvest (tons/sq. mile/year) from Reinig et al. 1991.

Harvest	Type/Method	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
clearcut	tractor	340	180	140	90	40	20
clearcut	helicopter	65	34	27	17	8	4
clearcut	skyline	112	59	46	30	13	7
partial cut	tractor	241	128	99	64	28	14
partial cut	helicopter	48	25	20	13	6	3
partial cut	cable	146	77	60	39	17	9

3.4.3 Relative Phosphorus Loading from Surface Erosion and Mass Wasting Sources

Phosphorus is an important nutrient that is often associated with eroded sediments and can contribute to eutrophication in lakes. The amount of phosphorus contributed from eroded sediments depends upon the phosphorus content of the particular sediment source, and the

availability of that phosphorus to algae and other microorganisms (bioavailable phosphorus). Actual phosphorus loading from different sediment sources is a very complex issue since phosphorus levels vary considerably both within a soil profile and between different soil types in a watershed. Some limited data on relative phosphorus levels in soils have been collected in the Gold Fork River watershed, south of the Payette Lake basin (Fisher et al. 1997). The Gold Fork data indicate that bioavailable phosphorus from the A soil horizons (surface soil layer; rich in organic matter) averaged 5 times higher that from C soil horizons (lower, parent material layers). Bioavailable phosphorus is generally associated with and transported by clay-sized sediments from eroded soil. Clay content of granitic soils averages 5 percent; clay content of road fills is typically 3 percent (Walt Megahan, pers. comm. 1997).

In order to provide an estimate of the relative amount of phosphorus (relative phosphorus loading - RPL) from different sediment sources in the Payette Lake watershed, the following relationships were used (Walt Megahan, pers. comm. 1997). It should be noted that these estimates do not provide actual phosphorus levels, but only relative loading levels to help compare the effect of different sources.

Soil Creep/Background Sediment RPL:

RPL = 0.05 x sediment input x 2.0

where:

0.05 = percent clay in creep material

2.0 = P concentration factor equal to the weighted average P factor assuming a 0.5 foot thick A horizon (P factor 5.0) and a 1.5 foot thick C horizon (P factor 1.0) for creep material.

Mass Wasting RPL:

RPL = 0.05 x sediment input x 1.33

where:

0.05 = percent clay in landslide material

1.33 = P concentration factor equal to the weighted average P factor assuming a 0.5 foot thick A horizon (P factor 5.0) and a 5.5 foot thick C horizon (P factor 1.0) on landslide areas.

Road Erosion RPL:

RPL = 0.03 x sediment input x 1.0

where:

0.03 = percent clay in road fills

1.0 = P concentration factor equal to C horizon P factor.

Harvest Unit RPL:

RPL = 0.05 x sediment input x 5.0

where:

0.05 = percent clay in A soil horizon

5.0 = P concentration factor equal to the A horizon P factor.

Burned Areas RPL:

RPL = 0.05 x sediment input x 5.0

where:

0.05 = percent clay in A soil horizon

5.0 = P concentration factor equal to the A horizon P factor.

3.5 Boating Recreation/Creel Survey Techniques

The IDFG, jointly funded by DEQ, conducted a creel census and boating recreation survey from July 1995 through June 1996. The survey was structured to sample eight weekday and weekend days in consecutive four week periods. Days were split into two equal time periods between sunrise and sunset. We made three angler/boat counts per day during the selected count period at three hour intervals. The survey days and count periods were randomly selected using the IDFG standard creel survey computer program (McArthur, et. al. 1993). This program was used to summarize data and generate total angler participation estimates.

Kokanee are, and will continue to be, the major species supporting sport fishing on Payette Lake. They not only provide 73.1% of the total harvest, they also provide the prey base for the lake trout. The IDFG annually monitors the kokanee population in Big Payette Lake using mid-water trawling techniques and by counting the number of adult fish in the spawning run. Mid-water trawling techniques are described in detail in Grunder (1990) and Bowles et al. (1986,1987). In general the mid-water trawl is a long funnel shaped net with a ten foot square mouth. This net is pulled through the water at various depths which contain kokanee. The number of kokanee caught in the net is directly proportional to the total number of fish in the lake. The number of kokanee caught in the trawl is then expanded to give an estimate of the total kokanee population size in the lake.

The N.F. Payette River provides important spawning habitat for kokanee. Each year, spawning begins in late September and extends through October. The kokanee spawning run is enumerated by walking the entire stretch of the N.F.Payette River that is utilized by spawning fish and counting all live fish. This count is made every three to four days until the number of fish counted begins to decrease. The peak count is then multiplied by a correction factor of 1.73 (Frost 1994).

3.6 Assessment of Sediment Accumulation Rates

A paleolimnologic analysis of a lake within it's watershed uses lake sediment stratigraphies to reconstruct a historical pattern. This method is analogous to the use of tree rings to assess atmospheric and/or disturbance conditions affecting the region surrounding a particular forest stand. A historical pattern is derived from both techniques through careful sample collection and subsequent physical, chemical and biological analyses of extracted segments.

A paleolimnologic study of Payette and Upper Payette Lakes was devised in order to contribute to the understanding of the natural and human events which occurred within the catchment over the last 140-180 years.

The purposes of this study were to:

1.) Establish a quantitative record of sediment inputs to Payette and Upper Payette Lake from approximately 1840 through to the present day;

2.) Correlate changes in sedimentation records to known catchment events of both natural and human origin. Also note significant watershed events that fail to produce a response in lake sedimentation rates; and

3.) Assess the potential for a degradation in water quality that may result from particle-bound nutrients moving into the lake(s).

The results from this study, taken in concert with other research projects conducted by the Idaho Division of Environmental Quality (IDEQ) within the Payette Lake catchment, will provide a basis for acceptable water quality criteria within Big Payette Lake and Upper Payette Lakes.

3.6.1 *Sampling*

A lake sediment stratigraphy is sampled by collecting a lake sediment core. The coring device used to retrieve material from Big Payette Lake and Upper Payette Lakes uses a sphincter-like aperture mounted at the end of a plexiglass tube to seal a sediment core in place. The 'sphincter corer' (designed and constructed by Gubala and Eilers) weighs approximately 200 lbs and is deployed by means of a custom crane and boom rigging from a standard 17' powerboat. The corer is lowered gently into the sediment, where the sphincter is then tripped and sealed. A 1-1.5 m long, 10 cm diameter tube of sediment is then captured within a plexiglass tube and raised to the surface. Upon retrieval, the sediment core is then subsectioned horizontally at 1.0 cm intervals starting from the sediment-water interface and working downward. This process is facilitated through the use of a vertical extrusion device, which pushes the sediment up from the bottom in a calibrated manner, to be sliced and packaged at the top.

Approximately 75 cc of wet sediment material is recovered for each centimeter of depth within a 10 cm diameter sediment core. Given an average % water content for lake sediments, 75 cc of material translates to 6-10 grams dry weight of useable material per centimeter slice. This relatively large mass of material derived from the 'sphincter corer' permits multiple sets of analyses on the same sediment intervals, increasing statistical power and reducing sampling costs.

3.6.2 Sample Site Selection

The accuracy of a paleolimnologic reconstruction depends upon the 'representativeness' of the sediment cores retrieved from the target lake. There are two distinct and important components of the term 'accuracy' mentioned here. First (I) is the accuracy of the historical reconstruction, relating to the timing and *relative* response of a lake to a single or series of watershed events. The second (II) component of paleolimnologic accuracy relates to the *absolute* response of a lake to the same events.

To obtain high degree of Type I accuracy, a paleolimnologist must locate a sampling site with sufficiently high and integrative sedimentary region to insure the highest possible degree of temporal resolution within the recovered core. This is accomplished by retrieving a sediment core from a deep, stable basin within a lake, taking advantage of higher than average whole lake accumulation rates. In this manner, small scale changes in sedimentation patterns will be amplified to detectable levels upon analysis.

Type II accuracy is obtained through collection of multiple cores, recovered from a variety of sedimentary environments within a lake. Unique sedimentary environments are typically defined by a combination of lake hydraulics and depth. Sediment accumulation rates derived from a sufficiently diverse sample of sedimentary environments then yield an accurate whole lake response to catchment events and/or disturbances. Obtaining a high degree of Type II accuracy can be a time consuming and costly affair as multiple cores are required to achieve statistical significance.

In an effort to balance the data quality objectives against the budgetary constraints of the IDEQ, this study sought to optimize for Type I accuracy. As such, preferentially high sedimentation rate regions within Big Payette Lake and Upper Payette Lakes were sought for sample collection. Based upon existing basin morphometry, two sample sites were selected from within Big Payette Lake: the deepest section of the northwest (NW) arm and a similar trough in the southeast (SE) region (Figure 3-3). Since bathymetric data did not exist for Upper Payette Lake, a cursory hydroacoustic survey revealed an appropriate stable basin for coring to the northern section of the lake at a maximum depth of 28 m.

The three cores collected from the two lakes likely represented an accurate reconstruction of each of the basin histories. Since the sample sites were selected to optimize for temporal resolution, the absolute rates of sediment accumulation, presented in the results, will overestimate the absolute rates of accumulation in each system. The degree of overestimation is likely limited to a factor of two, since the morphometries of the two lakes suggest a small to medium potential for 'sediment focusing.' (The highest degree of 'sediment focusing' is noted in conically shaped lake basins and has been noted as no greater than a factor of two times the average whole-lake accumulation rates).

3.6.3 Stratigraphic Dating and Sediment Accumulation Rates

A history of the sediment accumulation rates are the primary response factor(s) sought from this sediment coring project. To determine the rates of accumulation, specific dates must be assigned to each sediment interval sliced from the core. This process is accomplished through the analysis of a naturally occurring radioisotope, 210Pb. 210Pb, a particle derived from the decay of naturally occurring radon gas, is continuously deposited upon the lake and it's watershed. A continuous source of this material is also deposited into the lake sediments, both directly and through the movement of soils and sediments into the lake from the watershed. With a half life of 22.6 years, 210Pb decays quickly upon burial within the sediments. Comparison of the residual 210Pb found buried in the sediment with the amount deposited at the surface yields a

relative age of deposition of the down-core layers. Based upon current analytical techniques, 210Pb can be measured to as low as 0.1 disintegrations per minute (dpm). Given a typical rate of supply of 210Pb to a North American watershed, the 0.1 dpm analytical limit is sufficient to detect the material in the sediment for approximately 7-8 half lives (160-180 years). To refine this radiometric dating process a model known as the 'Constant Rate of Supply' (CARS) is applied to the results from the sediment sequences of each core (Appleby and Oldfield, 1978).

Once a sediment core has been retrieved and subsectioned, 210Pb is systematically determined in each interval, starting from the surface and working down through the core (or backwards in time). These analyses are halted once a steady background of 210Pb has been established to the extent of the analytical limits. The CARS model is applied and dates or 'time before present' is determined for each discrete interval. Combining this dating curve with determination of cumulative dry mass in each interval and core then yields the desired results of sediment accumulation rates versus time before present over the last 160-180 years.

3.6.4 Dating Confidence

The confidence intervals of 210Pb dates and subsequent sediment accumulation rates assigned to each sediment interval become larger as one moves backwards in time. This is due to the fixed analytical limit for measuring 210Pb (0.1 dpm) relative to the decreasing amount of material to be measured at depth in a core. Correctly propagating error through the cumulative calculations also broaden the confidence intervals significantly beyond the 100 year before present period. But while the confidence intervals for down-core intervals may appear large, additional confidence in the data is obtained through the time series provided by continuous record in the core. Interpretation of each dating and sediment accumulation rate curve must acknowledge these potential limitations as well as the advantages of a robust, explicit and continuous historical reconstruction.

3.6.5 Nutrient Content Analysis

In addition to ^{210}Pb analysis, selective core segments were analyzed for total phosphorus, total nitrogen, total carbon, iron, and particle size. This analysis was performed by the University of Idaho soils laboratory. This analysis was performed to ascertain historical differences in the nutrient content of accumulated sediments which may further indicate whether changes in the sedimentation processes are related to internal verses external sources.

3.7 Minimum Stream Flows

The Lake Reservoir Company holds 3.000 acre feet of storage in Upper Payette Lake for use downriver near the town of Payette. This Irrigation storage is typically released from Upper Payette Lake in late summer so that the company could meet other requirements for irrigation, Payette Lake levels and stream flows below Lardo dam.. The minimum stream flow study was prompted by a concern that the needs of fisheries resources in the river below Upper Payette Lake have not regularly been met under past management of releases, and the needed resource flows

have not been quantified. Figure 4-31 a. on page 191 shows river discharge at the USGS gauge downstream from Fisher Creek for the period of record The gauging station began operating October 1, 1994.

3.7.1 Field Studies

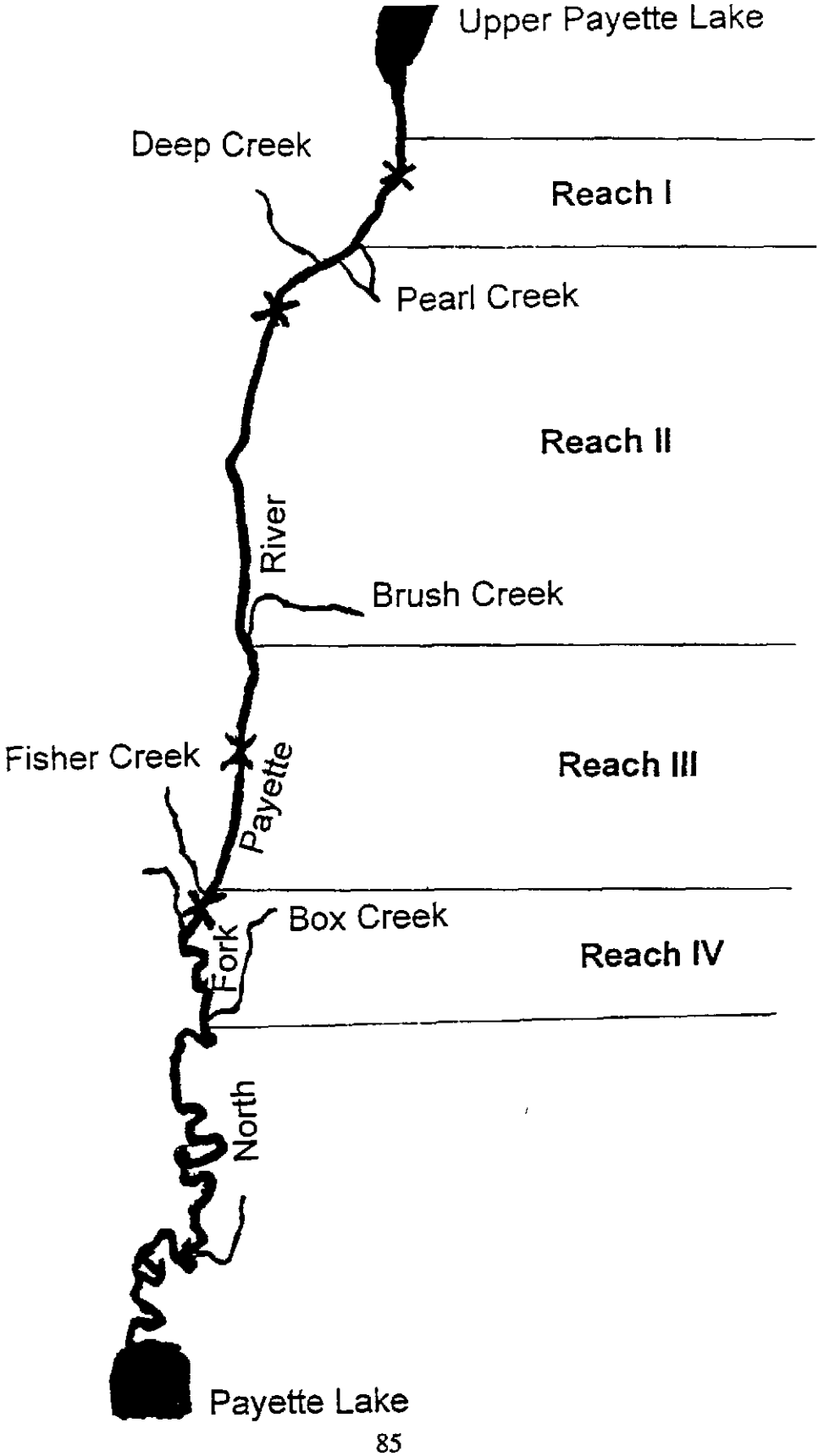
Four reaches were identified in the North Fork of the Payette River from Upper Payette Lake Dam to slack water above Payette Lake based on gradient and frequencies of four habitat types (pools, riffles, runs, and pocket water): I -- Upper Payette Lake Dam to Pearl Creek, II -- Pearl Creek to Brush Creek, III -- Brush Creek to Fisher Creek, and IV -- Fisher Creek to Box Creek (Figure 3-7). In July, 1996 one study site was established in each reach. Each study site consisted of two or three transects. The downriver transect at each site was selected just above a hydraulic control that influenced water velocities and depths of the entire site. Streambed elevations were measured along each transect to 0.01 feet relative to a benchmark established at each site. Water surface elevation was measured for each transect on three occasions, at relative high, intermediate, and low discharges. Water velocities were measured at the downriver transect of each site on all three occasions. Velocities were measured at all other transects at the intermediate discharge only. Water surface elevation and velocities were measured on July 8 - 9, July 18 - 19, and August 7; at discharges of 310 cfs, 135 cfs, and 27 cfs, respectively (as measured by the USGS Gauge below Fisher Creek).

Summer water temperatures were monitored with a Hobo electronic temperature recorder (model HTI -5 to +35°C) placed in the river at the USGS gauging station downriver from Fisher Creek.

Fish density and length information was collected at each site by snorkeling on July 24. Five snorkelers moved abreast upstream from the downriver to the upriver transect, recording species, number and length of all salmonids seen. Discharge at the USGS gauge was 111 cfs.

Frequency of pools, riffles, runs, and pocket water was determined by a "50 pace survey" on July 18 - 19, at a discharge of 135 cfs. To conduct the survey a person, taking uniform steps, walks down the river, and stops at every 50th pace, recording the habitat type at that specific location.

Figure 3-7 Minimum Stream Flow Assessment Sites. Study sites are marked (X).



3.7.2 IFIM Simulations

The computer-based Riverine Habitat Simulation (RHABSIM) program, developed by Thomas R. Payne (Payne and Associates 1995), was used to model the relationship between discharge and available fish habitat. This program is a modification of the Physical Habitat Simulation (PHABSIM) program, a part of the Instream Flow Incremental Methodology (IFIM) developed by the Midcontinent Ecological Science Center, U.S. Geological Survey, Fort Collins, Colorado. This group was formerly known as the Instream Flow Group and was under the administration of the U.S. Fish and Wildlife Service. The reader should consult Instream Flow papers No. 11 (Milhous et al. 1984) and No. 26 (Milhous et al. 1989) for a more in-depth discussion of the methodologies of the programs. Suitability curves were used from Cochnauer and Elms-Cockrum (1986) for rainbow trout, and Foster and Bennett's (1995) habitat suitability curves for spawning kokanee to quantify available fish habitat for a given discharge.

Chapter IV

4.0 Watershed Assessment - Results and Analysis/Quantity and Quality of Watershed Runoff

4.1 Watershed Water Budgets

4.1.1 Precipitation and Snow Pack Conditions

Rainfall and snow pack conditions were obtained from the U.S. Natural Resources Conservation Service (NRCS) Snotel Data Site at Secesh Summit (elevation 1,978 meters) located on the northern edge of the North Fork Payette River basin boundary. Monthly precipitation and the snow water equivalent (SWE) of the snowpack for water years 1994-1996 are presented in Figure 4-1 and 4-2. The SWE recorded at this site provides an estimate of the quantity of water contained in the snowpack that would be available for runoff. Water volume stored as snowpack is generally greatest in April and May at the onset of snowmelt and reflects the accumulated storage of precipitation deposited as snow during the earlier months. A comparison of the SWE with the historical trend (1961 - 1990; Figure 4-2) shows that water content of the snowpack exceeded historical averages by 15% (38.0 inches or 965 mm) and 9% (36.1 inches or 917 mm), respectively, at the onset of the snowmelt season in May of 1995 and 1996.

Rain on snow events can potentially generate episodic peak flows in runoff that exceed normal rates of snowmelt. Precipitation amounts were below normal in May (2.1 inches or 53 mm) and above normal (5.0 inches or 127 mm) in June 1995 (Figure 4-1). These conditions were reversed during the following snowmelt season with above normal precipitation in May (7.2 inches or 183 mm) and well below normal in June (1.1 inches or 30 mm). Total annual precipitation at the Secesh Summit for both water years was 1,514 mm (59.6 inches) and 1,661 mm (65.4 inches) in 1995 and 1996, respectively. These totals exceeded the annual average (1961-1990) of 1.298 mm (51.1 inches).

Local precipitation information near Big Payette Lake was obtained from the McCall Airport (elevation 5,030 feet) climate monitoring site (Figure 4-3). Total precipitation in calendar year 1995 was 824 mm (32.5 inches) and 665 mm (26.2 inches) in calendar year 1996. Daily precipitation amounts follow a distinct seasonal pattern with lower rainfall amounts occurring during the warmer summer months and increasing in the fall and winter with passage of cold fronts. These weather fronts can generate significant runoff to Big Payette Lake as rain on snow events. These events are most likely to occur in February or March when air temperatures begin fluctuating above freezing.

Figure 4-1. Comparison of the first month Snow Water Equivalent (SWE) from snowpack for water years 1994-1996 and the historical average (1961-1990) measured at Secesh Summit Snotel Site.

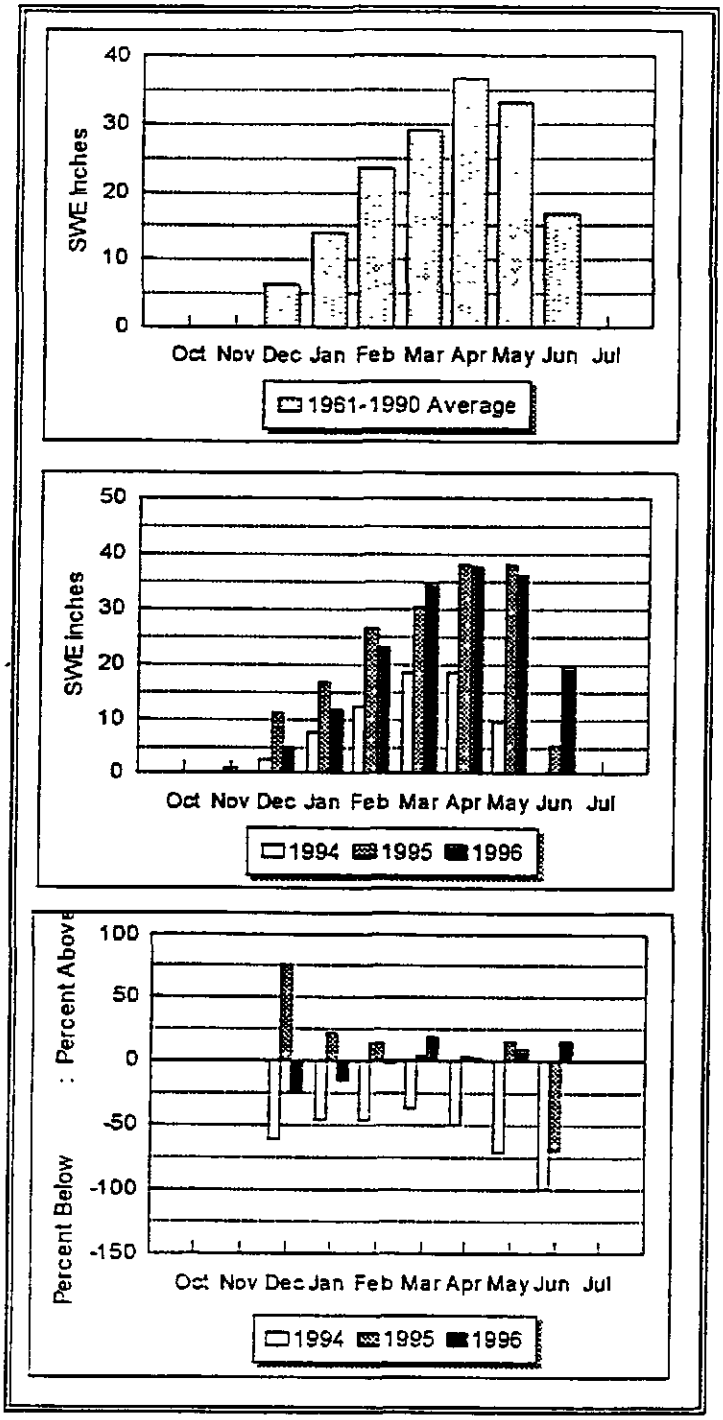


Figure 4-2 Comparison of the precipitation amounts measured for water years 1994-1996 and the historical average (1961-1990) measured at Secesh Summit Snotel site

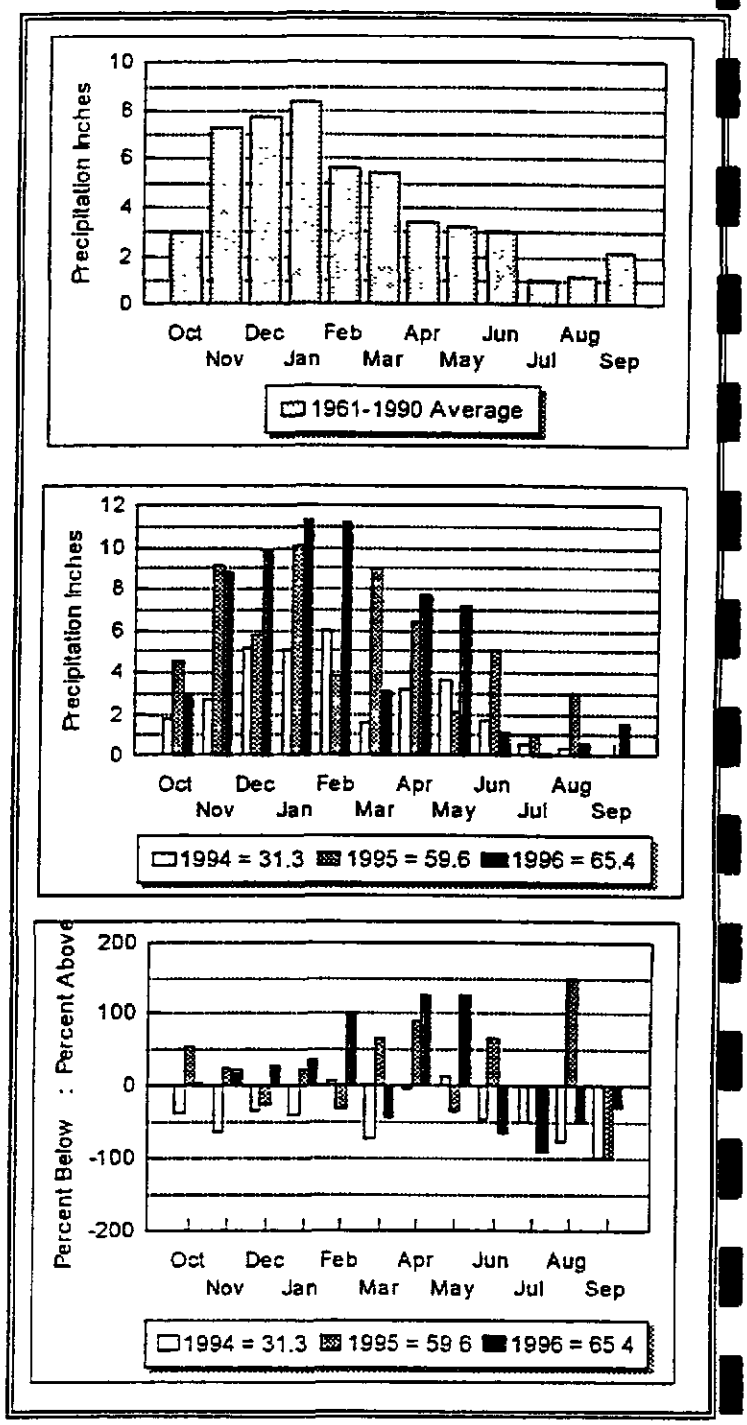
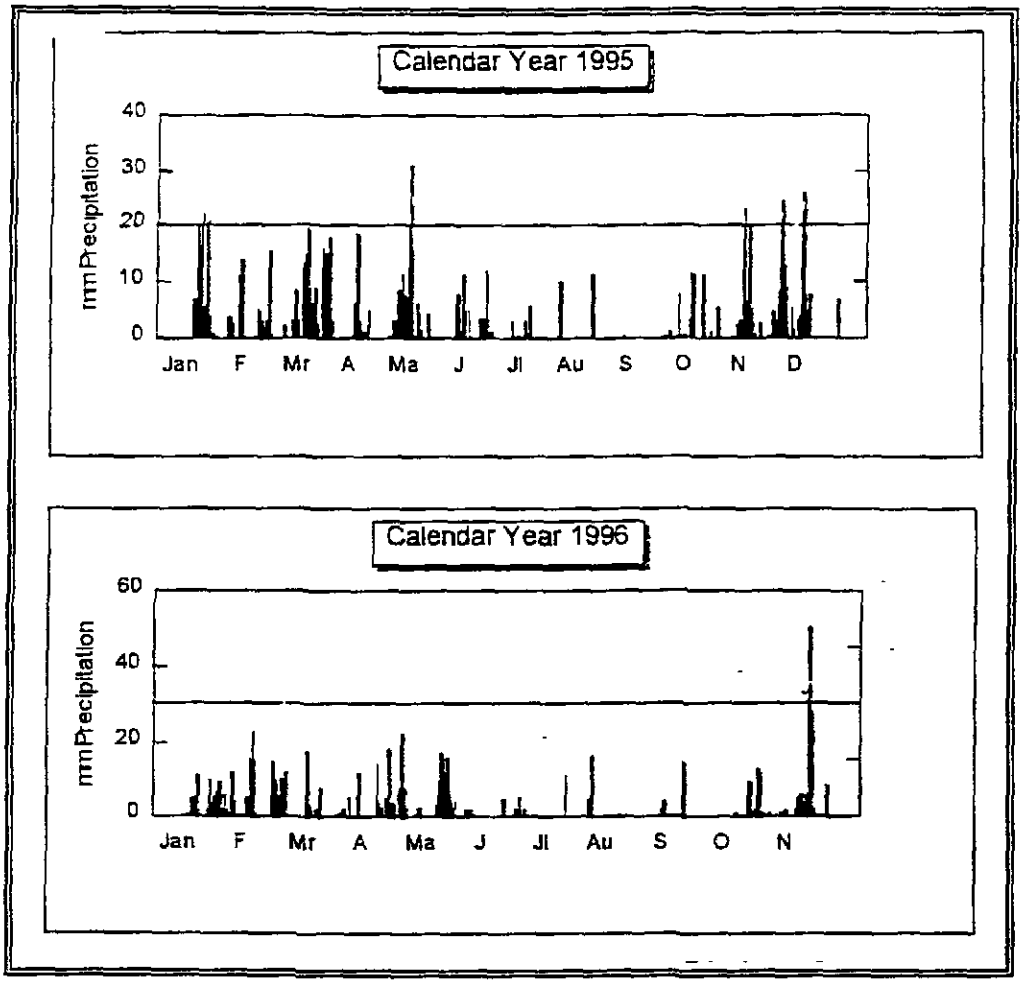


Figure 4-3. McCall rainfall amounts.



4.1.2 Tributary Stream Flows and Water Budgets

Upper Payette Lake Tributaries: Hydrographs based on field flow measurements and continuous water level recorders are presented in Figures 4-4. The daily hydrograph at the N.F. Payette River above Upper Payette Lake represents the typical pattern in runoff observed in the Upper Payette Lake drainage basin. Selection of a suitable site for monitoring stream flow was limited due to backwater affects from the Upper Payette Lake and the braided stream conditions that were present upstream. Consequently, stream flows were measured from a bridge spanning a well defined channel near the stream confluence with Upper Payette Lake. The close proximity of this site to the lake and lack of slope influenced recorder sensitivity during the period July through September when the lake was normally full (5555.3 ft. msl). Effects on the discharge estimates during the remainder of the year were minimal due to regulation of water levels within the lake. Water levels are typically reduced by 0.9 m (3.0 ft) in the fall to create additional storage space for the following year snowmelt.

Peak flows in WY 1995 were observed in late May coinciding with the rise in air temperatures as recorded at the NRCS Secesh Snotel Data Site (Figure 4-4). Runoff volume declined through the remaining snowmelt period and reached a seasonal low in late September. The following year hydrograph was similar but with peak flows occurring approximately two weeks later (June) due to cooler spring temperatures.

Highest tributary stream flows were recorded from the North Fork Payette River above Upper Payette Lake. Flow estimates from this site for WY 1995 ranged from 0.8 - 522 cfs. Higher peak flows were recorded during the second week of June in WY 1996 which exceeded 810 cfs, but fewer days of high flow rates were observed in WY 1996 as compared to WY 1995.

Continuous flow measurements on Twentymile Creek were maintained for only a short period before the gauge site was damaged during the first year peak flow event. Field measurements of flow rates were obtained throughout the study whenever stream conditions permitted. Peak flows were difficult to measure due to changes in channel routing under high flow conditions. Two distinct channels are present near the confluence of this stream with Upper Payette Lake. At flow volumes below 50 cfs, runoff is typically confined to the mainstem channel (north branch). As flows increase and reach bank full stage, additional water spills into a second channel (south branch) which continues to the lake. This south channel appears to have been formed in recent years during peak runoff events and currently has a bottom channel elevation higher than the river mainstem. The substrate in this south channel is sandy in texture and appears to be eroding downward and laterally.

The hydrograph pattern in runoff for Cougar Creek was similar to that of the North Fork Payette River flowing into Upper Payette Lake. Stream flow volumes ranged from 0.2 - 109.7 cfs in WY 1995 and from 0.1 - 131.6 cfs in WY 1996. As with the North Fork Payette river inflow, an accelerated runoff event was recorded during the second week of June and produced the highest peak flows for the water year.

Comparison of synoptic field flow measurements taken throughout the two water years confirm there is a high degree of similarity in the temporal runoff characteristics between streams draining into Upper Payette Lake (Table 4-1). Highest correlations were observed among flow measurements between the North Fork Payette River above Upper Payette Lake and other streams.

Figure 4-4. Daily Hydrographs representing a) gauged seasonal runoff from tributary streams; b) synoptic field flow measurements in the Upper Payette Lake drainage basin, and; c) average daily air temperature (degrees Celsius) at Secesh Summit Snotel Site. Trend line estimated for missing data by interpolation.

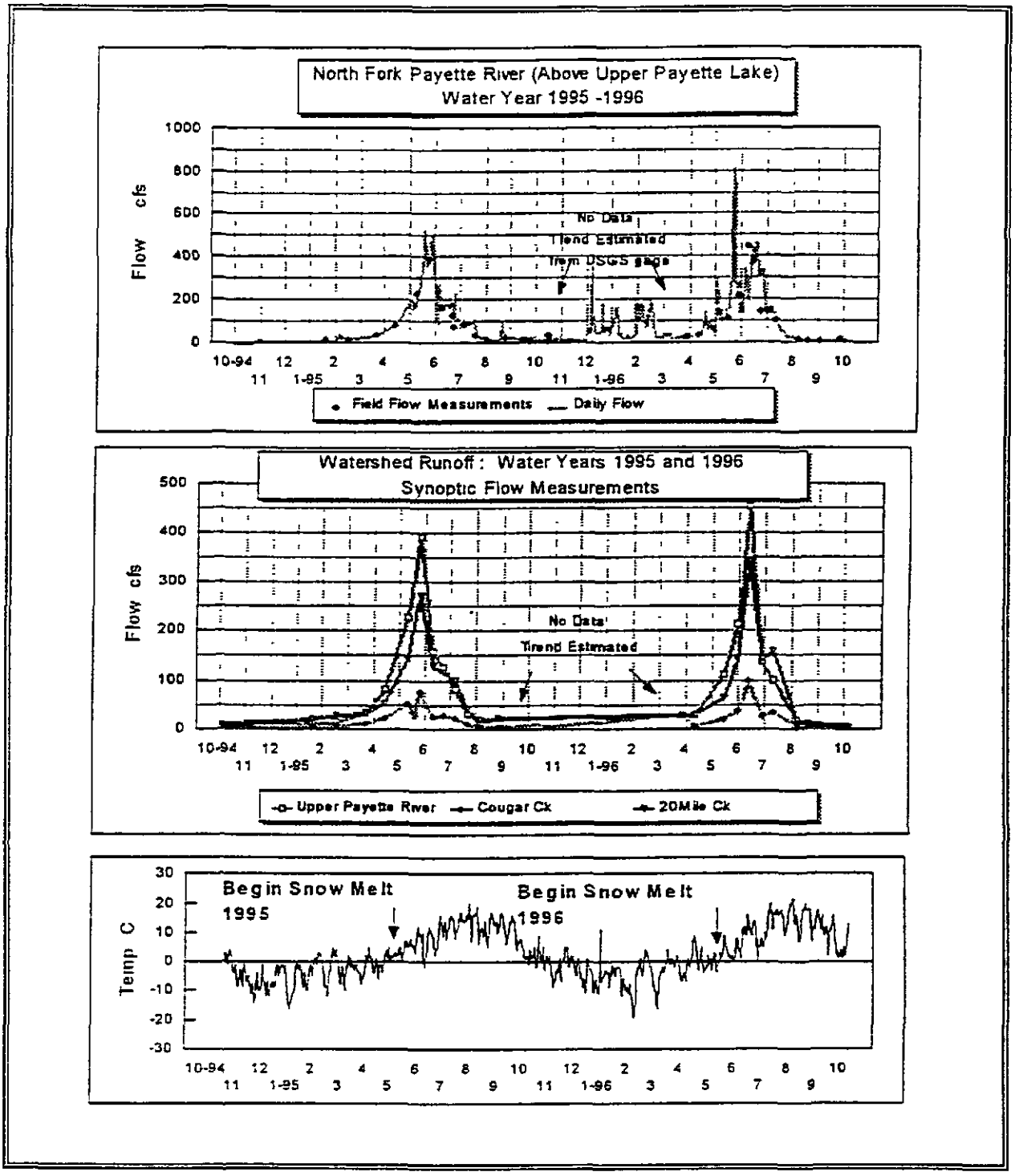


Table 4-1. Correlation matrix of synoptic stream flow measurements obtained during water years 1995 and 1996.

	Upper Basin Streams			Lower Basin Streams		
	UPL-In	Cougar	20Mile	Deep	Pearl	Fisher
Cougar	.97					
20Mile	.95	.96				
Deep	.81	.84	.85			
Pearl	.90	.83	.83	.43		
Fisher	.97	.96	.95	.70	.73	
UPL-Out	.95	.95	.95	.87	.71	.96

Upper Payette Lake Water Budget: Total inflow to Upper Payette Lake was estimated by combining runoff from the gaged and ungaged inflows (Table 4-2). Ungaged inflows to Upper Payette Lake include runoff from Camp Creek on the west side of the lake and Outlet Creek on the east side. Total water yield from these sources was estimated by computing the water yield coefficient (m^3/hectare) for Cougar Creek and applying this yield to the drainage area of the ungaged streams. Both ungaged streams are lower yield perennial streams (compared to other inflows) but drain different land types. The Camp Creek drainage is similar to Cougar Creek and characterized by a glaciated valley with steep walls and subject to short-term, intense runoff. Culverts placed in the campground road crossing this stream adjacent to Upper Payette Lake were washed-out during the 1994 snowmelt season. Outlet Creek drains a smaller basin composed of moraines and glacial outwash with low slope gradients. Accordingly, the yield coefficient for Outlet Creek was reduced by fifty percent to reflect these differences in land type and drainage conditions.

Estimated water yields from monitored streams for the Upper Payette Lake subbasins ranged from 10,500 - 15,700 m^3/ha (Table 4-2). Despite the significant loss of vegetation cover associated with wildfires in these watersheds, the estimated water yields fell within the range of estimates for unburned watersheds (see Table 4-4 and Table 4-5). Estimates of pre-burn water yield characteristics are not available. Reduction of vegetation cover by wildfires can result in increased snow depths and affect melt rates (McNabb and Swanson, 1990). Other studies on the changes in hydrology related to wildfires have reported increased water yields, higher peak flows, increased overland flow and stream baseflow (Tiedemann et al., 1979). Initial increases in the annual yield range from approximately 762 - 5,077 m^3/ha (3-20 acre-inches/acre) have been reported in the northwest (Beschta, 1990). A post fire assessment of these watersheds conducted by the forest service rated these streams as having a moderate to high risk potential for change in flow or stream channel characteristics following the fire (Payette National Forest, 1995).

Table 4-2. Monthly cumulative (cf) estimates for streams flowing into Upper Payette Lake. Streams designated as UPLIN = North Fork Payette River into Upper Payette Lake, 20Mile=Twentymile Creek, COUGAR = Cougar Creek. Cumulative flows for Camp Creek are based on water yield of Cougar Creek. Cumulative flows for Outlet Creek are based on Cougar Creek water yield at 50%.

	cf					
WY95	UPLIN	20MILE	COUGAR	CAMP	OUTLET	Total
OCT	90	68	17	14	3	192
NOV	157	118	33	27	6	341
DEC	132	100	28	23	5	287
JAN	173	264	48	39	8	533
FEB	539	1,064	225	185	37	2,049
MAR	1,058	1,107	391	321	64	2,942
APR	3,520	2,167	971	797	159	7,614
MAY	9,734	6,486	2,071	1,699	340	20,329
JUN	4,686	3,480	909	746	149	9,970
JUL	1,636	2,002	483	397	79	4,598
AUG	776	698	132	108	22	1,736
SEP	471	379	30	25	5	910
Total	22,973	17,933	5,339	4,380	876	51,501
(m3/ha)	12,377	10,597	13,429	13,429	6,714	11,698
(Acre-Ft/Acre)	4.1	3.5	4.4	4.4	2.2	3.8
WY96						
OCT	444	388	73	60	12	976
NOV	1,008	965	126	104	21	2,223
DEC	2,655	2,670	595	488	98	6,505
JAN	2,158	2,335	466	382	76	5,417
FEB	1,785	2,006	419	343	69	4,621
MAR	632	756	159	131	26	1,704
APR	2,632	2,230	571	468	94	5,994
MAY	8,450	4,983	1,476	1,211	242	16,361
JUN	7,835	7,063	1,606	1,318	264	18,085
JUL	1,152	1,388	314	257	52	3,162
AUG	172	181	41	34	7	434
SEP	289	306	24	20	4	642
Total	29,210	25,269	5,868	4,814	963	66,124
(m3/ha)	15,737	14,933	14,759	14,759	7,379	15,020
(Acre-Ft/Acre)	5.2	4.9	4.8	4.8	2.4	4.9

Figure 4.5. Comparison of total monthly inflow and outflow water volume for Upper Payette Lake.

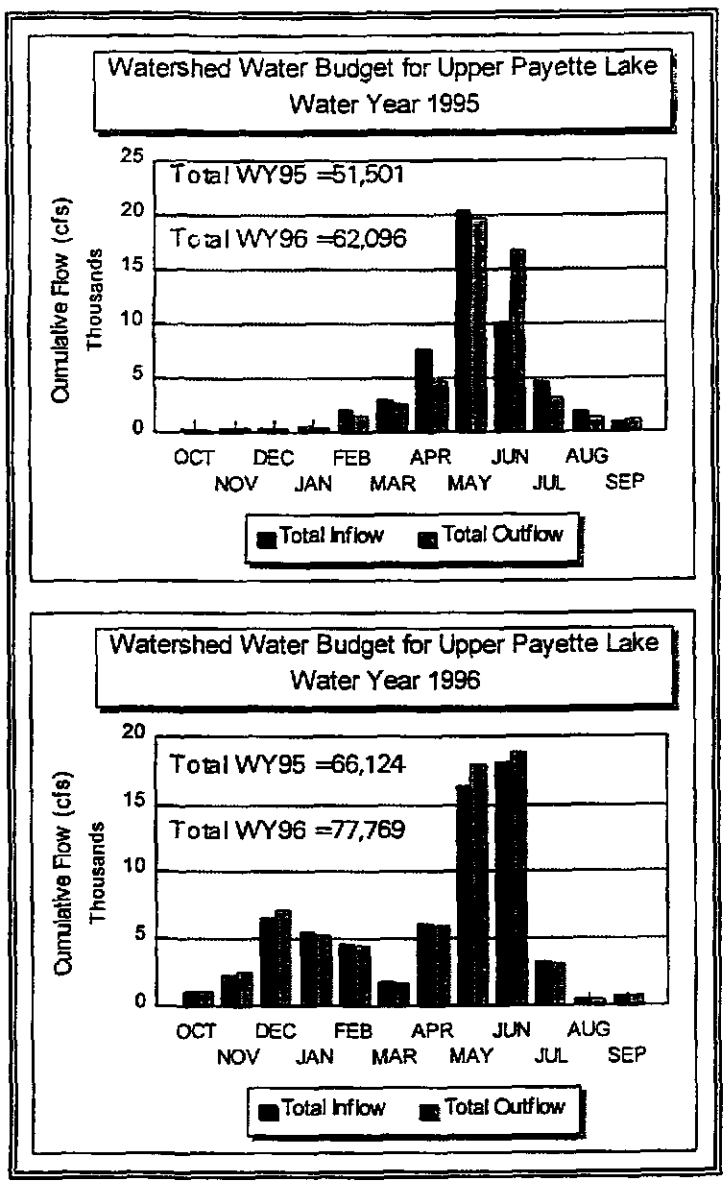


Table 4-3. Radial gate openings and discharge volumes.

3-Radial Gates Open

Feet of Head	cfs
1	90
2	270
3	500
4	770
5	1,070
6	1,410
8	2,170

Discharge Over Spillway Gates Closed

(Feet of Head)	cfs
1	206
2	580
3	1,070

Monthly outflows from Upper Payette Lake were nearly equal to inflows throughout the period of study (Figure 4-5) due to the small volume of storage capacity within the lake (2,500 acre-feet). Outflows exceeded inflows only during the month of June in water year 1995 suggesting this increase was associated with manipulation of lake storage. Radial gates regulating the outflow from the lake are adjusted on a seasonal basis depending on downstream water demands. These gates are designed to pass a specific volume of water depending on the gate adjustment and height of water above the spillway sill elevation (Table 4-3). Records of the gate openings and discharge are not available. Total annual inflows (in cubic hectometers) into Upper Payette Lake were estimated at 126 hm^3 (51,501 cf) and 162 hm^3 (66,124 cf) in water years 1995 and 1996,

estimated at 126 hm^3 (51.501 cf) and 162 hm^3 (66.124 cf) in water years 1995 and 1996, respectively. Differences in the estimated volumes of cumulative inflow and outflow are attributed to the estimation errors, ground water inputs and direct runoff into the lake from the lake perimeter not included in the stream flow estimates. These error sources were approximately 17% and 15% of the total estimated outflow.

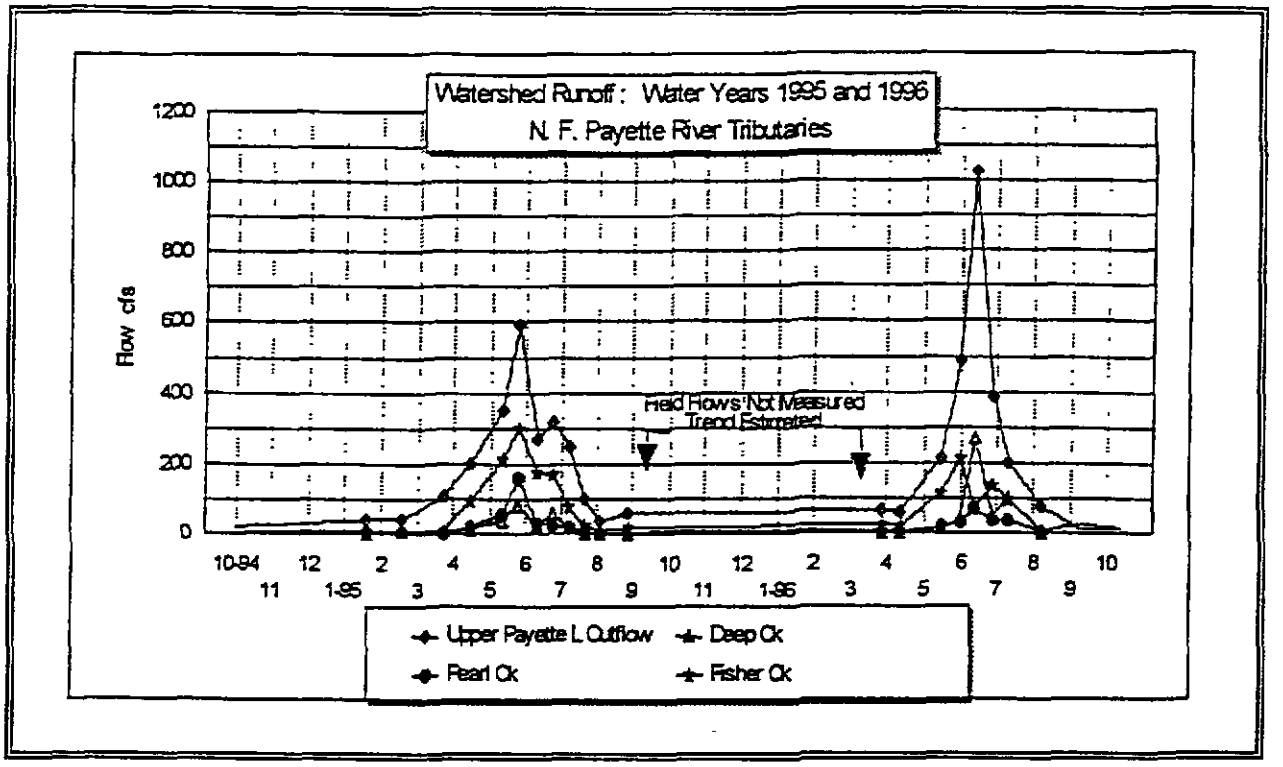
Mainstem North Fork Payette River Tributaries: Total annual stream flow for the mainstem North Fork Payette River below Fisher Creek (USGS gauge 13238322), totaled 304 hm^3 (124,197 cf) with daily volumes ranging from .011 hm^3 (October 9) to 7.03 hm^3 (June 3) during 1995; during 1996, the annual volume totaled 399 hm^3 (165.210 cf) with daily volumes ranging from .083 hm^3 (November 6) to 8.717 hm^3 (May 15). These estimates reflect approximately 68 percent of the drainage area of the mainstem river (Box, Twah, Copet and No-Name watersheds contribute runoff below the USGS gauge). About 71 percent of the annual streamflow in 1995 was delivered during May and June; in 1996, about 54 percent was delivered during May and June.

Runoff volumes for subwatersheds contributing to the mainstem streamflow were calculated separately for monitored and unmonitored streams. Deep, Pearl and Fisher Creek watersheds were not monitored with continuous water level recorders but stream flows were periodically measured in conjunction with other stream monitoring events. This resulted in a variety of flow rates obtained over a wide range of flow volumes taken synoptically with other streams having continuous flow records. With the exception of Deep Creek, a comparison of synoptic flow measurements among streams indicates the rise and fall of stream volumes was similar to the gauged upper basin streams above Upper Payette Lake (Figure 4-6 and Table 4-1).

Accordingly, the N.F. Payette River (above Upper Payette Lake) daily flow rates were used to estimate corresponding daily flows for intervals between field measurements at the Deep, Pearl and Fisher Creek sites. Runoff volumes were further corrected to the measured field flows to reduce bias of the regression estimates. Monthly flows from unmonitored streams such as Box, Brush, Twah, Copet, No-Name (Figure 2-3) and the middle reach of the N.F. Payette River were estimated using the water yields from gauged sites. To account for potential differences in water yield attributed to burned and unburned portions of a watershed, the total water yield was partitioned according to the proportion of total watershed burned. Burned estimates were obtained by computing the monthly water yield of Pearl Creek and applying this ratio to the burned acreage estimates. The corresponding water yield from unburned portions of each watershed were computed using an average monthly water yield from Fisher Creek and Deadhorse Creek.

Table 4-4 summarizes the water budget for the mainstem N.F. Payette River tributaries. Outflows from Upper Payette Lake make up the largest proportion of the north fork base flow, about 39% for both water years. Fisher Creek was the second largest source of runoff contributing approximately 15% of the baseflow. Water yield per unit area of watershed was highest at the Deep Creek. An analysis of water quality data indicates this additional yield was attributed to groundwater (see water quality section below).

Figure 4-6. Comparison of synoptic stream flow measurements taken in the tributaries of the mainstem N.F. Payette River.



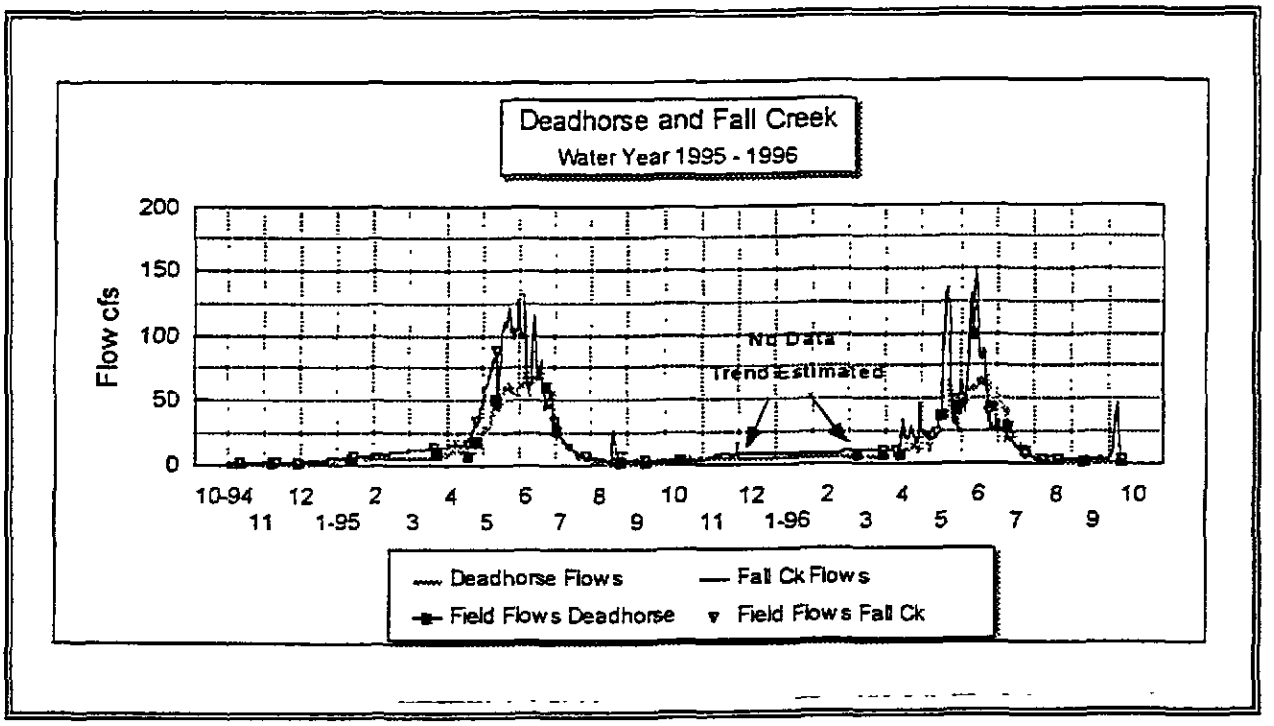
A comparison of the total runoff estimated by the above combination of measured and extrapolated discharge from watersheds closely approximates the total cumulative flow measured at the USGS gauge site on the N.F. Payette River. The sum total contribution of discharge by subwatershed upstream of the USGS gauge was approximately 258 hm^3 (105,412 cf) and 335 hm^3 (136,870 cf) during water years 1995 and 1996, respectively. Differences between these estimates and the USGS gauge were 15% and 17% for each respective water year.

Big Payette Lake Tributaries: Data obtained from continuous water level recorders installed on both the Deadhorse and Fall Creek watersheds are presented in Figure 4-7. Hydrographs from these sites also showed similar intra and inter annual variations in flow rates. Peak discharge rates for Fall Creek, however, were considerably greater compared to the Deadhorse site during snowmelt in WY1996. Fall Creek discharge volumes ranged from 0.6 to 132 cfs and 1.3 to 151 cfs in water year 1995 and 1996, respectively. Discharge volumes from Deadhorse Creek ranged from 0.1 to 72.6 cfs and from 0.1 to 66.7 cfs during the same period. Total annual volume streamflow for Fall Creek was 17.3 hm^3 in 1995 and totaled 15.3 hm^3 in 1996. For Deadhorse Creek, the annual total streamflow was 11.7 hm^3 in 1995 and totaled 11.4 hm^3 in 1996.

Table 4-4. Monthly cumulative flow (cf) estimates for watersheds tributary to the mainstem N.F. Payette River. Streams designated as UPLOut=Outflow from Upper Payette Lake, Copet/No-Name=Combined watersheds of Copet Creek and No-Name Creek, and MNFPR = Middle Reach mainstem watershed of the North Fork Payette River. Other watersheds are as indicated. Water yields for unmonitored streams are underlined and based on surrogate estimates of monitored streams. Burned watersheds are **Bold** type.

	cf									
WY95	UPLOut	**Deep**	**Pearl**	Fisher	**Brush**	**Box**	Twah	Copet/ No-Name	MNFP	Total
OCT	198	30	27	74	45	45	39	17	23	498
NOV	384	59	47	144	78	80	70	34	45	940
DEC	326	50	40	122	70	100	87	29	38	861
JAN	367	56	52	137	96	163	142	32	43	1,089
FEB	1,377	200	161	487	275	315	274	115	151	3,355
MAR	2,595	378	317	921	532	556	483	217	285	6,284
APR	4,634	1,247	1,054	3,037	1,736	1,594	1,387	714	940	16,345
MAY	19,676	3,644	2,915	8,872	4,847	4,765	4,147	2,087	2,746	53,688
JUN	16,679	1,732	1,404	4,216	2,416	2,939	2,557	992	1,305	34,238
JUL	3,057	632	490	1,538	817	817	711	362	476	8,899
AUG	1,188	284	233	692	380	332	289	163	214	3,777
SEP	1,028	163	141	397	230	198	172	93	123	2,545
Total	51,508	8,477	6,881	20,637	11,523	11,904	10,358	4,855	6,387	132,529
Water Yield										
(m^3/ha)	11,700	18,129	12,721	10,833	12,823	13,535	13,535	10,833	10,833	12,162
(Acre-Ft/Ac)	3.8	5.9	4.2	3.6	4.2	4.4	4.4	3.6	3.6	4.0
WY 1996										
OCT	961	163	133	396	223	233	203	93	123	2,527
NOV	2,511	248	302	603	494	435	378	142	187	5,300
DEC	7,129	1,097	795	2,670	1,300	1,126	980	628	826	16,550
JAN	5,101	785	646	1,910	1,058	927	807	449	591	12,275
FEB	4,387	675	535	1,643	879	800	696	387	509	10,511
MAR	1,554	239	189	582	323	376	327	137	180	3,907
APR	5,842	947	788	2,305	1,308	1,269	1,104	542	713	14,817
MAY	18,000	3,067	2,531	7,467	4,199	4,065	3,537	1,757	2,311	46,933
JUN	18,835	2,897	2,347	7,054	3,923	4,006	3,486	1,659	2,183	46,390
JUL	3,064	471	345	1,147	589	686	597	270	355	7,525
AUG	422	65	51	158	88	105	92	37	49	1,068
SEP	712	110	87	267	144	142	124	63	83	1,730
Total	68,517	10,763	8,749	26,203	14,529	14,170	12,330	6,164	8,109	169,534
Water Yield										
(m^3/ha)	15,563	23,018	16,175	13,755	16,167	16,113	16,113	13,755	13,755	15,558
(Acre-Ft/Acre)	5.1	7.6	5.3	4.5	5.3	5.3	5.3	4.5	4.5	5.1

Figure 4-7. Daily hydrograph representing seasonal runoff from tributary streams draining to Big Payette Lake.



A portion of the headwaters for Fall Creek originates as spillover from Blackwell Lake. This is a small, regulated glacial lake located in the upper third of the basin. Discussions with the local operators of the control structures indicate water levels in this lake are actively regulated during the spring and late summer. Records detailing the manipulations in storage are not maintained. Consequently, the effects of the fluctuations in the lake storage volume on the stream hydrograph could not be determined.

Water budgets were extrapolated for other major tributaries draining to Big Payette Lake using the unit area water yields from Deadhorse and Fall Creek (Table 4-5). Monthly water yields for Lemah Creek were computed using monthly yields from Fall Creek. Both watersheds are similar in size, soil type and in the proportion of total watershed area burned. Water yields for Lemah and Sylvan Creeks were computed based on monthly yields from Deadhorse Creek. From these estimates, tributaries directly draining to the Big Payette Lake contributed approximately 52.2 hm^3 (21,343 cf) and 48.2 hm^3 (19,698 cf) of runoff in water years 1995 and 1996, respectively.

Table 4-5. Monthly cumulative flow (cf) estimates for watersheds tributary to Big Payette Lake. Stream designations as indicated. Water yields for unmonitored streams are single underlined and based on surrogate estimates of monitored streams. Burned watersheds are **Bolded**.

WY95	Fall	Deadhorse	Lemah	Sylvan Ck	Wagon Bay	Total
OCT	17	16	13	7	7	61
NOV	31	30	23	13	14	112
DEC	98	73	73	32	33	309
JAN	182	144	136	64	65	591
FEB	252	163	187	72	74	748
MAR	375	234	279	103	106	1,097
APR	677	414	504	183	187	1,965
MAY	2,743	1,599	2,043	705	721	7,811
JUN	2,063	1,712	1,537	755	772	6,839
JUL	374	286	279	126	129	1,195
AUG	177	60	132	27	27	422
SEP	73	34	55	15	15	192
Total	7,064	4,767	5,261	2,101	2,150	21,343

Water Yield

(m^3/ha)	9,877	9,341	9,876	9,341	9,341	9,645
(Acre-Ft/Acre)	3.2	3.1	3.2	3.1	3.1	3.2

WY96	Fall	Deadhorse	Lemah	Sylvan Ck	Wagon Bay	Total
OCT	87	97	64	43	44	334
NOV	206	123	153	54	56	591
DEC	254	150	189	66	68	728
JAN	262	174	195	77	79	786
FEB	251	184	187	81	83	787
MAR	275	199	205	88	90	857
APR	650	417	484	184	188	1,921
MAY	1,779	1,315	1,325	580	593	5,591
JUN	1,902	1,546	1,416	681	697	6,242
JUL	263	354	196	156	159	1,129
AUG	78	59	58	26	27	247
SEP	235	48	175	21	21	501
Total	6,241	4,665	4,648	2,056	2,104	19,715

Water Yield

(m^3/ha)	8,727	9,142	8,726	9,142	9,142	8,909
(Acre-Ft/Acre)	2.9	3.0	2.9	3.0	3.0	2.9

4.2 Tributary Water Quality

4.2.1 Physiochemical Data

With the exception of Deep Creek, electrical conductivity of all monitored streams ranged from approximately 7-30 uS/cm throughout the monitoring period (Figure 4-8). Marked seasonal increase in conductivity was associated with seasonally low rates of discharge in August of each year. By contrast, lowest conductivity values were measured in July following the peak runoff period, indicating dilution of dissolved salts. Streamflow pH was slightly acidic throughout most of the year but declined during the spring snowmelt (after 05/03/95 & 96). Differences between burned and unburned watersheds were minimal in both pH and conductivity.

Deep Creek was somewhat atypical of the other streams in that conductivity and pH were consistently greater compared to other sites. Results suggest groundwater may contribute a proportionately greater amount to stream base flows, particularly during low water levels in September. Additional evidence of groundwater interaction was documented by Smith College during a field study of groundwater and geologic interactions in August 1996 (pers. comm. Robert Newton, Smith College).

4.2.2 Watershed Nutrient and Sediment Contributions

Upper Payette Lake Basin: As expected, the concentrations of total phosphorus (TP) measured from burned watersheds were greatest and more variable following the first snowmelt after the fire (Figure 4-9). These differences were less pronounced the second year following the fire with smaller increases in concentration of TP measured in runoff. Within the Upper Payette Lake drainage basin, Cougar Creek was the highest source area for TP in runoff. Peak concentrations during the first year snowmelt exceeded 100 mg/m^3 P but remained near background levels during the second season snowmelt. Runoff from the Upper North Fork Payette River drainage (above Upper Payette Lake) was the second highest source with peak concentrations occurring in both snowmelt seasons. In contrast, concentrations of TP in runoff from the Twentymile Creek watershed were moderate during both snowmelt seasons. These observations were somewhat surprising given the greater number of acres impacted by wildfire in Twentymile and Upper N.F. Payette River watersheds compared to the Cougar Creek watershed. The terrain along the river corridor in Cougar Creek, however, is flanked by steep slopes and rocky surfaces, thus reducing the time of concentration for water borne nutrients to be transported quickly to the stream.

Figure 4-8. Stream conductivity and pH of burned and unburned watersheds.

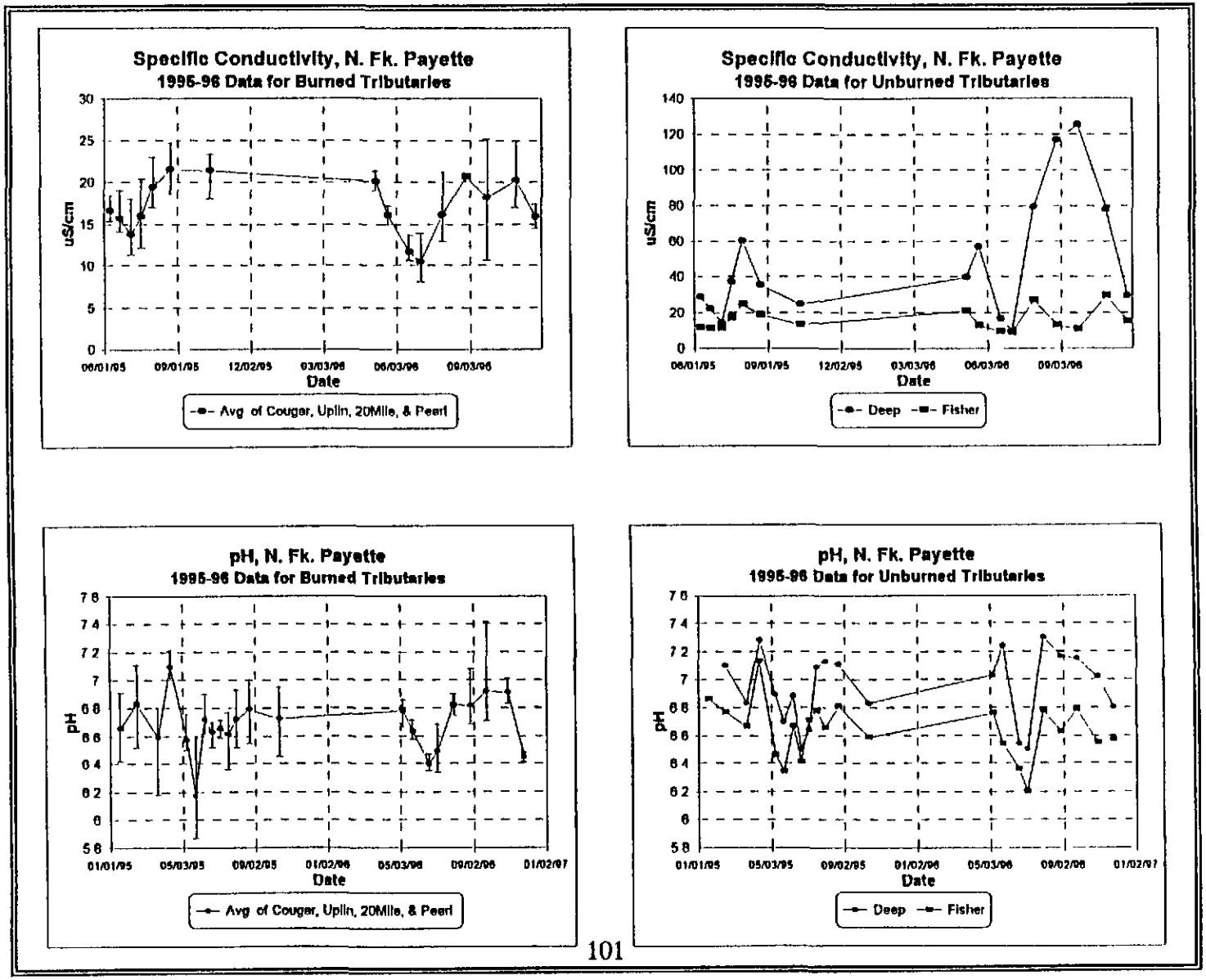
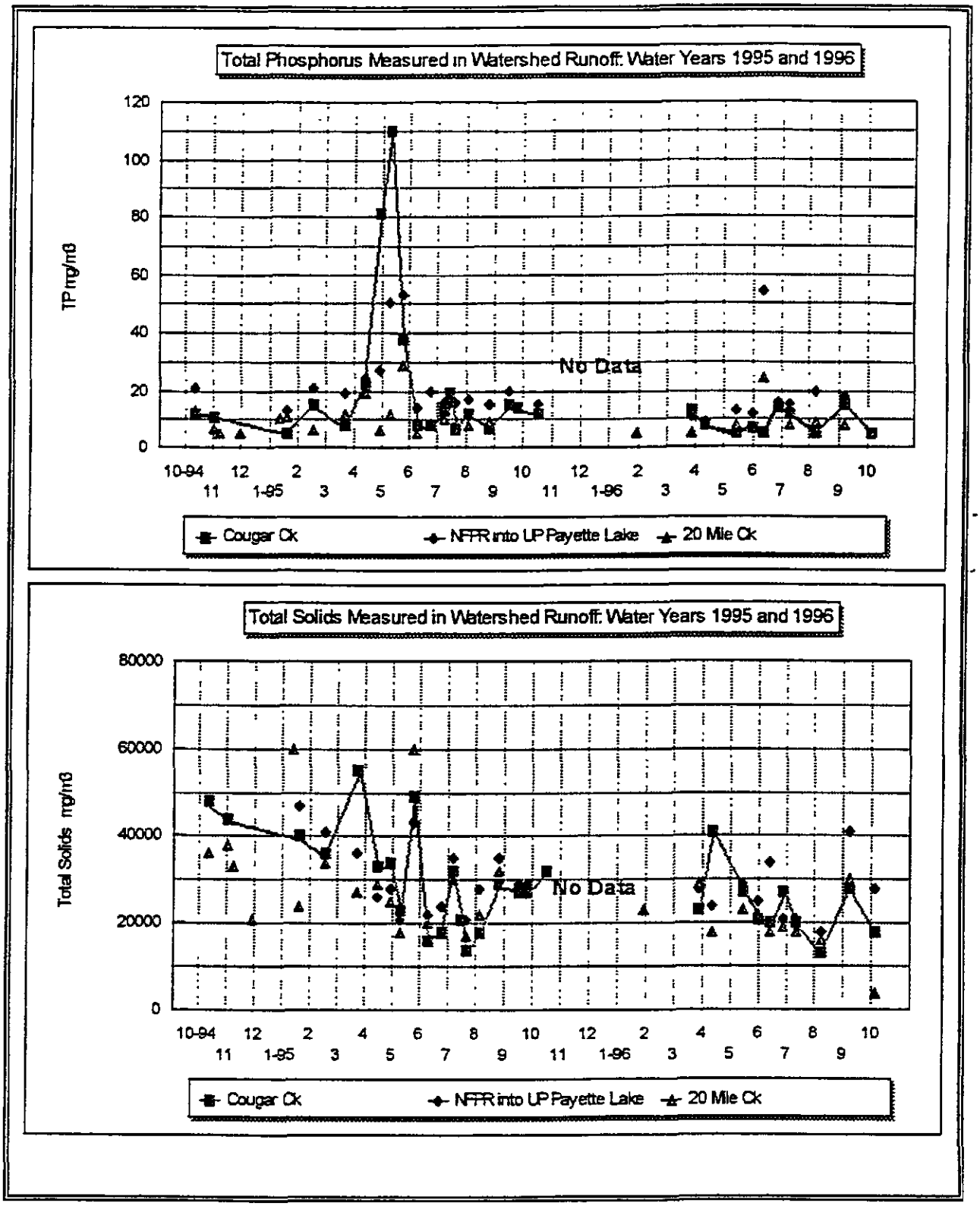


Figure 4-9. Total Phosphorus (TP) and Total Solids (TS) observed in samples from watersheds above Upper Payette Lake.



The trend in total solids concentrations (includes organic and inorganic particulate materials) appeared to reflect fire impacts on the watersheds as well. Concentrations of total solids were greatest and most variable during the early fall following the fire when stream volumes were lowest. Rain events during this period flush newly deposited ash and other debris into local streams. Concentrations of total solids steadily declined through the winter and then increased slightly during the first spring snowmelt in late May. Due to a break in monitoring, a similar trend could not be determined during the following fall. Concentrations of total solids during the second year snowmelt were again similar to the previous season.

Greater differences were observed among monitored watersheds in the flux of nitrogen associated with stream runoff. In general, total nitrogen concentrations increased beginning in fall, declined with the snowmelt and reached lowest concentrations in late July coinciding with the reduction in stream flows (Figure 4-10). This pattern was consistent among all monitored watersheds and related to the marked seasonal increase in the flux of dissolved inorganic nitrogen (DIN).

Highest concentrations of dissolved inorganic nitrogen (DIN) were measured from the more severely burned watersheds (Figure 4-10) with Cougar Creek drainage exceeding 1000 mg/m^3 followed by Twentymile Creek (600-700 mg/m^3) and the upper N.F. Payette River (400-500 mg/m^3). In each of these watersheds, peak runoff concentrations were greater during the second year monitoring compared to the first.

Mainstem North Fork Payette River Tributaries: Wildfires swept through most of the Pearl Creek watershed lying east of the N.F. Payette River mainstem. As a result, total phosphorus concentrations in samples from the Pearl Creek watershed exhibited a trend consistent with other burned watersheds (Figure 4-11). Peak concentrations of TP coincided with the first year snowmelt and again declined to background levels during the following year. Headwaters of the Fisher Creek and Deep Creek watersheds were only lightly burned and exhibited no increase in TP export during the first year snowmelt. However, slight increases in the stream water concentrations of TP were observed during the second year snowmelt. This difference may be attributed to the higher peak flows and hence greater runoff volume experienced in the second year snowmelt.

Seasonal trends in total solids concentrations were also similar to those observed in burned watersheds above Upper Payette Lake. Concentrations of total solids were greatest during the fall following the fire and declined throughout winter and increased slightly during the spring snowmelt. Trends during the following spring snowmelt again showed a slight increase in TS concentration in response to increased runoff.

As with other burned watersheds, the flux of inorganic nitrogen was greater from the Pearl Creek watershed compared to other unburned watersheds within the mainstem N.F. Payette River basin (Figure 4-12). Concentrations were highest immediately preceding or coinciding with peak stream flows and were generally twofold greater compared to unburned

Figure 4-10. Inorganic nitrogen (DIN) and organic nitrogen (Org-N) observed in samples from watersheds above Upper Payette Lake.

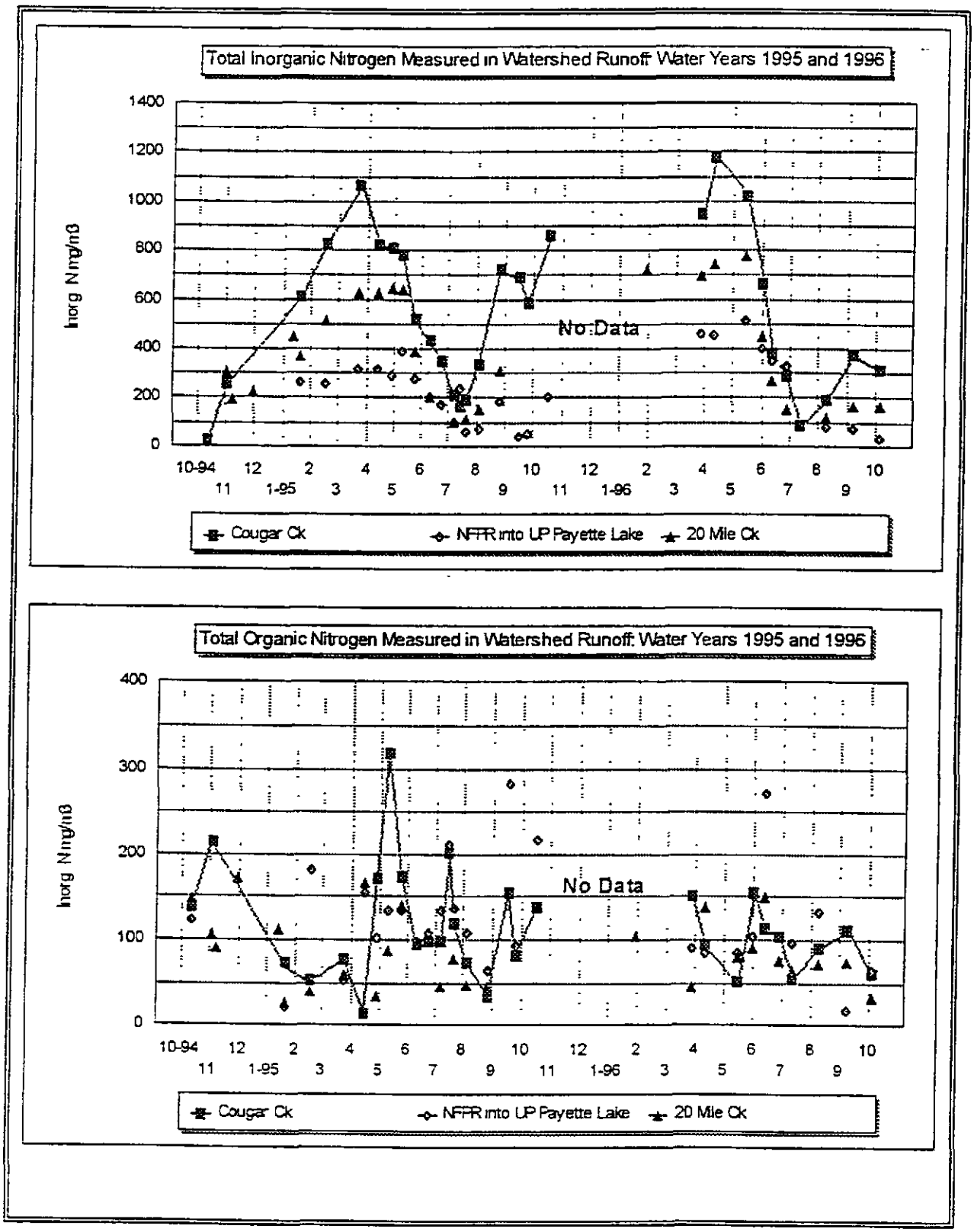


Figure 4-11. Total Phosphorus (TP) and Total Solids (TS) observed in samples from watersheds tributary to the N.F. Payette River mainstem.

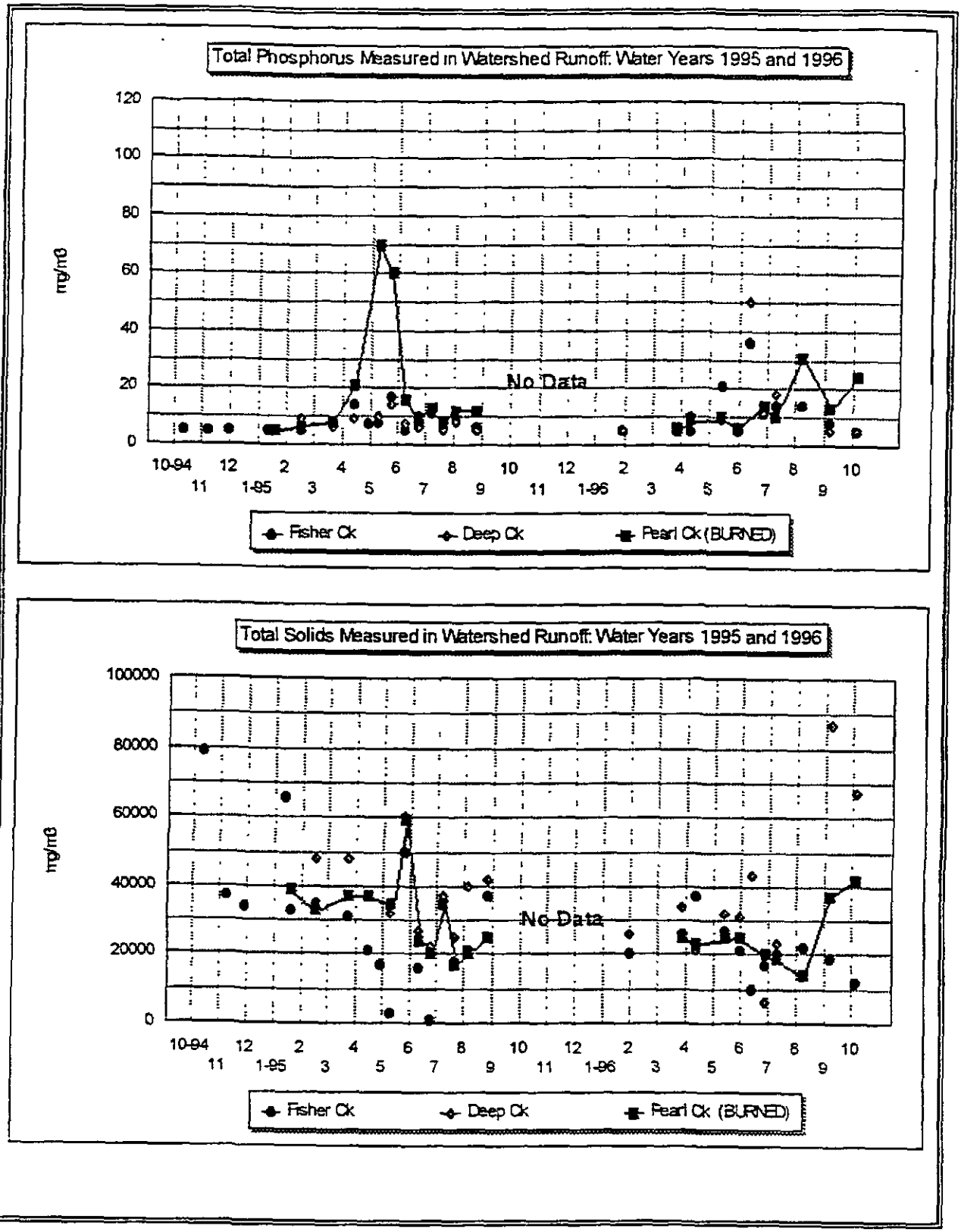
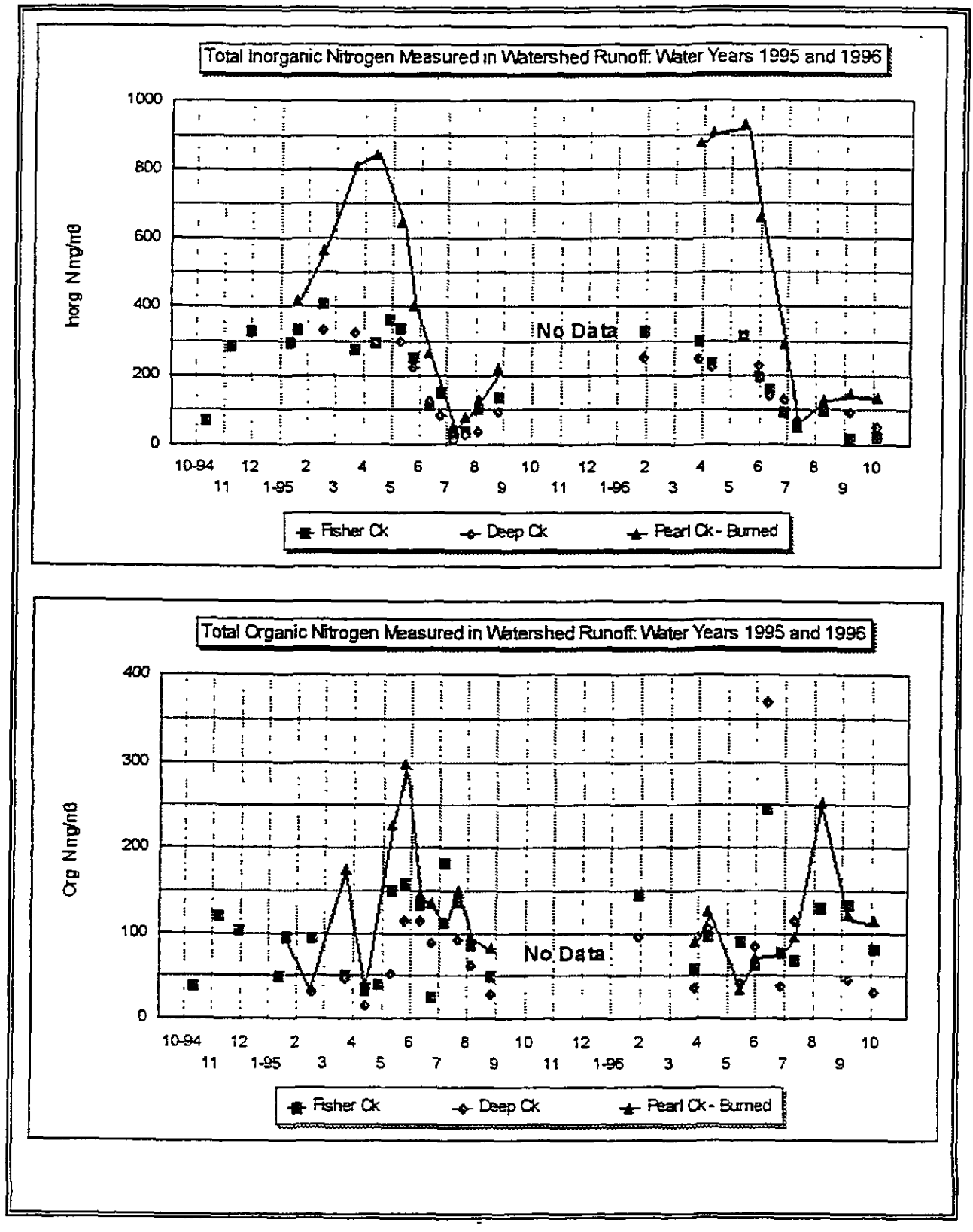


Figure 4-12. Inorganic nitrogen (DIN) and organic nitrogen (Org_N) observed in samples from watersheds draining to the N.F. Payette River mainstem.



watersheds. Organic nitrogen concentrations were also greater in the Pearl Creek stream water during the first year snowmelt. Unusually high peak concentrations of organic nitrogen were also detected during the second year snowmelt at both the unburned sites. These samples were collected near the peak of the discharge hydrograph. A sample was not collected from the Pearl Creek monitoring site during the same period.

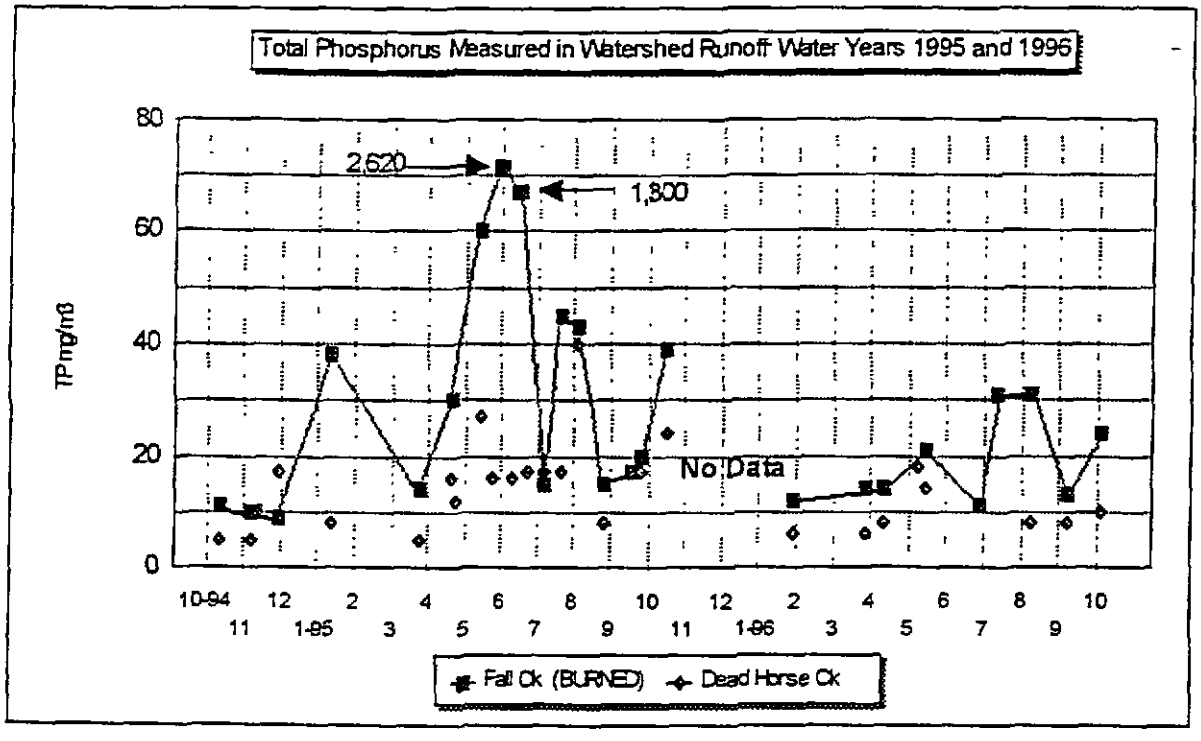
Tributaries to Big Payette Lake: Highest concentrations of total phosphorus among all watersheds monitored were obtained from the Fall Creek watershed directly draining to Big Payette Lake (Figure 4-13). Measured TP concentrations from this tributary were 2,062 and 1,003 mg/m^3 P during the first year spring snowmelt. Wildfire in the headwaters of this watershed caused extensive tree mortality and removed most of the ground cover. Concentrations of TP in runoff during the second season snowmelt were much lower and only slightly greater than concentrations from the unburned Dead Horse Creek watershed located on the opposite side of Big Payette Lake. Concentrations of TP in runoff from Dead Horse Creek watershed were generally below 20 mg/m^3 during most of the year and increased only slightly during snowmelt.

Concentrations of total solids (TS) in runoff from these watersheds were generally constant throughout the year. An exception was the brief but concentrated flux of TS from the Fall Creek watershed during the first year snowmelt. Samples collected during this period contained ash and other debris suggesting that residues from the fire were carried by overland flow into the stream during snowmelt.

The higher flux of inorganic nitrogen from the burned Fall Creek watershed was again consistent with other burned sites (Figure 4-14). Concentrations were again greatest coinciding with peak runoff and were generally two to four times greater than concentrations from the unburned Deadhorse Creek watershed. A short term but concentrated flux of organic nitrogen was also measured from the Fall Creek watershed during the first year snowmelt. As with the phosphorus data, these peaks in organic nitrogen were the highest among all monitored watersheds (2,688 mg/m^3 on 23 May and 1,236 mg^3 on June 8, 1995).

Fire, Nutrient and Sediment Relationships: A well documented effect of forest fires has been the increase in nutrient loads delivered to receiving waters (Grier, 1975; Tiedemann, and others, 1979; Schindler, and others, 1980; Tiedemann, 1981; Helvey, and others, 1985). Fires affect a forest's nutrient balance in four principal ways: remove nutrients from the site, redistribute nutrients as ash, temporarily disrupt normal nutrient-cycling processes, and increase the flow of water and nutrients to the soil mantle (Tiedemann, 1981). Although combustion renders nitrogen and phosphorus more available for transport to receiving waters most studies show nitrogen loads were increased substantially more than phosphorus loads (Tiedemann, and others, 1979; Schindler, and others, 1980) because the potential phosphorus load was attenuated by its adsorption to soil particles. For nitrogen, however, there are several mechanisms by which its

Figure 4-13. Total Phosphorus (TP) and Total Solids (TS) observed in samples from watersheds tributary to Big Payette Lake.



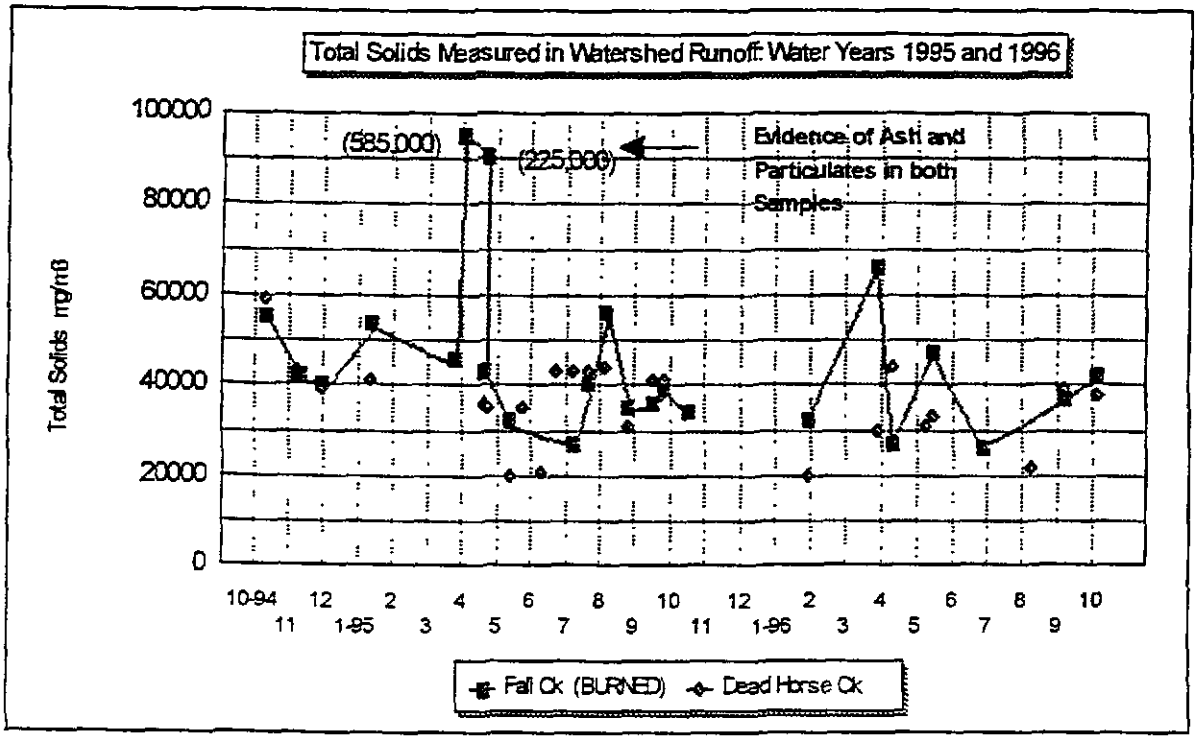
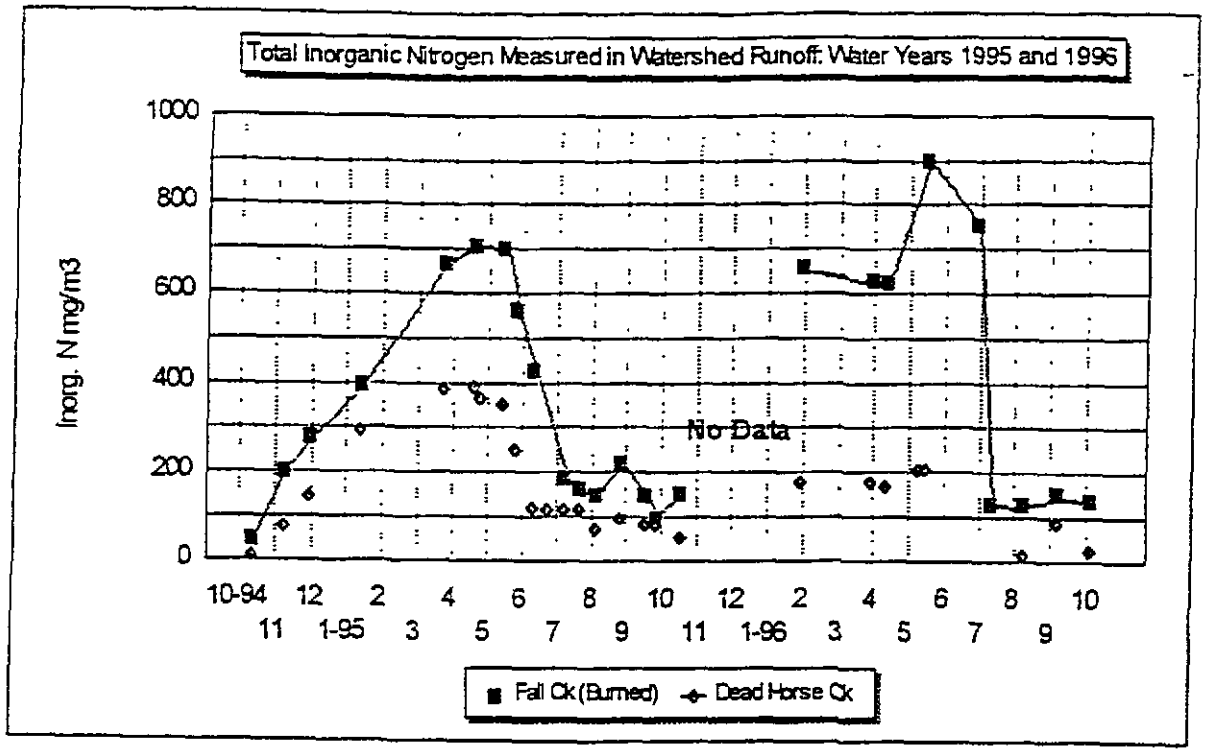
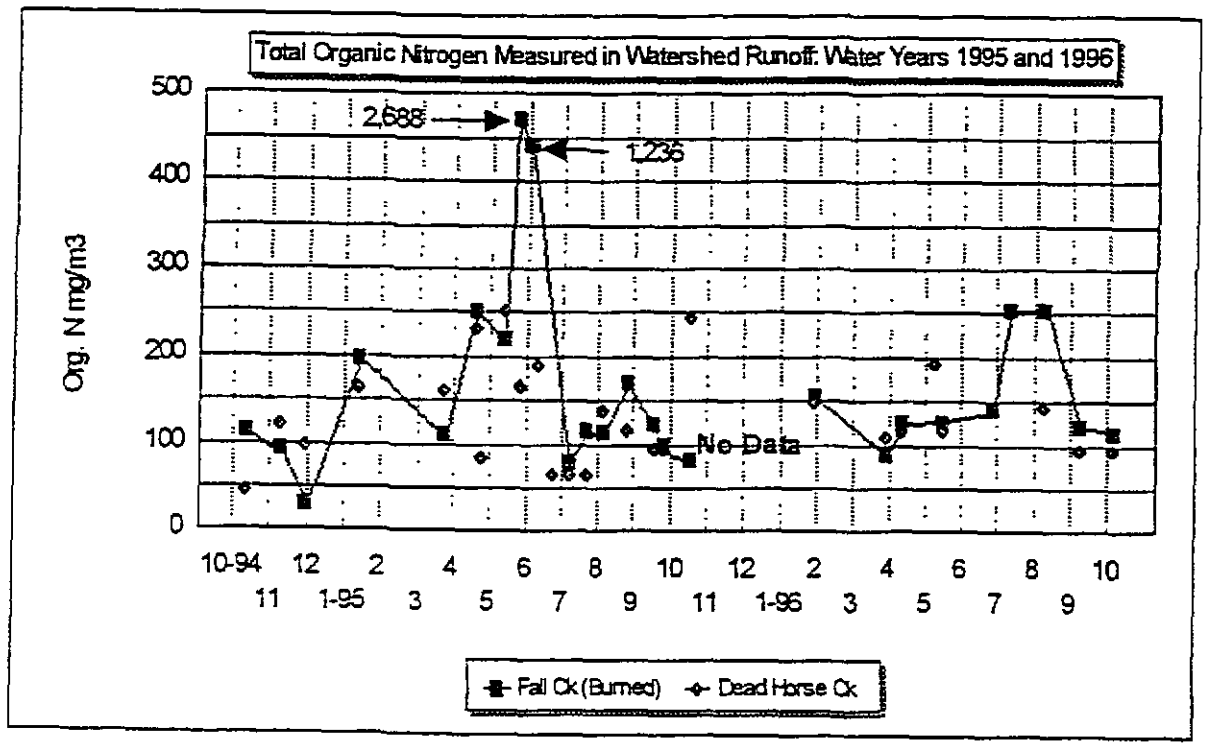


Figure 4-14. Inorganic nitrogen (DIN) and organic nitrogen (Org_N) observed in samples from watersheds draining to Big Payette Lake.





transport to receiving waters is enhanced (Tiedemann, 1981). The nitrogen in redeposited ash is readily leachable and moves into the soil mantle where it can be transported as surface or subsurface runoff. Runoff of nitrogen can also be increased by the loss of vegetation which reduces uptake of soil nitrogen. Another important process is nitrification which is increased by favorable increases in soil pH and electrolyte concentrations following a forest fire (Ahlgren and Ahlgren, 1960).

Differences in phosphorus export among burned and unburned watersheds were related to the flux of particulate phosphorus (PP) during higher flow events (Figure 4-15). These interactions were further complicated by inter and intra annual differences in snow pack and associated runoff volumes. The proportion of particulate phosphorus (PP) in runoff from the Upper NF Payette River (above Upper Payette Lake) and Twentymile Creek was nearly constant in both snowmelt seasons and averaged 64% and 41-46% of the total phosphorus, respectively (Table 4-6). The consistency of these results is particularly remarkable given that both watersheds were burned throughout most of their respective drainage areas and experienced greater runoff volumes in the second season after the fire.

Table 4-6. Comparison of Average Total Phosphorus (TP) mg/L, Particulate Phosphorus (PP) and the Percent of TP as PP (%) from watersheds in WY 1995 and 1996.

	Upper NF Payette			Cougar Creek			20 Mile Creek [1]		
	TP	**PP**	**%**	**TP**	**PP**	**%**	**TP**	**PP**	**%**
1995	.029	0.21	64.2	.041	0.35	65.2	.012	.007	41.6
1996	.020	.015	64.5	.009	.004	31.4	.012	.006	46.7

	Pearl Creek			Deep Creek			Fisher Creek		
	TP	**PP**	**%**	**TP**	**PP**	**%**	**TP**	**PP**	**%**
1995	.032	.022	57.0	.010	.004	35.8	.010	.005	33.8
1996	.010	.005	45.1	.017	.012	52.2	.015	.011	56.8

[1] For 20 Mile Creek, the proportion of TP occurring as particulate P in the first year snowmelt was just slightly lower than the second year due to inclusion of a single sample in which the dissolved P = TP.

In contrast, differences in the PP measured between the first and second year snowmelt seasons from Cougar Creek were significantly different ($P < .05$). Concentrations of PP were ten times greater during the first year snowmelt and declined to background during the second year. Changes in the proportion of the PP export in Cougar Creek were accompanied by higher flows and highly correlated with increased concentration of suspended sediments in WY 1995 (Figure 4-16). These variables were unrelated the following season.

Figure 4-15. Comparison of annual trends in Total Phosphorus (PP + DisP), particulate phosphorus (PP), dissolved inorganic phosphorus (Dis-P) and flow for burned watersheds discharging to Upper Payette Lake. Note that some samples contained unusually high proportions of dissolved inorganic phosphorus.

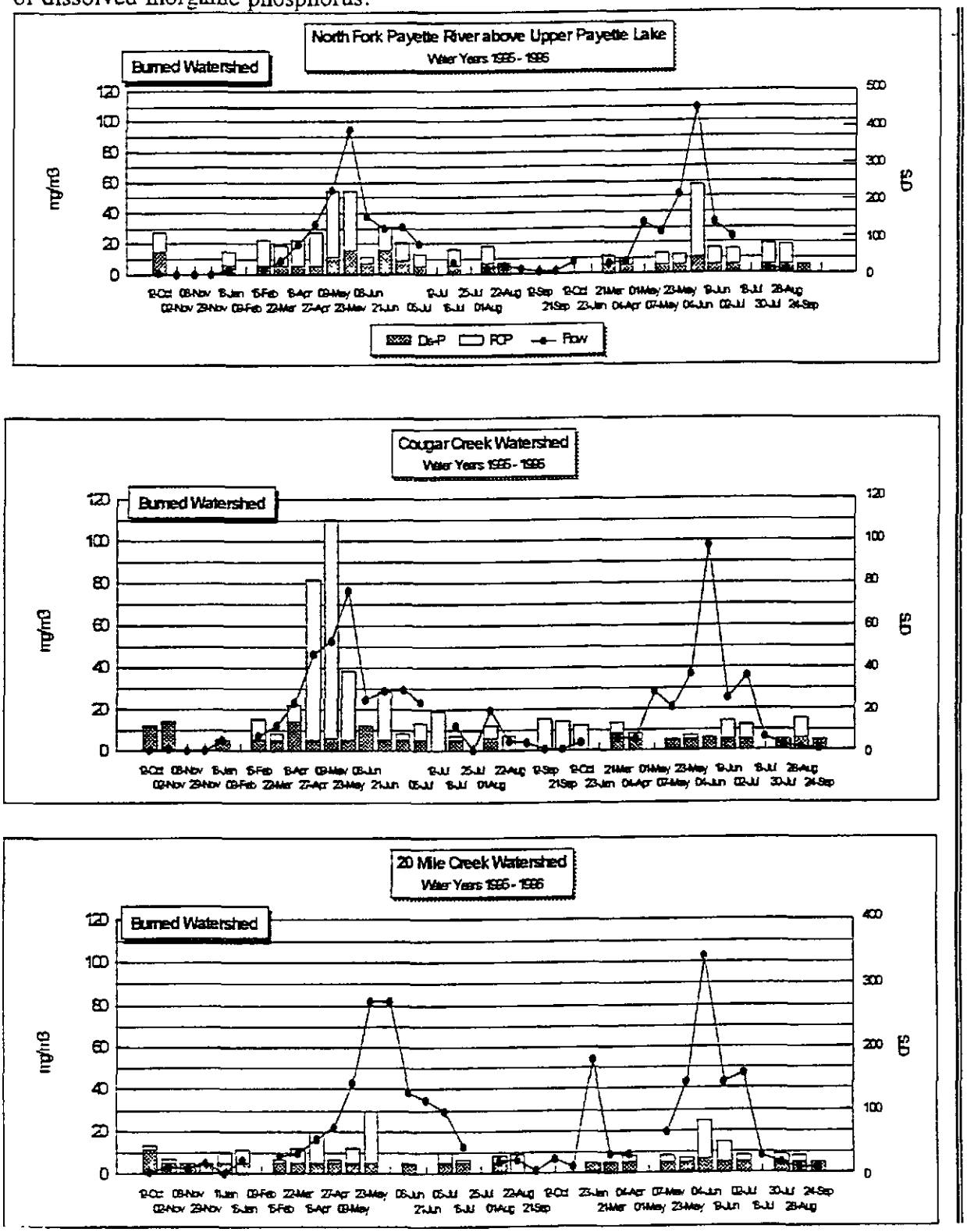
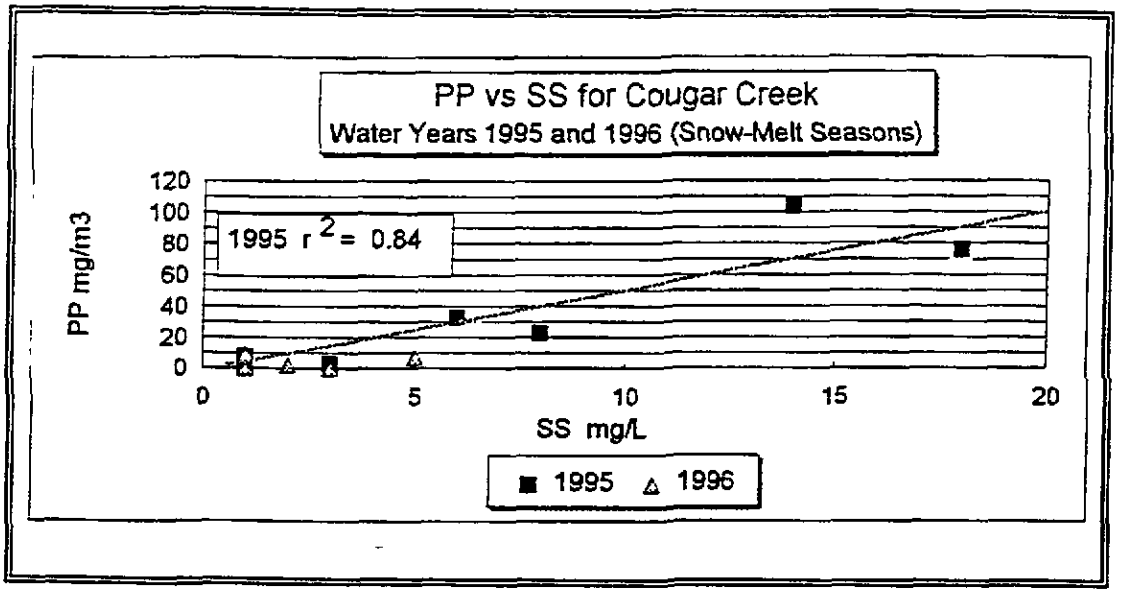


Figure 4-16. Linear regression of particulate phosphorus (PP) on suspended sediment (SS) concentrations from Cougar Creek water quality samples.



More extensive and intensive fires in the Pearl Creek watershed were associated with a higher proportional export of particulate P in the first year snowmelt. Whereas, the proportion of particulate P measured in the lighter burned Fisher Creek and Deep Creek watersheds was relatively constant during the first year snowmelt. Greater increases were observed in these latter watersheds associated with higher peak flows in the following year snowmelt.

The apparent decline in phosphorus concentrations instream waterr from burned watersheds is consistent with observations from other northwest studies. Gluns and Toews (1989) reported similar declines in phosphorus concentrations during the second year runoff following a wildfire. They reported that concentrations were undetectable in the third year runoff. Total and orthophosphorus concentrations were two to three times greater in burned watersheds of north-central Washington three to five years following wildfire (Tiedmann, 1978). Other studies following the Yellowstone Wildfire reported elevated concentrations of phosphorus in streams but levels were within pre-burn ranges of variability (Mahoney, et al., 1988).

Wildfire effects on watershed nitrogen sources are typically more prolonged. Robinson et al. (1993) reported elevated N-NO_3 levels five years after wildfires in Yellowstone National Park. Similar results were also reported for wildfires in Glacier National Park streams in which pulses of nitrogen continued to enter streams during spring runoff five years following the fire. An increase in stream water nitrate nitrogen (principally NO3-N) during the second year of snowmelt was also reported by Tiedemann et al. (1978), Stotlemyer (1987), and Gluns and Toews (1989).

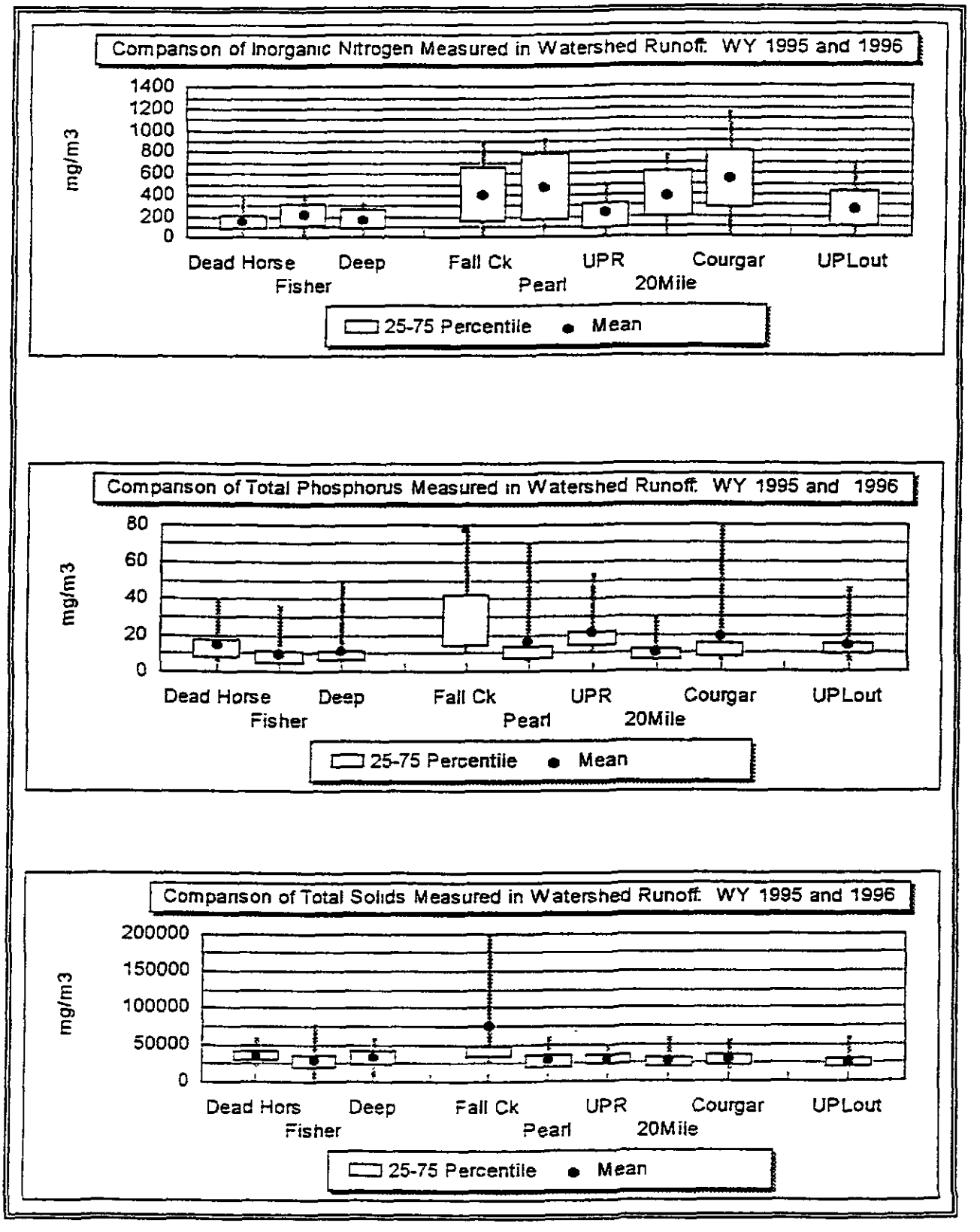
Sediment impacts following wildfires are unpredictable and highly dependent on intensity of storm events and annual accumulations of snowpack that contribute to spring runoff. Large amounts of sediment are typically carried as debris torrents and transported as bedload by streams. Bedload sediments were not measured in this study, consequently the suspended sediment analysis only represents a small fraction of the total sediments that may be impacting streams. Suspended sediments are comprised of materials easily transported by water and thus provide a relatively good indication of the overall erosion activity. Elevated levels of sediment erosion persisted for five years following fires in the Entiat experimental watershed in the Cascade Range of central Washington (Helvey et al., 1985). Similar results were reported following the Yellowstone fire (Brass, et al. 1993). Although the current study spans only two years, the decline in peak concentrations of sediment from burned watersheds during the second year suggests that revegetation of ground cover has already begun to stabilize these areas.

An additional fire-related source of nitrogen and phosphorus for watershed streams and Payette Lake is the large quantity of ash fall-out produced from the fire and fire retardant air-dropped during fire suppression efforts in 1994. An estimate of the nutrient load added to Payette Lake's watershed by the 1994 fires was developed on the basis of previously published studies and data on fire retardant composition and amounts dropped on the watershed. The most applicable studies were of the Entiat fire of 1970 in eastern Washington (Grier, 1975; Tiedemann, 1981) because its species mix was similar to that of the Payette Lake fire. The ash residue from the Entiat fire averaged 2900 kg/ha and contained an average of 23 kg/ha of nitrogen (Grier, 1975). The 1994 fires at Payette Lake burned about 20,000 ha in a species mix considered by Tiedemann (1981) to have a very high nitrogen content. On the basis of the Entiat fire, the Payette Lake fire produced an ash residue of 58 million kilograms that contained 460,000 kg of nitrogen. The phosphorus content of the Entiat ash was not determined, but the ratio of nitrogen and phosphorus yields was 11.4 for post-fire conditions (Helvey, and others, 1985). On that basis, the ash from the Payette Lake fire contained about 2.3 kg/ha of phosphorus; thus, the ash-associated phosphorus was 46,000 kg. No data was found that would allow estimation of the additional nitrogen loads attributable to enhanced nitrification. The amounts of nitrogen and phosphorus added by fire retardant drops were 2,500 and 830 kg, respectively. These estimates were derived by multiplying the amount of retardant dropped on the watershed by the retardant's nitrogen and phosphorus content (J. Fitzgerald, U.S. Forest Service, written commun., 1995). The nutrient contribution from fire retardant was less than 1.0 percent of that added by the ash residue.

4.2.3 Summary of Tributary Water Quality and Watershed Mass Loadings

Comparison of water quality of runoff among monitored watersheds is summarized in the modified box plots of certain key parameters (Figure 4-17). Results show that the flux of inorganic nutrients from unburned watersheds was lower and less variable than burned watersheds. Differences after combining the concentrations over the two water years, however, were not significantly different with the exception of the inorganic nitrogen from the Cougar Creek watershed (P.05).

Figure 4-17. Box plot comparisons summarizing nutrient and sediment data for combined water years 1995 and 1996. UPR = Upper Payette River, UPLout = Upper Payette Lake outflow, all other watersheds as designated.



Watershed Water Quality Appendix Tables summarize the seasonal nutrient loading rates estimated for each of the watersheds tributary to Upper Payette Lake, mainstem of the N.F. Payette River and tributaries to Big Payette Lake. Annual loading estimates for basins and annual contribution by the subwatersheds is listed in Table 4-7. Loading rates from unmonitored watersheds were extrapolated based on a generalized export coefficient for burned and unburned watersheds:

$$Load_u = Load_r/Area_r * Area_u$$

where L is load, subscript u is the unmonitored watershed and subscript r is the reference watershed. Sensitivity of this method was tested by extrapolating loads for unmonitored watersheds and comparing results with monitored data from the same watershed (Richards, 1989).

As with the water budgets, the calculated loading of nutrients derived from burned and unburned portions of watersheds tributary to the mainstem N.F. Payette River were partitioned separately. Pearl Creek nutrient and sediment loadings were used to estimate the flux of materials from burned areas within the contributing areas of the N.F. Payette River mainstem. The corresponding flux of nutrients and sediments from unburned portions of these watersheds was estimated using an average of the material loads from Fisher Creek and Deep Creek.

The potential groundwater influence associated with estimates from Deep Creek may be a source of error causing a low bias in the load estimates for unmonitored watersheds. However, this error may be somewhat compensated for by inclusion of Fisher Creek in the flux estimates due to the scale differences in the watershed size resulting in larger loads associated with higher flows.

For the Upper Payette Lake basin, the upper N.F. Payette River was the single largest source of phosphorus and suspended sediments, accounting for 52% to 59% of TP, and 43% to 53% of SS in water years 1995 and 1996, respectively (Table 4-7). With the exception of 20Mile Creek, loading estimates were lower the second year following the fire and reflect the decline in concentrations of these constituents even though discharge volumes were higher than the previous water year. The upper N.F. Payette River and Twentymile Creek were significant sources of nitrogen loading and contributed nearly equal amounts during both water years, approximately 34% and 38% in 1995 and 1996, respectively.

Unlike TP and SS loadings, nitrogen loadings to Upper Payette Lake increased the second year following the wildfires. This increase was largely the result of increased mobilization of soluble inorganic nitrogen (NO3-N) from leaching and mineralization of organic matter. This loss of nitrogen may have implications for future fertility and productivity of forest stands. Other studies in the northwest region indicate nitrogen losses from forest watersheds are typically low from undisturbed watersheds (Martin and Harr, 1988).

Table 4-7. Annual basin loading and subwatershed contributions for total phosphorus (TP), total nitrogen (TN) and suspended sediments (SS).

Basins and Tributaries	TP		TN		SS	
	95	96	95	96	95	96
Upper Payette Lake Basin Total kg/yr	3,387	2,575	63,127	93,933	499,533	441,843
			Subwatershed Total Each Year			
Cougar Ck	500	213	9,926	34,619	83,230	45,715
N.F. Payette	1,762	1,509	21,192	36,559	215,881	236,285
Twentymile	550	609	20,608	34,619	104,855	107,341
Outlet Ck	164	70	3,257	3,475	27,311	15,001
Camp Ck	410	174	8,143	8,688	68,276	37,502
N.F. Payette Mainstem Total kg/yr	6,773	5,378	129,519	175,243	1,122,499	942,078
			Subwatershed Total Each Year			
Outlet UPL	2980	2026	48,394	89,304	224,448	244,590
Deep Ck	137	297	3,159	5,456	26,343	89,946
Pearl	589	289	10,029	8,805	148,303	54,965
Fisher	488	773	16,832	19,375	103,613	133,213
Brush	949	494	16,329	14,651	237,832	96,971
Box	723	577	13,692	14,489	174,058	133,587
Twah	629	502	11,915	12,608	151,461	116,244
Copet/ NoName	115	182	3,960	4,558	24,374	31,338
Middle Reach NFPR	151	239	5,209	5,996	32,066	41,226
Tributaries to BPL Basin Total kg/yr	20,661	1,581	48,833	30,691	3,106,897	791,178
			Subwatershed Total Each Year			
Fall	14,571	803	25,960	13,782	2,174,828	466,795
Deadhorse	198	178	4,370	3,934	2,174,827	63,294
Lemah	5,717	441	14,606	9,468	869,931	197,794
Sylvan	87	78	1,926	1,734	932,069	31,647

The potential removal of nutrients and sediments by Upper Payette Lake was evaluated by comparing the change in concentrations of constituents and mass balance of inflows and outflows. A flow weighted concentration for various constituents was computed from the respective inputs of Cougar Creek, Twentymile Creek and N.F. Payette River above Upper Payette Lake. Figure 4-18 compares the flow weighted concentration of these inflows to the outflow concentrations passing through the dam. Results show the lake has some influence on the reduction of phosphorus, inorganic nitrogen and sediments passing through the lake. Concentrations of phosphorus were reduced by 29-71% during the initial rise in the runoff hydrograph. Although similar reductions were not observed the following snowmelt season, small reductions in concentration (10-30%) of outflow phosphorus were measured during the summer. Reductions in suspended particulate matter were more consistent ranging from 6-26% the first year and 4-74% the second. Consistent reductions in the inorganic nitrogen inputs were also evident ranging from 4% > 80% in both years. Greater reductions are associated with lower discharge rates flowing out of the lake (longer residence time for water entering the lake). Large pulses of organic nitrogen are typically discharged from the lake presumably due to biotic production and conversion of inorganic nutrients to organic matter (phytoplankton, periphyton and aquatic vegetation litter).

The function of Upper Payette Lake as a nutrient and sediment sink is further supported by a comparison of the mass balance budgets (Table 4-8). Total phosphorus removal by mass averaged almost 12% each year. Total nitrogen export was reduced by roughly 23% the first year but retained only 1.9% of nitrogen inputs during the second year. Marked reductions in the suspended particulate matter were also observed.

Export of nitrogen and phosphorus from Upper Payette Lake comprised the single largest flux of these nutrients to the mainstem N.F. Payette River (Table 4-7). Phosphorus loading from Upper Payette Lake was three times greater than any single tributary during water year 1995 (44% of total inputs) and two and a half times greater than other sources in water year 1996 (38% of total inputs). The proportion of nitrogen loading attributed to Upper Payette Lake discharges increased from 37% to 51% of total inputs to the mainstem N.F. Payette River due to the high flux of nitrogen during the second year snowmelt. In comparison to the above nutrients, export of suspended sediments from Upper Payette Lake comprised a smaller proportion of the total loading to the river mainstem contributing 20% and 26% of the total in water years 1995 and 1996, respectively.

Validity of the annual loading rates of phosphorus, nitrogen and sediment attributed to other sources are dependent on the extrapolation method used to estimate loads from unmonitored watersheds. Assuming that impacts of conditions in monitored watersheds can adequately be extrapolated to other burned watersheds, sediments derived from Brush Box and Twah Creeks were major contributions to the total sediment load of the river mainstem. In contrast, the total phosphorus contribution of these watersheds was moderately high compared to other monitored watersheds both burned and unburned.

Figure 4-18. Comparison of inflow and outflow concentrations of nutrients and suspended sediments for Upper Payette Lake.

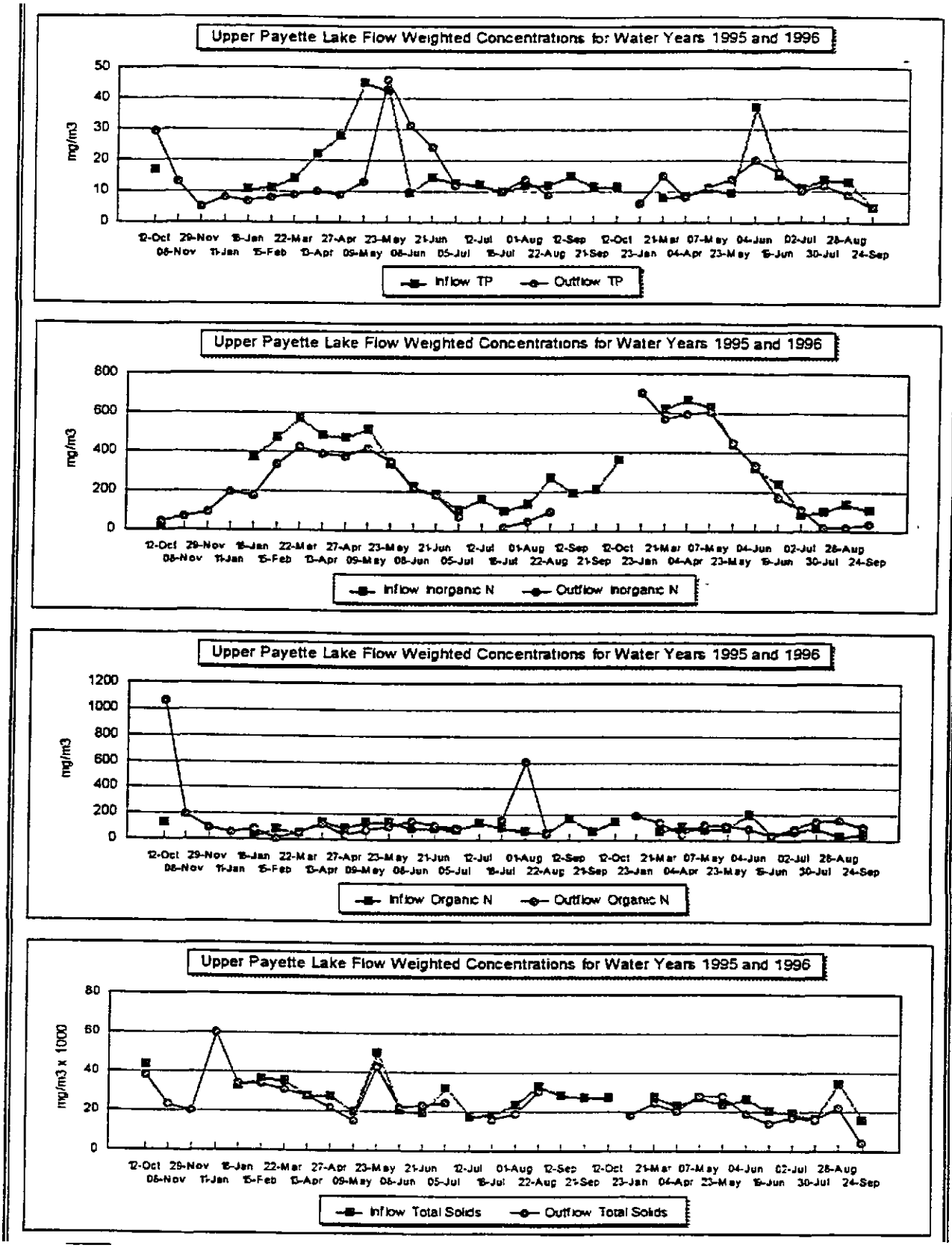


Table 4-8. Water, nutrient and suspended sediment budget for Upper Payette Lake.

Total Inflow Loading to Upper Payette Lake

	WY1995				WY1996			
	TP kg/month	TN kg/month	SS kg/month	Flow cf/month	TP kg/month	TN kg/month	SS kg/month	Flow cf/month
OCT	7	120	478	176	28	1,327	8,314	907
NOV	10	261	847	309	58	3,337	15,879	2,103
DEC	8	275	715	260	164	11,014	40,693	5,940
JAN	14	612	1,323	486	126	9,909	25,681	4,976
FEB	60	2,972	5,104	1,836	105	8,544	18,357	4,224
MAR	104	5,018	15,908	2,568	37	3,198	4,608	1,553
APR	545	12,282	176,925	6,793	134	11,935	14,893	5,443
MAY	2,201	29,125	269,198	18,680	519	26,164	78,308	14,933
JUN	336	8,041	44,381	9,102	1,029	17,397	196,553	16,546
JUL	140	2,861	19,872	4,140	92	1,383	15,840	2,,862
AUG	51	1,438	6,453	1,609	14	232	2,216	395
SEP	29	812	4,952	881	12	274	2,346	619
Total	3,505	63,815	546,154	46,842	2,317	94,714	423,688	60,500

Total Export from Upper Payette Lake

	WY1995				WY1996			
	TP kg/month	TN kg/month	SS kg/month	Flow cf/month	TP kg/month	TN kg/month	SS kg/month	Flow cf/month
OCT	10	341	2,526	198	19	989	2351	961
NOV	10	262	1,309	384	44	3,635	6143	2,511
DEC	5	171	797	326	118	12,433	17,441	7,129
JAN	7	240	898	367	80	10,892	12,480	5,101
FEB	27	1,161	3,369	1,377	95	8,995	10,734	4,387
MAR	56	2,899	6,960	2,595	50	2,765	3,801	1,554
APR	109	5,326	23,411	4,634	133	9,762	45,349	5,842
MAY	1,563	21,998	118,336	19,676	594	26,908	123,701	18,000
JUN	1,175	13,691	80,431	16,679	795	14,652	46,081	18,835
JUL	91	1596	8,661	3,057	80	1,437	7503	3,064
AUG	30	872	4,524	1,188	10	179	2289	422
SEP	21	687	2,514	1,028	11	265	2928	712
Total	3,103	49,242	253,735	51,508	2,029	92,911	280,801	68,517

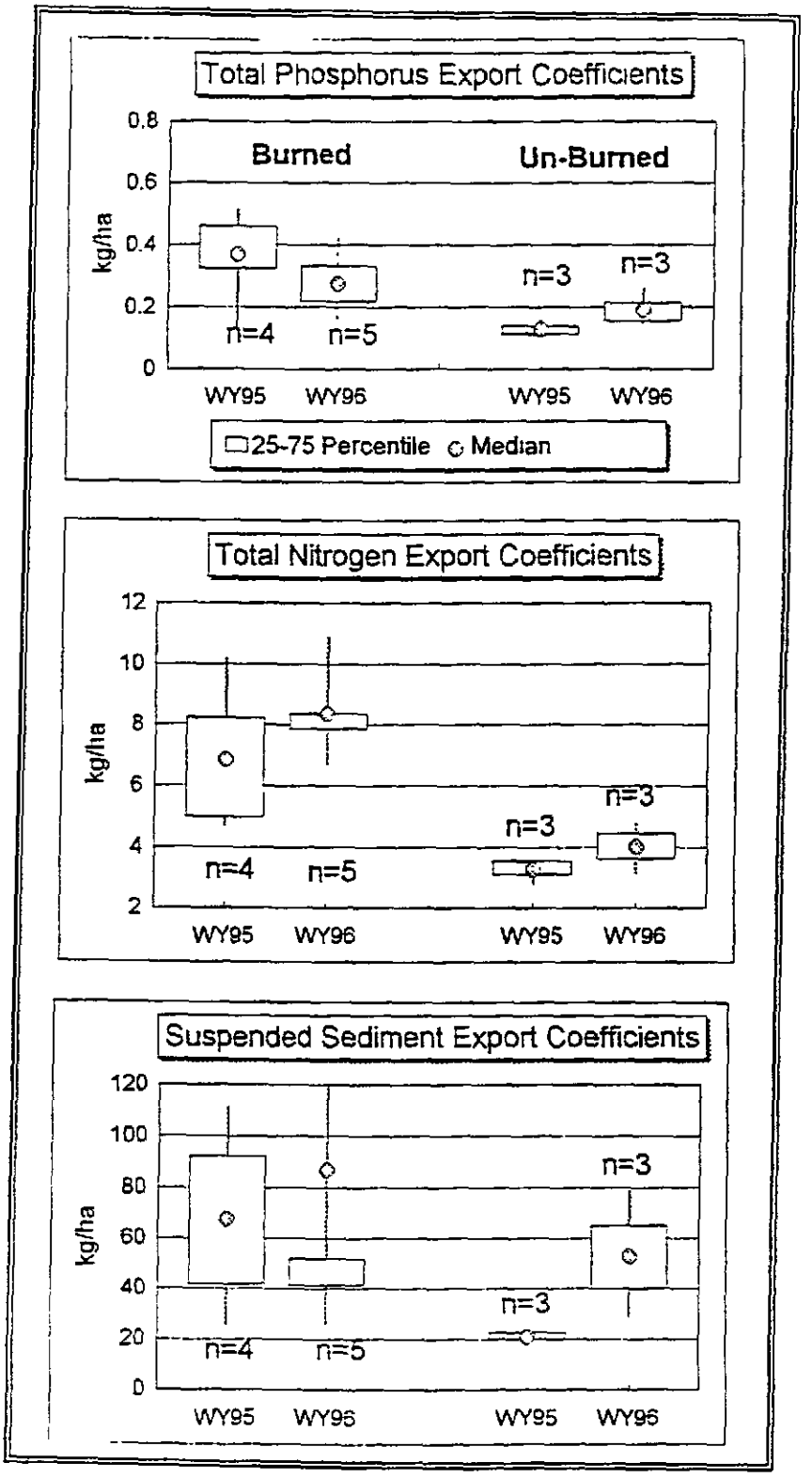
Percent of Inflows Retained	WY1995				WY1996			
	11.5	22.8	53.5	-10.0	12 4	1.9	33.7	-13.3

The apparent increase in loading of sediment and phosphorus from the unburned watersheds Fisher Creek and Deep Creek corresponds to an increase in stream water concentrations observed during the second year snowmelt. This increase was subsequently applied to extrapolated estimates for the unburned watersheds Copet/No-Name and the middle reach of the N.F. Payette River. Consequently, increases in loading from these latter sites may not reflect true conditions for these watersheds. The effect of this error on the overall budget calculations are relatively minor. Estimated loadings of nitrogen from other mainstem tributaries were surprisingly consistent between water years and largely reflects differences in the water budgets. A minor increase in the nitrogen loading derived from Deep Creek and Fisher Creek resulted from short term increases in stream concentrations.

Loading estimates for watersheds draining directly to Big Payette Lake were equally difficult to determine due to a combination of confounding factors. Table 4-7 summarizes the estimated loadings for the monitored (Deadhorse and Fall Creek) and unmonitored watersheds (Lemah, Sylvan and Wagon Bay Creeks). The load estimate and standard errors for Fall Creek are quite large for water year 1995 due to the extreme variability in stream water concentration of nutrients and sediments. By contrast, load estimates for the Deadhorse Creek watershed were relatively consistent for both water years. The Lemah Creek watershed on the east side of the lake is similar in size and topography to Fall Creek and was burned throughout a similar area of its headwaters. For this reason, it would seem reasonable to extrapolate nutrient and sediment loads for this watershed using Fall Creek as a reference. However, field observations suggested that conditions within the Fall Creek watershed were somewhat unique. Intense wildfire burned throughout the stream riparian area and destabilized the stream bank. Evidence of overland flow events entering the stream were prevalent suggesting that stream water chemistry may reflect these site specific conditions. Alternatively, the loading computations were made by combining information from Pearl and Fall Creek as a reference to reflect a combination of the two sets of response conditions to fire. Loading estimates for Sylvan and Wagon Creek watersheds were extrapolated from the monitoring results of Deadhorse Creek. Accordingly, the annual yields for these watersheds were small and consistent between the water years.

A unit area comparison of the nutrient and sediment yields shows that fire effects resulted in substantial increases in the yield of phosphorus and nitrogen over unburned watersheds (Figure 4-19). These differences, however, were not statistically different due to the small sample size (P.05). Other landscape variables such as road densities, history of harvest, and land type association may also be important factors contributing to the increase in these nutrient yields. Further analysis is needed to ascertain what synergistic influence these factors may play in the availability and transport of nutrients. Surprisingly, the sediment yield increased at two of the three unburned watersheds (Deep Creek and Deadhorse Creek) during the second year monitoring causing the range and average yield per unit area to increase for this group. Factors accounting for this increase are not clear. As peak flows and total discharge declined slightly in the second year compared to the first, the increase sediment yield is not explained by an increase in runoff volume as occurred in other watersheds at higher elevations.

Figure 4-19. Comparison of nutrient and sediment yields by unit area for monitored burned and unburned watersheds. Fall Creek values for burned watersheds have been excluded in the first year calculations due to extreme high yields. (n=number of samples)



Future Loading Conditions

An issue of concern is the potential impacts of additional fires within the watershed and the implication for additional sediment and nutrient loading to Big Payette Lake. Re-burn of previously burned watersheds posses a substantial threat due to the accumulation of new fuels from trees killed by the previous fire. Sources of information in the literature pertaining to this scenario is limited and mostly related to prescribed fires. Wildfires entering previously unburned areas of the watershed will likely occur under the proper conditions. The potential contribution of sediments and nutrients from these areas can be roughly estimated by extrapolating the resulting loadings based on the existing burned watershed data.

Table 4-9 lists the approximate loading based on the mean kg per unit area contribution of burned watersheds. For burned conditions, these rates are 0.37, 6.9 and 68 kg/ha for total phosphorus, total nitrogen and suspended sediment, respectively. Results from this table assume that previously burned areas have stabilized (no re-burning) and the resulting nutrient and sediment yields per unit area for recovered forest would be similar to those of unburned watersheds monitored during this study and under similar climatic conditions. The expected loading from future wildfires burning the remaining watershed (forest not burned in 1994) would be roughly double the amounts contributed by these same watersheds. By extrapolating the unburned and monitored watershed results throughout the drainage, the approximate pre-burn loading rates to Big Payette Lake from these watersheds would be 4,000 kg phosphorus, 97,000 kg nitrogen and 553,000 kg suspended sediment. Validity of these estimates, however, is subject to a wide array of assumptions.

4.2.4. Stream Sediment Enrichment

Fine sediments, in addition to impacting fish habitat, have a strong affinity for nutrients, particularly phosphorus, and may accumulate additional nutrients through other biogeochemical processes (Taylor and Kumishi, 1971; Bostrom, et al, 1988). Accumulation of these nutrients was evaluated on selected stream monitoring sites. Sediment cores were extracted from the stream bed (bed) and stream bank wetted edge (bank) at Elip Creek, Pearl Creek and Trail Creek. Samples were not collected from other sites due to a lack of suitable substrate containing fine materials. Most of the stream monitoring sites contained substrates ranging from coarse sands to gravels or a sufficient mixture of these materials so that the hand cores could not penetrate the substrate.

Table 4-9. Estimate of future nutrient and sediment loadings from watersheds. The future burn loading assumes the remaining unburned acres burn at some future date. The normal unburned or stable condition assumes that nutrient and sediment yields return to a pre-fire status approximating unburned watershed yields.

				Future Load if Burned (Kg)			Pre-burn/Recovery Load (Kg)		
Watershed	ha	% Burned	% Unburned	TP	TN	SS	TP	TN	SS
NF Payette	4,542	87	13	722	17,050	122,744	579	14,945	95,199
Cougar	973	73	27	188	4,138	32,648	124	3,201	20,393
20 Mile	4,141	82	18	709	16,282	121,563	528	13,625	86,792
Camp	798	15	85	266	5,044	48,373	102	2,626	16,727
Outlet	319	100	0	41	1,050	6,691	41	1,050	6,691
* Sub-Total				1,733	33,545	156,049	1,236	27,295	106,127
Deep	1,144	32	68	334	6,538	60,273	146	3,764	23,980
Pearl	1,323	95	5	185	4,590	30,824	169	4,354	27,738
Fisher	4,661	40	60	1,272	25,308	228,171	594	15,337	97,701
Brush	2,199	94	6	312	7,705	52,239	280	7,235	46,085
Box	2,152	76	24	400	8,921	69,192	274	7,080	45,101
Twah	1,873	34	66	538	10,567	96,902	239	6,161	39,248
Copet/NoName	1,096	0	100	406	7,516	74,123	140	3,607	22,979
Middle NF	1,442	0	100	534	9,888	97,517	184	4,746	30,231
Fall	1,750	69	31	355	7,692	61,985	223	5,758	36,678
Dead	1,248	0	100	462	8,559	84,411	159	4,108	26,168
Sylvan	550	0	100	203	3,770	37,185	70	1,810	11,528
Wagon Bay	563	0	100	208	3,860	38,064	72	1,852	11,800
Lemah	1,304	70	30	261	5,685	45,581	166	4,291	27,332
**Total				7,204	144,144	1,132,517	3,953	97,399	552,,696

* Sub-total assumes Upper Payette Lake continues to assimilate approximately 10% and 53% of the total phosphorus, nitrogen and suspended sediments produced by upstream watersheds.

** Total includes cumulative N.F.Payette River inputs plus streams directly draining to Big Payette Lake.

Of the samples collected, nutrients, minerals and metals were considerably higher in the bank samples compared to the samples from the stream bed (Table 4-10). Bank samples contained several times the amount of nitrogen and carbon as bed samples. Total phosphorus content of bank sediments averaged 356 mg/kg compared to the 187 mg/kg of bed samples. High concentrations of aluminum and iron were also measured in bank samples.

Table 4-10. Average concentration and standard error of nutrients, minerals and metals in stream bed and stream bank sediment samples. All units are mg/kg dry weight.

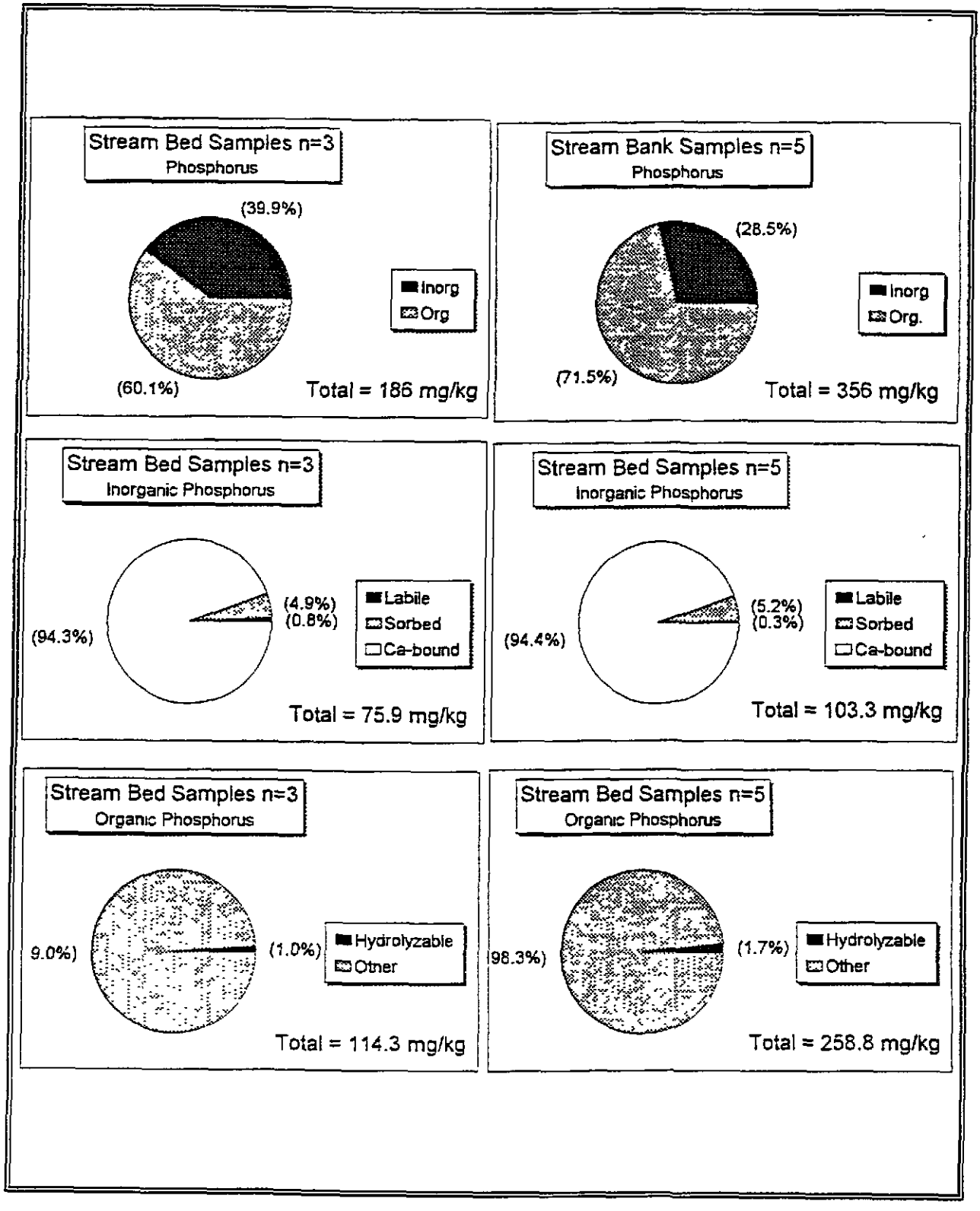
	Bed (n=3)	S.E.	Bank (n=5)	S.E.
TP	187	28	356	42
TN	100	0	1,700	534
C	59,900	21.637	232,640	175,826
Ca	391	65	1,355	534
Mg	98	17	185	37
Al	299,500	76,500	1,163,200	292,260
Fe	347,000	61,000	816,300	42.599

Although the phosphorus content was greater in the bank samples, analysis of the phosphorus forms present indicated the differences were largely due to greater amounts of organic phosphorus (Figure 4-20). Organic P accounted for 71.5% of the total P present in bank samples compared to 60% in the bed samples. Bicarbonate extraction of the organic P indicated the hydrolyzable organic phosphorus comprised a small portion of the organic P present, less than 2% in the bed and bank samples. The hydrolyzable P is easily leached from organic material and could be an important source of phosphorus for biological uptake. The majority of the remaining organic P (94%) was comprised of more complex organic forms, some of which may also be unavailable for biological uptake without further biological/microbial processing.

The relative amounts of inorganic phosphorus extracted by the HCL digestion process was consistent between bed and bank samples. The HCL digestion process used in the analysis extracts calcium bound phosphorus associated with mineral forms of apatite. This form of phosphorus is considered unavailable for biological uptake due to the strong chemical bonds which form between the phosphorus and calcium molecules. Of the total phosphorus measured, approximately 27.4 % of the bank phosphorus and 38.4% of the bed phosphorus was unavailable for biological uptake by aquatic plants, periphyton or algae.

The KCl extracted fraction of the inorganic sediments approximated the labile fraction of inorganic P present in the sediments. This fraction is a primary regulator of soluble and particulate P in soil porewater and is readily available for plant uptake. KCl extracted P accounted for approximately 1% of the total phosphorus present in sediments. Loosely sorbed inorganic phosphorus is phosphorus sorbed to fine sediment and organic particles. This fraction was a small percentage of the inorganic P present.

Figure 4-20. Phosphorus forms measured in streambed and stream bank sediments. (N = number of samples)



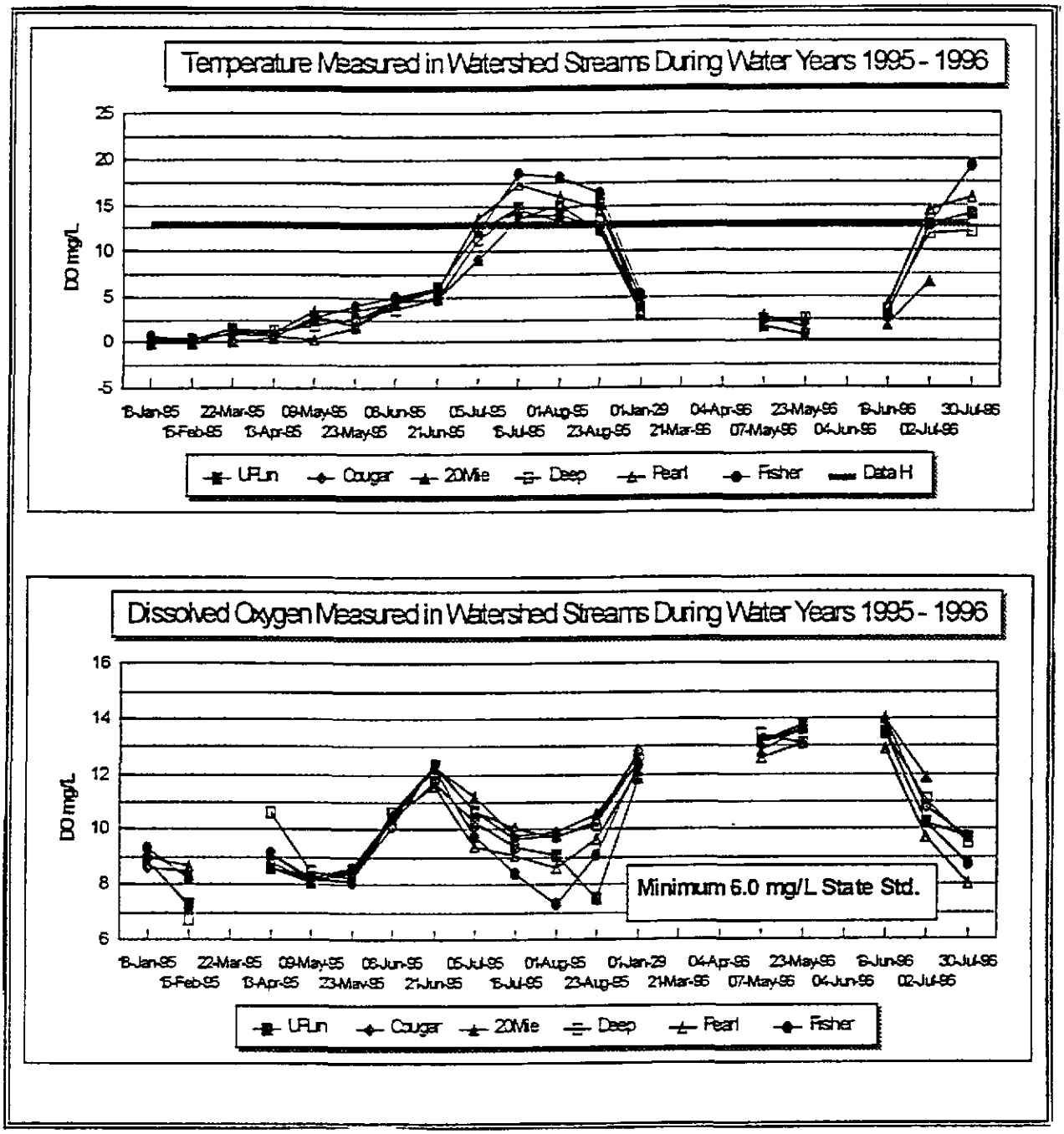
Presence of higher minerals, carbon, nitrogen and organic phosphorus in bank sediments suggest these differences are a direct result of hydraulic processes that tend to wash and transport fine sediments and organic materials downstream. Accumulation of these materials occurs at the wetted stream edge where stream velocities are lowest and fine grained materials are able to settle onto the stream substrate. These materials are subsequently available for later transport when stream velocities increase and erode these deposits.

The relative degree to which the bank sediments may have been enriched above natural background by runoff from the fires could not be ascertained since cores were only sampled from burned stream segments. The sample size was also too small to provide meaningful comparisons among the burned stream segments.

4.2.5 Stream Temperature and Dissolved Oxygen Conditions

Synoptic sampling of stream temperature and dissolved oxygen concentrations are presented in Figures 4-21. Temperatures of monitored streams exceeded the maximum 13°C maximum for salmonid spawning beginning in late June and remained above the standard until late August. As these were single daily measurements, the potential exists that temperatures exceeded standards at an earlier period within the season. Highest temperatures were recorded for the Fisher Creek, Pearl Creek, N.F. Payette River above Upper Payette Lake and outflow from Upper Payette Lake. Elevated temperatures appear to correspond to removal of riparian vegetation with the exception of Fisher Creek. Causal factors contributing to high temperatures at this site are not clear. Discharge from Upper Payette Lake is controlled by radial gates that draw water from the surface of the lake where solar heating is maximum. Dissolved oxygen concentrations ranged from 6 - 14 mg/L and remained above the minimum state standards.

Figure 4-21. Temperature (degrees Celsius-C) and dissolved oxygen (mg/l) measured during synoptic sampling of watershed streams.



4.3 Stormwater Monitoring of Developed Areas

Stormwater runoff was collected from storm drains or culverts draining directly to Big Payette during the fall rainy season (October 1995 and September 1996) and during spring snowmelt (May 1996) (See Section 3.2.2, page 49 and 50 for methods). All samples were collected within Basin 7 and Basin 3 as described in the City of McCall Stormwater Management Plan Phase I (Toothman-Orton, 1991). Results are summarized in Figures 4-22. A sequence of samples collected from the Marina storm drain in October shows concentrations of total phosphorus and nitrogen (organic and inorganic) increased with the passage of a frontal system and reflects the additional pollutant inputs generated from developed areas and surface runoff.

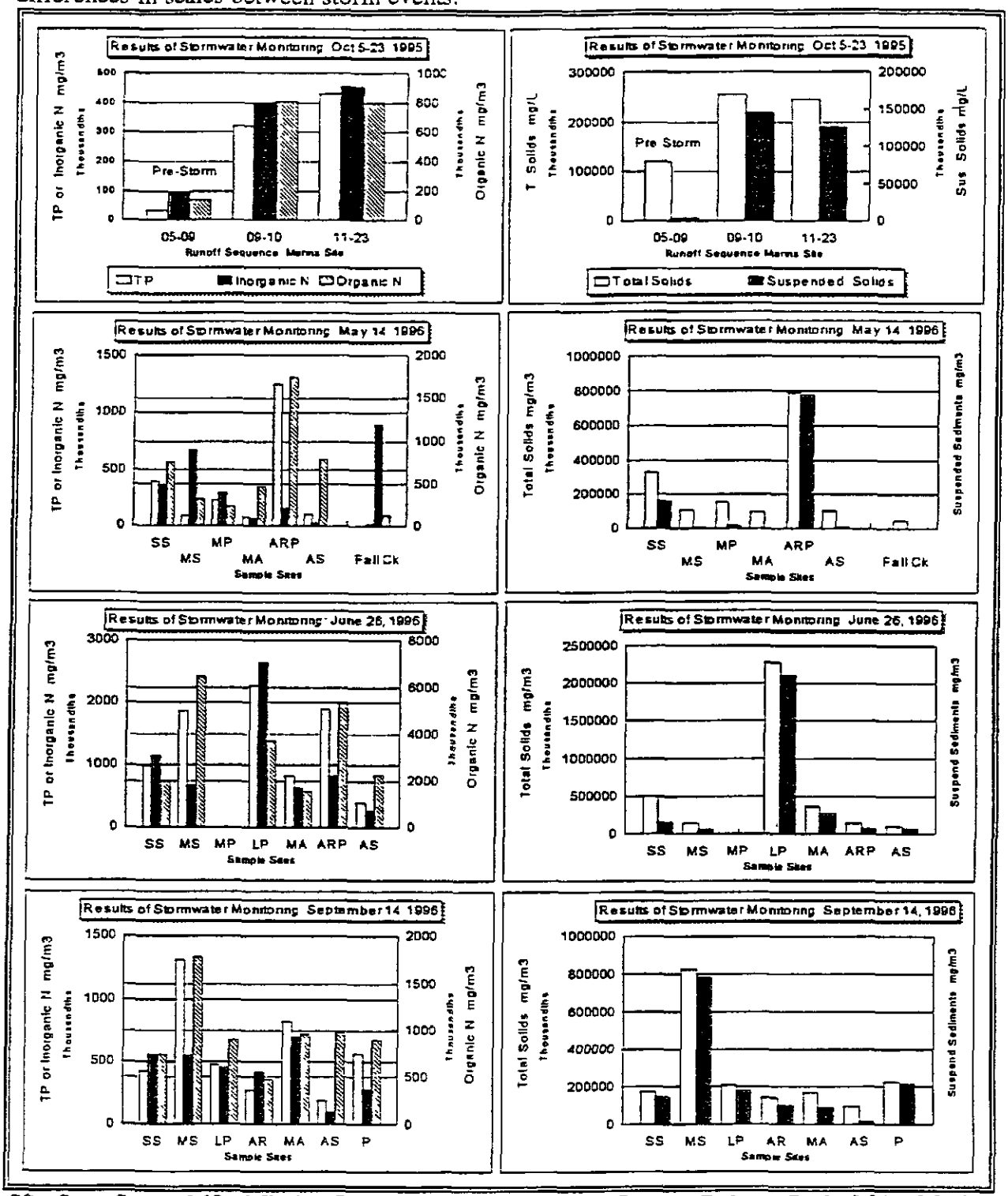
Additional samples collected the following May indicate storm runoff from more urban drains are a significant source of phosphorus entering the littoral zone of the lake (Art Robert site, Figure 4-22). Concentrations of TP and organic nitrogen from these drains were much greater, by comparison, than contributions from the burned Fall Creek watershed during a similar period. These storm drains were also a significant source of suspended solids and turbidity for the lake. Construction activity near the State Street storm drain contributed large amounts of suspended solids during the May rainfall event. Road construction and repairing along Highway 55 fronting the lake resulted in additional concentrated inputs of suspended sediments in September. Bacteria was highly concentrated in storm runoff (fecal streptococcus 1,000-16,000 counts/100 ml and Coliform 2,000-6,000 counts/100 ml) among all sites monitored compared with other inputs from the N.F. Payette River and Fall Creek (Figure 4-23) and exceeded those reported for the recreation impact survey (see section 4.6.1). Fecal coliform counts were actually highest in fall (September) following a dry period and coinciding with warmer weather. Counts greatly exceeded 8,000/100 ml of sample but actual concentrations could not be determined due to cell densities exceeding the dilution/count test. Fecal streptococcus in these samples ranged from 8,000-16,000 counts/100ml. Extremely high counts of fecal coliform (8,100 counts/100 ml) and fecal streptococcus counts (71,000,000 counts/100 ml) were previously reported from the Art Roberts storm drain during a survey conducted by the Central District Health between 1983-1985 (Jeff Lappin, pers. comm). Comparison of bacterial results from the Nationwide Urban Runoff Program (EPA, 1983) show levels reported in this study are similar to the national average (Table 4-11).

Table 4-11. Comparison of Fecal Coliform Bacteria concentrations in Urban McCall with results from the Nationwide Urban Runoff Program (NURP).

Concentration (counts/100 ml)		
Source Area	NURP Data	City of McCall
Parking Lots	2,500	
Residential Streets	37,000	3,000 to >8,000[1]
Commercial Street	12,000	5,000 to >8,000
Lawns	24,000	

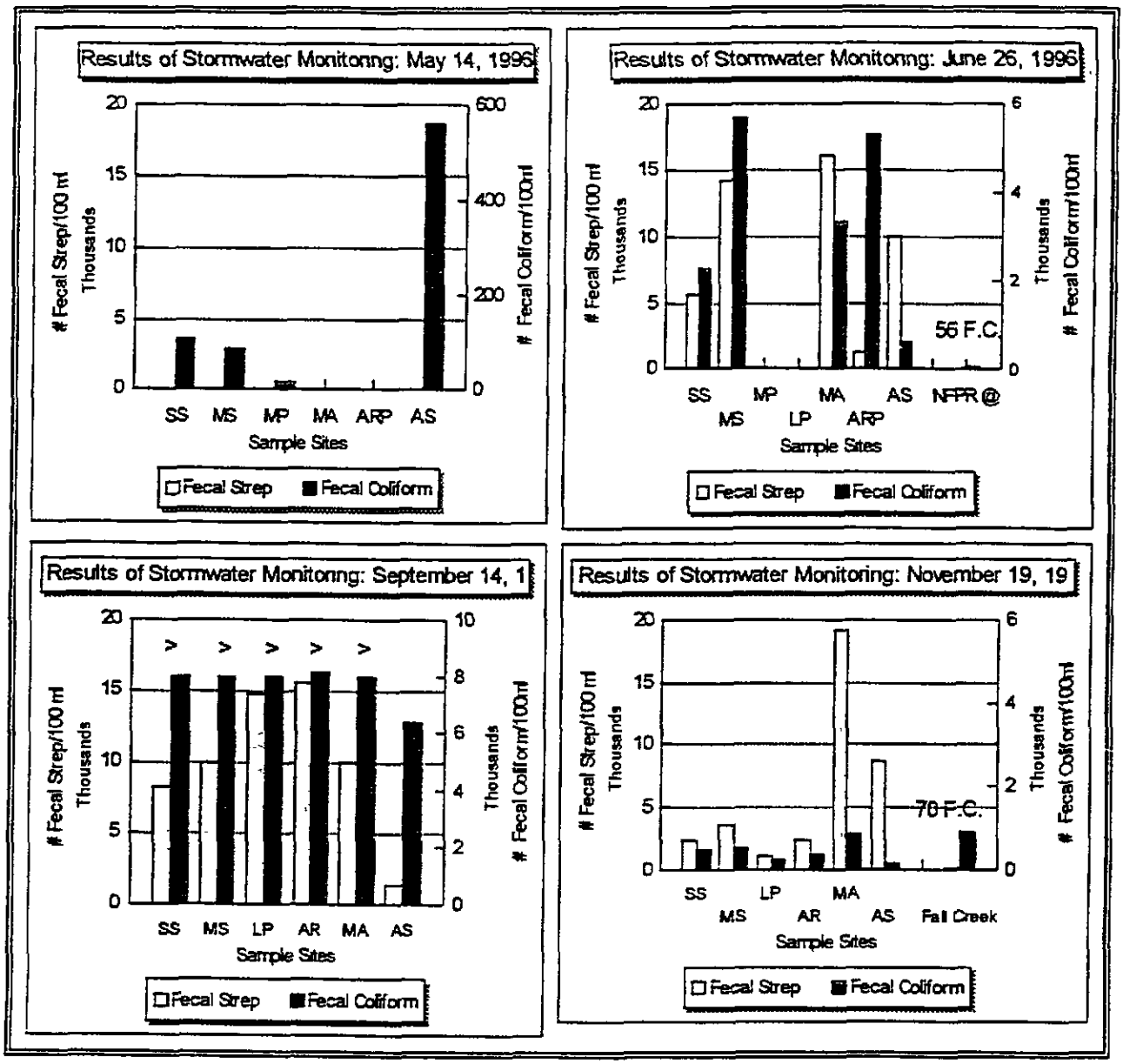
[1] Sample concentrations exceeded dilution series used for enumeration by the laboratory.

Figure 4-22. Total phosphorus (TP), inorganic nitrogen, organic nitrogen, total solids and suspended sediment concentrations measured and collected from developed areas. Note differences in scales between storm events.



SS=State Street, MS=Mission Street, LP=Legacy Park, AR=Art Roberts Park, MA=Marina, AS=Agate Street, P=Paul's

Figure 4-23. Bacteria results from stormwater sample collections. Note differences in scales between sample events. Fecal coliform samples included from N.F. Payette River on June 26 as a reference for other sources of bacteria.



In conjunction with other monitoring, a series of samples was collected for heavy metals analysis in stormwater runoff. Ultra-clean techniques were not used as generally recommended for metals analysis since samples would only be used for screening purposes to determine whether high concentrations were present. Samples were collected from the principle storm drains during an active thunderstorm. Results indicated that heavy metals concentrations were not particularly high in storm drain runoff. Analyses for dissolved fractions of copper, lead, mercury, chromium, and nickel were below detection limits. Elevated concentrations of total lead, iron and chromium were present in runoff from the Mission Street storm drain. These elevated concentrations coincided with construction and resurfacing of Highway 55 in the immediate area and probably reflect leaching of these materials from the asphalt mix.

Table 4-12. Heavy metals concentrations measured in stormwater samples collected on September 14, 1996. Values underlined are reported at the limits of detection. Diss=dissolved concentrations, Tot=Total concentrations.

	Agate St. (AS)	Marina (MP)	Legacy Pk (LP)	Art Roberts Pk (ARP)	Mission St. (MS)	State St. (SS)	Paul's (P)
Chromium. Dis	3	2	2	2	2	2	2
Chromium. Tot	4	2	7	4	23	6	9
Copper Dis	10	10	10	10	10	10	10
Copper Tot	40	10	20	10	60	10	20
Iron Dis	150	70	30	20	40	50	20
Iron Tot.	1,230	5,040	6,230	3,540	32,900	6,130	6,460
Lead Dis.	5	5	5	5	5	5	5
Lead Tot.	28	14	40	32	170	25	60
Mercury Dis	1	1	1	1	1	1	1
Mercury Tot	1	1	1	1	1	1	1
Nickel Dis	5	5	5	5	5	5	5
Nickel Tot	5	5	5	5	13	5	5
Zinc Tot	37	78	130	96	193	85	91

4.3.1 Loading Estimates from Developed Areas

Export coefficients have been widely used to estimate pollutant loads from urban runoff. Selection of a specific coefficient varies depending on a multitude of factors such as the amount of impervious surfaces, the mix of residential and commercial uses, and degree of pre-treatment of runoff. Table 4-13 lists typical average pollutant concentrations found in urban runoff and the recommended concentrations to estimate loadings. Results of this study were based on mixed commercial and residential densities from a national survey, which may exceed typical conditions in the McCall urban core.

Table 4-13. Water Quality Characteristics of Runoff from Residential and Commercial Areas Based on Nationwide Urban Runoff Program (EPA, 1983).

Constituent	Average Residential or Commercial Site Concentrations	Weighted Mean Residential or Commercial Site Concentrations	NURP Recommendations for Load Estimates
TSS	239,000 mg/m^3	180,000 mg/m^3	180,000-548,000 mg/m^3
BOD	12,000 mg/m^3	12,000 mg/m^3	12,000-19,000 mg/m^3
COD	94,000 mg/m^3	82,000 mg/m^3	82,000-178,000 mg/m^3
Total P	500 mg/m^3	420 mg/m^3	420-880 mg/m^3
Sol. P (SRP)	150 mg/m^3	150 mg/m^3	150-280 mg/m^3
TKN (Org.N)	2,300 mg/m^3	1,900 mg/m^3	1,900-4,180 mg/m^3
NO2+NO3	1,499 mg/m^3	860 mg/m^3	860-2,200 mg/m^3
Total Cu	53 mg/m^3	43 mg/m^3	43-118 mg/m^3
Total Pb	238 mg/m^3	182 mg/m^3	182-443 mg/m^3
Total Zn	353 mg/m^3	202 mg/m^3	202-633 mg/m^3

One method of estimating the quantity of nutrients contributed by the developed areas around the lake is to calculate a loading based on the runoff volume and unit load for the various land uses found around the lake perimeter. This method was proposed by Schuler (1987) and similar variations have been used or proposed for other initial lake assessments of nutrient sources (Walker et al., 1989; Reckow et al., 1980). In this study, the contribution of total phosphorus, total nitrogen and suspended sediment contributed by the developed areas around the southwest basin of the lake are estimated using the Schuler method:

Load (kg/yr) = A*P*R*C

here A = land use area
P = annual rainfall
R = runoff coefficient
C = mean concentration of pollutant
A = Recent Increase in Development

Table 4-14 shows the major land use categories delineated for the stormwater planning area in and around the City of McCall. This information was compiled by Toothman-Orton Engineers for the city stormwater master plan. Data in this table reflects existing and permitted land use designations identified in 1991. Of the thirteen basins delineated, only six basins (1-4 and 7-8) directly drain to Big Payette Lake southwest basin. In addition, some basins directly draining to Big Payette Lake, such as basin number 3, have recently experienced increased development with conversion of open spaces to multiple and single family dwelling units.

Table 4-14. Urban Drainage Basin characteristics for the City of McCall and surrounding area.

	Basin												
Development Type (acres)	1 495	2 625	3 161	4 260	5 135	6 286	7 200	8 231	9 544	10 262	11 645	12 3,975	13 1,440
Low Density Residential	20	14	45	23	45	23	60	80[4]	65	8		5	
Med Density Residential		4	45	11			20			6			
Commercial			3	11	25	22	20	20	10	3			
Industrial											30		30
Rural Residential	30[1]	47[3]	7			22			50	26	7	8	30
Undeveloped	50[2]	25[4]		55[4]		35					53	92	35

1 = Ponderosa Park 2 = Forest Land 3 = Meadow 4 = Woodland

A critical parameter affecting loading attributed to a land use type is the amount of precipitation generated as runoff. The volume of runoff generated is influenced by infiltration, the amount of impervious surfaces, soil storage and antecedent rainfall conditions. Runoff coefficients for this study were calculated for each basin using the amount of impervious area attributed to each land use type and the relationship established for runoff from the NURP study (Schuler, 1987); where runoff (R) = 0.05 + 0.009 (Percent Impervious Area). (Alternative method is to use the rational method to compute the coefficient by Q=C*I*A where C is the runoff coefficient (non-dimensional), I is the average rainfall intensity, in inches/hr over a duration for the time of concentration for the contributing area and A is the contributing area).

Table 4-15 shows the calculated runoff coefficient for predominate land uses in the study area compared with other values reported in the literature for similar land use types. Due to the small lot sizes prevalent within the drainage basins, medium density was assumed to contain a relative high proportion of impervious services with out buildings, parking, higher street density and other hardened surfaces. Commercial areas were assumed to contain mostly zero lot zoning with most of the land surface devoted to high density parking. Similar assumptions were made for industrial designations. Unimproved lands are mostly characterized as open wood lots with minimal improvements and generally vegetated with trees or other brushes. Although no industrial zone drains into Big Payette Lake, the McCall City Code limits development to approximately 51% of the average lot. There are no agricultural lands in the City of McCall. Almost half of the rural residential land in Basin 1 is Ponderosa State Park. Rural residential acreage in Basin 2 is owned by three individuals and the McCall Municipal Golf Course. At least 30% of the land in Basin 2 is undeveloped.

Table 4-15. Comparison of the calculated runoff coefficient by land use type and other literature values.

McCall Land Use Type	Est. % Impervious	Calculated Coefficient[1]	Normal Range[2]
Commercial (downtown)	95[4]	0.81	0.70 - 0.95
Commercial (westside)	80	0.68	0.70 - 0.95
Low Density Residential	25	0.25	0.30 - 0.50
Medium Den. Residential	35	0.31	0.25 - 0.40
Industrial	95	0.81	0.50 - 0.80
Unimproved	7	0.10	0.10 - 0.30
Agricultural	10	0.13	0.13 - 0.17[3]

[1]= Based on Schuler (1987).
[2]= Adapted from the ASCE/WEF, 1992.
[3]= Used Heavy Soil Lawns; no agricultural ranges provided
[4]= The City of McCall does not permit impervious surfaces on greater than 85% of a developed site.

Water quality data collected in conjunction with storm events from the various sources were averaged over the seasons and according to predominate land use types within the contributing drainage basin (Table 4-16). These average concentrations were used to approximate the mean pollutant concentration. Since pollutant concentrations often vary among and within a given storm event, it is preferred that event mean concentrations (load/flow) be used to represent mean pollutant concentrations. Flow weighted samples were collected at the Marina and Art Roberts Park storm drains which integrate pollutant concentrations over a given event based on volume of flow. Accordingly, these sites and their calculated mean pollutant concentration approximates the event mean concentration for low density residential and commercial land uses, respectively. For medium density land use, the average concentration of individual grab samples collected from the State Street and Mission Street sample sites (Basin 7) were used to approximate the mean pollutant concentration. These samples were collected at various stages of the hydrograph during a storm event and thus, probably underestimate the actual concentration of pollutants.

Mean pollutant concentrations for rural residential and wooded/unimproved land use types could not be ascertained directly. Consequently, the average concentration for TP, TN and suspended solids from the Deadhorse Creek watershed were used to approximate mean pollutant concentrations for wooded/unimproved land use types. Rural residential land use designations are clustered in Basin 2 together with the City of McCall Golf Course and wooded/undeveloped lands. Rural residential designations generally include single family residences in combination with large lot sizes (2-10 acres) with two or more horses or other livestock. Observations in the Valley

County area below McCall suggest land disturbance associated with these uses can reflect a range of conditions approximating low density use to severe over-grazing and soil compaction depending on the density of confined animals. To estimate rural residential pollutant contributions, a mean concentration was calculated from grab samples taken at the Agate Street monitoring site (Basin 2) and adjusted by subtracting the mean pollutant concentration of wooded/undeveloped lands. The resulting difference actually represents a combined rural residential/golf course pollutant concentration. A comparison with the low density land use indicates nitrogen concentrations in runoff are roughly equivalent (Table 4-15) while suspended sediments and phosphorus were slightly lower. These reductions may be attributed to the trapping efficiency of the conveyance canal and associated vegetation lining the canal that drains this area.

Comparison of the calculated pollutant concentrations with the national averages (Table 4-13) shows runoff from the developed areas around the lake are higher than the range for total phosphorus in both the commercial and residential categories. Total nitrogen and total suspended solids were within the national range. The apparent higher concentrations of phosphorus may be related to differences in soil parent material and climatic conditions which may tend to concentrate phosphorus during periods of prolong dry periods with intermittent rainfall. These conditions enhance the accumulation of dust and dirt particles which selectively bind phosphorus. Additional sampling will be conducted to ascertain the reliability of these estimates.

Based on the above estimates of pollutant concentration, the calculated loadings from basins 1-4 and 7-8 using the Schuler formula are summarized in the Urban Stormwater Appendix Tables for both water years. Total precipitation recorded at the McCall Municipal Airport was 39.6 and 27.8 inches in water years 1995 and 1996, respectively. The resulting runoff from the basins draining directly to the southwest basin of Big Payette Lake contributed approximately 796 kg total phosphorus, 2,523 kg total nitrogen and 290,491 kg suspended sediment in water year 1995. Reduced precipitation in water year 1996 resulted in lower pollutant yields in runoff by approximately 11%, 18% and 11% for phosphorus, nitrogen and suspended sediment, respectively.

As shown in Figure 4-24, commercial land use contributed the highest pollutant loadings among the land use types monitored. Accordingly, basins with a high proportion of commercial development would be expected to contribute the largest proportion of nutrient and sediment loading. Commercial development is presently concentrated in basins 7 and 8 along the lake front. Higher calculated loadings from these basins were consistent with the higher density of commercial development. Estimates from basin 4, however, were unusually high and may have been over-estimated based on the 11% commercial land use designated for this basin (Toothman-Orton, 1991).

The nutrient and sediment yield per unit of land use type provides a more useful measure of comparison with other studies. Table 4-16 shows the nutrient yield by land use type calculated for this study and others reported in the literature. Residential results from this study fall within the range reported for other Idaho lake studies and national studies while medium residential and commercial pollutant yields appear higher. The higher yields are consistent, however, with the higher mean concentrations found in the runoff samples as previously described above.

Figure 4-24. Total estimated pollutant loading by land use type for water year 1995. Land use designations, LDR = low density residential, MDR = medium density residential, Com = commercial development, Rural R = rural residential and UnDev. = undeveloped or mostly woodlands. Results of water year 1996 are similar but slightly lower due to reduced total precipitation.

Cumulative Pollutent Loading by Land Use **Respective Basin Loadings (kg/yr)**

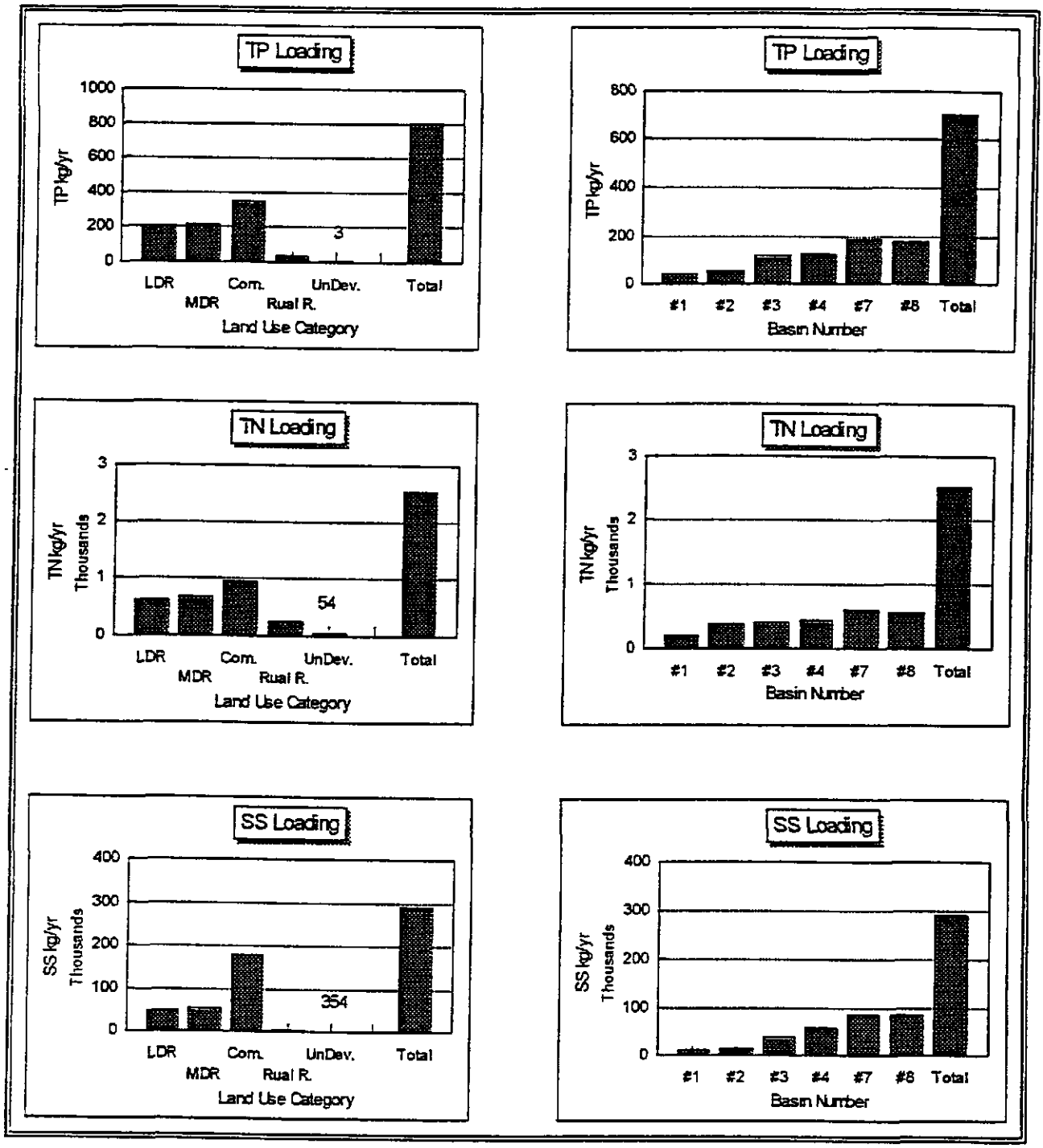


Table 4-16. Estimated pollutant yield (kg/ha) for developed areas around Big Payette Lake. TP = total phosphorus, TN = total nitrogen, and SS = suspended solids.

Payette Lake Urban Runoff Estimated Yield (kg/ha)			
Land Use Type	TP	TN	SS
Low Density Residential	0.86	2.39	218
Medium Density Residential	3.13	9.89	817
Commercial	7.23	19.64	3,709
Rural Residential	0.18	1.31	32
Undeveloped	0.01	0.25	2

Other Literature Values (kg/ha)

Land Type	TP	TN	SS	Source
Residential	0.99			Faulter & Good, 1987
	0.91			Bellatty, 1987
		1.1 - 1.5	138 - 185	Pitts et al., 1977
Commercial	1.46	12.2	549	Minnesota-DEQ, 1989

4.4 Watershed Sediment Sources and Contributions

An assessment of the amount of sediment produced in the Payette Lake watershed from natural (background) and land management sources was made to determine the relative contributions of each to streams and lakes in the basin. Background sources of sediment in the watershed include soil creep along all streams, mass wasting (landslides) from steep, glaciated portions of the upper watershed, and erosion of bare soil associated with burned areas following the 1994 Corral-Blackwell fires. Sediment produced from road construction and use is the largest source of sediment from land management activities in the basin; timber harvest delivers relatively small amounts of sediment to creeks.

4.4.1 Background Sediment Input

Calculation of the sediment yields from different erosion processes is useful to allow comparisons of the relative importance of each source. Calculation of the background sediment yield (the rate of sediment input into streams assuming undisturbed conditions in the basin) is important because it allows comparison of the amount that management activities in the basin have changed sediment input.

The major processes moving sediment downslope and into streams in undisturbed basins in central Idaho include soil creep, mass wasting, and erosion on burned, unvegetated hillsides. Soil creep is the slow downslope movement of soil resulting from gravitational forces and in our discussions includes soil movement resulting from biological activities such as animal burrowing and soil attached to roots of fallen trees. Mass wasting was observed to be an important delivery process in the steep valley sidewalls in the glaciated uplands in the watershed. A large fire (Corral-Blackwell fire), covering over half of the watershed occurred in 1994. Fires can remove vegetation protecting the soil and result in increased erosion.

Erodability of the surface soils and parent rock materials play a major role in determining the quantity and quality of sediment sources. The granitic rocks in the Payette Lake watershed appear to be similar to the rocks of the Idaho Batholith granitic lithologies. However, they are quite different in several ways that affect the amounts of material that are eroded from them by mass wasting and surface erosion processes. First, the granitic rocks of the Payette River Complex are different in composition than the granitic batholith rocks. The predominant granite lithologies in the watershed are tonalite and granodiorite. They contain biotite, calcium-rich plagioclase feldspar and hornblende, all minerals rich in calcium, magnesium, and iron. In contrast, the two-mica granites that are the predominant batholith lithology contain higher percentages of sodium and potassium rich minerals. Second, for reasons that are not readily apparent, the granitic rocks of the Payette Lake watershed appear to be less susceptible to the erosional breakdown caused by chemical weathering. This difference could be the result of the composition differences outlined above. It could also result from the intimate intermixing and association of the granitic and metamorphic lithologies. Finally, as noted in the following paragraphs, the ice sheet glaciation has generally stripped the weathered materials from the lithologies exposed in the watershed. All of these differences mean that the Payette Lake watershed has less material to be moved by surface erosion and mass wasting processes, and should not be compared to other "granitic" and unglaciated watersheds of central Idaho.

Soil Creep

Soil creep is the slow downslope movement of soil resulting from gravitational forces and includes soil movement resulting from biological activities such as animal burrowing and soil attached to roots of fallen trees. This soil is delivered to streams along both banks, and was calculated based on the length of stream in each subbasin (Table 4-17). The alternate sediment input calculated from average background sediment production rates in undisturbed basins is also displayed in Table 4-17.

Table 4-17. Sediment Input from Soil Creep.

Subbasin	Total Stream Miles	Estimated Soil Creep (tons/yr)	Alternate Background (tons/yr)
Box Creek	10.4	56	208
Brush Creek	7.7	41	121
Camp Creek	6.6	36	154
Copet Creek	2.2	12	72
Cougar Creek	7.3	39	94
Dead Horse Creek	12.5	67	121
Deep Creek	10.6	57	110
Fall Creek	14.6	79	169
Fisher Creek	29.8	161	450
Lemah Creek	15.0	81	126
Middle Payette	8.9	48	139
Payette Lake	5.1	27	463
Pearl Creek	9.9	53	128
Sylvan Creek	4.5	24	53
20 Mile Creek	19.3	104	400
No Name Creek	1.6	9	34
Upper NF Payette	26.4	142	438
Wagon Bay Creek	5.1	27	54
Twah Creek	19.0	102	181
Total	216.5	1,166	3,605

Mass Wasting

A complete summary of the principle characteristics of each real and possible landslide is included as a table in Sediment Source and Contribution Appendix Tables of this report. The following is a general description of landslide activity in the watershed, summarized by number, type, size, underlying lithologic unit, age and reactivation, slope, aspect, and delivery to streams. The effects of management practices on generating landslides in the Payette Lake watershed is discussed in the last part of this section. In the tables which also report annual tons of sediment for the

landslides having that characteristic, the figures include only the amounts of sediments that are assumed to have delivered to the stream. Some of the characteristics of the landslides, like lithology, slope, and aspect, were measured at the headwalls or initiation points of the slides. The character of this area of the slide gives clues to the triggering mechanisms for all the landslides in the watershed, as well as for the triggers in the local area surrounding a particular landslide.

Landslide Inventory

As a result of the aerial photo analysis and field investigations, a total of 209 landslides were inventoried and described. Figure 4-25 shows the locations and numbers of each inventoried landslide. In comparison to other watersheds that this analyst has studied in the central Idaho area, this number of landslides is low to moderate. Of the 209 identified landslides 153 are considered to be real in the sense that they could be identified in a number of aerial photographs and have characteristics that are typical of landslides. The other 56 landslides are labeled as possible and their locations and numbers are also shown. However, the analyst did not feel as certain about the existence of these features as landslides. This dichotomy is the result of the strong jointing pattern alluded to in an earlier section of this report. In many cases the lack of vegetation and overall character of an area in the aerial photograph suggested that it might be a landslide, but the pattern was not conclusive. Therefore, these features are considered to be only "possible" rather than "real" landslides. For the rest of the discussion of landslides in this report, only the 153 "real" landslides will be statistically analyzed and counted in the calculation of produced sediments. Figure 4-25 also shows some smaller features, called channel failures and fill failures. These features are also mass wasting features, but are too small to map accurately and measure at the 1:24,000 topographic map scale. Their locations are shown, but the sizes of the features are exaggerated. Plate 1 on Page 164 shows a segment of the north bank of Fall Creek that has been affected by a channel failure.

The distribution of failures, summarized in Table 4-18, shows that a third (31%) of the landslides in the watershed are located in Twentymile Creek. Fisher Creek and the Upper Payette subwatershed have the next highest numbers of slides, but they each have less than half the number in Twentymile Creek. When the number of landslides in each subwatershed is divided by the number of acres, a landslide density per acre results. Landslide densities per acre among the subwatershed vary from a high of 0.00459 in Twentymile Creek, to a low of 0.0025 in the Payette Lake subwatershed. Four subwatersheds, Dead Horse Creek, Pearl Creek, No Name Creek, and Wagon Bay Creek, contain no failures. It is interesting to note that Cougar Creek, which contains only 11 landslides, has a landslide density per acre of 0.00458, almost the same as Twentymile Creek. The average landslide density per acre for the entire watershed is 0.00166, which is a lower figure for this size of watershed in central Idaho. These density figures are calculated only using the number of slides and do not refer to their sizes or volumes.

Also shown in Table 4-18 is the total amount of sediment from mass wasting features estimated to deliver to streams and lakes from each subwatershed, as this is another way to measure the impacts of mass wasting on the fish-bearing waters of a watershed. The most striking feature of this estimation is the fact that almost three/fourths (73.1%) of the total amount of sediment calculated as produced annually comes from two subwatersheds, the Upper Payette River and

Twentymile Creek, at 1,388 tons and 3,906 tons, respectively. The other seventeen subwatersheds combined contribute only 1,948 tons per year to the total of 7,242 tons/yr. A complete description of the calculation used to estimate the annual tons of sediment produced by mass wasting is given in the next section..

Figure 4 - 25 Existing and possible landslides in the Payette Lake Watershed

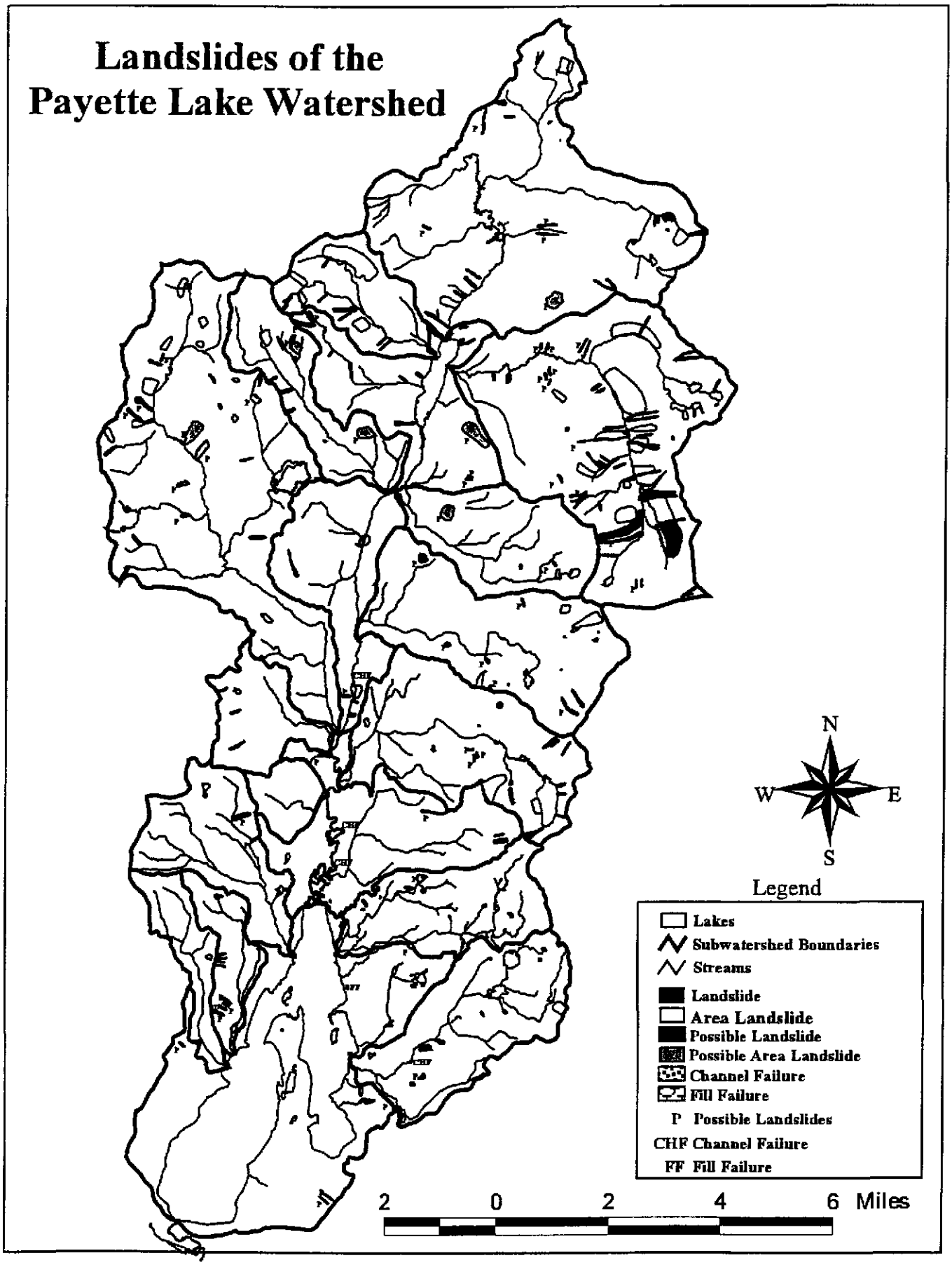


Table 4-18. Number, percent of total, density and delivered sediment of landslides by subwatershed.

Subwatershed	Total Acres	No. Of Landslides	Percent Total Landslides	Landslide Density per acre	Estimated Annual Delivered Sediment (tons)	Percent Annual Sediment
Box Creek	5,318	11	7%	0.00207	333	4.6%
Brush Creek	5,434	4	3%	0.00074	291	4.0%
Camp Creek	3,944	10	7%	0.00254	178	2.5%
Copet Creek	1,838	3	2%	0.00163	0	0.0%
Cougar Creek	2,404	11	7%	0.00458	1,388	19.2%
Dead Horse Cr.	3,084	0	0%	0.00000	0	0.0%
Deep Creek	2,832	5	3%	0.00177	175	2.4%
Fall Creek	4,282	5	3%	0.00116	14	0.2%
Fisher Creek	11,485	17	11%	0.00148	286	3.9%
Lemah Creek	3,262	1	1%	0.00031	0	0.0%
Payette Lake	15,535	3	2%	0.00025	24	0.3%
Middle Payette	3,566	6	4%	0.00168	35	0.5%
Pearl Creek	3,269	0	0%	0.00000	0	0.0%
Sylvan Creek	1,359	5	3%	0.00368	0	0.0%
20 Mile Creek	10,232	47	31%	0.00459	3,906	53.9%
No Name Creek	872	0	0%	0.00000	0	0.0%
Upper Payette	11,223	23	15%	0.00205	612	8.5%
Wagon Bay Cr.	1,391	0	0%	0.00000	0	0.0%
Twah Creek	4,628	2	1%	0.00043	0	0.0%
Total Watershed	95,958	153	100%	0.00166	7,242	

Landslide Types and Sizes

As shown in Table 4-19, only a single type of landslide, debris slides was identified in the watershed. However, the table divides this landslide category into two types, debris slides and debris slide area. The two types of slides are differentiated on Figure 4-25 by shading. For the purposes of this analysis the landslide types have the following definitions:

Debris slides (DS) ---These shallow, rapid failures principally result from a failure of the soil horizon and the weathered material just below it. They often become channelized and can flow for long distances down streams. When this occurs, they are usually called "debris flows, avalanches or torrents". However, in the Payette Lake watershed, no evidence remains of this type of flow and therefore the term "debris slide" was chosen for this type of failure. Although

these failures may be quite long, they generally are not very wide, and an average width of 5 yards was chosen for estimating sediment volumes derived from the landslides for the background surface erosion portion of the watershed analysis. In addition, they are not deep, so that an average depth of 2 yards was assumed for the sediment calculation. The slide areas visible in Plate 2 on page 163 are typical of debris slides located throughout the Payette Lake watershed

Debris slide areas -- In Figure 4-25, the debris slide category is divided into individual failures and debris slide areas. These latter areas were mapped in locations that contain many slides that are too closely-spaced to be shown individually at the 1:24,000 or greater map scale. For the purposes, again, of estimating the volumes of sediment produced by these areas, it was assumed that landslides in these areas occur every 50 feet. To find the number of landslides in a debris slide area, the width of the area measured from the topographic map was divided by 50. Each of the individual landslides was then assumed to be the average length of the entire mapped area.

Table 4-19 shows the total number of failures of each type in each subwatershed, and then the total number of each type of failure in the entire watershed, and the total amounts of the sediments each type contributes annually to the streams. Of the 153 total failures, the individual debris slide failures are the most common in the watershed with a total of 115 or 75% of the landslides. Thirty-eight debris slide areas were mapped in the watershed. However, the debris slide areas, because of the number of individual slides within each area, contributes over half (56%) of the annual sediment to the stream system. As discussed earlier, these numbers are typical of areas that have been extensively glaciated. Of interest, aside from the numbers of slides of each type in Twentymile Creek, is the fact that almost half of the total number of slides in Cougar Creek are debris slide areas, which accounts for the larger amount of annual delivered sediment that was reported for that subwatershed in Table 4-18 of the previous section.

The failures range in surface area from small (<500 yd^2) to very large ($>5{,}000$ yd^2). Table 4-20 lists the landslides by size for each subwatershed, the amount of sediment produced by each size category, and the total number of slides of each size. In general, most of the landslides identified in the watershed fall in the small and medium size categories. Over half of the landslides fall in the category of 500-2,000 yd^2. The watershed contains only 26 large and 15 very large slides. It is not surprising, however, that the small number of very large slides contribute 62% of the annual sediment load. The Twentymile Creek subwatershed contains the majority of the very large landslides, with 8 out of the total of 16. In Cougar Creek it only requires 2 very large landslide areas to produce over 1,000 annual tons of sediment.

Table 4-19. Landslides by mass failure type.

Subwatershed	Landslide Type	
	Debris Slide	Debris Slide Area (acres)
Box Creek	9	2
Brush Creek	1	3
Camp Creek	10	0
Copet Creek	3	0
Cougar Creek	6	5
Dead Horse Creek	0	0
Deep Creek	3	2
Fall Creek	4	1
Fisher Creek	10	7
Lemah Creek	1	0
Payette Lake	3	0
Middle Payette	5	1
Pearl Creek	0	0
Sylvan Creek	5	0
Twentymile Creek	32	15
No Name Creek	0	0
Upper Payette	21	2
Wagon Bay Creek	0	0
Twah Creek	2	0
Total Watershed	115	38
Percent Total Landslides	75%	25%
Estimated Annual Tons Sediment	3,172	4,068
Percent Total Sediment	44%	56%

Table 4-20. Landslides by size.

Landslide size (sq. yds.) and estimated delivered sediment (tons/yr)

Subwatershed	Small <500	Annual Sediment	Medium 500-2000	Annual Sediment	Large 2000-5000	Annual Sediment	Very Large >5000	Annual Sediment
Box Creek	4	50	5	74			2	209
Brush Creek			2	0	1	0	1	291
Camp Creek	8	54	1	21	1	103	0	0
Copet Creek	2	0	1	0				0
Cougar Creek			5	110	4	223	2	1,055
Dead Horse Creek								
Deep Creek	1	0	2	0	2	174		
Fall Creek	3	14			2	0		
Fisher Creek	1	0	11	76	4	209	1	0
Lemah Creek	1	0						
Payette Lake			3	24				
Middle Payette	4	34	1	0	1	0		
Pearl Creek								
Sylvan Creek	4	0	1	0				
Twentymile Creek	8	81	21	546	9	543	8	2,736
No Name Creek								
Upper Payette	9	68	12	217	1	143	1	184
Wagon Bay Creek								
Twah Creek	1	0			1	0		
Total Watershed	46	301	65	1,068	26	1,395	15	4,475
Percent total	30%		42%		17%		10%	
Percent sediment		4%		15%		19%		62%

Lithologic Units Underlying Landslides

Table 4-21 shows the lithologic units that underlie the identified landslides in the watershed. For each lithology the number and sediments produced in each subwatershed is given. These densities can show that, even though a lithology may not produce a large number of slides in comparison to the other lithologies, it may be producing more slides per acre than the other lithologies. This fact is the case in the Payette Lake watershed, so Table 4-21 lists the general landslide density for each lithologic type that contains slides.

When looked at individual rock types, the gneiss and granitic lithologies produce the most landslides (64 and 57, respectively) of all the units. It is important to note, however, that the gneissic rocks produce 5 times as much sediment as the granitic rock types. It is also interesting that the gneissic rocks produce a much higher landslide density (0.0035) than the granitic lithologies (0.0013). These figures mean that the gneissic rocks are more prone to failure than the granitic rocks, and that when they do fail, they are larger failures that produce more delivered sediments. The same facts are also true for the schist lithology in the watershed. Only 17 slides are initiated within the schistose rocks, but the landslide sediment production is higher (1,547 tons/year) than the granitic lithology and the landslide density (0.0032) is almost equal to the density of the gneissic lithologies, even though the amount of acres underlain by the schistose rocks is over one third less than the gneissic rocks. In addition, it is important to note that seven of the eleven landslides identified in Cougar Creek were initiated within the schistose rocks, and produces a fairly large amount (1,315) tons of sediment. The density figures given in Table 4-21 were used to produce a relative landslide hazard rating for each of the lithologic units, which will be discussed in the discussion section of this report.

Age and Reactivation of the Landslides

Pinpointing an approximate age of each identified landslide in this watershed is difficult because of the nature of the debris slides and because of the coverage of the 1946 aerial photograph sets. It is likely that many of the debris slides and debris slide areas in the watershed have failed multiple times, eroding ever higher elevation material as the slides continually fail at their headwalls. In addition, some of the debris slide channels may also be avalanche chutes, which is another sporadic event that would deliver debris, but not large amounts of sediment, to the streams. It is not possible to completely distinguish debris slide scars from avalanche scars on aerial photographs. Both remove vegetation in similar linear patterns on hill slopes. However, in the aerial photographs taken after 1946, only those areas showing disturbed soil and rock were mapped as "real" debris slides. Finally, the earliest set of aerial photographs, taken in 1946, does not cover the entire watershed. Therefore, some of the slides listed in Table 4-22 as being identified first in the 1969 photographs, may have actually existed at or before 1946.

Table 4-21. Landslides by Lithologic Units.

	Lithologic type and estimated delivered sediment (tons/yr)									
Subwatershed	Gneiss	Sediment	Granite	Sediment	Glacial till	Sediment	Modern sediments	Sediment	Schist	Sediment
Box Creek	10	333	1	0						
Brush Creek	3	291	1	0						
Camp Creek			6	146	2	12	1	9	1	12
Copet Creek			3	0						
Cougar Creek			4	73					7	1,315
Dead Horse										
Deep Creek			2	67			3	107		
Fall Creek			1	0	2	14			2	0
Fisher Creek	10	249	2	20					5	16
Lemah Creek					1	0				
Lower Payette					3	24				
Middle Payette			6	34						
Pearl Creek										
Sylvan Creek			4	0	1	0				
Twentymile	32	3,660	14	246	1	0				
No Name Creek										
Upper Payette	7	61	13	346			1	0	2	204
Wagon Bay										
Twah Creek	2	0								
Total Watershed	64	4,594	57	932	10	50	5	116	17	1,547
Percent total landslides	42%		37%		7%		3%		11%	
Percent sediment		63%		13%		1%		2%		21%
Total acres	18,505		44,319		13,250		3,637		5,371	
Landslide density per acre	0.0035		0.0013		0.0008		0.0014		0.0032	

Table 4-22. Landslides identified by air photo year.

Subwatershed	Date of Landslides					
	1946 photos	1969 photos	1976 photos	1987 photos	1995 photos	1996 field
Box Creek		7	2	1	1	
Brush Creek	2	2				
Camp Creek	1	3	2		3	1
Copet Creek		3				
Cougar Creek	2	6	2		1	
Dead Horse Creek						
Deep Creek	1	3		1		
Fall Creek		4				1
Fisher Creek	2	9	4	2		
Lemah Creek		1				
Payette Lake			3			
Middle Payette	2	4				
Pearl Creek						
Sylvan Creek		1	4			
Twentymile Creek	18	27	1		1	
No Name Creek						
Upper Payette	8	4	8		3	
Wagon Bay Creek						
Twah Creek		2				
Total Watershed	36	76	26	4	9	2

As shown in Table 4-22, 36 of the landslides were identified in the 1946 photos and 76 in the 1969 photos. Only 41 new slides were located in the aerial photos covering the period from 1976 to 1996. This number may fairly well represent the number of landslides that might be produce over a 30-year period under average weather conditions. The two slides identified during field work may have been too small or obscured to be identified from aerial photos.

Whether or not slides reactivate after the slide first occurs is a critical question, because each new activity can dump a new load of sediment into the stream system. To look at this question, the analyst scrutinized 5 sets of aerial photographs, approximately spaced every ten years. The photos were examined for new slides as well as fresh, unvegetated scars in the paths of the older, previously identified slides. Of the 153 total slides, 36 showed a reactivation of some type. Of this number 12 showed fresh scars in more than one photo set. The periods between each single reactivation were calculated and are tabulated in ten year categories for each subwatershed. Thus, the total number of reactivations shown in Table 4-23 far exceeds the number of reactivated slides. Almost half of the identified slides in Twentymile Creek reactivated at some point in the 50-year period represented by the aerial photographs. The period of 21 to 30 years had the most

reactivations. This fact may reflect an unusual storm event occurring between 1946 and 1976, or it may reflect the usual 25-year interval for major storms that are likely to create the initiation conditions that produce landslides.

In gathering this reactivation information, it was hoped that a general recurrence interval could be found and applied to the sediment calculation. As can be seen from the results shown in Table 4-23, no clearcut average period of reactivation appeared from the statistics. In the past this analyst has used a general reactivation interval of 25 years, and applied it to the slides identified in the oldest aerial photos in the area. Thus, the calculated sediment amount was doubled for any landslide identified in the 1946 aerial photographs. Given the inconclusive results of the small landslide sample in the Payette Lake watershed, it was felt that this average should not be applied. Instead, discussions with DEQ and other scientists suggest that such a calculation should be on

Table 4-23. Recurrence interval of landslides.

	Reactivated		Reactivation Intervals (years)				
Subwatershed	No	Yes	1-10	11-20	21-30	31-40	41-50
Box Creek	6	4	2	1	2		
Brush Creek	2	3	1	2	2		
Camp Creek	9	1			1		
Copet Creek	3	0					
Cougar Creek	5	5	1	1	2		1
Dead Horse	0	0					
Deep Creek	5	0					
Fall Creek	5	0					
Fisher Creek	17	0					
Lemah Creek	1	0					
Payette Lake	3	0					
Middle Payette	4	2		1			
Pearl Creek	0	0					
Sylvan Creek	5	0					
Twentymile	31	16	6	10	9		1
No Name Creek	0	0					
Upper Payette	18	5	1		2		3
Wagon Bay	0	0					
Twah Creek	2	0					
Total Watershed	116	36	11	15	18	0	5
Percent Total	76%	24%					

a case-by-case basis. Time did not allow for such an analysis in this present report, but it could be undertaken if it is deemed to be essential information. Thus, the sediment values for each identified landslide do not include a recurrence interval, but instead reflect only the original failure amount.

Slope and Aspect of the Identified Landslides

In the Payette Lake watershed slope plays a major role in producing landslides. As shown in Table 4-24, the largest number of landslides (56) occurred on slopes greater than 60%. In addition, these slopes produced the largest amounts of sediment at 61% or 4,383 ton per year. Once again, Twentymile Creek accounts for the majority of this sediment which was produced from the steep walls of this trough valley. Thirty-five percent of the slides were produced on the 20-45% slopes. This unusual fact may be the result of the somewhat unstable slopes of the area covered by the ice-sheet glaciation. It is likely that slides within this slope range are either located in slopes at the higher end of this category (45 %) or are within the small "pocket" high slope areas described in the methods section of this report However, these slopes produced only 17% of the total annual sediment. The results of this slope analysis will be used in association with the lithology results to predict areas that may have a higher occurrence of future landslides.

Inspection of the landslide inventory map, Figure 4-25, suggests that aspect also plays a role in the production of landslides in the Payette Lake watershed. Bearing in mind the north/south grain of the jointing patterns in the rocks that underlie the watershed, it is not surprising that the largest number of slides, as shown in Table 4-25, were produced on east and west facing slopes. Even the percentages of sediments produced by these two slopes is equal, at 28% each. The next highest scoring aspect is Southwest, which produced only 9% of the slides, but 21% of the sediment. Although aspect does not appear to play as critical a role in producing slides as lithology and slope, the statistics in this aspect analysis will be used to determine the high and moderate hazard areas on the mass wasting hazard map.

Delivery of Mass Wasting Debris to Streams

Of the 153 landslides identified in the watershed, 88 or 57% delivered sediment and debris to some body of water (see Table 4-26). This figure is fairly low in comparison to other watersheds that the analyst has studied in central Idaho. Because of the number of lakes in the watershed, and the interest in lake water quality, the number of delivered slides was further divided into those delivered to a lake and those delivered to streams. Although a majority (87%) delivered to streams, a significant number of slides delivered to lakes (21 or 24% of the total). Delivery to lakes also accounts for 13% or 970 tons per year of all the sediment delivered to the watershed. The majority of this delivery to lakes affects the lakes in the upper reaches of the watershed drainage, with no slides delivering directly to Big Payette Lake, and only four slides delivering directly to Upper Payette Lake. When the number of delivering slides is analyzed by subwatershed, Cougar Creek has the highest percentage of delivering slides (91%), with Camp and Twentymile Creeks tied for a distant second of 70% each. It is interesting to note that Fisher Creek, with one of the higher total number of landslides, only has 5 that deliver. Four subwatersheds, Copet, Lemah, Sylvan, and Twah, do contain slides, but none of them deliver.

Thus, eight of the 19 subwatersheds do not have any background mass wasting sediment included in the estimate of background sediment.

Total sediment input to streams was estimated to be 366 tons according to methods of fire related erosion transport adapted from Reinig et al. (1991). These estimates assume vegetation recovery progress normally and effectively stabilizing surface soils.

Table 4-24. Landslides by primary slope at and just below initiation point.

	Slope at headwall scarp and estimated delivered sediment (tons/year)							
Subwatershed	0-20%	Sediment	20-45%	Sediment	45-60%	Sediment	>60%	Sediment
Box Creek	1	26	0	0	2	25	8	282
Brush Creek	0	0	0	0	1	0	3	291
Camp Creek	1	21	8	145	1	12	0	0
Copet Creek	1	0	0	0	0	0	2	0
Cougar Creek	0	0	3	107	4	1,073	4	208
Dead Horse Creek	0	0	0	0	0	0	0	0
Deep Creek	0	0	1	107	3	0	1	67
Fall Creek	0	0	4	0	1	14	0	0
Fisher Creek	1	16	8	19	5	20	3	229
Lemah Creek	0	0	1	0	0	0	0	0
Payette Lake	0	0	2	24	1	0	0	0
Middle Payette	1	0	0	0	3	25	2	9
Pearl Creek	0	0	0	0	0	0	0	0
Sylvan Creek	0	0	4	0	1	0	0	0
Twentymile Creek	0	0	11	348	10	392	26	3,166
No Name Creek	0	0	0	0	0	0	0	0
Upper Payette	3	13	10	452	3	16	7	131
Wagon Bay Creek	0	0	0	0	0	0	0	0
Twah Creek	0	0	1	0	1	0	0	0
Total Watershed	8	76	53	1,202	36	1,577	56	4,383
Percent Total	5%		35%		24%		37%	
Percent Sediment		1%		17%		22%		61%

Table 4-25. Landslides by aspect of initiation point. (Tons)

	Aspect of slope															
Subwatershed	N	Sediment	NE	Sediment	E	Sediment	SE	Sediment	S	Sediment	SW	Sediment	W	Sediment	NW	Sediment
Box Creek			1	0	2	220					3	0	2	25	3	89
Brush Creek	1	0							1	0	1	291			1	0
Camp Creek			1	12	1	103	3	48			4	16	1	0		
Copet Creek			2	0	1	0										
Cougar Creek			7	284	2	152					1	881			1	71
Dead Horse Ck																
Deep Creek			3	67			1	0			1	107				
Fall Creek													1	0	4	14
Fisher Creek			2	20	7	158	5	107					3	0		
Lemah Creek													1	0		
Lower Payette													1	24	2	0
Middle Payette					1	9			1	0			4	26		
Pearl Creek																
Sylvan Creek					4	0	1	0								
20 Mile Creek	6	69	4	25	8	1,204	5	146	4	300	3	255	16	1884	3	23
No Name Creek																
Upper Payette	5	61	1	13	3	184	7	248	1	20	1	0	3	86	2	0
Wagon Bay Ck																
Twah Creek													2	0		
Total Watershed	12	130	21	421	29	2,030	22	549	7	320	14	1,550	34	2045	16	197
% Total landslides	8%		14%		19%		14%		5%		9%		22%		10%	
% Sediment		2%		6%		28%		8%		4%		21%		28%		3%

Table 4-26. Landslides by delivery to streams and lakes. (Tons)

Estimated Sediment Delivery						
Subwatershed	Does Not Deliver	Delivers To Stream	Annual Sediment	Delivers To Lake	Annual Sediment	Percent Delivered Landslides
Box Creek	4			7	333	64%
Brush Creek	3			1	291	25%
Camp Creek	3	3	48	4	131	70%
Copet Creek	3					0%
Cougar Creek	1	10	1,388			91%
Dead Horse Cr.						0%
Deep Creek	3	2	174			40%
Fall Creek	4	1	14			20%
Fisher Creek	11	5	269	1	16	35%
Lemah Creek	1					0%
Lower Payette	2	1	24			33%
Middle Payette	2	4	34			67%
Pearl Creek						0%
Sylvan Creek	5					0%
Twentymile Cr.	14	29	3,828	4	78	70%
No Name Creek						0%
Upper Payette	8	11	491	4	121	65%
Wagon Bay Cr.						0%
Twah Creek	2					0%
Total Percent	66	66	6,270	21	970	
Percent Total	43%					57%
% Delivered		75%		24%		
Percent Total			87%		13%	

4.4.2 Fire

Sediment input from surface erosion related to fire in the basin was calculated for the 1994 Corral-Blackwell fire. Based on observations made during the 1996 field work, surprisingly little evidence of surface erosion was seen on burned areas. In many locations, even where the fire burned with a moderate to high intensity and removed all surface vegetation, the surface ash layer was intact, with no rilling, gullying, or underlying mineral soil exposed, indicating little if any soil movement had taken place in the two years since the fire. In a few isolated locations, particularly at high elevations where concentrated surface runoff from areas of bare rock occur during snowmelt and high intensity rainstorms, some gullying was noticed (Plate 3, page 164). However, sediment transported from the gullies was deposited on low gradient or vegetated areas and did not reach the stream system. Unburned and regenerated riparian vegetation was effective at trapping eroded sediment before it reached stream channels (Plate 4, page 164).

An additional, indirect source of sediment from the fires in the basin could result from bank erosion along streams with severely burned riparian areas. With no living riparian vegetation to stabilize the stream banks, channel migration and avulsion (the stream cuts a new channel) could also occur as dead trees fall into the channel and create debris jams. These effects were noted in a few locations in Box Creek by other workers in the watershed (IDL 1995). Erosion resulting from channel migration processes is expected to be localized and were not calculated in the present study. Sediment input estimates for several watersheds are shown in Table 4-27.

Table 4-27. Sediment Input from Fire.

Subbasin	1995-1996 Estimated Sediment (tons)	1997-1998 Sediment (tons) (Projected)
Box Creek	39	2
Brush Creek	27	1
Cougar Creek	17	1
Fall Creek	31	1
Lemah Creek	70	3
Twentymile Creek	34	2
Upper Payette	90	4
Twah Creek	41	2
Total	350	16

4.4.3 Sediment Input from Management Activities

Any activity that disturbs the ground or removes the vegetation protecting soil has the potential to increase surface erosion. The primary land uses causing soil disturbance in the Payette Lake watershed include road construction and use, timber harvest, residential use, recreational use, and grazing. Erosion from roads and timber harvest are discussed in this section of the report. Residential uses are considered in a separate section of the report; recreational use and grazing were considered to have relatively small sediment inputs compared to other uses in the basin and were not calculated.

Roads

The construction and use of roads can be a significant source of sediment in forested basins. Road construction removes vegetation from the road cutslope, fillslope, ditch, and tread, leaving these areas susceptible to erosion. Over time, the cutslope and fillslope revegetate or armor with larger particles and erosion from these sources is reduced, however, the road tread and ditch continue to be sediment sources as long as the road is in use.

A total of 256 miles of road exist in the Payette Lake watershed. The Payette Lake (74 miles), Fisher Creek (45 miles) and Upper NF Payette (42 miles) subwatersheds have the most roads. All other subbasins have less than 10 miles of roads.

Roads in the basin were sampled to determine the condition of the road tread, cutslope, and fillslope and areas delivering to stream channels or lakes. Many of the roads in the basin are in good condition, gravel surfaced, well maintained, and drain to the forest floor (Plate 5, page 165). These road segments do not deliver any sediment to creeks. Other road segments drain directly to creeks, and if unsurfaced or receiving heavy traffic use, they can deliver large amounts of fine grained sediment (sand, silt, clay) to creeks (Plate 6, page 165).

Road segments delivering to waterways are shown on Figure 4-26. The average annual input of sediment from each of these segments was calculated (Table 4-28, see also Sediment Source and Contribution Appendix Tables). Both the BOISED and Washington Department of Natural Resources (WDNR) State Watershed Analysis estimates of road surface erosion are displayed in Table 17 for comparison. The Washington method estimates approximately twice as much sediment produced from roads in the entire basin as the BOISED method, although results are similar for some sub-basins. As explained in the methods sections, this is the result of the overall lower general erosion rates in the BOISED method and the more site-specific mitigation factors (i.e. road surfacing, cutslope vegetation) applied in the Washington method. The BOISED surface erosion estimates are probably a closer estimate of overall road surface erosion rates, but the results of the Washington method provides road managers with a better idea of which specific road segments and road prism components are producing the most sediment. For example, USFS Highway 21 that runs along the Payette River is paved. BOISED estimates this road delivers about 310 tons of sediment to streams/lakes each year (about 45 percent of the total sediment in the basin); the Washington method estimates about 190 tons/yr (about 12 percent of the total sediment in the basin). Road Segment M1 is a newly constructed road with unvegetated cut and

fill-slopes. The BOISED method predicts 2 tons/yr of sediment from this segment; the Washington method 20 tons/yr. The information on road conditions are listed in the sediment source and contribution Appendix Tables, along with the Washington method erosion rates. A compariosn of these these estimates will be most helpful for ranking road segments for mitigation.

The Upper Payette, Camp Creek, Middle Payette, Payette Lake, Fisher Creek and Pearl Creek sub-basins all receive considerable amounts of sediment each year from road erosion. Figure 4-26 shows segments delivering sediment to creeks in the watershed; segments with highest delivery rates are highlighted. The primary factors influencing the amount of surface erosion from a segment are (in decreasing order of importance): whether or not the segment drains directly to a stream or not; the amount of use a segment gets; whether or not the segment is surfaced with gravel (or asphalt) or unsurfaced, and how well the cut and fill slopes are vegetated or armored.

The calculated rates were made assuming all roads in the basin are "old" - that is, not newly constructed. Newly constructed roads have a much higher rate of erosion for the first 4-5 years following construction until the disturbed areas armor and revegetate (Megahan, 1974). During the road survey, approximately 2 miles out of the total 256 miles were newly constructed. On average, 1-2 miles or less of road will be newly constructed in the basin at any given time, depending upon the amount of road building for timber harvest. These segments will have high erosion rates; whether or not the segments deliver to creeks and the effectiveness of erosion control measures (mulching, etc.) will determine how much sediment reaches waterways from new roads.

The road erosion rates were calculated based on existing road conditions in the basin. As logging and use of the basin was just beginning earlier in this century, there were obviously fewer roads to produce sediment than at present. However, the roads built before about 1940 or 1950 were not built or maintained using current road engineering and technology and probably produced more sediment per unit length than roads built since that time.

Figure 4 - 26 Road segments delivering sediment to streams in the Payette Lake watershed

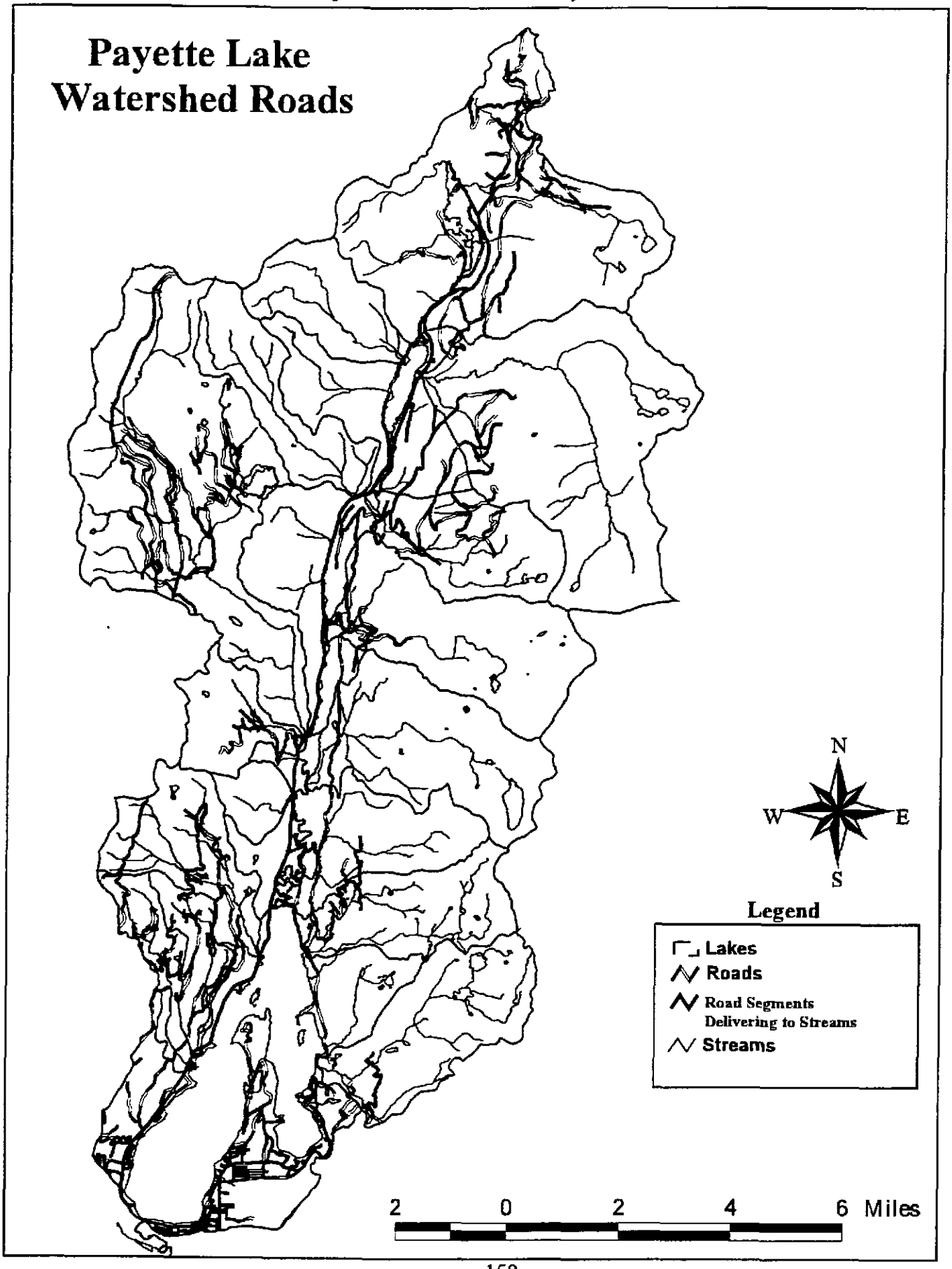


Table 4-28. Estimated average annual sediment input (tons/year) from roads.

Subbasin	Length of Road[1] (mi.)	BOISED (tons/year)	Washington Alt. est.[2] (tons/year)	Gullies (tons/year)	Total (BOISED + Gullies) (tons/year)
Box Creek	0.5	2	1	-	2
Brush Creek	0.5	4	16	10	14
Camp Creek	7.4	116	224	-	116
Copet Creek	0.1	2	3	-	2
Cougar Creek	0.3	5	85	-	5
Dead Horse Ck	1.5	27	148	-	27
Deep Creek	-	-	-	-	-
Fall Creek	0.8	24	88	-	24
Fisher Creek	3.9	58	242	7	65
Lemah Creek	1.0	11	35	-	11
Middle Payette	4.3	82	81	-	82
Payette Lake	9.9	69	93	-	69
Pearl Creek	1.9	44	93	17	61
Sylvan Creek	0.2	5	7	-	5
Twentymile Ck	0.7	10	25	-	10
No Name Creek	-	-	-	-	-
Upper Payette	8.8	235	349	104	339
Wagon Bay Ck	0.6	17	41	-	17
Twah Creek	1.8	9	13	-	9
Total	44.1	719	1,544	138	857

[1] Length of road delivering sediment (includes cut banks and surface).

[2] Alternative estimate of road delivered sediment using the Washington method.

Timber Harvest

Timber harvest in the Payette Lake watershed began around the turn of the century when the town of McCall was established. Commercial harvesting began in the 1950's. Larger scale harvesting began in the 1970's and 1980's. Area harvested by decade is shown in Table 4-29 and Sediment Source and Contribution Appendix Figures.

Table 4-29. Acres of timber harvest by decade.

Subbasin	1950's	1960's	1970's	1980's	1990-95	Total
Box Creek	0	0	0	0	725	725
Camp Creek	0	614	780	834	257	2,485
Brush Creek	171	9	0	23	461	664
Copet Creek	0	0	0	0	25	25
Cougar Creek	0	0	5	0	1	6
Dead Horse Ck	0	0	0	232	373	605
Deep Creek	0	0	0	35	0	35
Fall Creek	0	0	0	263	44	307
Fisher Creek	512	148	925	231	852	2,668
Lemah Creek	0	0	0	0	585	585
Middle NF	0	0	0	118	661	779
No Name Creek	0	0	0	0	4	4
Payette Lake	0	0	398	163	5	565
Pearl Creek	0	364	41	61	142	608
Sylvan Creek	0	0	94	279	60	432
Twah	0	0	0	5	1,355	1,360
Twentymile Ck	0	284	165	335	196	980
Upper Payette	0	63	387	138	237	826
Wagon Bay	0	0	94	6	0	100
Total	683	1,482	2,889	2,722	5,983	13,759

Harvest increased from the 1950's to 1970's and leveled off in the 1980's. Large areas of salvage harvest from spruce beetle and fire damage occurred in the 1990's. Partial cuts account for 60 percent of the total harvest in the watershed; the remaining 40 percent was clear-cut. Tractor skidding was used on 78 percent of the harvest acreage; helicopter logging on 18 percent; skyline and cable skidding were used on the remaining small areas.

Surface erosion from timber harvest considers erosion resulting from the felling, bucking, skidding, and loading of timber in harvest units. Each of these activities has the potential to disturb the ground to some degree by removing the vegetation and forest duff that protects the underlying soil from erosion (Plate 7, page 166). Compaction of the ground by repeated trips with tracked vehicles can also lead to increased erosion.

An evaluation of the potential for surface erosion from harvest practices in the basin was made based on observations from aerial photographs and field checking of individual harvest units. Observations in units and on aerial photographs showed that little sediment from timber harvesting or skid trails in recently harvested units was reaching creeks. Stream buffers and erosion control measures on skid trails (e.g. water bars) were effective at protecting waterways. The only potential for sediment to reach creeks was if skid trails or ground disturbance occurred close to creeks. Surface erosion from timber harvest within 50 feet on each side of streams within harvest units was calculated by decade (Table 4-30).

The computed sediment input rates from timber harvest are low, in agreement with field observations. Input rates during the 1990's were highest, reflecting the higher volume of salvage timber sales during the past few years. Average annual sediment input (tons/yr) for harvest during the 1990-1995 was calculated as an indication of recent sediment input from logging.

Management's Role in Producing Landslides

In the second column of Table 4-31, the number of management-caused landslides are listed for each subwatershed. Generally, only 13 failures, or 8% of the total failures were caused by some form of management activity. Of these 13 slides, only two delivered to streams, producing only 35 annual tons of sediment. This amount is only 0.48% of the total sediment calculated to be contributed annually by mass wasting to the streams in the watershed. Of the 13 total identified management-caused slides, four are the result of harvest activities and nine are related to road building activities. The two delivered failures were both from road building activities.

When the management-caused landslides are put in the perspective of the amount of road miles and the road mile density, it is plain that roads in the Payette Lake watershed are not susceptible to mass wasting. In other words, in most cases they are stable due to their landscape position within a stable depositional geology compared to other more active terrains.

Table 4-30. Estimated surface erosion from harvest units (tons).

Subbasin	Stream mi.within Harvest Unit	Cumulative Sediment Contribution						1950-1995 Average tons/yr
		1950's	1960's	1970's	1980's	1990's	Total	
Box Creek	3.7	-	-	-	-	15	15	0.3
Brush Creek	2.6	15	-	-	-	7	22	0.5
Camp Creek	5.1	-	31	23	21	-	66	1.5
Copet Creek	-	-	-	-	-	-	-	-
Cougar Creek	0.2	-	-	1	-	-	1	0
Dead Horse Creek	2.6	-	-	-	13	14	27	0.6
Deep Creek	-	-	-	-	-	-	-	-
Fall Creek	1.0	-	-	-	11	-	11	0.2
Fisher Creek	6.2	3	4	32	9	5	53	1.2
Lemah Creek	3.5	-	-	-	-	28	28	0.6
Middle Upper NF	-	-	-	-	-	-		-
No Name Creek	-	-	-	-	-	-		-
Payette Lake	-	-	-	-	-	-		-
Pearl Creek	1.7	-	20	1	3	-	24	0.5
Sylvan Creek*	2.6	-	-	-	35	1	36	0.8
Twah	3.0	-	-	-	-	17	17	0.4
Twentymile Creek	1.3	-	4	6	4	1	15	0 4
Up. Payette L.	0.4	-	-	8	-	1		0.2
Wagon Bay Creek	-	-	-	-	-	-		-
Total	34.0	18	59	67	87	88	319	7.2

*There is a small lake near the bottom of Sylvan Creek that prevents some sediment from reaching Big Payette Lake.

Table 4-31. Management activities and landslide production.

Subwatershed	Total # Slides	Management Caused Landslide		Natural Landslides		Percent Manage-ment	Total Road Miles	Road Density (mi/sq mi)
		Total #	Sediment (Tons)	Total #	Sediment (Tons)			
Box Creek	10	0	0	11	333	0%	2.0	0.2
Brush Creek	5	0	0	4	291	0%	5.6	0.7
Camp Creek	10	2	15	8	163	20%	12.3	2.0
Copet Creek	3	0	0	3	0	0%	4.6	1.6
Cougar Creek	11	0	0	11	1,389	0%	0.1	0.0
Dead Horse Creek	0	0	0	0	0	0%	9.5	2.0
Deep Creek	5	0	0	5	174	0%	0.1	0.0
Fall Creek	5	1	0	4	14	20%	4.2	0.6
Fisher Creek	17	3	0	14	285	18%	44.8	2.5
Lemah Creek	1	0	0	1	0	0%	3.6	0.7
Payette Lake	3	0	0	3	24	0%	74.2	4.0
Middle Payette	6	0	0	6	35	0%	7.9	1.4
Pearl Creek	0	0	0	0	0	0%	9.6	1.9
Sylvan Creek	5	4	0	1	0	80%	9.0	4.2
Twentymile Creek	47	0	0	47	3,906	0%	9.1	0.6
No Name Creek	0	0	0	0	0	0%	0.1	0.1
Upper Payette	23	3	20	20	592	13%	42.4	2.4
Wagon Bay Creek	0	0	0	0	0	0%	8.1	3.7
Twah Creek	2	0	0	2	0	0%	9.7	1.3
Total Watershed	153	13*	35	140	7,206		256.9	1.8
Total Percent Landslides		8%		92%				
Percent Sediment			0.48%		99.50%			

*All road related landslides

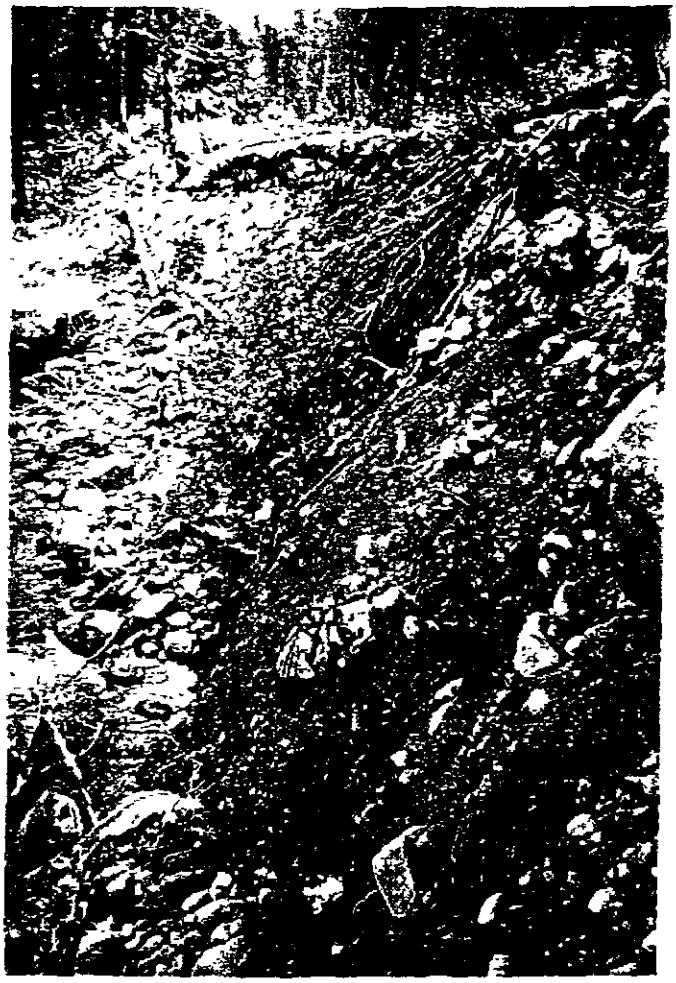


Plate 1



Plate 2



Plate 3



Plate 4



Plate 5

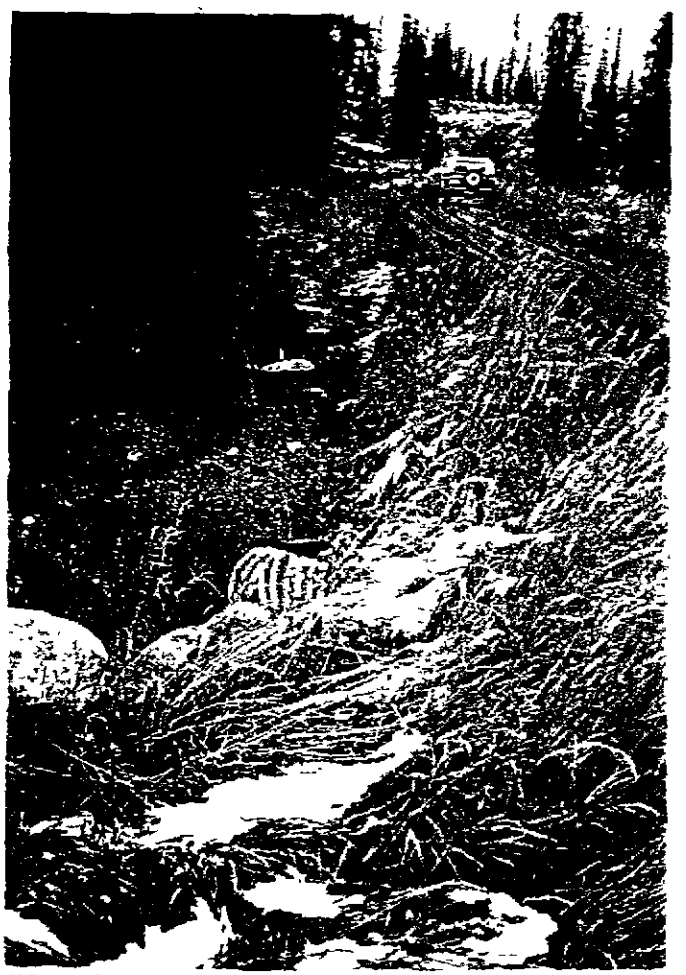


Plate 6



Plate 7

4.4.4 Mass Wasting Triggering Mechanisms

The principal natural triggering mechanism for landslides throughout the watershed is slope steepness. Areas with slopes of 60% or greater, as shown in Table 4-24 on page 149, are much more susceptible to mass failures. Because the slopes in the higher elevations of the watershed have been affected by valley glaciation, they are generally naturally oversteepened, and thus have a higher natural hazard for failure. The debris slide failures that predominate in these areas are common to glaciated terrains all over the Pacific Northwest. Slope steepness combines with lithology and aspect to be the factors most likely to produce the majority of the naturally occurring landslides identified in the watershed.

One important natural cause of landslides in this particular watershed is not taken into account in this analysis--the affect of fire on landslide hazard. Given the widespread and intense nature of the 1994 fires in the Payette Lake watershed, it is certain that the number of landslides in the watershed will increase, generated from a loss of root strength from the dead burned trees. However, this loss does not happen overnight and will take time to develop. In the analysis for this report which used the aerial photographs taken the summer following the fire, it was apparent that no landslides had been generated by the fires at that time. It must be expected, however, that over a five to ten year period following the fire, as the trees deteriorate and new trees are not yet established, the burns will generate new slides. The locations and intensities of these slides are difficult to predict and are partially dependent on the weather and winter storm patterns during the deterioration period.

Management-related triggering mechanisms are very rare and primarily related to roads and road building activities. Road construction practices, which have limited the numbers and sizes of culverts, may be part of the reason for the management-caused failures that do exist. Undersized culverts are more likely to plug, causing road fill materials to become saturated and fail. The other cause may be the overall aging of the road prism in the watershed. Older logging and access roads tend to fail more often than newer roads.

Mass Wasting Hazard

The final product in a mass wasting analysis is always a landslide hazard map (Figure 4-27). In the Washington State process similar landforms are defined, grouped and used as a basis for creating a hazard map. However, in this analysis, a more quantitative approach is taken, using the results of the statistical analysis to create criteria for dividing the landscape into three hazard categories, high, moderate, and low. The following rating system uses landslide density, slope steepness, lithology, and aspect factors to create a system of hazard ratings, which are then used to define the areas in the landscape containing the various levels of hazard.

Explanation of Hazard Ratings

It must be stressed at this point, that the rating system outlined in this section is qualitative, and not quantifiable. Other methods and processes do provide a so-called "quantitative" assessment of landslide hazard. The exact differences between those models and this analysis are too lengthy

to be discussed here, but the essential difference is that the Washington State process uses actual landslide locations and predictive geological characteristics based on the characteristics of the slides in the landslide inventory to create the mass wasting hazard potential rating and map.

The goal of this process is to create a map that defines areas where landslides are likely to occur, as well as areas where the likelihood of failure occurrence is rare to non-existent. Given these two goals, which define the end members of the hazard potential, it is obvious that some areas will not fit in either of these categories. These areas, where landslide occurrence is possible but not likely, are placed in an intermediate or moderate category. In all cases, because they are the only types of slides identified in the watershed, the ratings refer the hazard for the creation or reactivation of debris slides and debris slide areas. As drawn on Figure 4-27, the high, moderate, and low ratings have the following general hazard definitions:

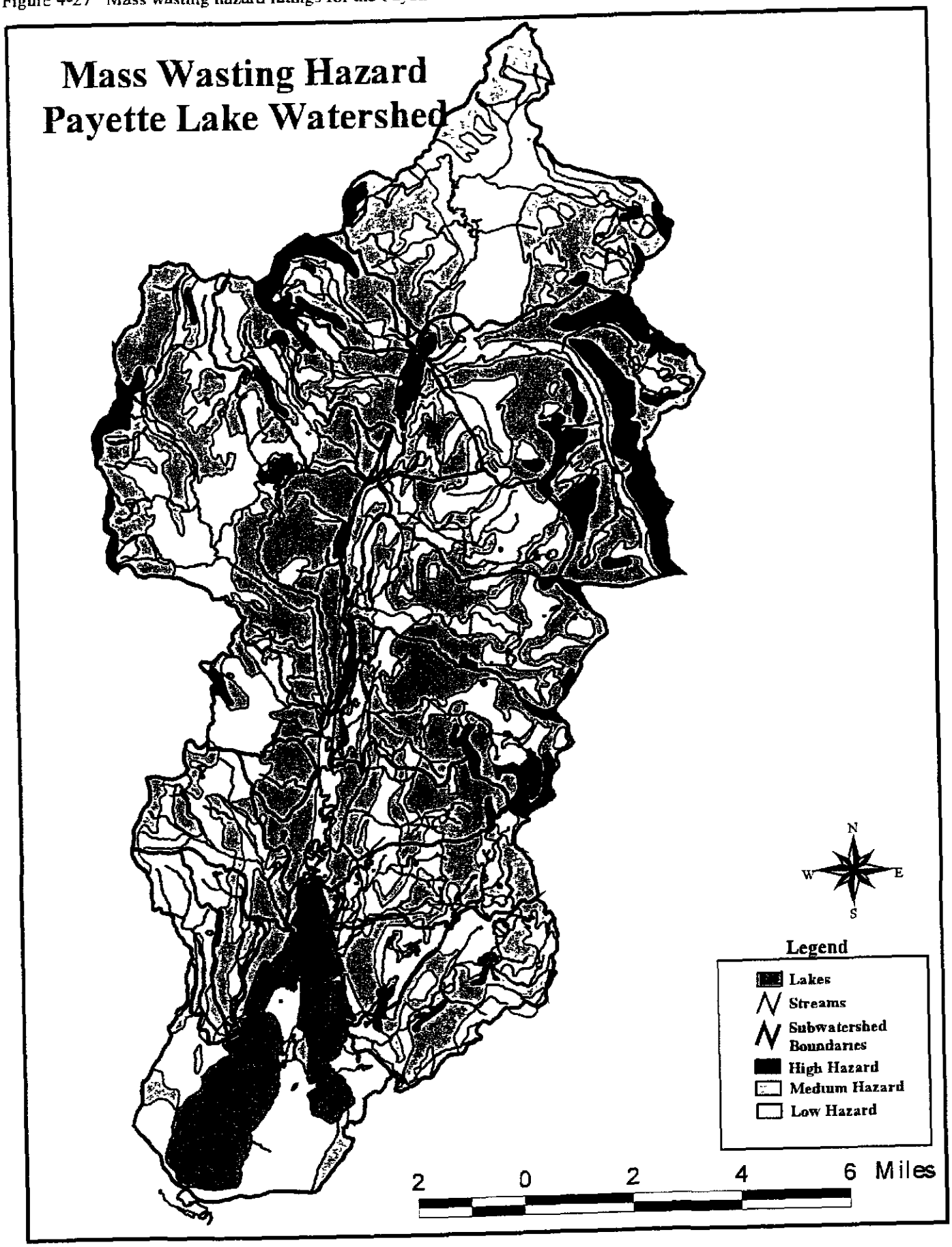
> High = Landslide occurrence or reactivation is common, and the potential is significant that landslides will occur in the future
>
> Moderate = Landslide occurrence or reactivation is possible, but the potential to produce significant amounts of landslides is much less
>
> Low = Landslide occurrence is rare to nonexistent

In relation to the riparian habitat conservation areas described in the INFISH process, those areas mapped as high hazard are landslide-prone, and the moderate and low hazard areas are not landslide prone.

In order to define the landslide hazard areas on the map, the statistical analysis of the landslide inventory was examined to suggest trends of factors affecting landslide occurrence. The various lithologies that presently contain landslides were each assigned a mass wasting potential rating. These ratings, based on the landslide densities of each lithology, are the following:

> High = gneiss, schist
>
> Moderate = granite
>
> Low = modern sediments, glacial till, basalt, and glacial sediments

Figure 4-27 Mass wasting hazard ratings for the Payette Lake Watershed



In addition, each aspect direction was also assigned a mass wasting potential rating. The following ratings are based on the percent of total landslides found in each aspect category, and the amounts of sediment produced by those slides:

High = east, southwest, and west

Moderate = southeast and northeast

Low = north, northwest, and south

The four principle factors that were found to be responsible for generating landslides in the watershed, according to their relative importance, are: identified landslide occurrence or density, slope, lithology, and aspect. These factors were combined to create the following criteria for placing a particular area of the watershed landscape into one of the three hazard potential rating classes:

High rating

Has slope of 45-60% that contains an area of >60% slope
and
Contains one or more identified landslides, but generally contains higher densities of landslides
and
Is within the polygon of a highly landslide prone lithology

OR

Has slope of 45-60% that contains an area of >60% slope
and
Contains one or more identified landslides, but generally contains higher densities of landslides
and
Has an aspect that is related to higher landslide occurrence

Moderate rating

Has a slope of more than 20%
and
Contains few identified landslides, none of which initiate within areas of >60% slope

Low rating

Has a slope of 25% or less
and
Does not contain the initiation point of any identified landslides

While these categories are not completely mutually exclusive as written, on the map they define areas with distinct differences in landslide hazard. In the case of the high ratings, an area had to meet all the requirements in one of the two criteria sets to be rated as a high hazard. It is possible that some of the areas rated as high meet the requirements in both lists. It is not possible that an area with a high rating does not meet all the requirements in at least one of the lists. For the low and moderate ratings, the area only needed to meet all the criteria in the single list. Because of the goals of the rating process, the category with the most diversity of characteristics is the moderate category. Some areas within the moderate category polygons do contain one or more landslides. However, the other requirements for a high rating, of lithology and aspect, were not met, and the sizes and densities of the landslides within the moderate areas were such that they did not fit the criteria for the high rating category. Finally, the ratings were applied equally across the watershed, based on physical characteristics alone and without attention paid to the locations of past, present, or proposed management activities.

4.5 Stream Habitat Quality

4.5.1 Description of Tables and Standards for Comparison

Stream habitat condition data for 12 Payette Lake Watershed streams are summarized in the Stream Habitat Quality Appendix Data Summary Tables. Each stream has a different combination of contributing agencies, types of data, and collection intervals. Data may be interpreted by referring to the Stream Habitat Parameter Interpretation Standards and References Section immediately following the Data Summary Tables (see Stream Habitat Quality Appendix Tables). Also see Section 3.3.6 on page 66 for references.

Stream parameters summarized below and in Table 4-32 are those used in this report to make conclusions regarding ecosystem functioning in the Payette Lake Watershed. Data was collected using different methodologies by the agencies described in the Methods Section 3.3. Comprehensive data was available for this watershed analysis for five streams in the PLWS from R1/R4 Fish Habitat Inventories conducted in 1994, including: Fall Creek (4.17 km surveyed), Fisher Creek (5.6 km. surveyed), North Fork Payette River (1.64 km. surveyed), Trail Creek (6.02 km. surveyed) and Twentymile Creek (8.9 km. surveyed). Another seven streams in the watershed were evaluated utilizing Idaho Division of Environmental Quality Beneficial Use Reconnaissance inventories covering distances of approximately 100 meters, including: Box Creek (3 sites), and Brush Creek, Cougar Creek, Dead Horse Creek, Deep Creek, Landing Creek, and Pearl Creek, with one site each. See Figure 3-6 on page 56 for habitat monitoring sites.

4.5.2 Stream Habitat Data Synthesis

Large Woody Debris (LWD)

Fisher, Fall, Trail, and Twentymile Creeks, together with the North Fork Payette River contained less large woody debris than Overton et al. (1995) found in natural condition streams surveyed in Idaho, representing "relatively unimpacted" streams with similar widths, gradients, and

geology. Fall Creek contained the most wood, 184.9 pieces / 1.6 km, with extensive recruitment from the 1994 fire, but still fell short of the 277.7 pieces Overton found in the natural condition streams. Fisher Cr. contained the least LWD, with an average of 66 pieces / 1.6 km over the 4 reaches surveyed, 34% of the amount found in the natural condition streams. The North Fork Payette River contained an average of 36 pieces / 1.6 km, Trail Creek contained 179 / 1.6 km, and Twentymile contained 98 / 1.6 km. With the exception of Reach 1 on Twentymile and Reach 3 on the NF Payette River, the streams surveyed with the R1/R4 technique met INFISH (1995) standards of a volume of wood greater than 15.57 m^3 /1.6 km. Streams surveyed with the BURP technique, Brush Creek. (1.44 m^3 / 100 meters), Cougar Creek (1.01 m^3 / 100 meters), Dead Horse Creek (0.99 m^3 / 100 meters) contained adequate volumes of LWD as compared to INFISH minimum volume standards of 0.97 m^3 / 100 meters. Box Creek and Landing Creek with average volumes of 0.50 m^3 / 100 meters and 0.28 m^3 / 100 meters respectively, had sub-optimal levels of LWD by these standards.

Table 4-32. Payette Lake watershed stream habitat parameter summary.

	-- R1/R4 Fish Habitat Inventories --					**---------- IDEQ BURP Inventories----------**						
	20-Mile Cr	Trail Cr.	Fisher Cr.	NF Payette R.	Fall Cr.	Box Cr.	Brush Cr.	Cougar Cr.	Dead Horse Cr.	Deep Cr.	Land-ing Cr	Pearl Cr.
Year	1994	1994	1994	1994	1994	1994 1995	1994	1994	1994	1993	1994	
LOD* m^3/ 100 meters	-	-	-	-	-	94-0.43 95-0.60	1.44	1.01	0.99	nd	0.28	nd
LWD pieces/ 1.6 km	98	179	66	86	185	-	-	-	-	-	-	-
Width /Depth Ratio	26.5	19.1	61.1	21.8	27	94-18.8 95-55.6	20.5	5.14	6.05	19.09	11.9	18.0
# pools/ 1.6 km	24.4	33	39	30.4	32	-	-	-	-	-	-	-
Pool / Riffle Ratio	1.71	0.45	0.70	1.27	0.26	94-0.23 95-0.17	0.06	0.05	1.16	1.31	nd	0.31
Bank Stability (%)	77.5	66.3	88.3	75	68	94-98.7 95-30	100	97	100	100	42.5	100
Surface Fines <6 mm (%) WPC	32.6	54.7	25.5	44.9	34.1	94-33.9 95-11.5	10.9	29.4	32.4	nd	42.9	nd
Macros Taxa Rich	34	nd	25	31	31	94-36 95-23	31	29	35	15	20	28
Macros EPT Index	24	nd	17	20	23	94-27 95-20	26	20	26	9	10	23

*LOD - Large Organic Debris

<u>R1/R4 Fish Habitat Inventories:</u>
Values represent mean of reach surveyed

<u>Macroinvertebrates:</u>
Values represent mean of sites sampled 1993-1995
Twentymile Creek-1993 (1 site), 1994 (2 sites)
Fisher Creek- 1993 (2 sites)
NF Payette River- 1993 (1 site), 1994 (3 sites)
Fall Creek- 1994 (2 sites), 1995 (1 site)

<u>DEQ BURP:</u>
Values represent 1 site, with exception of:
Pearl Creek- mean of 2 sites
Box Creek- 1994, mean of 2 sites, 1995, 1 site

Significance: LWD provides one of the most important sources of habitat for fish populations in streams by increasing habitat complexity and suitability, ensuring cover over a wide range of flow and climatic conditions (MacDonald et al. 1991). In addition it provides storage sites for organic material which can provide the bulk of energy for the aquatic food chain. In the absence of woody debris, organic material and nutrients may be flushed rapidly downstream (MacDonald et al. 1991). Smaller streams have been found to contain more wood than larger systems; and riparian tree density is positively related to LWD in streams in eastern Washington (MacDonald et al. 1991). Bilby and Wasserman found that streams with finer substrates had about half the amount of LWD compared to streams with boulder and bedrock substrates (Overton 1995). Large wood has been found to influence channel meandering, bank stability, variability in channel width, and the forms and stability of gravel bars (Overton 1995). Billy (1984) determined that 80% of pools in a small stream in southwest Washington were associated with wood, and Rainville et al. (1985) found that 80% of pools in a series of small streams in the Idaho Panhandle were wood associated (MacDonald et al. 1991). Research has shown a direct relationship between the amount of LWD and salmonid production, and wood removal has been shown to reduce fish population densities. Overton (1995) states that there is a high range of natural variability in the content of LWD in natural streams and sampling error associated with measurement of this parameter appears to be high.

Width/Depth Ratio

All streams in the PLWS fail to meet INFISH (1995) standard of a width to depth ratio < 10 with the exception of Cougar Creek. (5.14 w/d ratio) and Dead Horse Cr.(6.05 w/d ratio). Streams varied as compared to IDEQ (1996) standards for width to depth ratio, with Twentymile, Fisher, and Fall rating poor (w/d ratio >25), Trail, NF Payette, Brush, Deep, and Pearl rating marginal (w/d ratio 15-25), Landing Cr. rating sub-optimal (w/d ratio 8-15), and Cougar and Dead Horse in the optimal range (w/d ratio < 7). Box Creek rated marginal at 2 sites inventoried in 1994, and poor at the site inventoried in 1995. Compared to Overton's natural condition streams, Box had 2 sites narrower than comparable natural condition streams, however, the site evaluated in 1995 and a ratio of 55.56, twice the ratio of natural condition streams. Twentymile Creek B channel was 23% wider than the natural condition streams, while the C channel was 29.6% narrower. Fisher Cr. reaches varied from 50-60% wider. Other streams including Cougar, Trail Fall Brush, N.F. Payette, Dead Horse, Pearl, Landing, and Deep had width to depth ratios either less than or approximately equal to the ratios found by Overton et al. (1995). Generally, two references (INFISH and IDEQ) indicate streams in the PLWS are wider, shallower, and less than optimal quality, although they may be judged as having quality similar to the natural condition streams (except for all reaches on Fisher and 1 reach on Twentymile) with similar gradients and geology.

Significance: Sediment accumulation in stream channels reduces stream depth (MacDonald et al. 1991). Large width to depth ratios are often a result of lateral bank erosion due to increased peak flow, increased sediment availability, and eroding banks due to loss of streamside vegetation (Overton 1995, and Beschta and Platts 1986). MacDonald et al. (1991) cites major adverse effects

of the biological community with a decrease in channel depth and an increase in channel width. A decrease in depth reduces the number of pools (Beschta and Platts 1986), and this will reduce certain types of fish habitat. An increase in stream width will lead to an increase in net solar radiation and higher summer water temperatures (Beschta et al. 1987). The combination of shallower pools and increased solar radiation can greatly affect the suitability of the stream for coldwater fish. An increase in stream width also results in a reduced riparian zone which decreases it's ability to capture sediment and nutrients (MacDonald et al. 1991), and as increases in channel width result from bank erosion, a corresponding increase in sediment inputs to the channel occur. Changes in width or the width-depth ratio can be used as an indicator of change in the relative balance between sediment load and sediment transport capacity (MacDonald 1991).

Pools

The streams surveyed with the R1/R4 technique had fewer pools per 1.6 km as compared to the natural condition streams, and failed to meet INFISH pool frequency objectives of 56 pools / 1.6 km. Twentymile Cr. averaged 24.4 pools / 1.6 km, the lowest value, and Fisher Cr. averaged the most with 39 pools / 1.6 km. This parameter was not evaluated for the IDEQ BURP sites due to the limited distances inventoried. The PLWS streams evaluated have fewer pools than the optimal number of pools by two references, and thus less available fish habitat.

Significance: Pools are the major stream habitat of most fish. Salmonids often require backwater or dammed pools with water moving at slow velocities to permit survival of harsh winter conditions, and pools of all shapes, sizes, and quality are needed to support different age classes (Beschta and Platts 1986). Juvenile fish need shallow, low quality pools that other fish will not use, until increased growth allows them to eventually compete, without predation stress, in the higher quality pools which have better food supplies and winter rearing habitat. Thus fish utilize a combination of pools for year-round rearing. Deep, slow-velocity pools with large amounts of overhanging vegetation support the largest and most stable fish populations (Beschta and Platts 1986).

The frequency and size of pools is dependent on stream size, gradient, confinement, flow, sediment load, and large woody debris (Overton et al. 1995). Pools characterized by low flow velocities (backwater or dammed pools) are particularly susceptible to filling with sediment, thus the depth, area, or volume of these pools can serve as indicators of coarse sediment loading due to forest harvest, road building and maintenance, mining, and other management activities (MacDonald et al. 1991) Overton et al. (1995) found fewer deep pools in an intensely timber-managed watersheds compared to a non-timber-managed watershed. A decrease in the amount of large woody debris may lead to a reduction in the number and size of pools (see above), and a change in peak flows will alter the ability of a stream to transport sediment, altering pool measurements (MacDonald et al. 1991). Landslides, debris flows, and other mass movements typically result in a loss of pool area and volume (MacDonald et al. 1991).

Pool/Riffle Ratio

Fisher Cr. (pool/riffle ratio 0.70), N.F. Payette River (1.3), Dead Horse (1.16), Deep (1.3), and Twentymile (1.7) have near optimal ratios of pool to riffle habitat as measured by habitat lengths. A ratio of 1 is considered optimal (MacDonald et al. 1991) and a ratio between 1 and 3 is considered optimal by IDEQ (1996) standards. Other streams including Box (pool/riffle ratio 0.2), Brush (0.06), Cougar (0.05), Pearl (0.31), Fall (0.2), and Trail (0.45) have suboptimal amounts of pool habitat.

Significance: The pool/riffle ratio may be used to predict the streams capability of providing resting and feeding pools for fish and riffles to produce their food and support their spawning (Platts et al. 1983). Riffles are the most productive portion of the channel for generating food, especially insects for fish (Beschta and Platts 1986). Salmon and trout use riffles for spawning because embryo and alvelin survival require the specific hydraulic conditions. Riffles provide the needed water velocities to keep the substrate clean, high surface and subsurface flows for adequate transport of dissolved oxygen, and sufficient subsurface flows to remove embryo and alvelin wastes (Beschta and Platts 1986). Salmon and stream dwelling trout select riffles for spawning which are typically devoid of boulders, low in fine sediments (because of the need for subsurface flow permeability), and high in gravel and small rubble (to form the protective cover over embryos which allows subsurface flows but which can still withstand most erosional velocities in the stream). Salmon and trout select spawning areas that also have high quality rearing areas nearby. Young salmon and trout use slow moving riffles with large rubble substrate for winter cover, and steelhead utilize riffles as rearing habitat (Beschta and Platts 1986).

Bank Stability

Bank Stability for the R1/R4 Fish Habitat Inventory streams surveyed over the greatest distances ranged from 46% stable (Fisher) to 77.5% (Twentymile). Trail Cr. bank stability was 66%, NF Payette River, 75%, and Fall Cr., 68% for the reaches surveyed. The BURP surveys found Landing Cr. with a low bank stability of 42%, and the 1995 site on Box Cr. with a bank stability of 30% (which corresponds to the high width to depth ratio found there) while others including: Brush, Cougar, Dead Horse, Deep, and Pearl ranged from 97 to 100% stable. Values of 80% rate as "excellent" (Platts) and as meeting interim objectives (INFISH). Values from 50 to 79% are rated as "good" by Platts, and from 25 to 49%as "fair". Overton's (1995) natural conditions database shows values ranging from 84 to 88 percent stable for streams with similar geology and gradients.

Significance: Bank stability is rated by observing existing or potential detachment of soil from upper and lower stream banks and its potential movement into the stream. Steeper banks are generally more subject to erosion and failure, and streams with poor banks will often have poor instream habitat (Plafkin 1989). The adverse impact from an eroding streambank can be much greater than the adverse effects of a comparable area of eroding hillside because sediment is

delivered directly to the channel (MacDonald et al. 1991). Protection from erosion is provided by plant root systems as well as by boulder, cobble, or gravel material (Plafkin 1989). A study by Platts found that where channel bank and riparian vegetation were in good condition, the channel handled flooding without habitat damage (Beschta and Platts 1986). Channel bank conditions are closely linked to the quality of fish habitat, affecting fish populations and providing important rearing habitat for fish. Detrimental changes in the productivity and composition of riparian vegetation can increase stream channel width, decrease stream depth, increase stream temperature in summer and decrease it in winter, and decrease food supply (Beschta and Platts 1986). These factors may individually or collectively reduce fish populations. A study by Behnke in 1977 indicated that the elimination of streamside vegetation and collapsing of banks were principal factors in the decline of native trout populations throughout many western streams (Beschta and Platts 1986). Bank stability is an important indicator of watershed condition and can directly affect designated uses.

Substrate Composition

Surface fines (<6 mm) were generally high throughout the watershed as evaluated by the Wolman Pebble Count (BURP methodology); and as evaluated by the R1/R4 inventories with ocular estimates, 49-Intersection grid technique, and Wolman Pebble Count. The BURP sites had surface fine levels ranging from Brush Cr.-10.9%, to Landing Cr.- 42.9%. Other BURP site values included Box Cr.- 33.9% and 11.5%, Cougar Cr.- 29.4%, and Dead Horse- 32.4%. Fisher Cr. fine sediment levels ranged from 4.5 mean % to 33.7 mean % over 4 reaches, with an overall average of 25.5 mean % (Wolman Pebble Count). Ocular estimates ranged for 7.6 mean % to 15.3 mean %. Fall Cr. levels ranged from 39.82 mean % (ocular estimates) to 34.09 mean % (Wolman Pebble Count). Twentymile Cr. had an ocular mean % of 22.03, and a Wolman mean % of 32.57 averaged over 2 reaches. Trail Cr. had the highest values with a mean % ocular fine sediment estimation of 57.33, and a Wolman mean % of 54.74. The N.F. Payette River had the second largest amounts of fine sediment with a mean % of 44.9 (Wolman Pebble Count), and 51 mean% (ocular estimates) over the two upper elevation reaches inventoried.

Significance: The particle size of the bed material directly affects the flow resistance in the channel, the stability of the bed, and the amount of aquatic habitat (Beschta and Platts 1986). In addition, the size of the bed material controls the amount and type of habitat for small fish and invertebrates. If the bed is composed only of fine materials, the spaces between particles are too small for many organisms (MacDonald et al. 1991). The greatest number of species are usually associated with complex substrates of stone, gravels, and sand. Coarse materials provide a variety of small niches important for juvenile fish and benthic invertebrates (MacDonald et al. 1991). The mix of coarser particles in riffles has been shown to provide the richest aquatic insect habitat (Gordon et al. 1992). Numerous studies (Brusven and Prather 1974; Bjornn 1977; and Hawkins 1983) have shown reduced invertebrate abundance with fully embedded streambed particles (Meehan 1991). Cummins' (1974) literature review found no single factor with greater biological significance in the stream than channel substrate (Beschta and Platts 1986). Salmon and trout have evolved and adapted to the natural size distributions of channel sediments utilizing them for food and cover; and it is believed that no single size particle-size group will create the ideal

environment for all phases of salmonid growth and survival (Beschta and Platts 1986). The optimum spawning substrate mix according to Beschta and Platts (1986) appears to be gravel containing small amounts of fine sediments as well as small rubble to support egg pockets and guard against bed erosion from floods. Fine sediments in spawning substrate have been shown to be a major cause of embryo and larval mortality. Survival is high only if the eggs receive an adequate supply of dissolved oxygen, an adequate flow of water through the gravel to supply this oxygen, and necessary flows to remove metabolic wastes (Beschta and Platts 1986). Percent emergence of swim-up fry has also been shown to be reduced by fine sediment, less than 6.35 mm, by a number of researchers (Bjornn and Reiser 1991). When particle sizes less than 6.35 mm exceed 20-25% of the total substrate, embryo survival and emergence of swim-up fry is reduced by 50% (Bjornn and Reiser 1991). Earlier studies by Bjornn (1968 and 1974) found that riffles with less than 20% fine sediment supported salmon fry emergence of approximately 90% (Hogen 1996). Forest harvest, road building and maintenance, and placer mining can increase erosion and sediment delivery rates. In addition, there is some evidence that an increased deposition of fine sediment may be self perpetuating (MacDonald et al. 1991). Reid et al. (1985) found that the onset of bedload transport may be delayed when the interstitial spaces are filled with fine sediment, and the reduced frequency of bedload transport allows for fewer opportunities for fines to be washed out during high flows (MacDonald et al. 1991).

Temperature

All streams evaluated in the PLWS exhibited temperatures over 13°C, and all those evaluated with thermographs exhibited temperatures over 15°C. In 1994, Fisher Cr. had 65 days with temperatures > 13°C and 50 days with temperatures > 15°C . Also in 1994, Box Cr. had 69 days with temperatures > 13°C, and 52 days with temperatures > 15°C. In 1995, streams with temperatures above these levels include: Twentymile Cr. 37 days > 13°C, and 24 days > 15°C; Trail Cr.- 54 days > 13°C, and 22 days > 15°C; And the N.F. Payette River with 47 days > 13°C , and 16 days greater than 15°C. In 1996, Twentymile Cr. had 53 days > 13°C, and 36 days > 15 C; Trail Cr. had 60 days > 13°C, and 36 days > 15°C; N.F. Payette River had 72 days > 13°C, and 64 days > 25°C, and Pearl Cr. had 35 days > 13°C, and 18 days greater than 15°C. These temperatures exceed INFISH and IDEQ criteria, and approach levels considered unacceptable for optimal growth and development for the life stages of resident aquatic species.

INFISH (1995) objectives require maximum water temperatures below 15°C within adult holding habitat, and below 8.8°C within spawning and rearing habitat. In both 1993 and 1994, temperatures exceed these criteria. IDEQ (1996) criteria for salmonid spawning (these criteria include rainbow and brook trout) state the maximum instantaneous temperature may not exceed 13°C, and the maximum daily average may not exceed 9°C.

Significance: The temperature of a stream is critical to aquatic organisms through effects on metabolic rates and thus growth and development time. As a general rule, a rise of 1°C increases the rate of metabolism in cold-blooded aquatic organisms by 10%. Thus, aquatic organisms respire more and eat more in warmer waters than in colder ones (Gordon et al. 1992). Different life stages of aquatic organisms have maximum and minimum temperatures between which they

can survive. Unusually high temperatures have been shown to cause disease outbreaks in fish, inhibit growth, and cause fish to cease migrating (Platts 1983).

Water temperatures in salmonid streams vary daily, seasonally, annually, and spatially (Bjornn and Reiser 1991). Although small streams in dense forests of the Pacific northwest may be too cold in summer for maximum growth of salmonids, warming the stream by altering riparian vegetation may not result in enhanced growth unless food abundance can satisfy the increase in fish metabolism (Bjornn and Reiser 1991). In many large streams, temperatures become too warm for salmonids in summer for a variety of reasons, including excessive exposure to the sun.

The upper incipient lethal limits for salmon, trout, and char ranges from 23-29°C depending on species and acclimation temperature (Bjornn and Reiser 1991), with the optimal temperature for most salmonid species approximately 12-14°C (MacDonald et al. 1991). Although some salmonids can survive at relatively high temperatures, most are placed in life-threatening conditions when temperatures exceed 23-25°C, and fish will move to other areas to avoid these temperatures (Bjornn and Reiser 1991). Salmonid eggs and juveniles are much more sensitive to high temperatures.

In small streams where daily maximum temperatures approach upper incipient lethal values, salmonids may thrive if the temperature is high for only a short time, and then declines well into the optimum range. A study by Bjornn (1978) found that in an Idaho stream with daily maximum temperatures up to 24°C that lasted less than 1 hour and minimum temperatures of 8-12°C, juvenile chinook salmon and steelhead maintained high densities and grew normally. A study of larger Idaho streams where summer maximum temperatures were 24-26°C, but minimum temperatures were relatively high (15-16°C), most young salmon and trout moved upstream or into tributaries where temperatures were lower (Bjornn and Reiser 1991).

Little information is available on long term exposure of salmonids to altered thermal regimes due to forest harvest, and recent studies are beginning to address these effects (MacDonald et al. 1991). Generally, a reduction in forest cover along streams increases solar radiation, and hence peak summer stream temperatures. However, the Department of Lands Cumulative Watershed Effect protocol indicates that this does not occur at higher elevations. It has been shown that increases in stream temperature generally are additive, and the alteration of shaded and unshaded reaches is not an effective strategy to minimize increased summer temperatures due to forest harvest. In colder locations, clearing the riparian zone may cause increased anchor ice or freeze up, with the largest changes occurring in small, shallow, slow-flowing streams with insignificant amounts of ground water inflow (MacDonald et al. 1991).

Aquatic Macroinvertebrates

Metrics used in the assessment of macroinvertebrates provided a wide range of interpretations when compared to selected standards used in this study. In many cases, one or more metrics suggested streams were simultaneously exhibiting characteristics of degraded habitat while meeting standards when compared to other regional indices.

Box Creek sites had the highest values for macroinvertebrate metrics analyzed in the Payette Lake Watershed and are used as the regional reference for the other streams in this watershed. Box Creek Site 1 exhibited the best values for an EPT (Ephemeroptera, Plecoptera and Trichoptera) index value of 28 and a taxa richness value of 37. All sites examined on Box Creek rate as optimal for this metric, as they fall within 80% of both the Northern Rockies Ecoregion values and the highest value for the PLWS streams in this analysis, indicating good water quality. The Hilsenhoff Biotic Index (HBI) values rate below 85% of the reference values for all sites on Box Creek (Site 3 has the best value for the watershed and is used for the regional reference, although it is only 25% of the Northern Ecoregion Standard). This metric indicates a population of macroinvertebrate species with increased tolerance to pollutants in Box Creek, possibly related to the large amounts of fine sediment at Sites 1 and 2. Percent Dominance (dominance of the community composition by a single or few species) was below 20% for Sites 1 and 2 indicating optimal values (Plafkin 1989), however the Site 3 value, 34%, indicates a community dominated by relatively few species suggesting environmental stress. The Shannon's H' Diversity Index values, which measures the statistical distribution of species within a population, were within 80% of both the PLWS reference and Northern Rockies Ecoregion values for Sites 1 and 2, indicating optimal species diversity and evenness of distribution of individuals in the community. Site 1 had the highest value for this metric in the PLWS and is used as the reference. Site 3 values rated below 80% in comparison to the two references, indicating low diversity and a stressed community which tends to be unstable (Rosenberg and Resh 1993). Percent Scrapers within the macroinvertebrate community fell below 80% for all sites as compared to the Northern Rockies Ecoregion reference. Sites 1 and 2 (values of 26 and 16) also fall below 80% of the PLWS reference, Site 3, which has the highest percent scrapers for the watershed (53). Scrapers provide an indication of the periphyton community composition and availability of suspended fine particulate organic material associated with organic enrichment. Scrapers increase with increased abundance of diatoms and decrease as filamentous algae and aquatic mosses increase (Plafkin 1989). They also decrease following sedimentation or organic pollution.

There may be two explanations for the high number of scrapers at Site 3. First, Site 3 was evaluated in 1995, one year following the fire. It is likely that fire effects increased nutrient loading similar to other burned watersheds thus stimulating periphyton growth and providing favorable conditions for scrapers. These conditions would promote a community comprised of a larger percentage of scrapers, explaining the higher percent dominance values, lower species richness, and lower Shannon's H' diversity.

Secondly, an increase in stream width or a more open canopy would allow increased sunlight to reach the stream resulting in increased primary production and more food for scrapers. Normally, lower order streams have reduced numbers of scrapers due to heavy canopy cover and less light reaching the stream as described in the river continuum concept (Ward 1992). Site 3 canopy cover was 57%-- greater than canopy cover at Sites 1 (34%) and 2 (63%), which had fewer scrapers. The width to depth ratio of Site 3, however, was over twice the ratios of Sites 1 and 2. Thus the increased % scrapers, higher percent Dominance, lower species richness, and lower

Shannon's H' diversity indices at Site 3 could be a result of the 1994 fire, as well as the large width to depth ratio of this site. Flow variability may also have contributed to these results as it varied between sites: Site 1, 13.7 cfs, Site 2, 25.9 cfs, and Site 3, 6.0 cfs. Sites 1 and 2 have fewer pollution sensitive species, indicating moderate degeneration of habitat (MacDonald et al. 1991). However other indices show no impairment, indicating optimum community structure (composition and dominance) for stream size and habitat quality.

In contrast, all indices for the Deep Creek site differed from the Northern Rockies Ecoregion values by more than 20%. All indices also differed more than 20% as compared to the best condition reference for the PLWS (Box Creek), with the exception of percent scrapers and percent dominance. This was somewhat surprising given the limited history of management within this watershed. These results indicate lower water quality (% EPT, and EPT index); a higher number of pollutant tolerant species (HBI index); and suboptimal biodiversity due to a lack of habitat diversity or suitability (taxa richness and Shannon's H' index). Only 15 different taxa were identified at this site, of which only 9 were from the EPT orders. A recent study by Fore, Karr, and Wisseman (1996) demonstrated that total taxa richness and richness of Ephemeroptera, Plecoptera, and Trichoptera easily separated disturbed sites from less disturbed sites, declining as disturbance increased. The percentage of scrapers was 91% of the PLWS reference value, indicating an abundance of diatoms and periphyton, most likely a result of the more open canopy (47% canopy cover), or the low amounts of fine sediment normally found in A channels (no sediment data is available). The percent dominance value was 19% (optimal < 20%) indicating an even balance of species among those present. In summary, these indices were the lowest in the PLWS and reflect degraded stream conditions at this site. The Deep Creek site MBI value was 4.1, indicating no impairment of community assemblage according to IDEQ (1996) criteria (MBI score greater than or equal to 3.5= not impaired).

An overall evaluation of the streams suggest the following rating based on the combination of macroinvertebrate indices: sites rated in good condition were Box Creek, Twentymile Creek and the upper sites (1 and 2) on the N.F. Payette River; sites exhibiting some stress were Brush, Cougar, Deadhorse, Fall and Pearl Creeks; degraded sites were Deep, Fisher, and Landing Creeks together with site 3 on the N.F. Payette River.

These assessments are preliminary and may be revised subject to additional evaluation of the post fire impacts. Additional analyses will be conducted to evaluate fire related changes in the macroinvertebrate populations.

Significance: Macroinvertebrates have several major roles in aquatic ecosystems as consumers at intermediate trophic levels. They graze on periphyton (attached algae) and feed on terrestrial organic matter that falls in the stream. Other macroinvertebrates are predators and filter feeders (MacDonald et al. 1991). Macroinvertebrates are influenced by both bottom up and top down forces in streams and have important effects on nutrient cycles, primary productivity, decomposition, and translocation of materials (Wallace and Webster 1996). They also constitute an important source of food for numerous fish, and unless outside energy inputs are greater than instream food resources, effective fisheries management must account for fish-invertebrate interactions with resources and habitats (Wallace and Webster 1996).

Platts (1983) and Rosenberg and Resh (1993) note several characteristics which make macroinvertebrates useful indicators of water quality: they are abundant in most streams, the large number of species provides a spectrum of responses to environmental stresses, their sedentary nature allows for site specific analysis of pollutant or disturbance effects, and their life spans of several months to a few years allow them to be used as indicators of past environmental conditions. In addition, the sensitivity of aquatic insects to habitat changes and water quality changes have shown them to be more effective indicators of stream impairment than chemical measurements (MacDonald et al. 1991).

Recent studies by Karr and Wisseman (1996) determined 10 attributes of macroinvertebrate assemblages to be reliable indicators of disturbance, including logging and associated road construction. Among their findings: taxa richness and richness of Ephemeroptera, Plecoptera, and Trichoptera species separated the best sites from the poor sites and in general declined as disturbance increased. Other studies have shown that while a decrease in riparian canopy through logging may increase total abundance, species diversity is reduced. Fine sediment increases have also been shown to decrease aquatic insect populations (MacDonald et al. 1991).

Fish

Fish densities varied in the watershed. Deep Creek had the highest density of rainbow trout (3.15 to 5.12 per 100 seconds), and Trail Creek had the highest density of brook trout at 16.82 per 100 m^2. Cutthroat trout densities in the N.F. Payette River were 0.20 per 100 m^2, and 58,810 spawning kokanee were counted in the N.F. Payette River in 1993. Whitefish, dace, sculpin, and red shiner are also found in the watershed.

Significance: Fish populations are a result of the physical, biological, and chemical factors surrounding them, and through their link to the trophic levels below them, provide understanding of total ecosystem functioning (Platts et al. 1983). Size, structure, and growth rates of fish populations allow insight into the habitat conditions that existed in the past 2 to 10 years. Year class strength is usually set in the early life history of fish, which allows known habitat conditions to be followed while determining reactions of fish to these conditions (Platts et al. 1983). Salmonid species generally have the most economic importance and stringent habitat requirements, thus most monitoring activities focus on them (MacDonald et al. 1991). Forest management can affect a wide variety of physical and biological parameters critical to fish reproduction, rearing, and growth, including temperature, substrate, primary productivity, peak runoff, low flows, and macroinvertebrate populations. In some cases adverse effects for one species may benefit another. Research has demonstrated the need to evaluate forestry impacts by species and life cycle stage, and not rely on single indices such as the total number of fish (MacDonald et al. 1991). Generally fewer fish species occur in undisturbed streams and lakes in the Pacific Northwest than in the Midwest or Southeast, which impairs the use of diversity indices as indicators of water quality. However, the number of native species may be a sensitive measure of the deterioration of fish habitat (MacDonald et al. 1991).

4.6 Recreation Survey

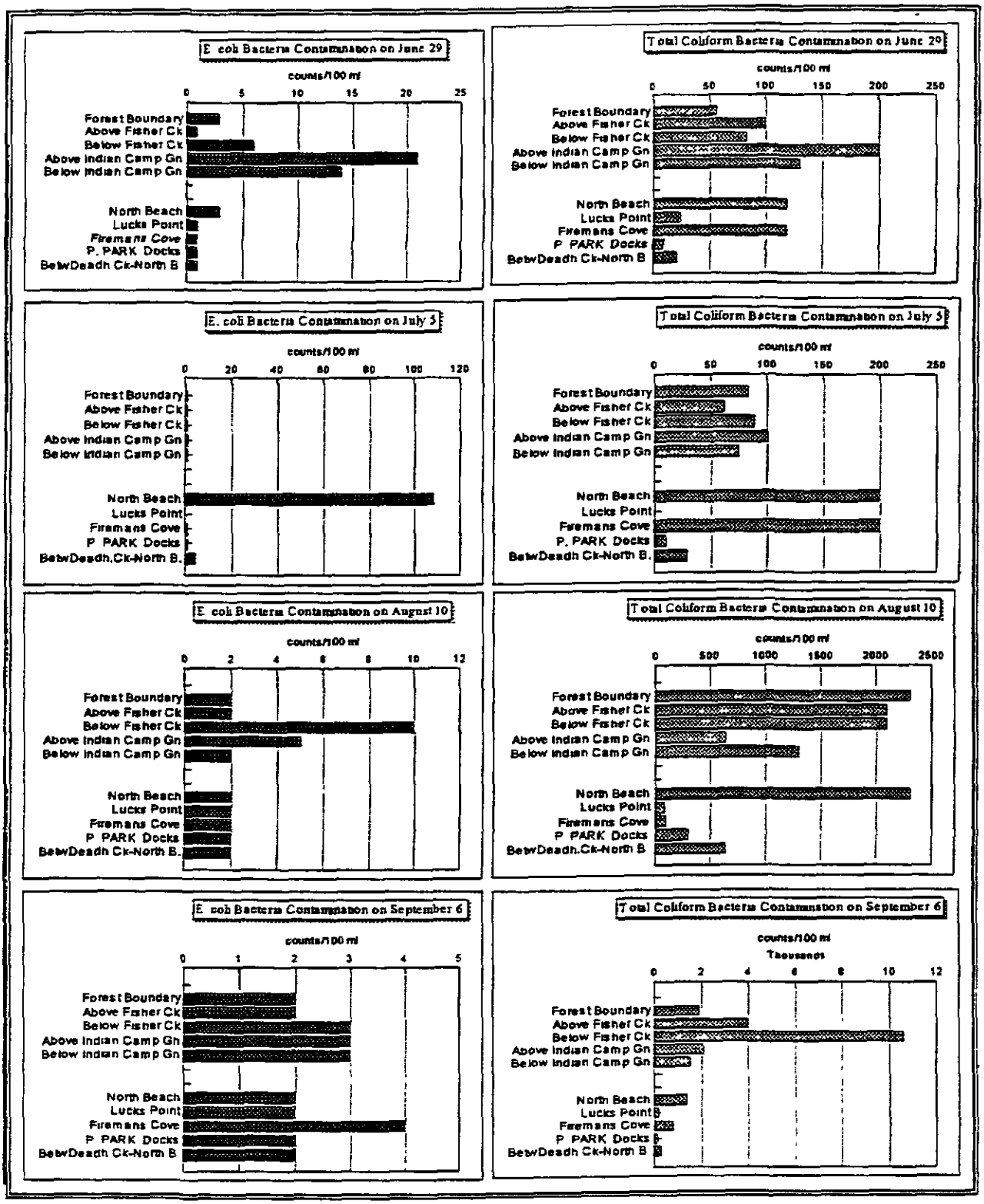
4.6.1. Bacteria Contamination

Recreational impacts within the Big Payette Lake Drainage are most evident in those areas of least development. The Northeast shore and the river corridor from North Beach to Upper Payette Lake are most impacted from recreation. This area receives little funding for recreational management and facility construction. Problems occurring are soil erosion and compaction, unsanitary conditions and loss of shoreline. Some improvements have been made in this area of the water shed. The Idaho Department of Parks and Recreation (IDPR) has constructed new toilet facilities, parking lot, trails, rented six porta-potties for the last three summer seasons and has eliminated twenty dispersed camp sites.

IDPR, working with the Soil Conservation Service and Trout Unlimited constructed revetments, planted willows and placed soil blankets in five highly eroded areas along the river between North Beach and the east side bridge. In 1992 Valley County passed a no-wake/5 mph speed limit on motorized boats in the North Fork above the lake including Upper Payette Lake. This has helped to reduce some of the erosion along the river corridor. IDPR also worked with Valley County, Idaho Department of Lands and the U.S. Forest Service (USFS) on construction of a snowmobile parking lot 2.5 miles north of North Beach replacing the west side parking lot that was on the shoreline of the lake. This parking lot eliminates any chance for accidental fuel or oil spills contaminating the lake. The USFS has redesigned and improved Upper Payette Lake campground. This included, hardening campsites, construction of new toilets, roads and trails.

In 1994 and 1995 the IDPR and Idaho Department of Fish & Game (IDFG) collected water samples from 10 highly used recreation areas along the lake and the river. Samples were tested for total coliform and E. coli. Results are presented in Figure 4-28. Although results are not definitive, evidence indicates that those areas of least development (most primitive) and high use have the highest counts of bacteria. Highest counts of total coliform and *E. coli* were present at undeveloped camp sites located along the N.F. Payette River. Samples collected below Fisher Creek and below Indian Camp Ground frequently contained elevated levels of bacteria compared to upstream samples. Unexpected high peaks in concentrations were also observed at sample sites above Indian Camp Ground. This collection site was located between camping areas and not expected to yield high concentrations of bacteria. High concentrations of total coliform bacteria may indicate a general increase in ground disturbance. These concentrations reached a seasonal peak shortly after the Labor Day holiday when general recreational use is also highest.

Figure 4-28. Bacteria monitoring results from recreation use areas along the N.F. Payette River and lake shoreline.



Levels of bacteria contamination were not as great among the developed lakeshore camping/recreation sites. Test for presence of *E. coli* were generally below the detection level of 2 counts/ml. Dilution within the nearshore areas of the lake may account for the low bacteria numbers. An exception was the occurrence of a large spike of bacteria at the undeveloped North Beach site on July 5 coinciding with the holiday weekend. These large spikes of *E. coli* counts in water samples can probably be attributed to Recreation Vehicles (RV) or boat holding tank dumping.

4.6.2 Boating Recreation and Creel Survey

We estimated a total of 36,558 hours of boating activity occurred during the period from July 1, 1995 through June 1996. Nonspecific motor boat, sight seeing and transportation, use was the most common type of boat use and accounted for 41% of the total. Personal watercraft (jet skis), water skiing boats, sail boats, fishing boats and canoes made up 19, 15, 13, 8, and 4% respectively of the total boating hours. By month we found that July, August and September were the most important months in terms of boating hours. Nonspecific motor boat use (largely sightseeing and transportation) made up the biggest share of use in all months except May, when fishing boat use was greater.

A July 22, 1995 count of all boats, moored and in use, enumerated 717 boats on Payette Lake on that day. Similar counts on August 10, 1996 and July 12, 1997 were 747 boats and 739 boats, respectively. None of these counts included small fishing boats, personal water craft or canoes.

4.6.3 Angler Use and Harvest Estimates

Anglers spent an estimated 11,849 total hours (5.5 hrs/ha), from May 1995 through June 1996 to catch 1,440 fish. A total of 922 fish were kept and 518 were released. Catch rates averaged 0.102 fish/hour for all fish caught and 0.069 fish/hr for all fish harvested. (See Appendix Table Recreation Survey).

Kokanee were the most important species in the creel with an estimated 638 being harvested. A total of 121 rainbow trout, 28 cutthroat trout, and 53 lake trout were also harvested (See Appendix Table Recreation Survey).

The majority of fishing effort on Payette Lake was by boat anglers. They made up 95% of all fishing pressure on Payette Lake and spent 11,304 hours fishing. Shore anglers accounted for 376 hours. Ice angling pressure was very limited with only 169 total hours spent. More in depth analysis of the angler survey was presented in a report by Janssen and Anderson (1997).

4.6.4. Kokanee Migration and Recruitment

The IDFG contracted with the University of Idaho to provide a Master's Degree student to evaluate kokanee migration and juvenile recruitment in the Payette Lake population. The major

questions to be answered included, 1) how many adult kokanee ascended the N.F. Payette River for spawning, 2) what is the recruitment of juvenile kokanee to Payette Lake from the spawning, 3) is recruitment limited by flow fluctuations during spawning and incubation, and, 4) is recruitment limited by substrate composition in the spawning areas? The final report is on file with the IDFG.

In general, the study found adequate numbers of kokanee in the spawning run to seed Payette Lake. It also estimated ample recruitment of Age 0 fry to the lake. It determined that flow fluctuations caused some mortality during incubation, but did not appear to limit the resulting kokanee population in the lake. And, it observed that while subsurface fines (0.83-6.4 mm) exceeded optimum levels, that incubation success was acceptable, given the number of adults in the spawning run.

The IDFG will continue monitoring the kokanee population using mid-water trawling, hydro acoustic sounding and spawner counts to adjust fishing regulations, if needed, in the future.

4.7 Minimum Stream Flows N.F. Payette River Assessment

In many ways, the flows in the NFPR effect the health of the fish populations and the quality of water in Payette Lake. Idaho Code 42-1501 declares minimum flow to be a beneficial use for the protection of fish and wildlife habitat, aquatic life, recreation, aesthetic beauty, transportation and navigation values, and water quality.

4.7.1. Minimum Streamflow Analysis

Quantity of habitat available for several life history stages of rainbow trout for the range of discharges measured are presented in Figure 4-30 and the Minimum Flow Assessment Appendix Tables. Habitat availability for spawning kokanee was also determined for Reach IV, below Fisher Creek. All reaches show similar trends in available habitat as discharge increases.

The two categories of juvenile rainbow trout (<4" and 4-8") are the most sensitive, and have the most conflicting life history stages with respect to quantity of habitat that is available with changing discharge. As discharge increases depths become more suitable for 4-8" fish, then velocities begin to limit habitat when flows exceed 100 cfs. Conversely, conditions are more suitable for fry and yearling trout at low flows because velocities are low and depth >0.5 feet does not limit use.

Peak spawning of kokanee in the river occurs by September 7 (Bennett and Frost 1995). During the two years of their study Bennett and Frost observed kokanee migration onto spawning grounds coincided with increased flows (caused by evacuation of upriver reservoirs), that peaked at an average of 114 cfs. Kokanee continued to spawn through mid-October as flows decreased to 14 cfs. This decrease in flows did not result in a significant number of dewatered redds; and redds that were subsequently dewatered appeared to remain moist throughout incubation. Bennett and Frost stated: (Fry and alevin) "survival in dewatered redds was similar to survival in areas that were watered

throughout the incubation period." The authors recommended, however, that "reservoir evacuation should occur over an extended period of time and not be limited to short releases of large amounts of water and should be completed by the end of the first week in September."

To maximize habitat available for 4-8" trout without severely reducing habitat for smaller juveniles, we recommend a minimum discharge of 35 cfs from Upper Payette Lake, to provide 60 cfs at the USGS gauging station below Fisher Creek from July 1 through September 7. We recommend that the Lake Reservoir Company consider this minimum release from Upper Payette Lake in the management of their reservoir storage, realizing that the availability of water for this flow is subject to annual water supplies, irrigation demand, and the possible consequences to other uses downstream. The IDFG will also pursue a stream resource maintenance flow, to be held by the Idaho Water Board. This will not effect senior water rights, but will indicate a desire for the maintenance of resource flows in the future.

This flow will maintain the fisheries resources in the upper N.F. Payette River (Figure 4-31). Available habitat for rainbow trout is higher at lower discharges in the upper reaches vs. lower reaches. This seems reasonable, as critical depth would be maintained in the narrower upper river at lower discharges. The discharge relationship developed from our data shows that approximately 35 cfs released from Upper Payette Lake during summer will provide 60 cfs to the river below Fisher Creek (Figure 4-31). After September 7 flows should be decreased to base flows to avoid dewatering of kokanee redds. Management of water releases into Fisher Creek from Granite Reservoir was not considered in this study. At this time we leave recommended changes in release management of Granite Lake and Box Lake to the Lake Reservoir Company so they can coordinate releases from the reservoirs to best meet the competing water needs.

Habitat availability for spawning rainbow trout was included merely for interest. An analysis of substrate would be necessary to actually quantify spawning habitat.

Water temperatures in the river in 1996 did not exceed 21°C (70°F) and therefore were not limiting to rainbow trout (Scott and Crossman 1979) (Figure 4-31). We will continue to monitor summer river temperature until data are collected over an adequate range of weather and water conditions.

Fish species observed during the snorkeling survey included rainbow trout, cutthroat trout, mountain whitefish, largescale sucker, sculpin, and dace. Densities were dominated by juvenile rainbow trout (Figure 4-31). Total densities of naturally produced trout ranged from a high of 4.4 fish/100 m^2 at the upper reach to a low of 0.02 fish/100 m^2 (one fish observed) in Reach IV. Density of rainbow trout ≥6" were less than one fish/100 m^2, low compared with other similar sized rivers throughout Idaho (Schill 1991).

Approximately 5,000 catchable sized rainbow trout (>9") are stocked annually throughout the upper N.F. Payette River from June through August. Another 10,000 rainbow trout are stocked in Upper Payette Lake. We know that some of these fish go downriver. Splake also leave the lake.

Figure 4-29. a.) North Fork Payette River kokanee spawning counts (1988-1996) and b.) mid water trawling estimates of age 1+ kokanee (1988-1996).

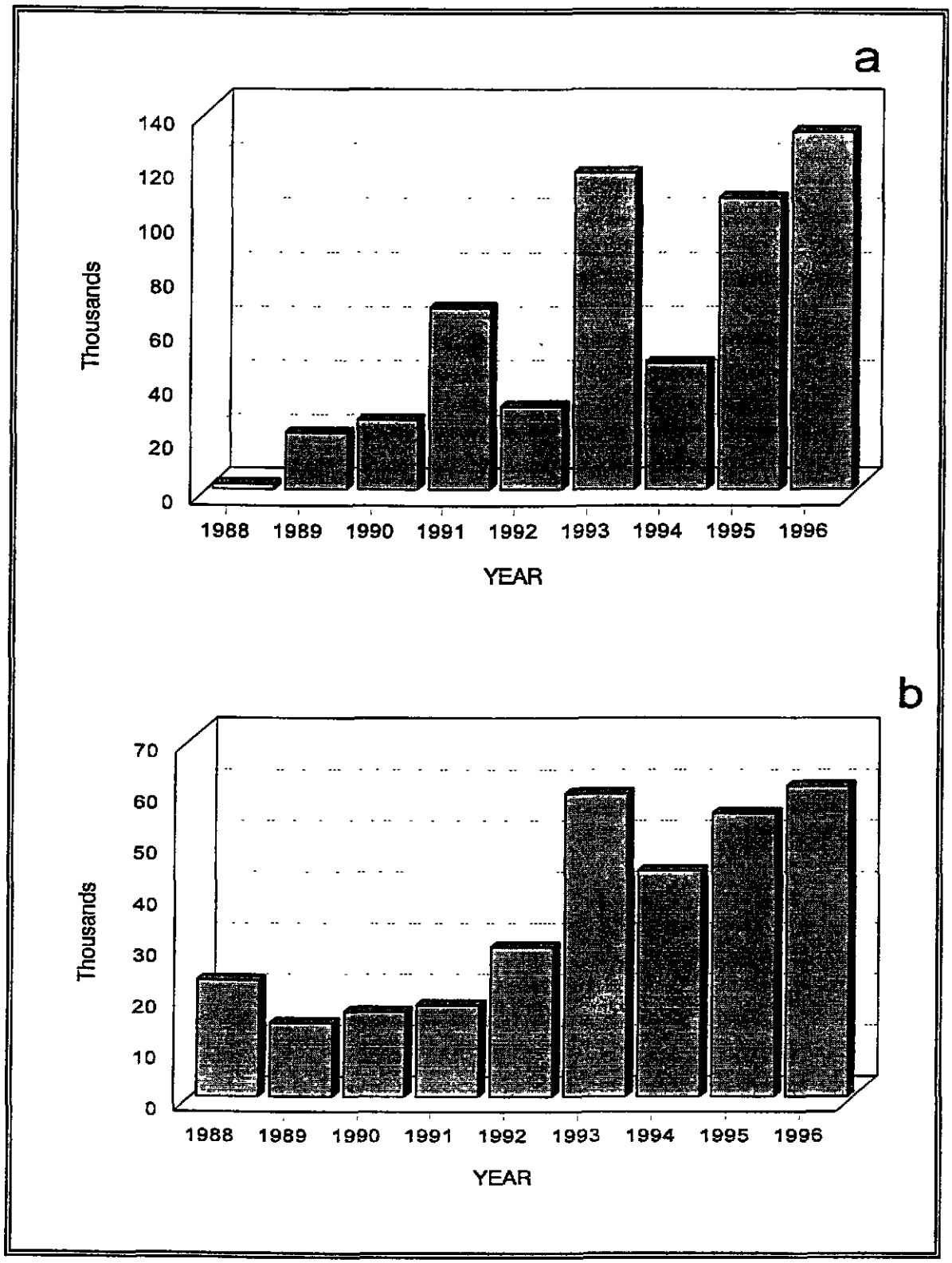
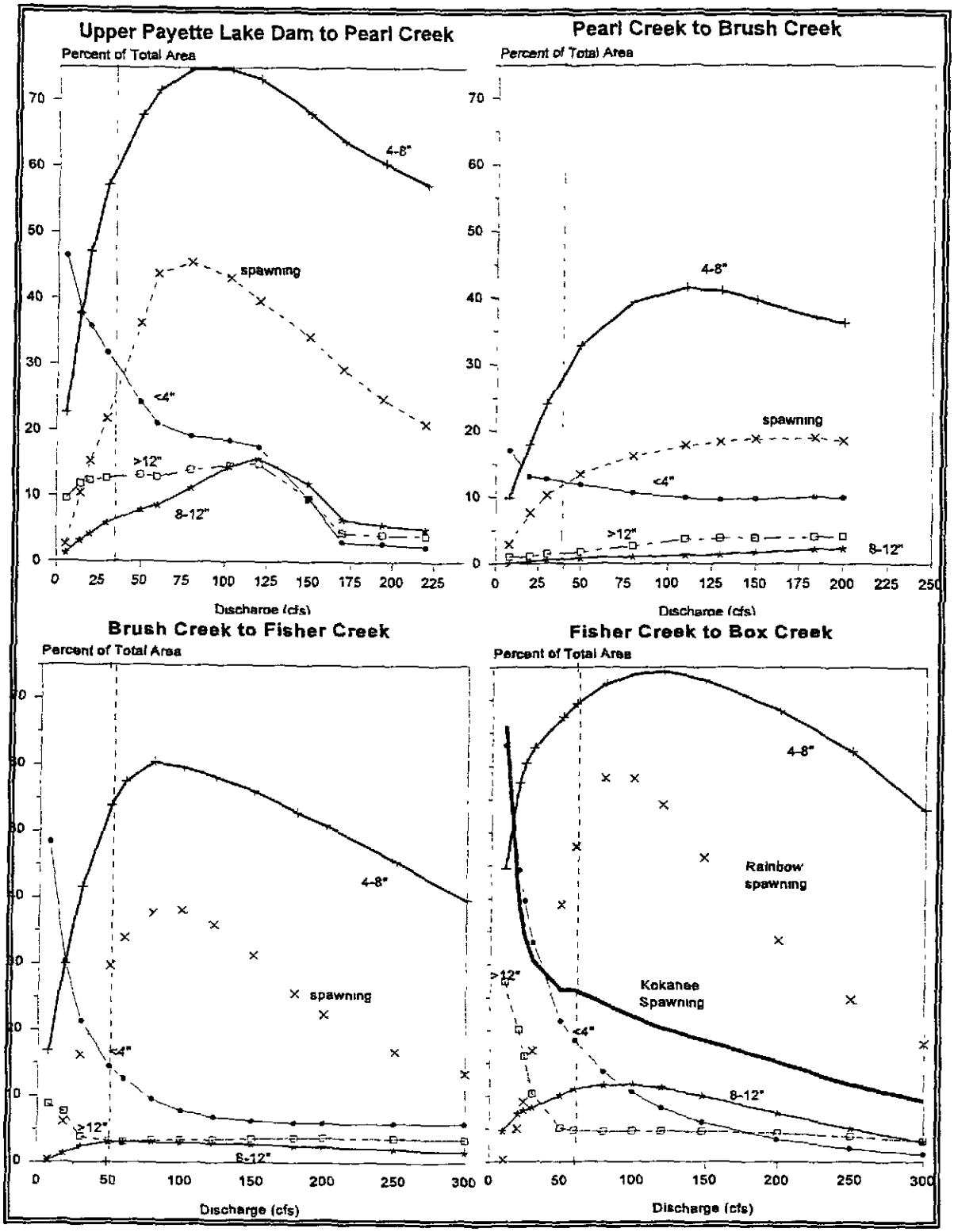


Figure 4-30. Habitat available to rainbow trout and spawning kokanee at various discharges in the upper North Fork Payette River, expressed as a percent of the total area of each study site. Vertical line in each chart represents recommended minimum discharge for that reach.



Three hatchery reared rainbow trout were observed during snorkeling, and only in the two upper reaches. A few splake were observed during our snorkeling survey of the upper reach, but were outside of the measured area, so densities were not calculated.

In addition to rainbow trout, three juvenile cutthroat trout (4-5") were observed in Reach II; five whitefish (8-10") were observed in Reach I, and three 12" whitefish were counted in reach III. Non-salmonid fishes were noted as present, but not counted.

Habitat frequency data shows the paucity of pools (5% of the total distance) in the upper N.F. Payette River (Figure 4-32). Autumn pool frequency in a stream between 35% and 65% is considered ideal for adult rainbow trout (Raleigh et al. 1984). Our survey to determine frequency of habitat was conducted at a discharge approximately three fold higher than average fall base flows, but given the relatively steady gradient of the river we do not expect pool frequency to increase significantly with reduced discharge.

Figure 4-31. a.) Recommended summer discharge for mainstem N.F. Payette River, as measured at the USGS gauge below Fisher Creek, b.) Discharge relationship among all reaches of the river, c.) Summer water temperatures at USGS gauge, and d.) Densities of rainbow trout in study reaches.

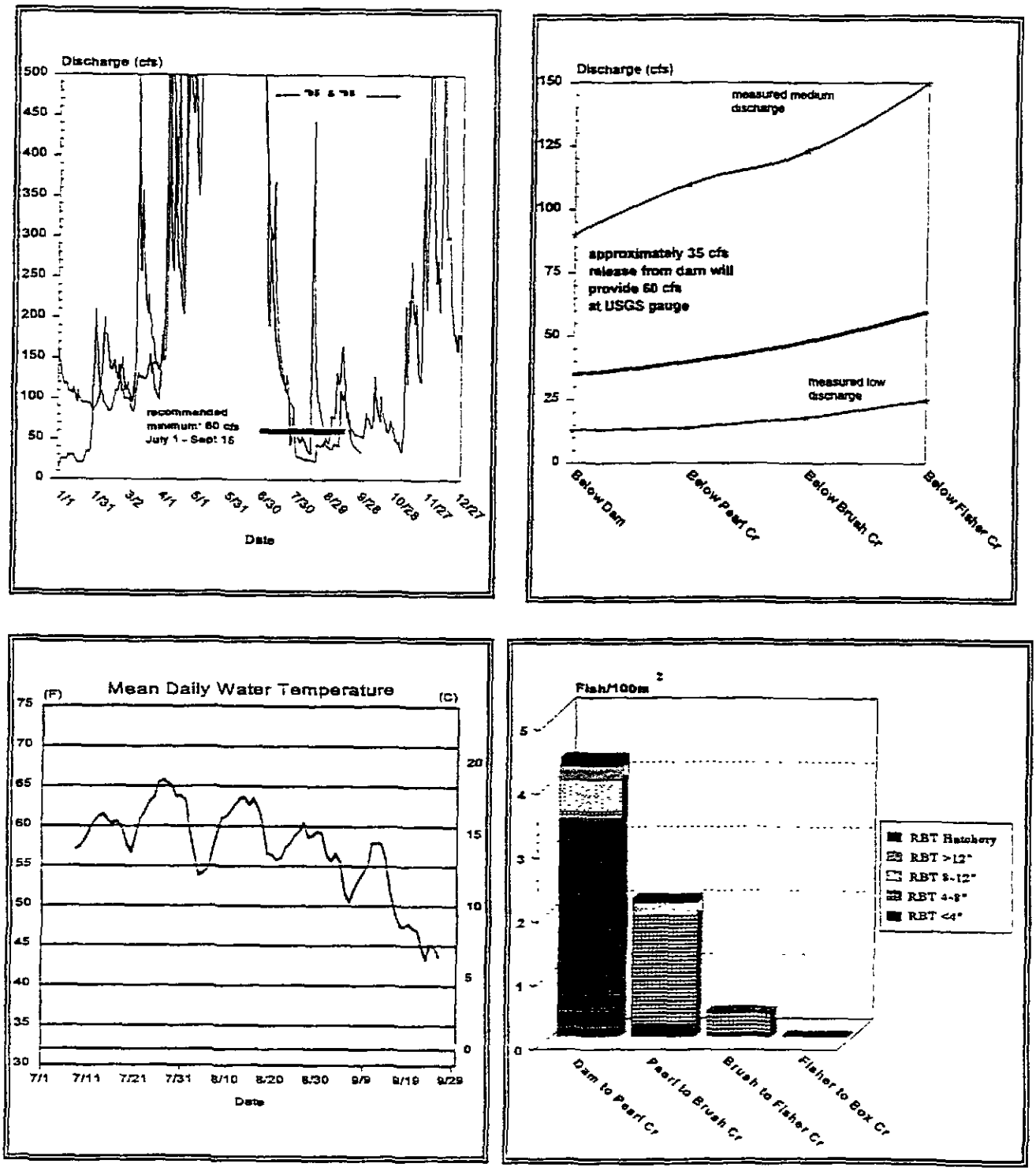
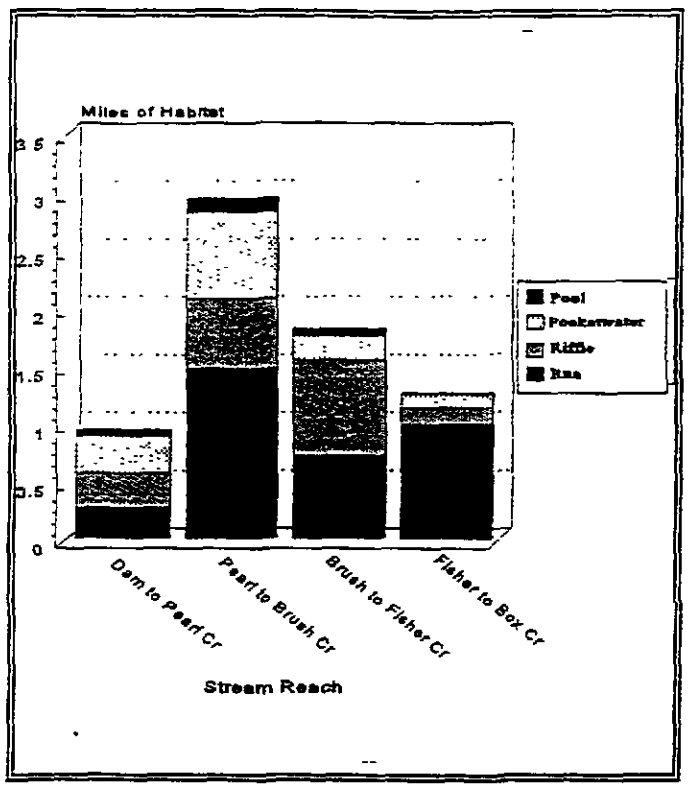


Figure 4-32. Quantity of habitat types in the upper North Fork Payette River.



Though no data were collected regarding riparian or instream cover, abundance of large woody debris in the river channel appears to be low. Fallen trees left in the river could increase pool abundance and depth, increase macro invertebrate production, provide velocity refuge for all trout life histories, and could provide sorting of sediment to provide spawning gravels (Hunter 1991).

4.8 Sediment Accumulation Rates and Nutrients

High quality sediment cores were successfully retrieved from Payette and Upper Payette Lakes during July of 1996. Duplicate cores were collected from each of the three target basins, with subsections from the best of each set further processed for 210Pb analysis. The spare cores were also subsectioned and archived for future consideration. All cores were subsectioned at one centimeter intervals through the first 30 cm and then at 2 cm intervals through the remainder of the strata.

4.8.1 Core Composition

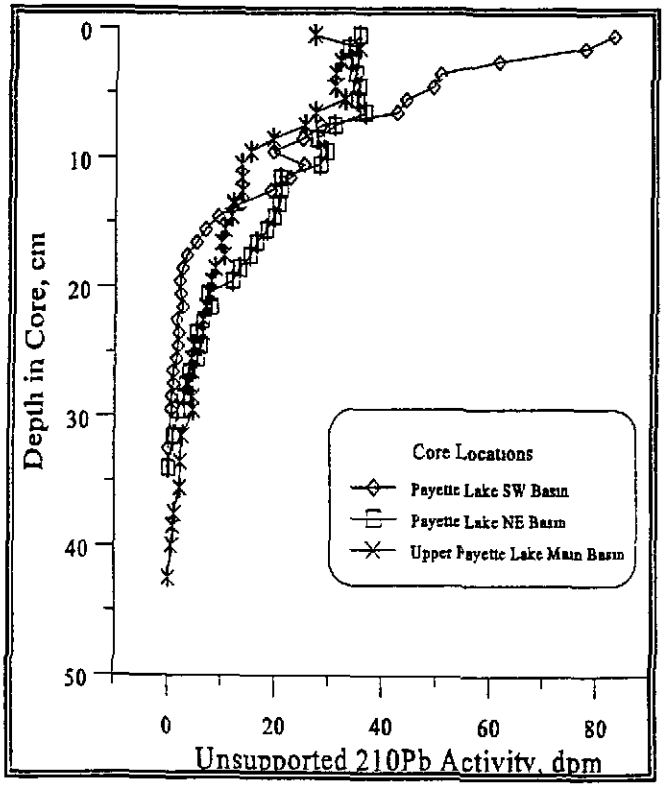
The three cores used for analyses varied in thickness from 70 cm (Main Basin, Upper Payette Lake: UPL), 98 cm (NE Basin Payette Lake: NEP) and 107 cm (SW Basin Payette Lake SWP). The excessive thickness of each core was necessary to insure that the entire period of 210Pb activity (160-180 years) was captured completely. The UPL core was visually unremarkable, grading from a flocculent surface material at the sediment/water interface, into a more densely packed fine mud at the bottom. This is a common change resulting from gravity compaction and dewatering. No significant coloration changes, sediment banding or other stratigraphic features were noted in the UPL core. There were no signs of surface disturbance or bioturbation in the core which could impact dating procedures.

By contrast, the NEP and SWP cores showed fined banding of sediment layers alternating in color between light brown and darker brown/black near the surface of each core. The banding persisted through the top 5-7 cm at a rate of 5-7 bands per centimeter and was most pronounced in the SWP core. The SWP core also showed signs of oxidized iron present in the surface layers. This is significant as iron and phosphorous cycling in lakes are intimately linked and directly related to water quality. The presence of oxidized (rust orange) iron at the surface of the SWP core indicates that iron has been cycling in the hypolimnion of that basin and that is readily available for release to the water column again. Since phosphorous is the most common co-precipitate of iron under changing redox conditions, phosphorous may also be stored in the surface sediment and available for recycling. Below the top 10 cm, no stratigraphic features were apparent in either the NEP or SWP cores. Each graded into denser material down through the core. There were no signs of surface disturbance or bioturbation in either core which could impact dating procedures.

4.8.2 Dating Results:

210Pb stratigraphies found in each core are depicted in Figure 4-33. All three cores showed similar ranges in 210Pb concentrations, which provides a good initial quality control check. Of the three, the SWP core shows the most classic decay curve, with 210Pb increasing at a relatively steady logarithmic rate from depth up to the surface. The extent of the detectable 210Pb concentrations ceased in each core within 30-45 cm of the surface. This indicates that a bicentennial record is contained within the top 0.5 m of each core and that the depth of penetration was sufficient in each instance to capture the appropriate record.

Figure 4-33. Observed 210Pb stratigraphies in each sediment core.



The raw 210Pb data were transformed into CRS model dates and are shown in Figure 4-34 (a). The first 10 cm of each core were deposited at an average linear rate of roughly one centimeter per year, yielding a satisfactorily high degree of temporal resolution. Cumulative dating error was also satisfactory, remaining below plus or minus 0.5 years (95% C.I.) through the top 20 cm of each core. The least precise dating interval reached plus or minus 5 years at the 120 years before present in the UPL core (<5% relative error). Relative to a range of other lakes and lake sediment cores, the three retrieved from UPL, SWP and NEP can be considered high quality and high resolution, meeting the data quality objectives of this study.

4.8.3 Sediment Accumulation Rates

The results in Figure 4-34 (c-d) depict the relationships between depth in the sediment strata and time. Normalizing for stratum-specific sediment densities, yields a much more useful representation of sediment accumulation rate (SAR) versus time (Figures 4-34, c-d). Note that the 95% confidence interval for the SARs in each core enlarge considerably with increasing time before present (Figure 4-34 c-d). This is typical for paleolimnologic reconstructions and represents a fair statistical treatment of the data. However, while the size of the confidence interval bars are relatively large before 1900, the overall patterns of SARs with time are still quite apparent. Figures 4-35 illustrate the SARs for each of the three basins.

The two cores from Payette Lake show very similar patterns of accumulation over an 80-100 year period from 1840 until about 1920-1940. The SARs of both cores increase nearly linearly from background rates of 0.1-0.2 $g/cm^2/yr$ in 1840 to three times those levels in 1920-1940. The precise patterns fluctuate somewhat, but the steady acceleration of sediment accumulation during this period is quite conclusive. During the same period, the UPL core exhibited a similar trend in SAR, increasing nearly four fold from 0.4-1.6 $g/cm^2/yr$. The comparable responses of each of three basins during this period suggest that a similar set of circumstances likely impacted them simultaneously.

The gradual, yet steady increase in SARs suggest non-cataclysmic promoting events during this period such as construction of non-paved roads or other forms of shoreline development. A succession of man-made and natural changes occurred during this time frame that may have contributed to increased watershed erosion. Beginning in the 1880's, large numbers of sheep were grazed in the upper watershed and a crude road was constructed along the west banks of Upper Payette Lake for access to mines located farther north. Fires also swept through the region in 1910 and 1919 burning most of the Upper Payette Lake watershed. Timber harvest of the region was initiated in 1914 through use of a portable sawmill and continued through 1922. Shortly after, fires again burned through the region in 1930. Development in and around the City of McCall hastened shoreline development as the region increased in popularity as a recreation resort. But, regardless of the cause, increasing the rates of sediment accumulation by 3-4 times in Payette and Upper Payette Lakes from 1840-1940 very likely increased the rates of nutrient inputs by a similar proportion.

Approximately 50-60 years ago, a dramatic change occurred in both Payette and Upper Payette Lakes, reflected in variable responses in the three cores. About 1940, the increasing rate of sediment accumulation ceased in Payette Lake, stabilizing in the NE basin and decreasing in the SW basin. The current SAR in the SWP core has decreased to 1840 levels at a rate of approximately 0.15 $g/cm^2/yr$. However, the SARs in the NEP core remain at 0.6-0.7 $g/cm^2/yr$, elevated 3 fold over 1840 levels. But, while Payette Lake SARs stabilized and decreased, Upper Payette Lake showed a dramatic increase in SAR around 1930-1940 increasing rapidly to a rate nearly 5 times the 1840 condition. And during the last decade Upper Payette Lake experienced and equally rapid decline in SARs back down to 1940 levels, but still elevated 3-4 times above 1840 conditions.

Figure 4-34. a.) CRS model dates and associated strata depth in core profile, b-d). CRS model dates and error estimates in the associated sediment accumulation rates for each core strata.

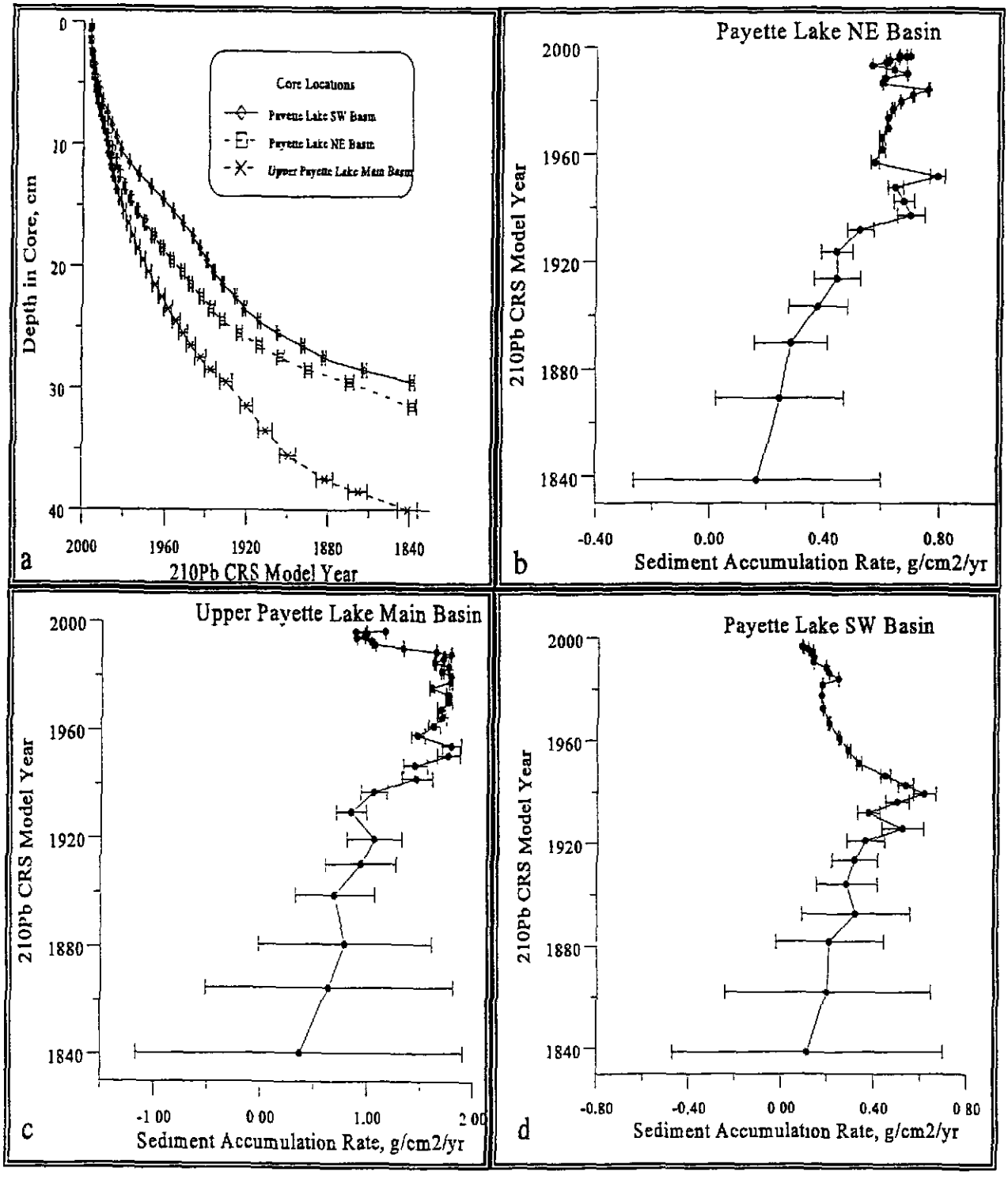
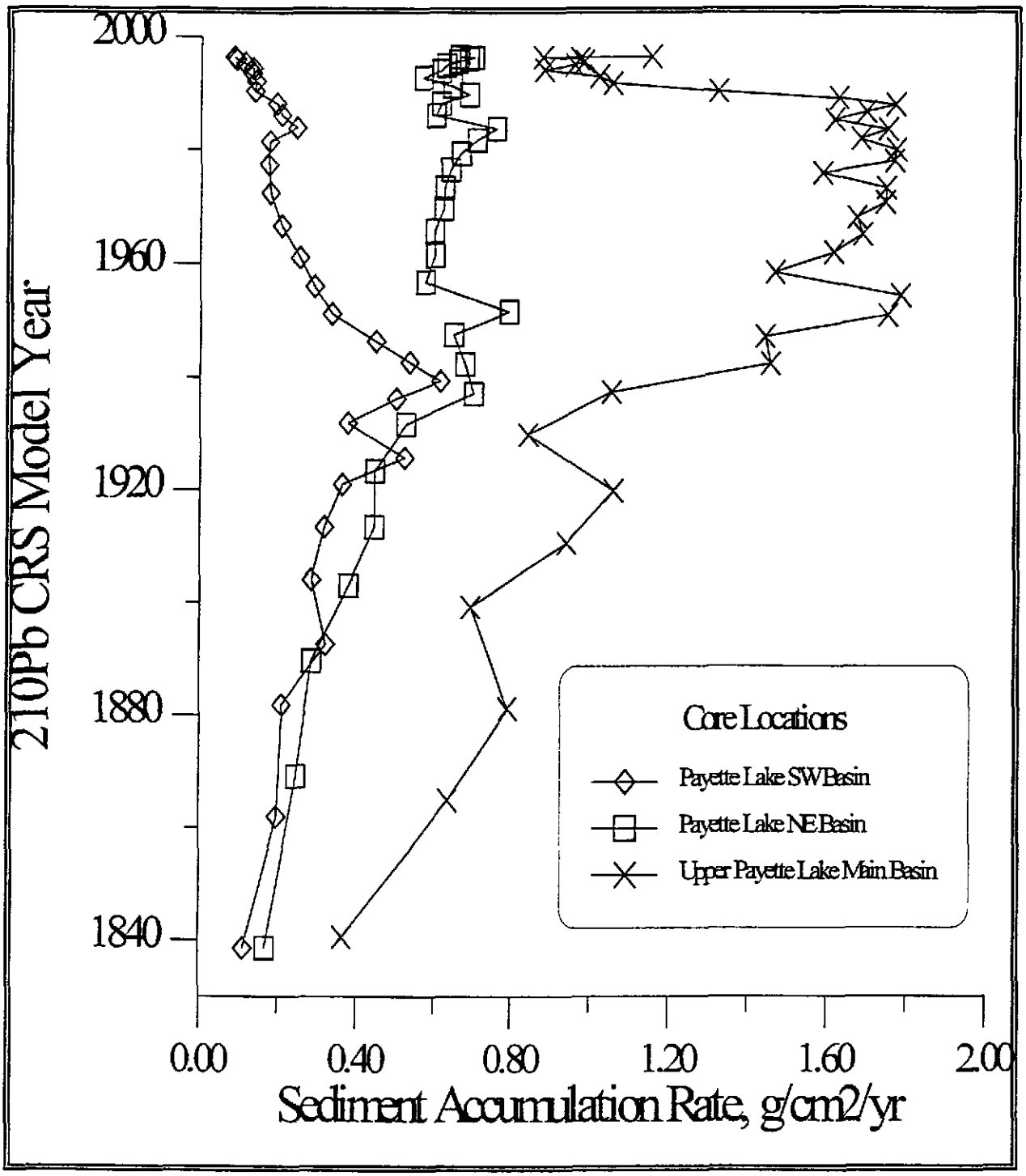


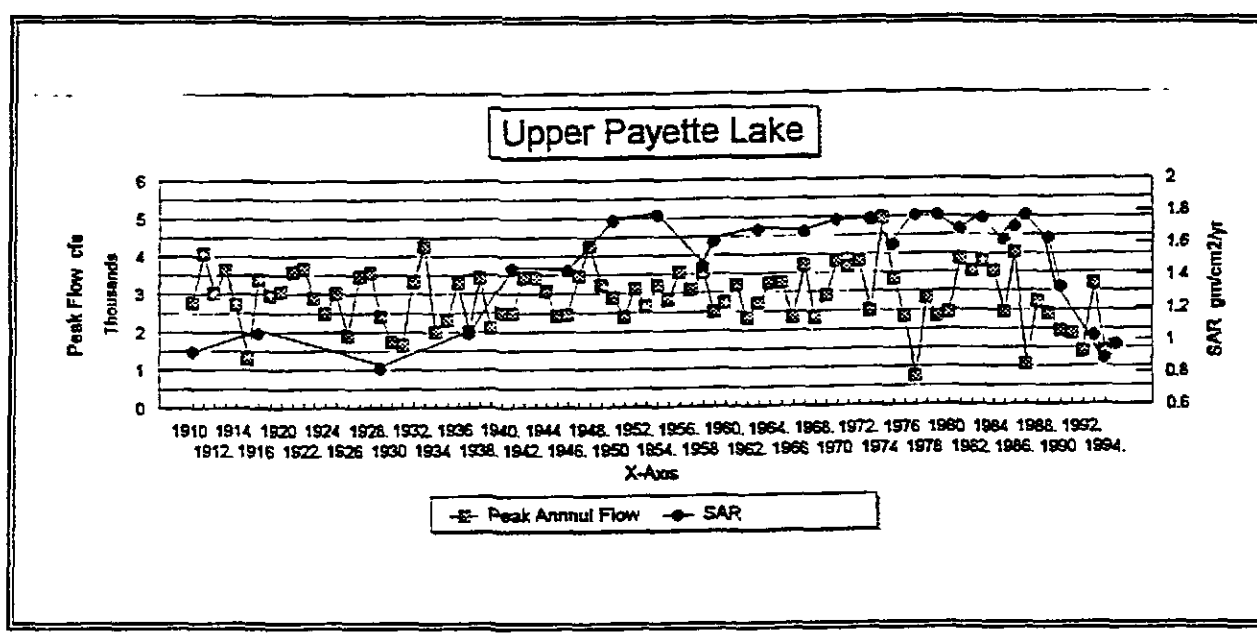
Figure 4-35. Comparison of SARs among sediment core sites in Upper and Big Payette Lake.



The observed changes in the sedimentation rates were not an anomaly related to concomitant changes in the annual runoff intensity as indicated by peak flow discharge volumes (Figure 4-36). Although direct discharge records are not available for the N.F. Payette River above Big Payette Lake, discharge records have been maintained at the Big Payette Lake outflow since 1910. Plotting the annual peak flows during spring runoff for the period of record shows that peak discharges from 1949 until the recent drought in 1987 were less variable (CV = 19.7%) and were roughly of equal magnitude compared to the preceding time span 1909-1948 (CV= 25.4). The corresponding sediment accumulation rates for Upper Payette Lake over this period clearly shows an increase in deposition after 1951 even though peakflows were less extreme (fewer high flow years) compared to the previous decades.

The events affecting the complicated patterns of SAR changes during the last 50-60 years are difficult to pinpoint in the continuum of further development and management of the basin. A significant influence amidst the changing landscape is the concerted effort to harness regional water resources through construction of dams; Upper Payette Lake (1929), Granite Lake (1932), Big Payette Lake (1944)[1] and others of unknown date (Blackwell Lake). While the exact construction regime is unknown, both Upper and Big Payette Lake were dammed during the period corresponding to the rapid changes in SARs (1930-1940).

Figure 4-36. Peak annual discharge as estimated by the Big Payette Lake outflows and corresponding sediment accumulation rates measured from Upper Payette Lake.



In Upper Payette Lake, an outlet control structure had raised the level of the lake 3-4 m over the apparent elevation of the historic outlet. While the precise bathymetry and depth/volume relationship of Upper Payette Lake is unknown, lakes of that type (single basin, valley train) typically have mean depth of approximately 1/3 of the maximum depth. With an approximate historical maximum depth of 24 m, the mean depth of Upper Payette Lake is likely about 8 m. Adding an additional 3-4 meters of stage height to the lake has the effect of increasing the hydraulic residence time of the system. The amount by which the residence time is increased might have ranged from 50-70%, depending upon the accuracy of the bathymetric assumptions. An increase in the hydraulic retention time would enhance the trapping of sediment by lengthening the time available for settling. It is reasonable to hypothesize that the 80-100% increase in SAR within Upper Payette Lake may be accounted for by the artificial change in hydrologic regime. However, the role of other natural and human events leading to increased SARs in Upper Payette Lake cannot be discounted. Unless a catchment history is simple and well known, SAR data alone is insufficient to establish causality. Current declines in SAR in Upper Payette Lake are likely the effect of another phenomena, drought. From the late 1980's through 1996, the Payette catchment has experienced much less than average precipitation. Less runoff results in lower SARs for the recipient systems. It is expected that the SARs in Upper Payette Lake will return to 1.6-1.8 $g/cm^2/yr$ once the precipitation pattern returns to normal.

Since the two lakes are hydraulically connected, the changes in the two Big Payette Lake basins will be impacted by changes occurring in Upper Payette Lake. With all other factors remaining the same, an increase in trapping efficiency in Upper Payette Lake should result in a decreased supply of material in Big Payette Lake. However, this projected pattern is not readily apparent. While the UPL core shows a doubling of SARs, the SARs from the NEP core region, which first receives water from the outlet of Upper Payette Lake, simply stabilize at 1940 levels. In other words, the NEP coring zone in Big Payette Lake has not received the benefits from enhanced upstream trapping of sediments. However, the SWP core region has shown a decline in SARs since 1940. It is then possible that Payette Lake as a whole may have received a beneficial decline in SAR due to the enhanced trapping of materials in Upper Payette Lake. Unfortunately, it is not possible to calculate a mass balance for materials in these lakes, as the sediment focusing factors for each basin and the extent of the lake regions that they represent are unknown (e.g., Type II accuracy is sub-optimal). Matters are further complicated by consideration of the outlet structure on Payette Lake. Stabilization of Payette Lake stage and seasonal management for flood control and water supply have likely changed the means by which sediment accumulates in the system. The sum of these effects are likely quite complex and would require more detailed hydraulic assessment in order to reveal the multiple processes controlling SAR patterns since 1940.

4.8.4 Nutrient Profiles

Concentrations of total carbon (C), phosphorus (TP), nitrogen (TN) and iron (Fe) are plotted with core depth and age for Big Payette Lake in Figure 4-37. Both total nitrogen and carbon content of cores extracted from the NE and SW basins reflect the differences in the sediment loading each of these basins received during the early sediment history (1840). TN and C concentrations in the SW basin averaged 6,061 ug/g (CV=9.8%) and 54,000 ug/g (CV=11.2), respectively.

Accumulations in the NE basin averaged 8,250 ug/g N (CV=6.2%) and 88,500 ug/g C (CV=4.3%). Nitrogen and carbon content in the SW basin appears to increase beginning at the 22 cm depth and consistently increases toward the surface. In contrast, changes in the NE basin nitrogen and carbon content over time are less dramatic and increase only slightly toward the surface.

Core results also show total phosphorus concentrations in the NE and SW basins prior to 1951 were relatively consistent during the preceding decades (Figure 4-37). Both cores appear to exhibit a slight decline in accumulated TP concentrations following 1951. This decline is synchronous between these sites suggesting this is not related to digenetic processes (post depositional changes in solubility). There is a marked (two fold) increase in concentration of TP, however, in the SW basin core near the surface. This latter increase is consistent with increased mobilization of phosphorus under anaerobic conditions.

Increased surface concentration of TP may be related to newly precipitated phosphorus diffused from deeper sediment layers (Hotan et al., 1988). Oxygen depletion reduces redox potential and sorption capacity in lower sediment layers. This desorbed phosphate diffuses along a concentration gradient toward the surface and then re-precipitates as iron phosphate as surface sediments re-oxygenate. Vertical distributions of iron in the sediment cores appears to strongly co-vary with TP. Stream sediments within the watershed contain large quantities of iron (see Stream Sediment Nutrient Enrichment) which are likely sources for deposited materials in the lake sediments.

Trends in the vertical profile of TP, C and TN in the Upper Payette Lake core were somewhat different. Total phosphorus content generally ranges between 1,300 - 1,600 ug/g and co-varies closely with the presence of iron throughout a majority of the core profile (Figure 4-38). TP content however, exhibits an increasing trend in concentration toward the surface above the base level. This increase may be related to digenetic processes increasing the mobilization of phosphorus in the surface layers of the sediment. This would suggest that sediments are anaerobic during part of the year due to oxygen depletion within the lake. Total nitrogen content also displayed a unique trend in that concentrations appear to oscillate around a base level and then increase at the 6 cm depth. A decline in the nitrogen profile was prevalent between the 8-12 cm depth where values fell below the base levels. This reduction could be the result of the upward diffusion of nitrogen but also corresponds to a reduction in the silt/clay composition of this core. The range in TN for older dated sediments appears erratic but varied from 8,400-9,500 ug/g which was 25-30% greater than sediments of the same age in the NE basin of Big Payette Lake. Changes in the carbon content of the core profile were dramatic and punctuated by distinct peaks above the base level at several different depths/ages within the core. Highest carbon levels in the soil correspond with the 1910 fires, however, additional peaks occur at other intervals seemingly unrelated to fire frequency. A step increase in the carbon content is apparent from approximately 6 cm to the surface.

Figure 4-37. Profiles of total carbon (C), total nitrogen (TN), total phosphorus (TP) and iron (Fe) in sediments from Big Payette Lake. Concentrations in ug/g dry sediment weight.

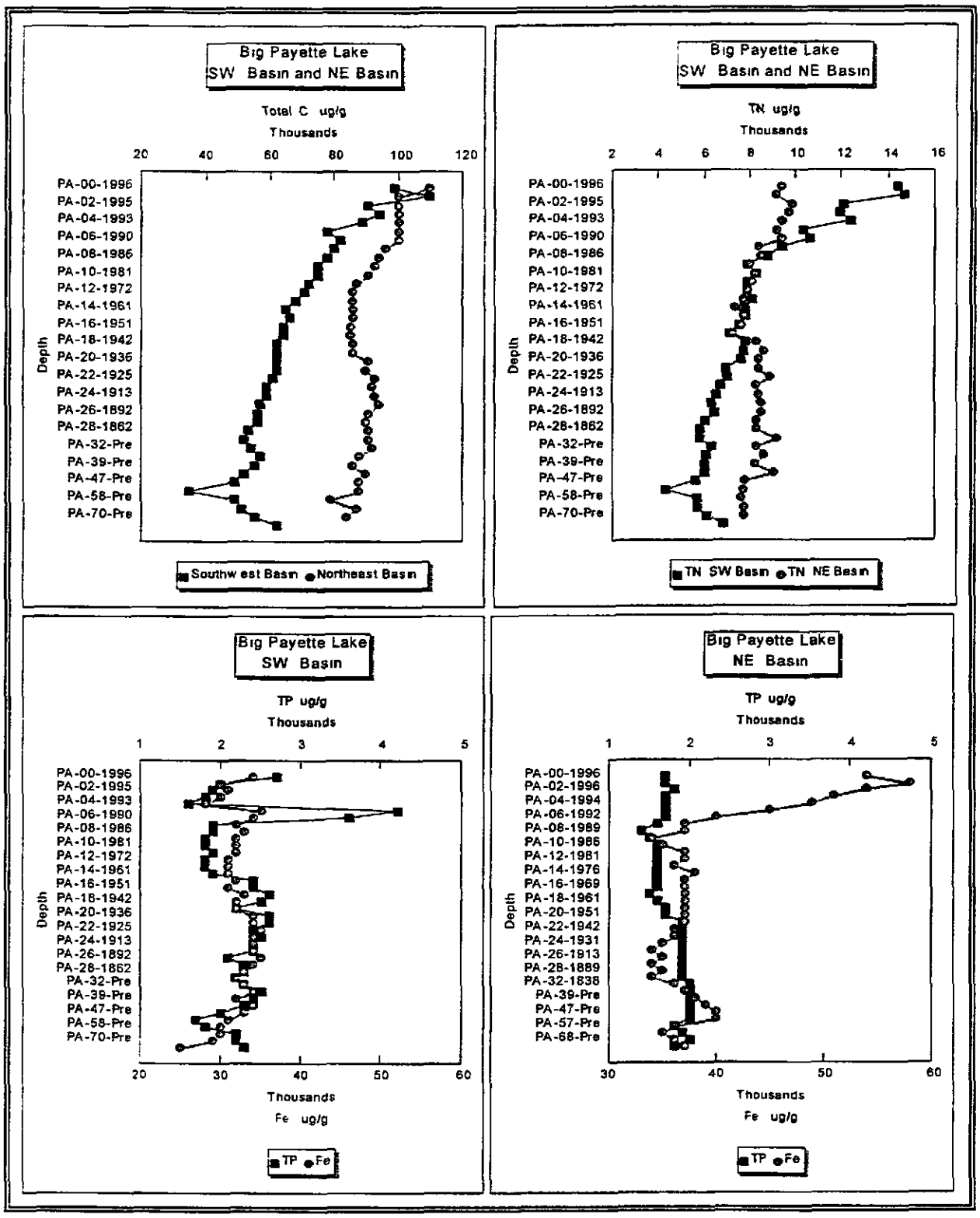
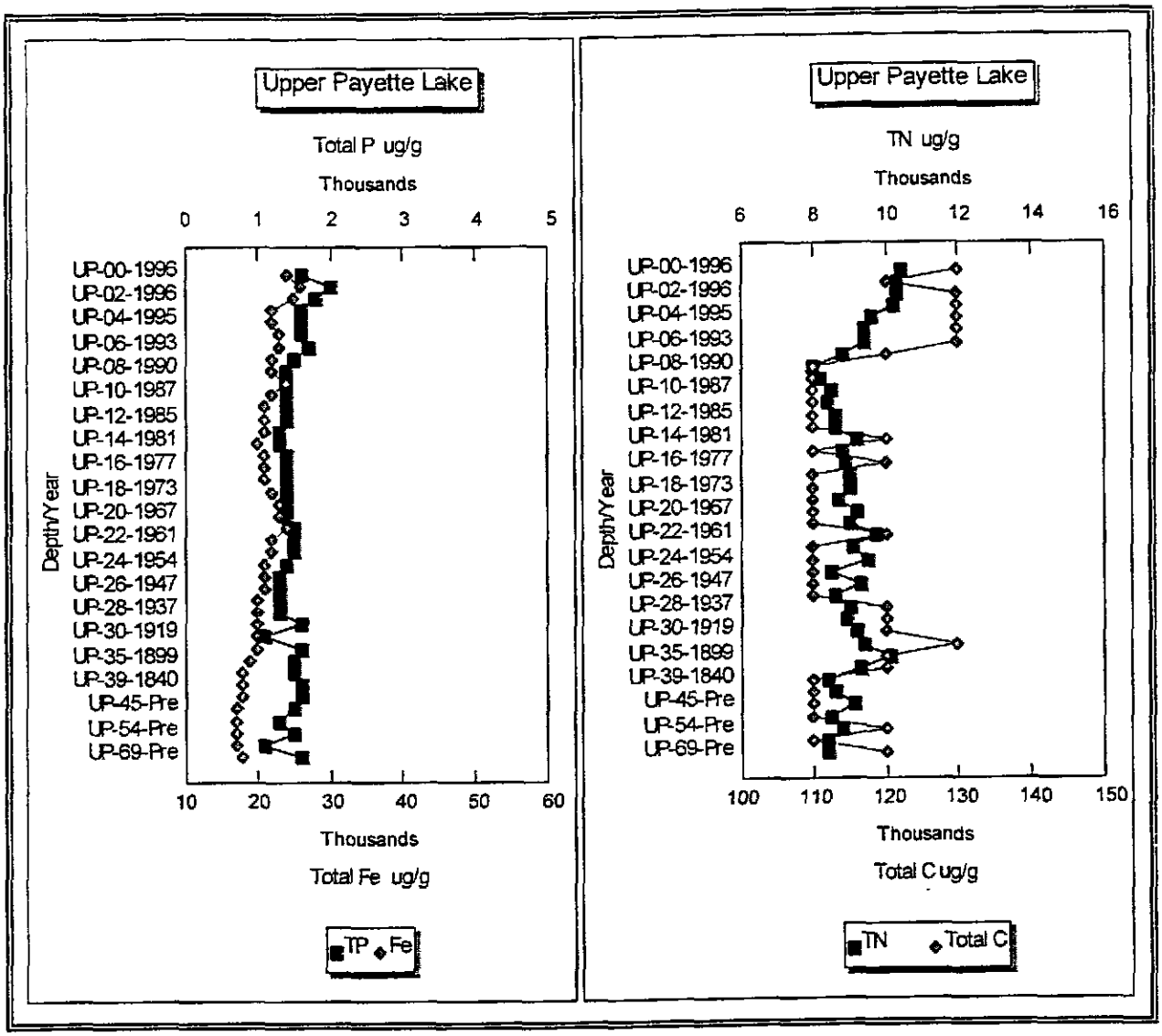
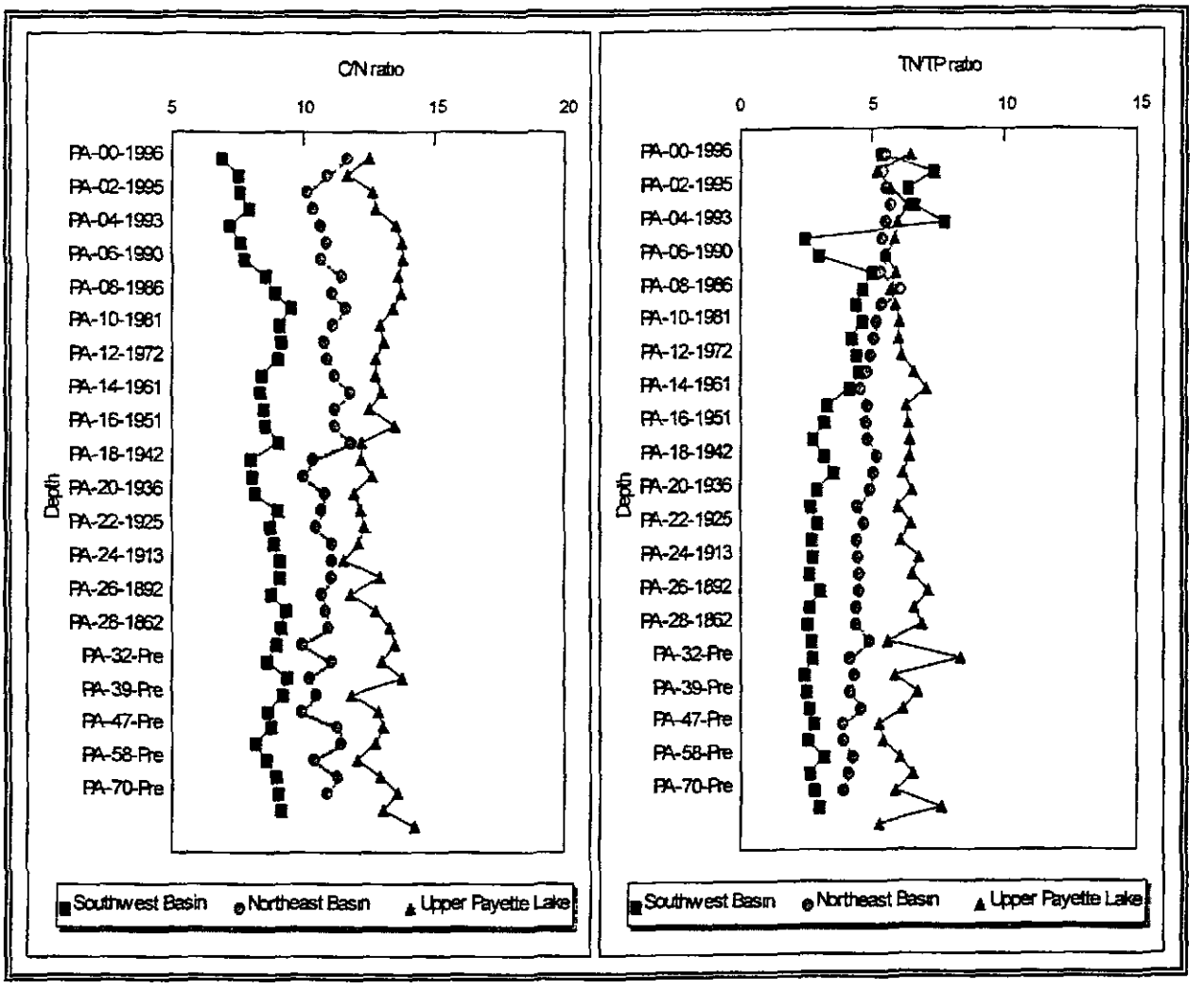


Figure 4-38. Profiles of total carbon, total phosphorus, iron and total nitrogen in sediments from Upper Payette Lake.



A comparison of the C:N and N:P ratios among the sites indicate subtle changes have occurred in the contribution of these nutrients within the SW basin over time (Figure 4-39). C:N ratios in the NE basin of Big Payette Lake vary between 10-12 throughout the core profile and do not exhibit any specific increasing or decreasing trend. Results indicate the relative contributions of carbon and nitrogen have remained relatively consistent. The pattern is somewhat similar for the C:N rations in the SW basin except for a general decline in the C:N ratio during the 1990's coinciding with the drought. Increasing ratios of N:P present at both sites suggest nitrogen export form the watershed has increased over time. This increase is most apparent in the SW basin

Figure 4-39. Ratios of C:N and N:P in vertical sediment profiles from Upper and Big Payette Lake.



beginning around mid 1950. These ratios become erratic near the surface where both phosphorus and nitrogen contents may be influenced by digenetic processes. For the Upper Payette Lake core, here again, a comparison of the C:N and N:P ratios of sediments suggest the content of these nutrients have undergone some recent changes (Figure 4-39). Ratios of C:N vary between 12-14 with a slight decline in response to recent drought.

It is interesting to note, that comparing the ratios of C:N and N:P among the different basins show a consistent trend of Upper Payette Lake > NE basin > SW basin. These differences are related to the proportional influence of watershed derived sediments on the sedimentation rates of the respective basins. Martinova (1993) found lake sediments with C:N ratios of 13-24 were dominated by macrophyte or external sources of sediment/detrital inputs. Lakes dominated by

internal plankton detritus as the sediment source exhibited C:N ratios from 3.5-7. Upper Payette Lake C:N ratios fall in the lower range of those lakes dominated by external sediment loading while the NE and SW basins appear to be intermediate between systems characterized by internal and external sources of sedimentation.

4.8.5 Limnologic and Ecological Implications

Regardless of the complexity of the SAR patterns since 1940, several important observations remain relevant. The SARs in Upper Payette Lake and the NE basin of Payette Lake are several times higher now than they were during the 1840's. And while the SAR of the SW basin of Payette Lake has recently returned to 1840 levels, a 120 year period of accelerated sedimentation has left behind a considerable amount of material in that lake region that would not likely have been present naturally. There are no direct linkages between the pattern of SAR acceleration with known natural events in the catchment suggesting that the changes have been due to a combination of human activities. Fires have occurred, but there is no discernable trace of an episodic pulse of materials associated with those events. The pattern of gradual SAR acceleration during the 1840-1940 period is also consistent with the effects of increasing development and human activity in the catchment.

The limnologic and ecological consequences of increasing SARs has little to do with the accumulation of inert material. An extra few centimeters of material accumulating in the 100 m+ deep Payette Lake will hardly threaten to fill up the lake for many generations. However, sediments found entering these lakes are typically enriched in nutrients, as evidenced by the higher organic phosphorus concentrations measured in stream sediments in this study. (See section 4.2.4). These nutrients and other oxygen demanding materials often have a quite profound impact on water quality. Nutrients bound to sediments also have the propensity to build up within a lake environment through cycling processes in hypolimnetic waters. By this means, the extra material fluxed into the SW basin of Payette Lake is likely exerting an influence on current water chemistry, even though the original sediment is now buried.

Thus, nutrient additions into lakes brought on by enhanced sedimentation periods have a cumulative and long-lasting effect upon water quality. However, the precise relationship between the SARs observed in the two lakes and the resultant water quality is not a straight forward interpretation without some perspective of the temporal changes in the lake ecology. Additional research, in the form of micro fossil analysis of the remaining sediments combined with long-term water quality monitoring would assist in defining these relationships.

Chapter V

5.0 Big Payette Lake Assessment

5.1 Lake Hydrologic Budget

The computed water budget for Big Payette Lake during water years 1995 and 1996 is summarized in Table 5-1. Total inflows for 1995 equaled 430 hm^3 and 534 hm^3 for 1996. Inflow to Payette Lake during 1995-96 was dominated by the North Fork Payette River, a gaged station (Table 5-1). The other two gaged stations, Dead Horse and Fall Creeks, provided less than seven percent of the inflow. Ungaged surface-water principally from direct surface runoff and other tributaries provided the second largest inflow and was produced by the 23.5 percent of the watershed area not measured by the three gaged stations. Direct precipitation onto the lake's surface accounted for about one percent of the inflow. More than 95 percent of the outflow was via the lake's outlet, the North Fork Payette River. The remaining outflow was evaporated from the lake surface or withdrawn by the City of McCall for its municipal water supply.

At the lake outlet station, North Fork Payette River at McCall, total annual outflow was 408 hm^3 and ranged from .098 hm^3 (40 cfs) on January 6 to 7.757 hm^3 (3,170 cfs) on June 5 in 1995. Total annual outflow in 1996 was 528 hm^3 and ranged from .069 hm^3 (28 cfs) on August 19 to 10.864 hm^3 (4,440 cfs) on June 18. About 66 percent of the annual outflow occurred during May and June in 1995; in 1996, about 56 percent occurred during May and June. The period of record at this station began in 1908 and has yielded an annual streamflow of 319 hm^3. Annual streamflow for 1995 was 128 percent of the historic annual mean and 166 percent for 1996.

Unit-runoff coefficients for the four gaged stations differed between the two water years (Table 5-2). Except for Fall Creek, the stations had larger coefficients in 1996, reflective of increased streamflow during 1996. The North Fork Payette River below Fisher Creek had the largest coefficients because it drains the highest elevation areas in the watershed.

Residence time represents the time theoretically required for the outflow to empty a lake and is determined by dividing lake volume by outflow volume. Payette Lake's residence time for 1995 and 1996 was 1.84 and 1.42 years, respectively. The larger outflow volume of 1996 would have emptied the lake more rapidly than in 1995. Historically, the outflow volume has averaged 319 hm3 which yields a residence time of 2.35 years. Thus, during this two-year study, Payette Lake had shorter residence times than normal.

The residual of the hydrologic budget was less than the overall error in both years; thus no definitive statement can be made about inflow or outflow of groundwater. Overall error was about 10 percent of total inflow in both years.

Table 5-1. Hydrologic budget associated with each budget component, Payette 1995-1996.

	1995		1996	
	Volume hm^3	Percent of Total	Volume hm^3	Percent of Total
Gaged Inflows	**Inflow**		**Inflow**	
North Fork Payette River	304	70.7	399	74.7
Fall Creek	17.3	4.0	15.3	3.6
Deadhorse Creek	11.7	2.7	11.4	2.6
[1] **Ungaged Tributaries**	90	20.8	101	23.6
[2] **Direct Surface Runoff** Developed and Undeveloped Lake Perimeter	2.9	0.7	2.7	0.6
Precipitation	4.7	1.1	4.1	0.9
	Outflow		**Outflow**	
North Fork Payette River	408	96.2	528	97.1
Evaporation	4.3	1.0	4.2	1.0
Municipal withdrawal	11.4	2.7	11.4	2.7
Summary				
Total Inflow	430		534	
Total Outflow	424		544	
Change in Lake Storage	30		-87	
[3] Residual	-24		77	

[1] Includes runoff contributions from watersheds below USGS gage 13238322 and other tributaries draining directly to the lake.

[2] Runoff = Area *rainfall*runoff coefficient. Runoff coefficients based on land types and values as presented in Tables 5-4 through 5-13 and 5-4 through 5-14.

[3] (Total inflow-total outflow)-change in lake storage.

Table 5-2. Annual coefficients for unit runoff and nutrient export for three gaged inflow stations and one gaged outflow station, Payette Lake, 1995-1996. [km^2, square kilometer; kh^3/km^2, cubic hectometer per square kilometer; kg/km^2, kilogram per square kilometer; TP, total phosphorus; TN, total nitrogen].

Station Name (Figure 3-2)	Drainage area (km^2)	Unit-runoff coefficient (hm^3/km^2)		Nutrient export coefficient (kg/km^2)			
				TP		TN	
		1995	1996	1995	1996	1995	1996
North Fork Payette River below Fisher Creek	221	1.38	1.81	12.0	16.5	725	951
Dead Horse Creek	12.8	0.93	0.91	15.5	13.9	370	307
Fall Creek	17.3	1.00	0.88	842	46.4	1,500	797
North Fork Payette River at McCall	373	1.09	1.42	6.2	8.0	278	400

5.2 Nutrient Budgets

Substantially more total phosphorus entered Payette Lake in 1995-96 than was discharged from the lake (Table 5-3). In 1995, the largest single source load of phosphorus to the lake was Fall Creek (55.4%). This creek was heavily impacted by the 1994 fire and contained high concentrations of phosphorus in the runoff. Accordingly, computed loadings and the standard error of the estimate for this creek was extremely high (6,682-22,480 kg). Assuming the lower loading estimate better approximates the phosphorus yield, the Fall Creek contribution of phosphorus would have exceeded 36% of all inputs. More stable post fire conditions in 1996 provide a better basis for comparing relative importance of the inflows to Payette Lake. These results indicate the N.F. Payette River accounted for 46 percent of the total loading of phosphorus to the lake. Other ungaged surface-water tributaries accounted for 23.6 percent of the incoming load. These two sources together accounted for nearly 70 percent of the incoming load. Direct surface runoff around the perimeter contributed 9.5 percent of the total phosphorus load. Atmospheric deposition accounted for roughly 8 percent of the load. The City of McCall's municipal water withdrawal accounted for about 3-percent of the outflow of total phosphorus; the remainder was via the lake's outlet.

As with total phosphorus, Payette Lake received substantially more total nitrogen in 1995-96 than it discharged (Table 5-4). The North Fork Payette River inflow dominated the inflow budget in both years; the next largest contribution was from ungaged tributary inflow. Atmospheric deposition accounted for less than 3-percent of the load. About 2-percent of the outflow of total nitrogen was via municipal water withdrawal.

Table 5-3. Total phosphorus budget Payette Lake, 1995-1996.

	1995		1996	
	Load kg/yr	Percent of Total	Load kg/yr	Percent of Total
Gaged Inflows	**Inflow**		**Inflow**	
North Fork Payette River	2,660	10.1	3,640	46.3
[1] Fall Creek	14,571	55.5	803	10.2
Deadhorse Creek	198	0.8	178	2.3
[2] **Ungaged Tributaries**	7,360	28.0	1,860	23.6
[3] **Direct Surface Runoff** Developed and Undeveloped Lake Perimeter	818	3.1	725	9.2
Atmospheric Deposition	660	2.5	660	8.4
	Outflow		**Outflow**	
North Fork Payette River	2,300		2,960	97.7
Municipal withdrawal	49		69	2.9
Summary				
Total Inflow	26,267		7,866	
Total Outflow	2,349		3,029	
Change in Lake Storage	129		-531	
[4] Residual	23,789		5,368	
Percent Retention	90.6		68.2	

[1] Estimate based on two consecutive sampling periods in which extremely high concentrations of TP were measured during high flow events. Estimated TP load with standard errors ranges from 6,682 to 22,460 kg/yr.

[2] Includes runoff contributions from watersheds below USGS gage 13238322 and other tributaries draining directly to the lake.

[3] Load=Area *Rainfall*runoff coefficient*TP concentration. Runoff coefficients based on land types and values as indicated in Tables 5-4 through 5-13 and 5-4 through 5-14. A runoff concentration of 14 mg/m3 TP was used for undeveloped lands. Mean pollutant concentrations used for developed lands as described in stormwater section (4.3.1).

[4] (Total inflow-total outflow)-change in lake storage.

Payette Lake acted as a trap (Outflow-Inflow = positive residual) for total phosphorus and total nitrogen (Tables 5-3 and 5-4). For example, the residual for total phosphorus in 1995 was 23,789 kg and 5,368 kg in 1996; thus the lake trapped roughly 90% of the inflow TP in 1995 and approximately 68% in 1996. The high trapping efficiency of the lake is due, in part, to its long residence time and the presence of a shallow morphometric constriction between the northern and southwestern basins. Model calibration indicated phosphorus sedimentation rates were particularly high resulting in rapid removal of particulate phosphorus from the water column as this material quickly settles to the lake bottom (see Model Calibration). Total nitrogen retention was also high at roughly 55 to 53% for the two water years.

Due to the long residence time, nutrient character of the source waters entering the lake are quite different compared to the outflow. The total and dissolved forms of phosphorus and nitrogen for the two North Fork Payette River stations (inflow and outflow) were concurrently measured and associated loads computed for each water year (Table 5-5). The percentage contribution of dissolved orthophosphorus to total phosphorus of the inflow averaged 22.4 percent and declined to 15.6 percent for the outflow station. Similarly, the percentage contribution of dissolved inorganic nitrogen to total nitrogen averaged 67.1 percent for the inflow station and 34 percent for the outflow station. These declines in the percentage contribution of the dissolved fractions between the inflow and outflow stations is attributable, in part, to phytoplankton and periphyton assimilation and conversion to the particulate nutrient pool of the lake (detrital algae).

Nitrogen and phosphorus was also added to Payette Lake from decomposition of kokanee salmon carcasses remaining from the autumn spawning run into the lower reach of the North Fork Payette River. About 7 kg of phosphorus and 55 kg of nitrogen were added to the lake in 1995 and 1996. These loads were not reported in the nutrient budgets (tables 5-3 and 5-4), but would have been a very small percentage addition. The loads were calculated using two data sources. Data from IDFG on numbers of spawning fish, mean biomass per fish and predation losses (P. Janssen, IDFG, written communication, 1996) were multiplied by the percentage composition of phosphorus and nitrogen in the carcasses. Phosphorus and nitrogen comprised 0.364 and 3.0 percent, respectively, of the biomass of rainbow trout *(Oncorhynchus mykiss)* as reported by Schuldt and Hershey (1995); these values were assumed to apply to kokanee salmon in the North Fork Payette River. Although this load was a small addition to Payette Lake's nutrient budget, it occurs annually and, thus, represents a long term, cumulative nutrient load.

An unquantified nutrient load to Payette Lake was from periphyton in the North Fork Payette River downstream from the USGS gaging station downstream from Fisher Creek (Figure 5-3). This lower most reach of the river supports a substantial amount of periphyton during the summer, partly because this is a quiescent reach affected by backwater from Payette Lake. Backwater conditions were produced by the damming of the lake in the early 1940's. In the autumn and winter, the periphyton become senescent and some portion, in a particulate and dissolved form, is scoured and transported into the lake with streamflow. This nutrient load was not quantifiable, but is probably not large in relation to the lake's nutrient budget. However, it represents another long term nutrient load.

Table 5-4. Total nitrogen budget Payette Lake, 1995-1996.

	1995		1996	
	Load kg/yr	Percent of Total	Load kg/yr	Percent of Total
Gaged Inflows	**Inflow**		**Inflow**	
North Fork Payette River	16,000	64.3	210,000	74.5
Fall Creek	25,960	10.4	13,782	4.9
Deadhorse Creek	4,730	1.9	3,934	1.4
[1] **Ungaged Tributaries**	48,069	19.3	44,631	15.8
[2] **Direct Surface Runoff** Developed and Undeveloped Lake Perimeter	3,532	1.4	2,965	1.1
Atmospheric Deposition	6,560	2.6	6,560	2.3
	Outflow		**Outflow**	
North Fork Payette River	104,000	98.2	149,000	98.3
Municipal withdrawal	1,890	1.8	2,530	2.4
Summary				
Total Inflow	248,851		281,872	
Total Outflow	105,890		151,530	
Change in Lake Storage	4,980		-19,300	
[3] Residual	137,981		149,642	
Percent Retention	55.4		53.1	

[1] Includes runoff contributions from watersheds below USGS gage 13238322 and other tributaries draining directly to the lake.

[2] Load = Area*Rainfall*runoff coefficient*TP concentration. Runoff coefficients based on land types and values as indicated in Tables 4-13 and 4-14. A runoff concentration of 305.7 mg/m3 TN was used for undeveloped lands. Mean pollutant concentrations used for developed lands as described in stormwater section (4.3.1).

[3] (Total inflow-total outflow)-change in lake storage.

Table 5-5. Loads of nitrogen and phosphorus for water years 1995 and 1996 at North Fork Payette River below Fisher Creek (13238322) and North Fork Payette River at McCall (13239000).

		Load (kg/yr)	
Station	Constituent	1995	1996
13238322	TP	2,660	3,640
	DOP	591	820
	TN	160,200	210,200
	TON	52,800	69,300
	DIN	107,400	141,000
	DN+N	106,200	139,400
	DAMM	1,200	1,570
13239000	TP	2,300	2,960
	DOP	356	462
	TN	103,500	148,700
	TON	66,200	101,200
	DIN	37,400	47,500
	DN+N	36,600	46,400
	DAMM	733	973

5.3 Limnology

5.3.1 Water temperature

Solar heating was sufficient to develop thermal stratification and thermoclines (decrease in water temperature with depth exceeds 1 C per meter) at the four stations in both years (Figure 5-1). Thermoclines developed during June and persisted into October. Thermocline depths ranged from about 4 m in June to about 10 m in October. Maximum water temperatures in both years were measured near the surface in late July. In 1995, the maximum was 21.1 C at station 1; in 1996, the maximum was 20.6 C at station 3. Minimum water temperatures reached 0 C immediately beneath the ice that covered the lake surface during the winter months. Hypolimnetic water temperatures ranged from about 4 C during ice cover to between 5 and 6 C near the end of thermal stratification.

5.3.2 Water-column transparency

The two measures of water-column transparency, secchi-disc transparency and euphotic-zone depth, had a strong positive correlation ($r=0.77$, $p<0.00001$, $n=71$). The smallest values for the two variables were measured during June of both years when snowmelt runoff had increased

turbidity in the lake (Figure 5-2). After June, the two variables steadily increased in depth as suspended sediment settled. One exception to this trend was at station 1 during 1996 when both variables either decreased in depth or failed to deepen substantially. Among the four stations, station 1 had the highest density of phytoplankton; thus, its water-column transparency was accordingly reduced.

Median secchi-disc transparencies at the four stations during 1995 were equal to or less than those measured in 1996 (Table 5-6). Median euphotic-zone depths were equivalent between the two years, except at station 3. The euphotic zone was typically deeper than the thermocline at each of the four stations. Under that condition, the phytoplankton circulating within the epilimnion (mixed zone above the thermocline) remain exposed to amounts of PAR sufficient for photosynthetic production of carbon in excess of respiratory demands.

Table 5-6. Medians and ranges of secchi-disc transparency and euphotic-zone depth at four limnetic stations, Payette Lake, 1995-1996.

	Secchi-disc transparency (meters)		Euphotic-zone depth (meters)		
Limnetic station	Median	Range	Median	Range	No. of Samples
1995					
1	4.5	2.5-7	11	9-13	9
2	5.3	2.3-7.2	11	9-13	9
3	4.6	2.5-8	10.5	8-13	8
4	4.2	2.5-6.6	11	8-13	9
1996					
1					
2	4.5	3.5-7	11	10-13	9
3	5.5	3.1-7.6	11	9-13	9
4	5.2	3.6-7.6	11	9-13	9
	5.3	3.5-7.8	11	9-13	9

Figure 5-1. Lines of equal temperature, in degrees celsius, at stations 1-4 during selected months of 1995-1996.

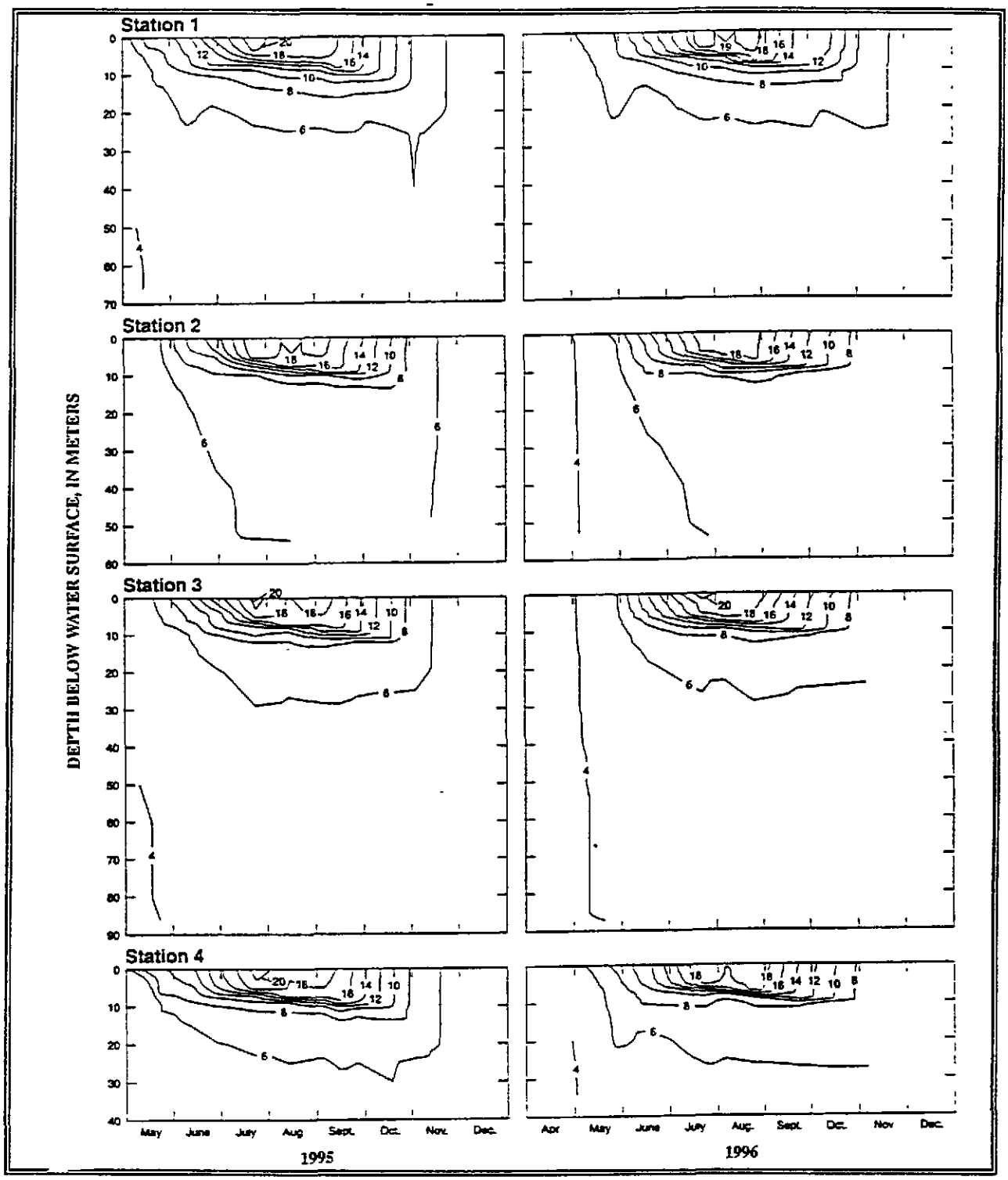
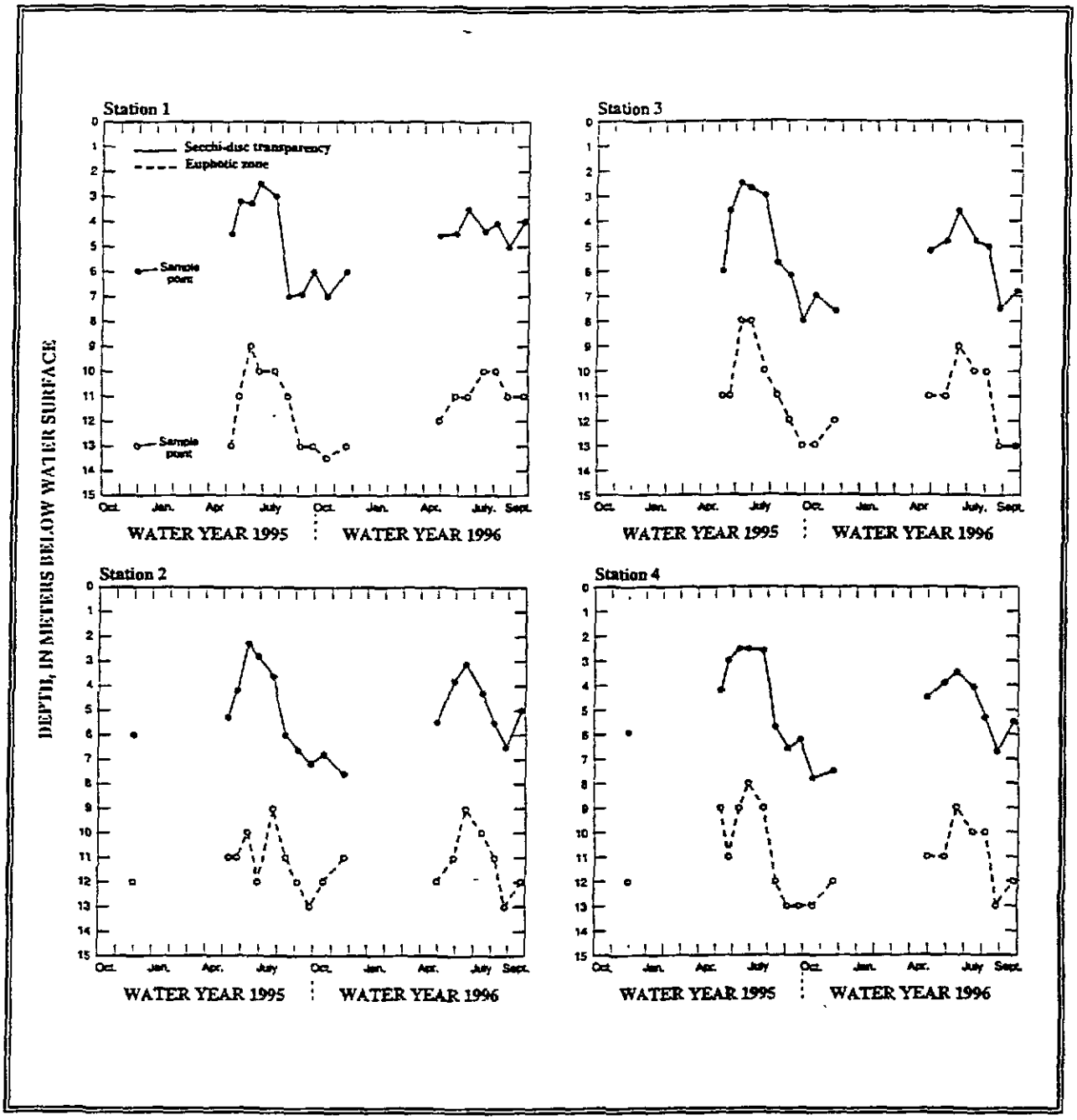


Figure 5-2. Depths of euphotic zone and secchi-disc transparency at stations 1-4 during 1995-1996.



5.3.3 Specific conductance

Specific conductance is a measure of the ability of water to conduct electricity and is typically proportional to the water's dissolved-solids concentration. For most natural waters, the ratio of dissolved-solids concentration to specific conductance ranges from 0.55 to 0.75 (Hem, 1985).

Specific conductance in Payette Lake ranged from 17 to 35 uS/cm; most values were about 20 uS/cm (Brennan and others, 1996, 1997). These values are considered low for natural waters (Hem, 1985). The values above 30 uS/cm were measured in the lower hypolimnion at station 1 in conjunction with anoxic dissolved-oxygen concentrations. The lowest values were measured during June and represented the dilution effects of snowmelt runoff.

5.3.4 pH

The variable pH represents the negative base-10 logarithm of the hydrogen ion activity in moles per liter. In dilute solutions, the overall range in pH can be 0 to 14; values above 7 are considered basic and those below 7 are considered acidic.

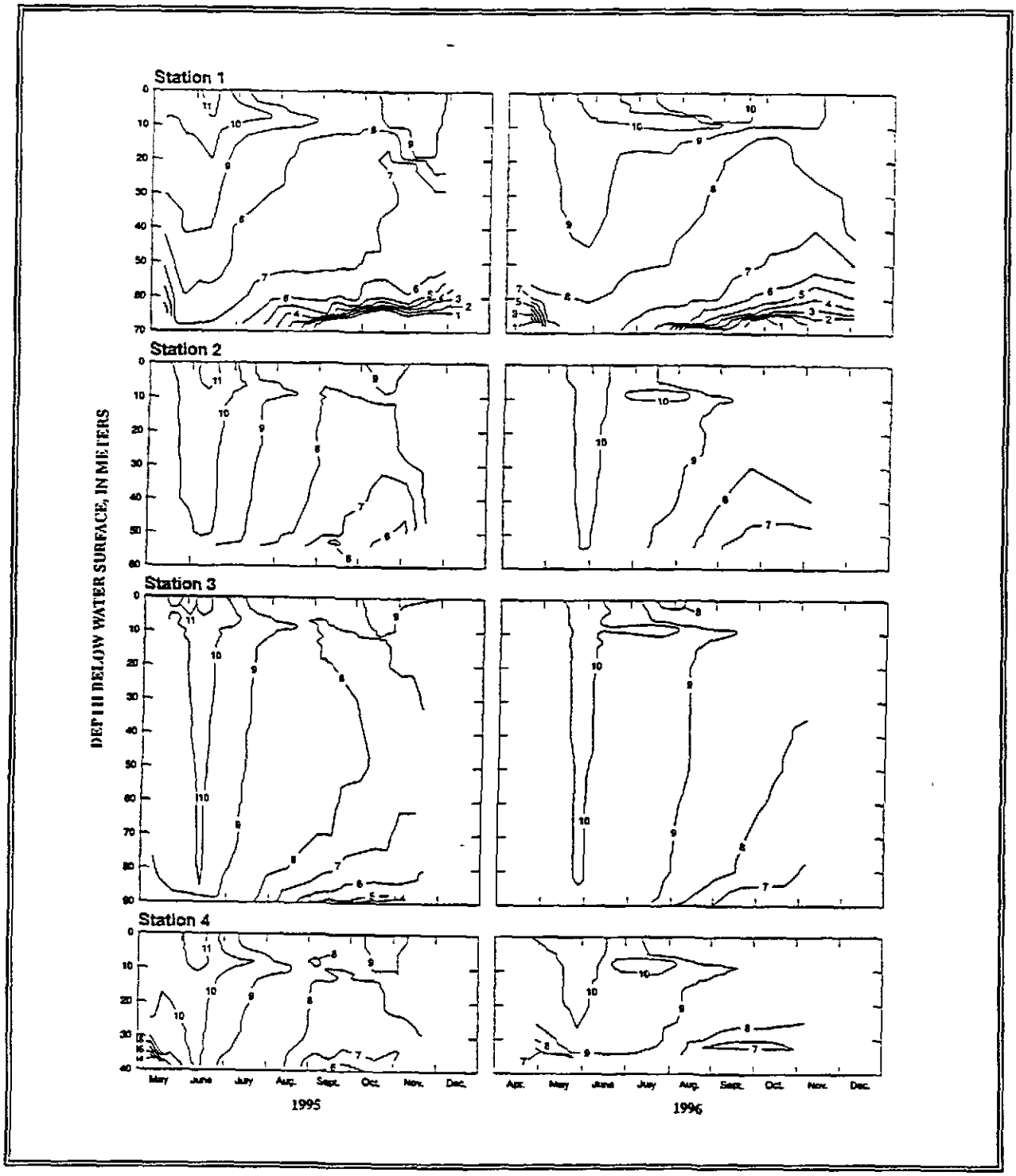
The overall range of pH in the lake was 6.2 to 8.8 (Brennan and others, 1996, 1997). The general trend in pH was larger values in the euphotic zone during July (1995) or August and September (1996) and smaller values in the hypolimnion during late summer and autumn. This overall pattern in pH fits that described for many lakes. In the summer, pH in the euphotic zone increases in response to photosynthetic utilization of carbon dioxide, whereas pH in the hypolimnion decreases as carbon dioxide is added by decomposition of organic matter.

5.3.5 Dissolved oxygen

The concentration of dissolved oxygen in natural freshwater is affected by temperature, barometric pressure, production of oxygen by photosynthesis, consumption of oxygen by respiration and decomposition, and mixing of water masses. The ratio (expressed as a percent) of measured dissolved-oxygen concentrations to those that would exist under saturated conditions at the same temperature and pressure is useful for comparing dissolved oxygen when significant variations in temperature and pressure exist, such as comparisons spanning time or depth.

The overall range in dissolved-oxygen concentration over depth and time at the four stations was 0 to 11.7 mg/L in 1995 and 0 to 11.0 mg/L in 1996 (Figure 5-3). The maximum concentration for each year was measured at station 4; in mid-June of 1995 and in late July of 1996. The anoxic concentrations were measured during both years, but only in the lower hypolimnion at station 1 (See station locations in Figure 3-3 on page 39). The pattern within a year was that maximum dissolved-oxygen concentrations were measured within the epilimnion during the summer when photosynthetic production of oxygen exceeded oxygen consumption by respiration and decomposition; minimum concentrations were measured in the hypolimnion during late summer and autumn when thermal stratification had reduced mixing of the oxygenated epilimnion with the

Figure 5-3. Lines of equal dissolved oxygen concentration, in milligrams per liter, at stations 1-4 during selected months of 1995-1996.



hypolimnion An important feature at station 1 was the lack of full re-aeration of the water column during spring circulation. In both years, dissolved-oxygen concentrations in the hypolimnion were increased to about 7.0 mg/L whereas the other three stations were re-aerated to about 10.0 mg/L.

Stations 1 and 4 had an additional period of low dissolved-oxygen concentrations in the spring, shortly after loss of the lake's ice cover (Figure 5-3). In early May, 1995, both stations had hypolimnetic dissolved-oxygen concentrations as low as 4 mg/L. In mid-April, 1996, station 1 almost developed anoxia in its lower depths. These incidences of dissolved-oxygen minima in the spring indicate that stations 1 and 4 can have a substantial hypolimnetic dissolved-oxygen deficit under winter ice cover. One set of winter samples were collected through the ice cover at stations 1 and 4 on February 21, 1996, about midway through the 4-month period of ice cover. Dissolved-oxygen concentrations in the lower hypolimnion were 6.2 and 5.8 mg/L at stations 1 and 4, respectively. As shown in Figure 6, dissolved-oxygen concentrations in the lower hypolimnion of station 1 continued to decline to 0.5 mg/L in mid-April; dissolved-oxygen concentrations at station 4 did not change much until the lose of ice cover.

The overall range in percent saturation of dissolved oxygen over depth and time at the four stations was 0 to 129 percent in 1995 and 0 to 122 percent in 1996 (Figure 5-4). The maximum percentage for each year was measured at station 4 in mid-June of 1995 and at station 1 in late July of 1996. The zero percents were measured in the lower hypolimnion of station 1 during the late summer and autumn of both years. Saturation greater than 100 percent (supersaturation) was measured in the euphotic zone of each station. During 1995, supersaturation began in May at stations 1 and 4 and in June at stations 2 and 3 and extended into October at the four stations. During 1996, the period of supersaturation at station 1 was comparable to 1995; however, the other three stations became supersaturated in June and ended supersaturation either in September (stations 2 and 3) or in August (station 4).

Depletion of dissolved oxygen within the hypolimnion of a stratified lake is an important symptom of eutrophication because it reflects the decay of organic matter produced within the euphotic zone or input to the lake by terrestrial sources. Dissolved oxygen was depleted in the hypolimnia of Payette Lake's four stations during both years; however, only station 1 developed anoxic dissolved-oxygen concentrations. Accordingly, an areal hypolimnetic oxygen depletion rate (AHOD) was calculated for station 1 for each year. AHOD, in milligrams per square meter per day, is defined as the rate of decrease of dissolved oxygen mass in the hypolimnion divided by the surface area of the hypolimnion. If AHOD is divided by the mean depth of the hypolimnion, one obtains the volumetric hypolimnetic oxygen depletion rate (VHOD), which is the rate of decrease of the volume-weighted-average dissolved-oxygen concentration in the hypolimnion. AHOD and VHOD were calculated for Payette Lake's station 1 for both years using procedures in Walker (1996). The calculated values represent the period from initial thermal stratification to the onset of anoxia in the hypolimnion. For 1995, this period was from June 12 to September 5; for 1996, it was from June 18 to September 24. The AHOD and VHOD for 1995 were 756 $mg/m^2/day$ and 24.9 mg/m3/day, respectively. These values were somewhat smaller in 1996; AHOD was 451 mg/m2/day and VHOD was 14.8 mg/m3/day.

Hutchinson (1957) used AHOD to define limits for oligotrophic and eutrophic lakes: if AHOD is less than 250 mg/m2/day, the lake is considered oligotrophic; if AHOD is more than 550 mg/m2/day, the lake is considered eutrophic. On the basis of these limits, Payette Lake would be considered eutrophic in 1995 and bordering on eutrophic in 1996. The 1981 study of Payette Lake (Falter and Mitchell, 1981) reported an AHOD for the west basin (station 1, this study) of 300 mg/m2/day; this result places the lake slightly above the threshold for oligotrophic but well below that for eutrophic.

5.3.6 Phosphorus

Phosphorus is one of several essential nutrients in the metabolism of aquatic plants. Eutrophication research has focused heavily on phosphorus because it is the nutrient typically found to have the smallest supply-to-demand ratio for aquatic plant growth. Phosphorus concentrations for this study are reported as total phosphorus and dissolved orthophosphorus, as phosphorus. Total phosphorus represents the phosphorus in solution and contained in or attached to biotic and abiotic particulate material. Dissolved orthophosphorus is determined from the filtrate that passes through a filter with a nominal pore size of 0.45 um. The orthophosphate ion is the most important form of phosphorus because it is directly available for metabolic use by aquatic plants.

Median concentrations of total phosphorus at the four stations ranged from 4 to 6.5 ug/L in the euphotic zone and from 4 to 8.5 ug/L in the lower hypolimnion; the largest median concentrations were at station 1 in 1996 (Table 5-7). Median concentrations of total phosphorus in the euphotic zone and lower hypolimnion were slightly larger in 1996, except at station 4. The median concentrations of dissolved orthophosphorus were 0.5 ug/L in the euphotic zone at the four stations; the medians for the lower hypolimnion samples ranged from 0.5 to 1 ug/L (Table 5-7).

Total phosphorus concentrations at the four stations ranged from 0.5 to 65 ug/L during 1995 and from 0.5 to 52 ug/L during 1996, whereas dissolved orthophosphorus concentrations ranged from 0.5 to 14 ug/L during 1995 and from 0.5 to 23 ug/L during 1996 (Figure 5-5). The largest concentrations of both constituents were measured in the hypolimnion of station 1 from September through November, 1995 when near-bottom water had become anoxic. Under anoxic conditions, constituents such as phosphorus, ammonia, iron, and manganese in the lakebed sediments are solubilized and released into the hypolimnion (Stumm and Morgan, 1970).

Phytoplanktonic uptake of dissolved orthophosphorus in the euphotic zone during the summer growing season can sometimes be discerned by distinct declines in that constituent and concomitant increases in total phosphorus as the phytoplankton population converts dissolved orthophosphorus into particulate phosphorus. Such a relationship was not evident in Payette Lake, on the basis of the temporal patterns illustrated in Figure 5-5. The relationship may have been masked by the very low concentrations of dissolved orthophosphorus typically measured in Payette Lake's euphotic zones.

Figure 5-4. Lines of equal dissolved oxygen, as percent saturation, at stations 1-4 during selected months of 1995-1996.

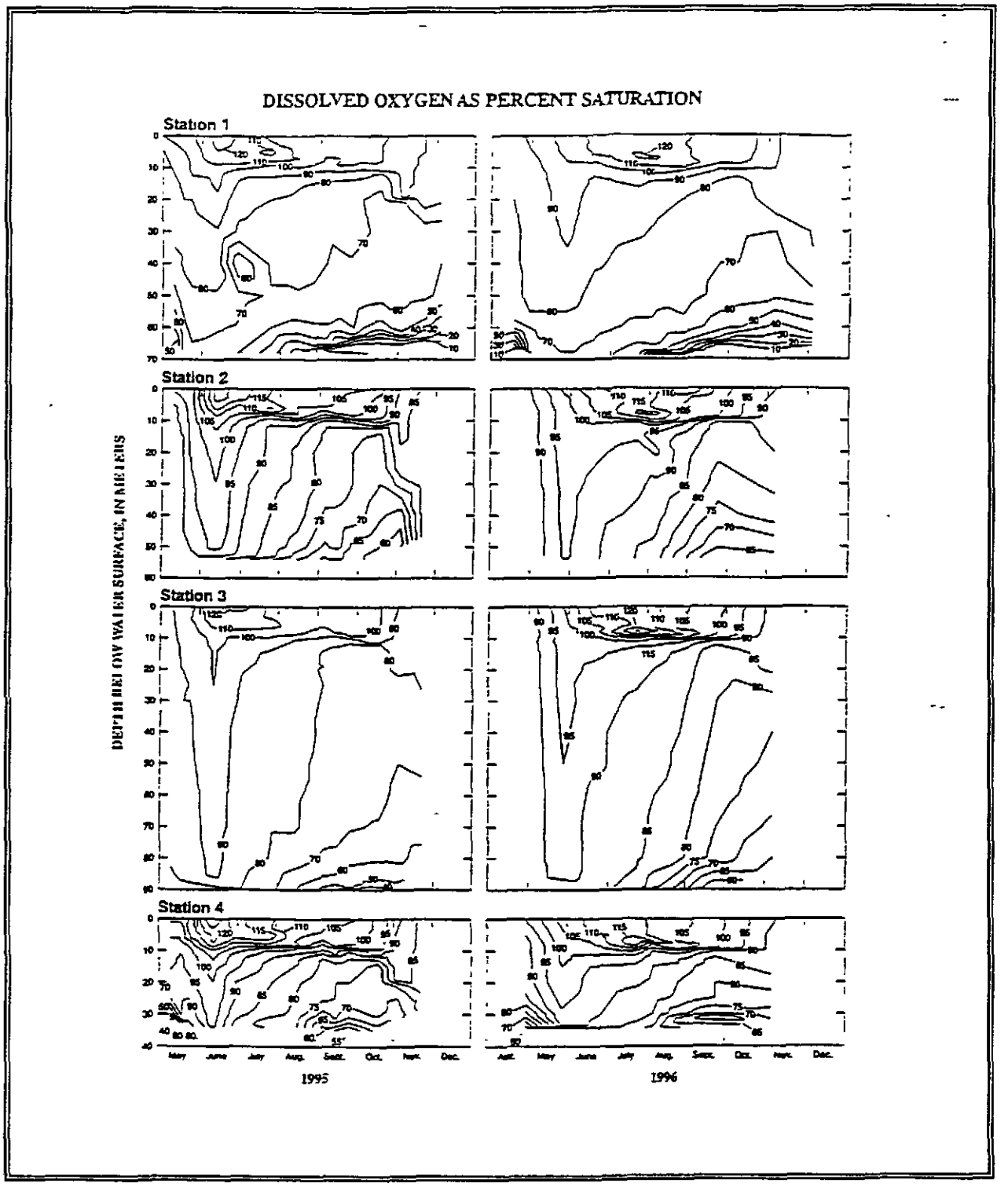


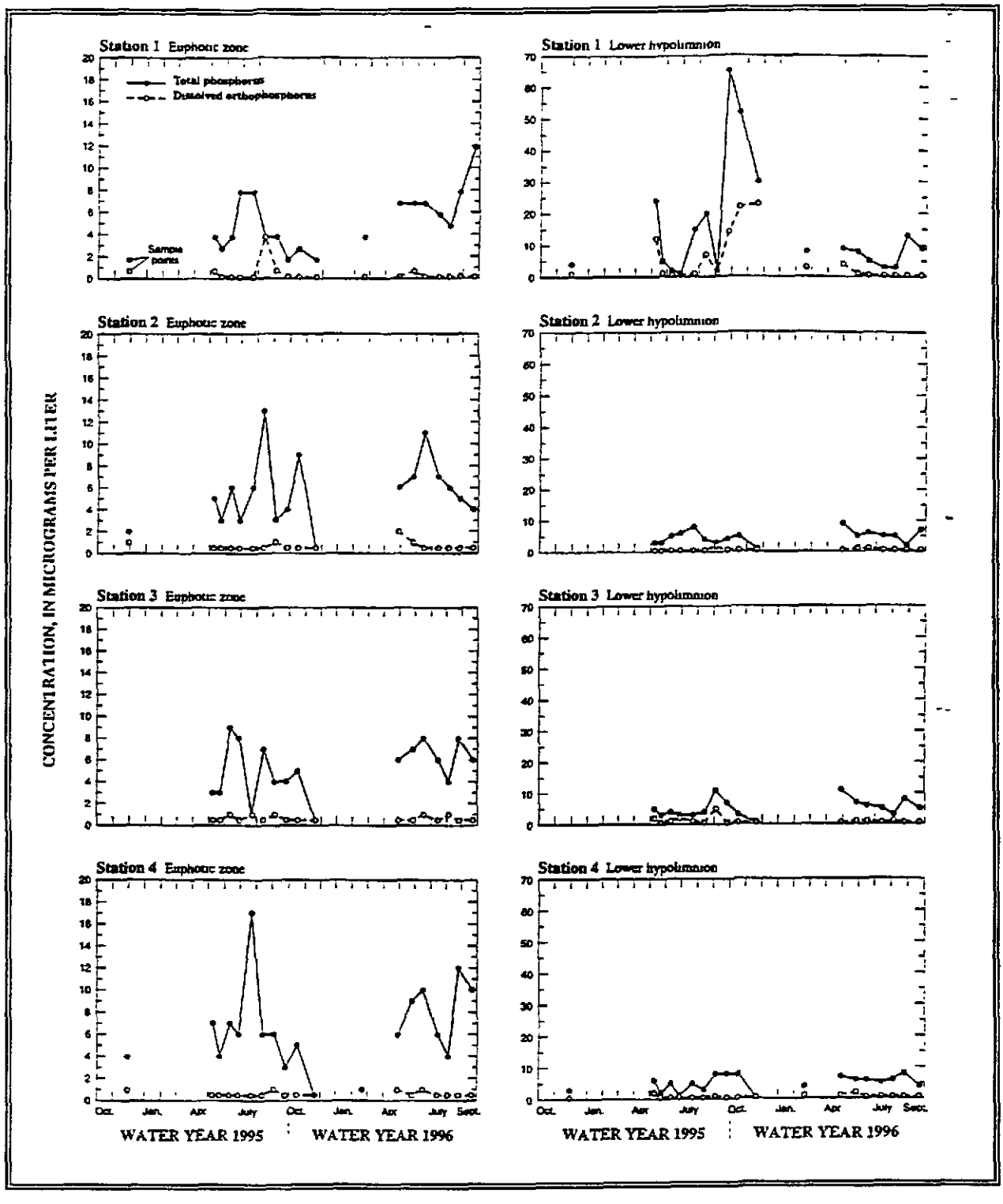
Table 5-7. Medians of total phosphorus and dissolved orthophosphorus from the euphotic zone and lower hypolimnion at four limnetic stations, Payette Lake, 1995 - 1996.

	Total phosphorus (μg/L)				Dissolved orthophosphorus (μg/L)			
Limnetic station	Euphotic Zone		Lower Hypolimnion		Euphotic Zone		Lower Hypolimnion	
	Median	n	Median	n	Median	n	Median	n
1995								
1	4	9	5	9	0.5	9	1	9
2	4	9	4	8	.5	9	.5	8
3	4	8	4	8	.5	8	1	8
4	6	9	5	9	.5	9	.5	9
1996								
1	6.5	10	8.5	10	.5	10	.8	10
2	6	9	5	9	.5	9	.5	9
3	6	9	5	9	.5	9	.5	9
4	6	10	6	10	.5	10	.5	10

5.3.7 Nitrogen

Nitrogen, like phosphorus, is essential to the metabolism of aquatic plants. The supply-to-demand ratio for nitrogen is small and, thus, nitrogen may limit the growth of aquatic plants as phosphorus does. The nitrogen cycle in aquatic ecosystems is complex because most processes involving nitrogen are biologically mediated. In aquatic ecosystems, nitrogen commonly exist in the following forms: dissolved molecular nitrogen, nitrogen-containing organic compounds, ammonia, ammonium, nitrite, and nitrate. Nitrogen concentrations for this study were analyzed as total ammonia plus organic nitrogen (commonly called Kjeldahl nitrogen), dissolved ammonia, and dissolved nitrite plus nitrate, as nitrogen. Total ammonia plus organic nitrogen represents the ammonia (includes ammonium) and organic nitrogen compounds in solution and associated with biotic and abiotic particulate material. The dissolved concentrations represent the ammonia (includes ammonium) or nitrite plus nitrate in filtrate that passes through a 0.45-um filter. The following discussion is for total nitrogen (the sum of total ammonia plus organic nitrogen and dissolved nitrite plus nitrate) and dissolved inorganic nitrogen (the sum of dissolved ammonia and dissolved nitrite plus nitrate).

Figure 5-5. Concentrations of total phosphorus and dissolved orthophosphorus in the euphotic zone and lower hypolimnion at stations 1-4 during 1995 - 1996.



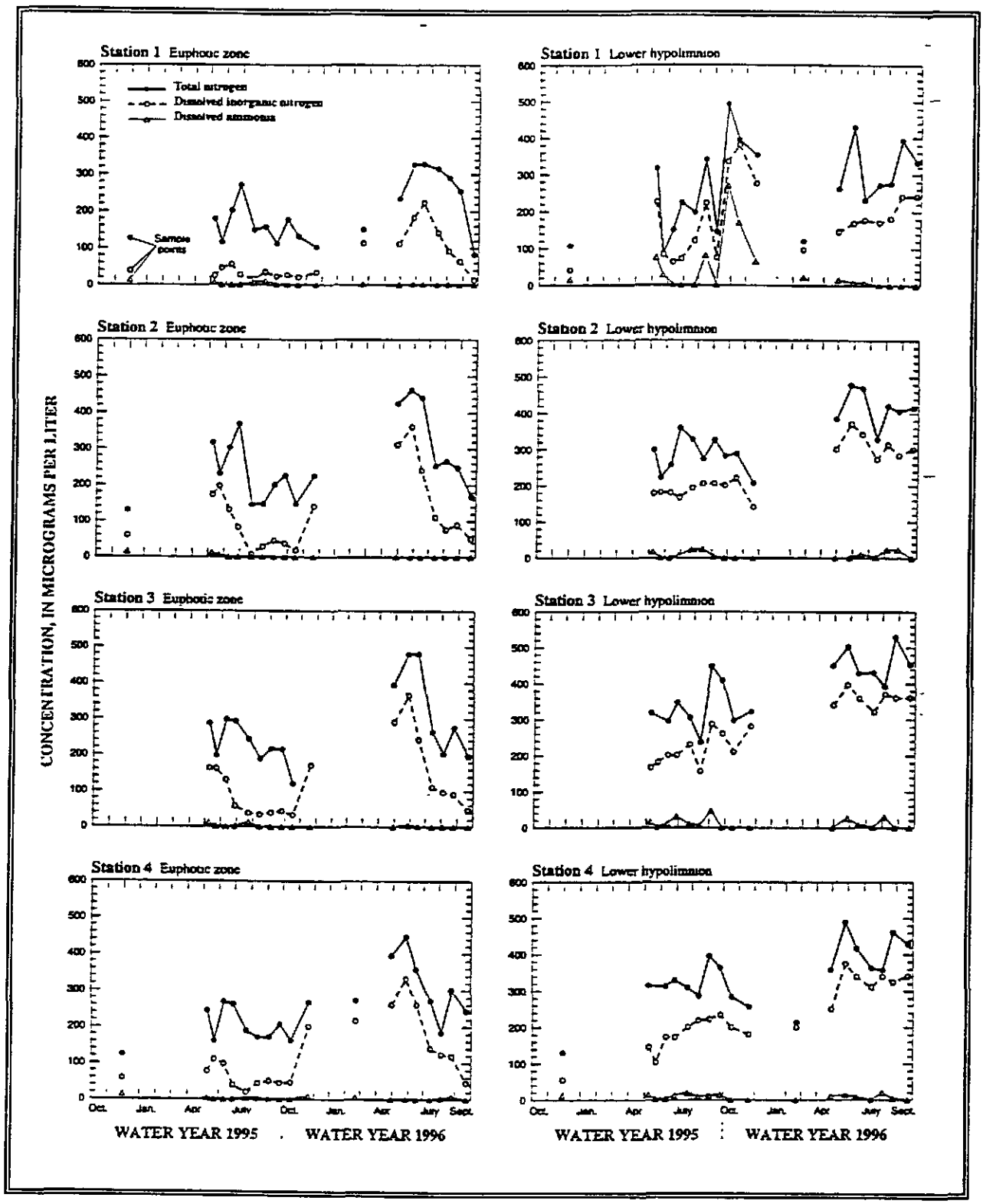
Median concentrations of total nitrogen at the four stations ranged from 158 to 272 ug/L in the euphotic zone and from 197 to 431 ug/L in the lower hypolimnion; 1996 medians were distinctly larger than those in 1995 (Table 5-8). Median concentrations of dissolved inorganic nitrogen at the four stations ranged from 28 to 170 ug/L in the euphotic zone and from 84 to 360 ug/L in the lower hypolimnion; as with total nitrogen, 1996 medians were larger than 1995 medians (table 8). The larger median concentrations of nitrogen measured in 1996 were attributable to the larger nitrogen loads delivered to the lake in 1996.

Table 5-8. Medians of total nitrogen and dissolved inorganic nitrogen from the euphotic zone and lower hypolimnion at four limnetic stations, Payette Lake, 1995-1996.

	Total nitrogen (μg/L)				Dissolved inorganic nitrogen (μg/L)			
Limnetic station	Euphotic Zone		Lower Hypolimnion		Euphotic Zone		Lower Hypolimnion	
	Median	n	Median	n	Median	n	Median	n
1995								
1	158	9	197	9	28	9	84	9
2	226	9	290	8	60	9	188	8
3	230	8	319	7	51	8	202	8
4	188	9	315	8	51	9	174	9
1996								
1	244	10	304	10	102	10	180	10
2	253	9	406	9	111	9	301	9
3	270	8	431	9	111	9	360	9
4	272	10	361	10	170	10	318	10

Total nitrogen concentrations at the four stations ranged from 86 to 493 ug/L during 1995 and from 83 to 529 ug/L during 1996 (Figure 5-6). Dissolved inorganic nitrogen concentrations at the four stations ranged from 7 to 335 ug/L during 1995 and from 13 to 397 ug/L during 1996 (Figure 5-6). Lower-hypolimnion concentrations of total nitrogen and dissolved inorganic nitrogen were larger than those in the euphotic zone. The increased hypolimnetic concentrations of the two constituents reflect the settling and decomposition of organic matter from the euphotic zone into the hypolimnion. The increase in dissolved inorganic nitrogen concentrations is also indicative of nitrification in the hypolimnion, whereby, under aerobic conditions, organic and ammonia nitrogen is converted to nitrite and then nitrate. The large increase in ammonia in the lower hypolimnion of station 1 during September and October of 1995 (Figure 5-6) reflects the release of ammonia from lakebed sediments when the hypolimnion became anoxic.

Figure 5-6. Concentrations of total nitrogen, dissolved inorganic nitrogen, and dissolved ammonia in the euphotic zone and lower hypolimnion at stations 1-4 during 1995-1996.



5.3.8 Limiting nutrient

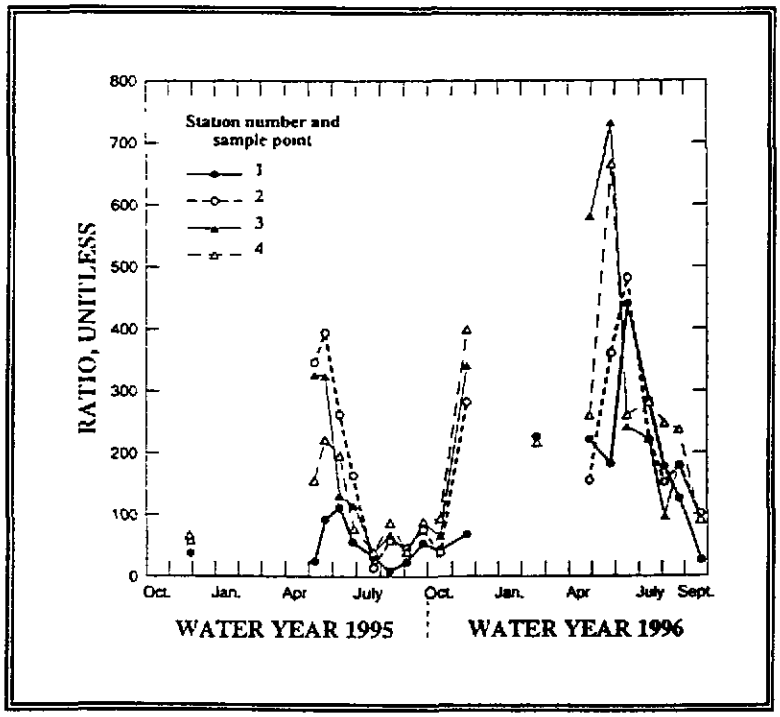
The limiting nutrient concept of Liebig, in concert with the stoichiometry of the photosynthesis equation, led to formulation of nitrogen-to-phosphorus ratios (N:P). These ratios have been used extensively in eutrophication studies to determine whether nitrogen or phosphorus was most likely to limit phytoplankton growth. The atomic ratio of nitrogen to phosphorus, 16N:1P, in the photosynthesis equation corresponds to a mass ratio of 7.2N:1P. Typically, N:P values are calculated using the biologically available forms of these two nutrients, dissolved inorganic nitrogen and dissolved orthophosphorus. If N:P (by weight) is less than 7.2, then nitrogen may be limiting, whereas if N:P exceeds 7.2, then phosphorus may be limiting (Ryding and Rast, 1989).

The N:P values in Table 5-9 and Figure 5-7 indicate a very strong tendency towards phosphorus limitation of phytoplankton growth in Payette Lake. The lowest ratio, 8.8, still exceeded the threshold of 7.2. The median ratios for 1996 were higher than those for 1995. This difference resulted from the higher concentrations of dissolved inorganic nitrogen measured in 1996 because dissolved orthophosphorus concentrations were nearly equal between the two years.

Table 5-9. Medians and ranges of ratios of dissolved inorganic nitrogen to dissolved orthophosphorus in samples from the euphotic zone at four limnetic stations, Payette Lake, 1995-1996.

	Ratio		
Limnetic station	Median	Range	No. of samples
1995			
1	38	8.8-112	9
2	76	14-394	9
3	102	38-326	8
4	88	40-222	9
1996			
1	180	26-440	10
2	180	38-480	9
3	222	66-732	9
4	254	92-666	10

Figure 5-7. Dissolved inorganic nitrogen to dissolved orthophosphorus ratio at stations 1-4 during 1995-1996.



5.3.9 Chlorophyll-a

Chlorophyll-a is the primary photosynthetic pigment of phytoplankton and, as such, is used as an estimator of phytoplanktonic biomass. Median concentrations of chlorophyll-a at Payette Lake's four stations ranged from 1.6 to 2.4 ug/L during 1995 and from 0.8 to 1.3 ug/L during 1996 (Table 5-10). The 1995 median was highest at station 4, whereas the 1996 median was highest at station 1. The overall range in concentrations was from 0.2 to 5.2 ug/L with the largest concentration at station 1 in 1995 (table 10). Chlorophyll-a concentrations at the four stations had a distinct peak during June of 1995; temporal variation was more muted during 1996 (Figure 5-8).

5.3.10 Phytoplankton

Phytoplankton collected at the four stations during 1995-96 comprised five phyla (Chlorophyta, or green algae; Chrysophyta, or yellow-brown algae; Cryptophyta, or crytomonads; Cyanophyta, or blue-green algae; and Pyrrhophyta, or dinoflagellates), 44 genera, and 67 species (Table 5-11). The taxonomic composition was strongly dominated by the subphylum Bacillariophyceae, or diatoms. The Cyanophyta, represented by Anacystis marina and Chroococcus minimus, were a very minor component.

Lakewide, median density and biovolume for the 64 samples was 663 cells/ml and 384,000 um^3/ml, respectively. Among the four stations, median biovolume was highest at station 1 in both years (Table 5-10). Biovolume peaked in July of both years; only station 1 had a substantial secondary peak in the autumn of both years (Figure 5-9). Biovolume was dominated by one diatom, Tabellaria fenestrata, which, on average, contributed 52 percent of the lakewide biovolume.

Table 5-10. Medians and ranges of chlorophyll-a concentrations and phytoplankton biovolumes in samples from the euphotic zone at four limnetic stations, Payette Lake, 1995-1996.

Limnetic station	Chlorophyll-a concentration (μg/L)			Phytoplankton biovolume (μm^3/ml)		
	Median	Range	n	Median	Range	n
1995						
1	2.2	0.7-5.2	8	962,000	70,000-2,770,000	7
2	1.6	1.0-3.4	8	426,000	189,000-2,520,000	7
3	1.6	.7-5	8	420,000	97,100-2,820,000	7
4	2.4	.7-5	8	774,000	109,000-2,840,000	7
1996						
1	1.3	.5-2.1	10	556,000	313,000-1,890,000	9
2	1.0	.2-1.8	9	184,000	88,200-923,000	9
3	1.1	.3-1.5	8	189,000	81,900-1,700,000	9
4	.8	.3-1.3	10	230,000	76,600-2,340,000	9

Figure 5-8. Chlorophyll-a concentrations at stations 1-4 during 1995-1996.

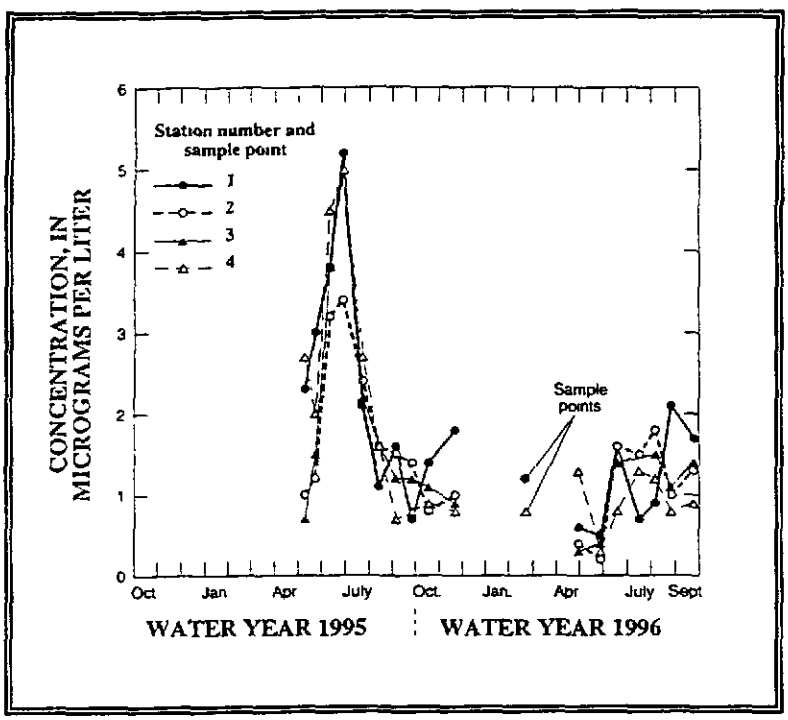
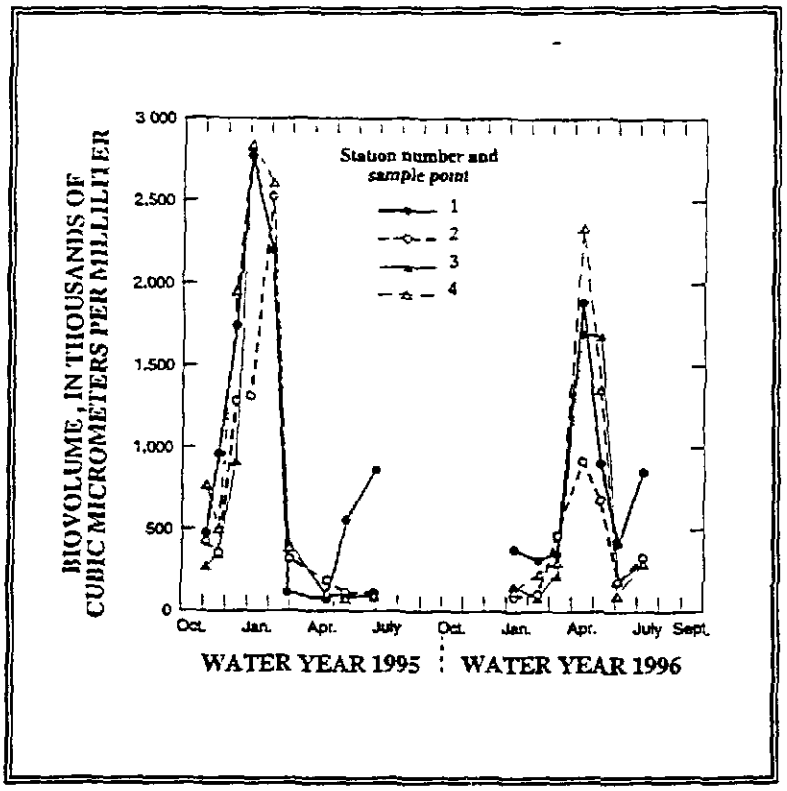


Table 5-11. Phytoplankton taxa at four limnetic stations, Payette Lake, 1995-1996.

Phytoplankton taxa[1]	Phytoplankton taxa[1]	Phytoplankton taxa[1]
Phylum Chlorophyta	Family Achnanthaceae (Continued)	Family Chromulinaceae (Continued)
Subphylum Chlorophyceae	*A. lanceolata*	*Kephyrion* sp.
Order Chlorococcales	*A. linearis*	*K. littorale*
Family Chlorococcaceae	*A. minutissima*	*K. spirale*
Tetraedron minimum	*Cocconeis placentula*	Family Chrysococcaceae
Family Coccomyxaceae	Family Cymbellaceae	*Chrysococcus rufescens*
Elakatothrix gelatinosa	*Cymbella affinis*	Family Pedinellaceae
Family Dictyosphaeriaceae	*C. minuta*	*Pseudopedinella* sp.
Botryococcus braunii	Family Fragilariaceae	Order Ochromonadales
Family Oocystaceae	*Asterionella formosa*	Family Dinobryaceae
Ankistrodesmus falcatus	*Diatoma hiemale* var. *mesodon*	*Dinobryon sertularia*
Oocystis lacustris	*Fragilaria construens*	Family Ochromonadaceae
O. pusilla	*F. construens* var. *venter*	*Ochromonas* sp.
Quadrigula closterioides	*F. crotonensis*	Family Synuraceae
Family Palmellaceae	*F. pinnata*	*Mallomonas* sp.
Sphaerocystis schroeteri	*Hannaea arcus*	Order Prymnesiales
Family Scenedesmaceae	*Synedra radians*	Family Prymnesiaceae
Crucigenia quadrata	*S. rumpens*	*Chrysochromulina* sp
Scenedesmus quadricauda	*Tabellaria fenestrata*	Phylum Cryptophyta
Order Volvocales	*T. flocculosa*	Family Cryptochrysidaceae
Family Chlamydomonadaceae	Family Gomphonemaceae	*Rhodomonas minuta*
Chlamydomonas sp.	*Gomphonema angustatum*	Family Cryptomonadaceae
Order Zygnematales	Family Naviculaceae	*Cryptomonas erosa*
Family Desmidiaceae	*Anomoneis serians*	Phylum Cyanophyta
Cosmarium sp.	*A. vitrea*	Order Chroococcales
Desmidium sp.	*Navicula* sp.	Family Chroococcaceae
Phylum Chrysophyta	*N. cryptocephala* var. *veneta*	*Anacystis marina*
Subphylum Bacillariophyceae	*N. decussis*	*Chroococcus minimus*
Order Centrales	*N minima*	Phylum Pyrrhophyta
Family Coscinodiscaceae	*N. minuscula*	Class Dinophyceae
Cyclotella sp.	*N. pseudoscutiformis*	Order Dinokontae
C. comta	*Nitzschia affine*	Family Ceratiaceae
C. stelligera	Family Nitzschiaceae	*Ceratium hirundinella*
Melosira ambigua	*Nitzschia frustulum*	Family Glenodiniaceae
M. distans	*N. linearis*	*Glenodinium* sp.
M. excurrens	*N. paleacea*	Family Gymnodiniaceae
Order Pennales	Subphylum Chrysophyceae	*Gymnodinium* sp.
Family Achnanthaceae	Order Chromulinales	Family Peridiniaceae
Achnanthes sp.	Family Chromulinaceae	*Peridinium cinctum*
A. hauckiana	*Chromulina* sp	

[1]Taxonomy based on Prescott (1970).

Figure 5-9. Phytoplankton biovolume at stations 1-4 during 1995-1996



5.3.11 Trophic state

The biological productivity, or trophic state, of a lake is commonly categorized into one of three trophic states: oligotrophic, or low productivity; eutrophic, or high productivity; and mesotrophic, or moderate productivity. Numerous variables have been used as the basis for trophic-state classification; some of the most frequently encountered are total phosphorus, total nitrogen, chlorophyll-a, and secchi-disc transparency. These four variables were used by Ryding and Rast (1989) to develop an open-boundary trophic-state classification system which compensates for the overlap in classification that commonly occurs with a fixed-boundary system. Under the open-boundary system, a lake is considered correctly classified if three of the four classification variables are within two standard deviations of their geometric mean for the same trophic state.

Annual geometric means for euphotic-zone values of total phosphorus, total nitrogen, chlorophyll-a, and secchi-disc transparency were computed for Payette Lake for comparison to the open-boundary trophic-state classification system (Table 5-12). The lake was classified as oligotrophic in both years on the basis of total phosphorus, total nitrogen, and chlorophyll-a. On the basis of secchi-disc transparency, the lake was mesotrophic in both years.

Three earlier studies also classified the trophic state of Payette Lake. During the late 1970's, the lake was classified as oligotrophic on the basis of chemical and biological variables (Idaho Department of Health, 1970). The National Eutrophication Survey of 1975 classified the lake as early mesotrophic (U.S. Environmental Protection Agency, 1977). Falter (1984) used areal phosphorus loading as his basis for classifying the lake as mesotrophic in the early 1980's. These three studies indicate an increasing trend in trophic state; however, the trend may be misleading because the basis for trophic-state classification was not consistent among the three studies.

Table 5-12. Trophic state of Payette Lake during 1995-1996 based on annual geometric mean values for four limnological variables.

Limnological Variable	Statistic[1]	Open-boundary trophic state classification[2] 0	M	E	Payette Lake[3] 1995	1996	1995-96
Total phosphorus (μg/L)	χ	8.0	26.7	84.4	4.5	4.9	4.7
	χ ±1 SD	4.8-13.3	14.5-49.0	48.0-189.0	2.0-6.8	0.9-8.9	1.4-8.0
Total nitrogen (μg/L)	χ	661	753	1,875			
	χ ±1 SD	371-1,180	485-1,170	861-4,081	199	252	225
					137-261	141-363	135-315
Chlorophyll-a (μg/L)	χ	1.7	4.7	14.3			
	χ ±1 SD	0.8-3.4	3.0-7.4	6.7-31.0			
					1.9	0.9	1.3
	χ				0.8-3.0	0.4-1.4	0.4-2.2
	χ ±1 SD	9.9	4.2	2.4			
Secchi-disc transparency (m)		5.9-16.5	2.4-7.4	1.5-4.0			
					4.3	5.2	4.7
					2.6-6.0	3.8-6.6	3.1-6.3

[1] Annual geometric mean and plus or minus one standard deviation.
[2] Modified from Ryding and Rast (1989).
[3] Annual geometric mean of euphotic-zone values.

5.3.12 Sediment nutrients

The lakebed sediments at the four stations had the following ranges for concentrations of total phosphorus and total nitrogen: 1,400 to 4,800 mg/kg and 720 to 920 mg/kg, respectively (Table 5-13). Station 1 had the highest concentration of total phosphorus, whereas station 4 had the highest for total nitrogen.

Table 5-13. Concentrations of total phosphorus and total nitrogen in lakebed sediments at four limnetic stations, Payette Lake, July 1996.

		Concentrations (Mg/kg)	
Limnetic station	Water depth (m)	Total phosphorus	Total nitrogen
1	68	4,800	720
2	55	1,400	910
3	90	1,900	740
4	34	1,400	920

Guidelines have been published for assessing the potential effects on benthic organisms of trace elements and nutrients in aquatic sediments (Persaud and others, 1993). The guidelines include three levels of effect: no effect, lowest effect, and severe effect. The lowest effect level signifies sediment contamination that can be tolerated by most benthic organisms whereas the severe effect level signifies polluted sediment that will significantly affect benthic organisms. For total phosphorus, the lowest and severe effect levels are 600 and 2,000 mg/kg, respectively. For total nitrogen, the lowest and severe effect levels are 550 and 4,800 mg/kg, respectively. The severe effect level for total phosphorus was clearly exceeded by station 1 and nearly met by station 3; total nitrogen concentrations at the four stations were well below the severe effect level (Table 5-13).

5.4 Littoral Zone

5.4.1 Periphyton production

Periphyton production in the littoral zone of Payette Lake was assessed to determine whether a statistical relation existed between periphyton production and various indices of nearshore development. The indices for each littoral station included housing density, percentage of lawn area, relative age of development, relative level of disturbance of natural soils and vegetation, and lake subbasin. The hypothesis was that stations with little or no disturbance of natural conditions would have low levels of periphyton production, whereas increased levels of disturbance would produce increased nutrient loads which would stimulate periphyton production.

Median periphyton production, as chlorophyll-a, at the 19 (one station was lost) littoral stations ranged from 0.38 (station 12) to 12.9 (station 22) mg/m^2, a difference of 33.9 times (Table 5-14). When normalized to PAR input, the median production ranged from 0.0007 (station 12) to 0.02 (station 22) $(mg/m^2)/E$, a difference of 28.6 times. For both comparisons, production was lowest at station 12 and highest at station 22. The nearshore development at station 12 included a very large home surrounded by an extensive lawn area. At station 22, new construction of several large homes had disturbed the majority of the soil and vegetative cover. This station is also at the former site of a lumber mill. On the basis of ranks, PAR-normalized periphyton production at stations 10, 11, and 15 was some of the lowest in the lake even though these three stations had substantial nearshore development. Conversely, stations 1, 2, and 4, all undisturbed, had some of the highest periphyton production.

Multiple linear regression (Helsel and Hirsch, 1992) was used to investigate the relation between PAR-normalized periphyton production and the five indices of nearshore development. Periphyton production was normalized with PAR to remove its influence from the predictive equation. Scatterplots and a correlation matrix indicated little, if any, relationship between PAR-normalized periphyton production and any of the indices of nearshore development. This observation was confirmed with the regression analyses. When the five indices were included in the model they explained 41-percent of the variation in the dependent variable; however the p-value for the F statistic was 0.175, indicative of no relationship. Of the five partial-regression coefficients, only relative level of disturbance was significant, with a p-value of 0.033.

Table 5-14. Periphyton production, as chlorophyll-a, at 19 littoral stations, Payette Lake, July-August 1996.

			Periphyton production normalized to PAR	
Littoral station	PAR input (E)[1]	Periphyton production (mg/m^2)[2]	[(mg/m^2)/E][2]	Rank[3]
1	637	1.01	0.0016	10
2	516	1.12	.0022	15
4	560	.97	.0017	12
6	546	.94	.0017	12
8	597	1.07	.0018	14
9	695	.84	.0012	7
10	559	.42	.0008	3.5
11	617	.52	.0008	3.5
12	552	.38	.0007	1
13	602	1.37	.0023	16
14	548	.66	.0012	6
15	560	.51	.0009	2
16	662	.63	.0010	5
17	653	.94	.0014	8
18	653	1.10	.0017	12
19	640	2.15	.0034	17
21	609	.88	.0014	9
22	647	12.9	.020	19
23	559	2.71	.0048	18

[1] Quantity of photon flux, as Einsteins (1 E = 1 mole of photons), input to periphyton during incubation period. [2] Median of three values. [3] Low production to high production.

The absence of a strong relationship between periphyton production and selected indices of nearshore development at Payette Lake was similar to results of a recent study at Priest Lake reported by Rothrock and Mosier (1996). Periphyton production, as chlorophyll-a, was measured on natural substrates at 21 nearshore locations during the summers of 1994-95 in Priest Lake, a 95-km2, oligotrophic lake in northern Idaho. Periphyton production in Priest Lake had no strong relationship with any of the following variables: site aspect, bank slope, fetch distance, developed versus undeveloped nearshore, and interstitial nutrient concentrations.

Boat Docks

The water quality impacts from the nearshore areas of Big Payette Lake also include boat docks. In discussions of the water quality impacts of boat docks, both existing and proposed, the emphasis usually centers on issues such as additional boat traffic, disturbances of soil (terrestrial and lakebed) during construction, encroachment into the nearshore zone of the lake, and dumping of trash. Another issue that has been neglected, but may be very relevant to Big Payette Lake, is the additional surface area of the piling and dock surfaces (those in contact with the lake water) that now grow periphyton. In the shallow, well lighted nearshore zone where docks are built, light conditions are optimal for periphyton growth. Docks tend to be built in developed areas where additional supplies of nutrients are available via urban runoff, lawn fertilizers, and septic system leachates. During the summer, additional growth of periphyton on docks may be regarded as a nuisance, but unless it is excessive, does not cause much concern. However, the water quality problem is more related to the demise of the periphyton during the fall and early winter when cold temperatures and reduced light levels cause it to die and slough off the docks. As the dead periphyton decomposes, either while settling through the water column or on the lakebed, it consumes oxygen and eventually releases the algal nutrients carbon, nitrogen and phosphorus. These nutrients may be incorporated into the lakebed sediments of the nearshore zone or currents may carry them to deeper areas of the lake. The hypolimnetic dissolved oxygen depletion within the southwest basin of Big Payette Lake is caused by an excessive oxygen demand which is fueled by the influx of organic matter undergoing decomposition. The influx is from various sources, both terrestrial and aquatic. The relative contribution of these sources is not quantifiable with the present data base. However, some portion of that influx is from the decay of periphyton from docks around the lake.

5.4.2 Aquatic macrophytes

Payette Lake contained nine genera of aquatic macrophytes on the basis of sampling at 19 littoral stations (Table 5-15). Isoetes lacustris and Myriophyllum spicatum var. exalbescens occurred most frequently, being found at 16 and 13 of the stations, respectively. Nitella sp. and Ranunculus aquatilis were each found at 8 of the stations. Chara sp. was found only at station 14. Diversity was highest at stations 11, 16, and 17, which had five genera, and lowest at station 15, which was devoid of aquatic macrophytes. Of particular interest was the discovery of M. spicatum var. spicatum at stations 21 and 22 which are adjacent to the city boat ramp. This plant, whose common name is Eurasian Milfoil, is considered a nuisance because it grows aggressively, can propagate via fragmentation, and is extremely difficult to eradicate. The occurrence of Eurasian Milfoil near the boat ramp suggests it was introduced to Payette Lake from a boat or boat trailer that had been used in a lake infested with the plant.

Table 5-15. Aquatic macrophyte taxa at 19 littoral stations, Payette Lake, July 1996.

Aquatic macrophyte taxa[1]	Littoral station No.
Phylum Chlorophyta	
Family Characeae	
Chara sp.	14
Nitella sp.	1,2,4,5,11,12,16,23
Phylum Pteridophyta	
Family Isoetaceae	
Isoetes lacustris	1,2,4,5,6,8,10,11,12,13,14,16,17,19,21,23
Phylum Spermatophyta	
Class Angiospermae	
Family Haloragaceae	4,6,8,9,10,11,12,13,14,16,17,18,23
Myriophllum spicatum var. exalbescens	21,22
M.spicatum var. spicatum	
Family Hydrocharitaceae	6,11,13,16,17,18,22
Elodea canadensis	
Family Naiadaceae	4,5,11,17,23
Potamogeton robbinsii	6,11,19
P. zosteriformis	
Family Ranunculaceae	8,9,13,16,17,18,19,22
Ranunculus aquatilis	

[1] Taxonomy based on Prescott (1969) and Steward and others (1963).

An earlier survey of aquatic macrophytes at six locations in Payette Lake was conducted in July and September, 1981 by Falter and Mitchell (1981). The 1981 taxonomic composition was similar to that of the current study, but only six genera were found and P. robbinsii was the dominant genera. Eurasian Milfoil was not reported in the 1981 study.

5.5 Fire Effects on Lake Water Quality

The effects of the 1994 forest fires on Payette Lake's water quality were evaluated on the basis of a limited data base collected by DEQ at four limnetic stations during July, September, and October of 1992 and August and September of 1993 (D. Worth, Idaho Division of Environmental Quality, written commun., September, 1995). DEQ data for chlorophyll-a and dissolved oxygen were compared with data collected during similar time periods in 1995 and 1996. Hydrologically, lake outflow during the 1992 water year was 49 percent of the long-term mean; in the 1993 water year, lake outflow was 106 percent of the long-term mean. Thus, the lake's residence time in 1992 was 4.8 years, or about twice its normal value; in 1993, it was 2.2 years, or about normal. Residence times for the 1995 and 1996 water years were 1.84 and 1.42 years, respectively; thus, both years had shorter than normal residence times.

The limnological basis for the comparison of residence times is that longer residence times are expected to enhance a lake's biological production because nutrients and phytoplankton are retained longer in the lake. If one disregards the effects of the 1994 forest fires in this comparison, one would expect Payette Lake to have been most productive in 1992, the year with the longest residence time. However, post-fire chlorophyll-a concentrations were about double those measured in the two years prior to the fires, even though post-fire residence times were much less than normal. Chlorophyll-a concentrations for the 1992 samples ranged from 0.2 to 1.15 ug/L and had a median concentration of 0.71 ug/L. The 1993 chlorophyll-a concentrations ranged from 0.5 to 1.0 ug/L and had a median concentration of 0.65 ug/L. A similar period in 1995 had chlorophyll-a concentrations that ranged from 0.7 to 2.7 ug/L, with a median of 1.4 ug/L; for 1996, the range was from 0.8 to 2.1 ug/L, with a median of 1.3 ug/L.

Payette Lake received substantially larger loads of nitrogen during 1995-1996 as a result of the 1994 forest fires. Phosphorus loads also increased substantially in 1995, largely because of loads from Fall Creek. A comparison of in-lake nutrient concentrations indicated post-fire concentrations of nitrogen were much larger than pre-fire concentrations, whereas post-fire concentrations of phosphorus were smaller. During August and September of 1993, median concentrations, in micrograms per liter, of dissolved inorganic nitrogen, total phosphorus and dissolved ortho-phosphorus were 12, 10.5 and 10 in the upper water column and 122, 23 and 11 in the lower hypolimnion, respectively. For similar dates during 1995-96, median concentrations, in micrograms per liter, of dissolved inorganic nitrogen, total phosphorus and dissolved ortho-phosphorus were 50, 5 and 0.5 in the upper water column and 251, 5 and 0.5 in the lower hypolimnion, respectively. The 2 to 4 fold increase in dissolved inorganic nitrogen is reasonable in that this constituent is soluble and is not readily adsorbed to particulate material which may settle rapidly after introduction to the lake. In contrast, the absence of a large post-fire increase in phosphorus may be due to its ready adsorption to particulate material.

Dissolved-oxygen concentrations were also measured by DEQ in 1992 and 1993; however, the profiled depths were inconsistent and often did not occur in the deepest parts of the four basins. Thus, the assessment of pre- and post-fire development of the hypolimnetic dissolved-oxygen deficit in the southwest basin (limnetic station 1, this study) is incomplete. The most valid comparison is for late July, 1992 when a dissolved-oxygen concentration of 2.8 mg/L was measured at the 71-m depth in the southwest basin. Similar dates and depths in 1995 and 1996 for this location had dissolved-oxygen concentrations of 2.6 and 1.0 mg/L, respectively. On the basis of this comparison, the fire effects on the hypolimnetic dissolved-oxygen deficit were undetectable.

5.6 Nutrient Load/Lake Response Model

5.6.1 Model Description

The empirical nutrient load/lake response model (Walker, 1996) applied to Payette Lake provided a mathematical method for simulating the lake's limnological responses to alterations in hydrologic and nutrient loads delivered to the lake from various sources. The model combined data on the lake's morphometrics, hydrologic and nutrient budgets, and limnological characteristics in order to simulate the following eutrophication-related variables: concentrations of total phosphorus, total nitrogen, and chlorophyll-*a*; secchi-disc transparency; and hypolimnetic dissolved-oxygen deficit.

Three programs, FLUX, PROFILE, and BATHTUB, compose the model. The FLUX program quantifies tributary loads of water and nutrients using a variety of calculation methods. The PROFILE program generates statistical summaries of water-quality conditions in the water body within a temporal and spatial context. The BATHTUB program applies nutrient-balance and eutrophication-response models within a spatially segmented hydraulic framework that accounts for advection, diffusion, and sedimentation. BATHTUB is a highly evolved version of empirical lake-eutrophication models, and incorporates additional variables to account for important processes such as nonlinear nutrient-sedimentation kinetics, inflow nutrient partitioning, seasonal and spatial variations, and algal growth limitation by factors such as phosphorus, nitrogen, light, and flushing rate. If error estimates are provided for input variables, BATHTUB can express output variables in probabilistic terms. An important feature of BATHTUB is the ability for modeling linked segments of the lake to account for spatial variations in water quality. Segment boundaries can be selected on the basis of factors such as lake morphometry, important sources of water and nutrients, and lake hydrodynamics.

Payette Lake was divided into four segments (Figure 3-3 on page 39); each segment's characteristics are listed in table 5-16 on page 224. Segment 1 is the deep, northeastern basin; it covers 6.5 km^2 and contains 0.28 km^3. This segment receives the lake's primary inflow from the North Fork Payette River. Segment 2 is the southeastern basin which covers 1.7 km^2 and contains 0.04 km^3. This segment is the most hydrologically isolated from the primary inflow and is furthest from the lake's outflow. Segment 3 is the smallest basin and connects the northeastern and southwestern basins. This segment covers 1.4 km^2 and contains 0.04 km^3. Segment 4 is the southwestern basin and contains the lake's outlet into the North Fork Payette River. This segment has the largest area and volume, 10.9 km^2 and 0.4 km^3.

Water-quality characteristics for each segment were input to BATHTUB. The characteristics were computed with PROFILE using data from the four limnetic stations. Excepting the hypolimnetic dissolved-oxygen deficit, the characteristics represented mean annual values for the euphotic zone for water years 1995 and 1996. The euphotic zone was the primary focus for modeling because most of the empirical relations used by BATHTUB were derived from studies of euphotic zones. The hydrologic and nutrient budgets (Tables 5-3 through 5-5) were the source of water and nutrient loads input to BATHTUB. Each segment received water and nutrient loads from the subwatersheds draining into it. If a subwatershed contributed to more than one segment its water and nutrient load was apportioned between the segments on the basis of drainage area.

5.6.2 Model Calibrations

Model Calibration and Verification

The model was calibrated with 1996 data using a selection of submodels discussed in the user manual (Walker, 1996, Table 4.2). The submodels for phosphorus and nitrogen sedimentation were based on second-order decay rates. The chlorophyll-*a* submodel was based on phosphorus, light, and flushing rate, whereas the secchi-disc transparency submodel was based on chlorophyll-*a* and turbidity. The dispersion submodel was numerically based per Fischer and others (1979). The submodels for calibration of nitrogen and phosphorus applied calibration factors to sedimentation rates, not concentrations. The initial calibration with submodels was adequate for most variables; however, several variables required calibration coefficients to achieve a satisfactory fit between estimated and observed conditions. The calibration coefficient for chlorophyll-*a* was 0.625, whereas it was 3.0 for the hypolimnetic dissolved-oxygen deficit.

Model calibration results for each segment and the area-weighted, lakewide mean values are summarized in table 17. Lakewide, the ratios between observed and estimated values for total phosphorus, total nitrogen, chlorophyll-*a*, and secchi-disc transparency were 1.11, 1.08, 1.01, and 1.0, respectively. In model segment 4, the ratio between the observed and estimated hypolimnetic dissolved-oxygen deficit was 1.12.

The model was verified with 1995 data and the submodels used in the calibration; the results are summarized in table 17. Lakewide, the ratios between observed and estimated values for total phosphorus, total nitrogen, chlorophyll-*a*, and secchi-disc transparency were 0.33, 0.7, 0.77, and 1.07, respectively. In model segment 4, the ratio between the observed and estimated hypolimnetic dissolved-oxygen deficit was 1.19.

The comparison of observed and estimated mean values is not the only criterion on which to judge the model's performance. The model output displays the mean value, plus or minus one standard error for each observed and estimated value. These statistical estimates are computed on the basis of errors associated with the model, as well as errors associated with each input variable. The presence or absence of overlap in the standard errors for each variable and segment is listed in table 18. For the calibration, the standard errors for all variables overlap in each segment and lakewide. For the verification, the standard errors do not overlap as follows: total phosphorus; all segments and lakewide; total nitrogen, segments 1,4, and lakewide; chlorophyll-*a*, segment 1. The lack of overlap for total phosphorus is largely attributable to the unusually large, but transient, load delivered by Fall Creek during May, 1995. When the model verification was performed with the 1995 total phosphorus load from Fall Creek adjusted to levels equivalent with those delivered by Fall Creek in 1996, then the standard errors for total phosphorus overlap in all segments.

Table 5-16. Results of model calibration with 1996 data and model verification with 1995 data, Payette Lake

[TP, total phosphorus, in micrograms per liter; TN, total nitrogen, in micrograms per liter; CHL, chlorophyll-*a*, in micrograms per liter, SD, secchi disc transparency, in meters; HODV, hypolimnetic dissolved oxygen deficit, volumetric, in micrograms per cubic meter per day]

		Calibration			Verification		
		Mean Value			Mean Value		
Segment (Fig.3-3)	Variable	Observed	Estimated	Ratio of observed to estimated value	Observed	Estimated	Ratio of observed to estimated value
1	TP	6.4	7.3	0.88	4.4	18.8	0.23
	TN	328	319	1.03	229	326	0.70
	CHL	1.0	1.3	0.79	1.9	4.0	0.47
	SD	5.4	5.2	1.04	5.2	4.1	1.28
2	TP	8.1	6.9	1.17	6.2	13.4	0.46
	TN	314	270	1.16	210	278	0.76
	CHL	0.9	1.2	0.75	2.2	2.7	0.82
	SD	4.8	4.6	1.04	4.9	4.6	1.06
3	TP	6.6	6.4	1.02	5.3	14.1	0.37
	TN	323	276	1.17	231	278	0.83
	CHL	1.1	1.1	1.00	1.8	2.9	0.63
	SD	4.8	4.8	1.00	5.2	4.6	1.14
4	TP	7.4	5.8	1.28	4.2	10.5	0.40
	TN	262	239	1.10	160	237	0.68
	CHL	1.2	1.0	1.24	2.3	2.0	1.15
	SD	4.3	4.4	0.97	4.9	5.1	0.96
	HODV	14.8	13.2	1.12	24.9	21.0	1.19
Lakewide	TP	7.1	6.4	1.11	4.5	13.7	0.33
	TN	291	270	1.08	191	272	0.70
	CHL	1.1	1.1	1.01	2.1	2.8	0.77
	SD	4.7	4.7	1.00	5.0	4.7	1.07

Table 5-17. Presence or absence of overlap in standard errors for observed and estimated values for five limnological variables for calibration and verification model runs, Payette Lake

[Lakewide, LW; Y, overlap present; N, overlap not present; —, not measured]

Variable	Calibration					Verification				
	Segment No. (Fig. 3-3)					Segment No. (Fig. 3-3)				
	1	2	3	4	LW	1	2	3	4	LW
Total Phosphorus	Y	Y	Y	Y	Y	N	N	N	N	N
Total Nitrogen	Y	Y	Y	Y	Y	N	Y	Y	N	N
Chlorophyll-*a*	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Secchi disc transparency	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hypolimnetic dissolved oxygen deficit	—	—	—	Y	—	—	—	—	Y	—

5.6.3 Simulation Results

A wide variety of simulations was possible owing to the complexity of Payette Lake and its drainage basin, as well as to a diverse assortment of nutrient-load alterations that could be proposed and evaluated. Simulations of nutrient-load alterations were achieved by decreasing or increasing nutrient concentrations of the inflows to the lake. The water volume delivered by the inflow source was not altered because nutrient-management scenarios were assumed to affect concentrations, not flows. Limnological responses to the nutrient-load alterations were simulated with the 1996 data. The magnitudes of the responses were evaluated by comparison with the 1996 conditions estimated by the model. The output format of the simulations allowed evaluation of changes in the mean value of each response variable, either within a segment or on an area-weighted, lakewide basis.

Simulation 1 estimated limnological conditions prior to the 1994 forest fires. Concentrations of total phosphorus, dissolved orthophosphorus, total nitrogen, and dissolved inorganic nitrogen in tributaries affected by the 1994 fires were scaled back to pre-fire concentrations. For the North Fork Payette River inflow, pre-fire concentrations were those measured in the 1975 National Eutrophication Survey of Payette Lake (U.S. Environmental Protection Agency, 1977). For Fall Creek, and the Box/Lemah Creek watershed, nitrogen and phosphorus concentrations were set equal to those for Dead Horse Creek in 1996. On a lakewide basis, concentrations, in micrograms per liter, of total phosphorus increased from 6.4 to 6.5 and total nitrogen decreased from 270 to 127 (Table 5-18). Chlorophyll-a and secchi-disc transparency were unchanged. The hypolimnetic dissolved-oxygen deficit in model segment 4 increased about 1 percent. The largest change was in total nitrogen concentrations because the 1994 fires primary impact on Payette Lake was the large increases in nitrogen loads. Because the lake's phytoplankton production is strongly limited by phosphorus, not nitrogen, there was little reduction in chlorophyll-a concentrations and, consequently, little change in secchi-disc transparency and hypolimnetic dissolved-oxygen deficit. The large reduction in nitrogen concentrations did not shift the lake's phytoplankton production from phosphorus to nitrogen limitation.

Table 5-18. Simulation 1: Limnological response to estimated phosphorus and nitrogen loads delivered to Payette Lake prior to 1994 forest fires.

	Total phosphorus (μg/L)		Total nitrogen (μg/L)		Chlorophyll-a (μg/L)		Secchi-disc transparency (m)		Hypolimnetic dissolved-oxygen deficit [(mg/m^3)/d]	
Segment (Fig.3-3)	1996	Response	1996	Response	1996	Response	1996	Response	1996	Response
1	7.3	7.1	319	138	1.3	1.2	5.2	5.2	—	—
2	6.9	7.1	270	129	1.2	1.3	4.6	4 6	—	—
3	6.4	6.5	276	128	1.1	1.1	4.8	4.8	—	—
4	5.8	6.1	239	120	1.0	1.0	4.4	4.4	13.2	13.3
Lakewide	6 4	6.5	270	127	1.1	1.1	4.7	4.7	—	—

Simulation 2 took the opposite approach to simulation 1: the one-half of the watershed not burned in the 1994 fires was assumed to be burned with a severity similar to the 1994 fires. Total nitrogen and dissolved inorganic nitrogen concentrations were increased by a factor to 2.5 for the North Fork Payette River inflow, Fall Creek and the Box/Lemah Creek watershed. The smaller multiplier for these three tributaries was because about one-half of their watersheds were burned in the 1994 fires. Total phosphorus and dissolved orthophosphorus concentrations were increased 1.5 times on the six tributaries to simulate increased soil erosion. On a lakewide basis, concentrations, in micrograms per liter, of total phosphorus, total nitrogen, and chlorophyll-a increased from 6.4 to 8.4, 270 to 476, 1.1 to 1.5, respectively; secchi-disc transparency declined from 4.7 to 4.5 m (Table 5-19). The hypolimnetic dissolved-oxygen deficit in model segment 4 increased 19 percent. The in-lake increases in total nitrogen concentrations were the most noticeable impact; smaller increases in total phosphorus concentrations helped create increase chlorophyll-a concentrations and the hypolimnetic dissolved oxygen deficit; increased chlorophyll-a caused a decline in secchi-disc transparency.

Table 5-19. Simulation 2: Limnological response to increased phosphorus and nitrogen loads caused by forest fires in watershed areas not burned during the 1994 forest fires.

	Total phosphorus (μg/L)		Total nitrogen (μg/L)		Chlorophyll-a (μg/L)		Secchi-disc transparency (m)		Hypolimnetic dissolved-oxygen deficit [(mg/m^3)/d]	
Segment (Fig.3-3)	1996	Response	1996	Response	1996	Response	1996	Response	1996	Response
1	7.3	10.1	319	607	1.3	1.9	5.2	4.8	---	---
2	6.9	8.7	270	454	1.2	1.6	4.6	4.4	---	---
3	6.4	8.6	276	493	1.1	1.6	4.8	4.5	---	---
4	5.8	7.3	239	399	1.0	1.3	4.4	4.3	13.2	15.7
Lakewide	6.2	8.4	270	476	1.1	1 1	4.7	4.7	---	---

Simulation 3 used the responses to simulated pre-fire nutrient concentrations (simulation 1, Table 5-18) as the basis for assessing the lake's response to 20-percent reductions in nutrient loads from developed shoreline areas. An assumption was made that substantive nutrient-management actions would not occur until after the limnological effects of the 1994 fires had been muted by natural recovery processes in the watershed and lake. Accordingly, concentrations of total phosphorus, dissolved orthophosphorus, total nitrogen, and dissolved inorganic nitrogen were reduced 20-percent for the developed shoreline areas of the southwest and southeast basins, the McCall urban area and the west shore of the peninsula. Sylvan, Dead Horse and Fall Creeks were assigned nutrient reductions of 10 percent to simulate management of their developed shoreline areas. On a lakewide basis, concentrations, in micrograms per liter, of total phosphorus, total nitrogen, and chlorophyll-a declined from 6.5 to 6.4 and 127 to 125, respectively (Table 5-20). Chlorophyll-a and secchi depth transparency were unchanged. The hypolimnetic dissolved-oxygen deficit in model segment 4 decreased about 1 percent. Small responses occurred in model segment 1, the northern basin, because it has very little developed shoreline to affect its large volume. Model segment 4, the southwest basin, also has a large volume, but has a substantial level of shoreline development. The responses of these two model segments were similar because both have large volumes in relation to the amount of nutrient loads delivered to them from developed shoreline areas.

Table 5-20. Simulation 3: Limnological response to 20-percent reduction in phosphorus and nitrogen loads from developed shoreline areas; comparison is to simulated response to pre-1994 forest fires (Simulation 1, Table 5-18).

	Total phosphorus (μg/L)		Total nitrogen (μg/L)		Chlorophyll-a (μg/L)		Secchi-disc transparency (m)		Hypolimnetic dissolved-oxygen deficit [(mg/m^3)/d]	
Segment (Fig.3-3)	Pre-fire	Response	Pre-fire	Response	Pre-fire	Response	Pre-fire	Response	Pre-fire	Response
1	7.1	7.0	138	136	1.2	1.2	5.2	5.2	---	---
2	7.1	6.9	129	127	1.3	1.2	4.6	4.6	---	---
3	6.5	6.4	128	126	1.1	1.1	4.8	4.8	---	---
4	6.1	5.9	120	118	1.0	1.0	4.4	4.4	13.3	13.2
Lakewide	6.5	6.4	127	125	1.1	1.1	4.7	4.7	---	---

Simulation 4 also used the responses from simulation 1 as the basis for assessing the lake's response to 20-percent reductions in nutrient loads from watershed areas subjected to timber harvest activities. Concentrations of total phosphorus, dissolved orthophosphorus, total nitrogen, and dissolved inorganic nitrogen were reduced 20-percent for the North Fork Payette River inflow, Box/Lemah Creek watershed, and Fall, Deadhorse, Copet, and Sylvan Creeks. On a lakewide basis, concentrations, in micrograms per liter, of total phosphorus, total nitrogen, and chlorophyll-a declined from 6.5 to 5.8, 127 to 108, and 1.1 to 1.0, respectively; secchi-disc transparency increased from 4.7 to 4.8 m (Table 5-21). The hypolimnetic dissolved-oxygen deficit in model segment 4 decreased about 8 percent. Model segment 1 had the largest percentage responses because most of the nutrient load reductions occurred in its tributary watersheds. The smallest percentage responses were in model segment 4 because its tributary watersheds were unaffected in this simulation.

Table 5-21. Simulation 4: Limnological response to 20-percent reduction in phosphorus and nitrogen loads from watershed areas subjected to timber-harvest activities; comparison is to simulated response to pre-1994 forest fires (Simulation 1, Table 5-18).

	Total phosphorus (μg/L)		Total nitrogen (μg/L)		Chlorophyll-a (μg/L)		Secchi-disc transparency (m)		Hypolimnetic dissolved-oxygen deficit [(mg/m^3)/d]	
Segment (Fig.3-3)	1995	Response	1995	Response	1995	Response	1995	Response	1995	Response
1	7.1	6.1	138	115	1.2	1.0	5.2	5.4	—	—
2	7.1	6 4	129	111	1.3	1.1	4.6	4.7	—	—
3	6.5	5.7	128	109	1.1	0.9	4.8	4.9	—	—
4	6.1	5.5	120	104	1.0	0.9	4.4	4.4	13.3	12.3
Lakewide	6.5	5.8	127	108	1.1	1.0	4.7	4.8	—	—

Simulation 5 combined the nutrient load reductions applied in simulations 3 and 4. On a lakewide basis, concentrations, in micrograms per liter, of total phosphorus, total nitrogen, and chlorophyll-a declined from 6.5 to 5.7, 127 to 108, and 1.1 to 0.9, respectively; secchi-disc transparency increased from 4.7 to 4.8 m (Table 5-22). The hypolimnetic dissolved-oxygen deficit in model segment 4 decreased about 8.5 percent. Of the three nutrient-reduction simulations, this one achieved the largest responses lakewide and in each of the four model segments.

Table 5-22. Simulation 5: Limnological response to 20-percent reduction in phosphorus and nitrogen loads from developed shoreline areas and watershed areas subjected to timber-harvest activities; comparison is to simulated response to pre-1994 forest fires (Simulation 1, Table 5-18).

	Total phosphorus (μg/L)		Total nitrogen (μg/L)		Chlorophyll-a (μg/L)		Secchi-disc transparency (m)		Hypolimnetic dissolved-oxygen deficit [(mg/m^3)/d]	
Segment (Fig.3-3)	Pre-fire	Response	Pre-fire	Response	Pre-fire	Response	Pre-fire	Response	Pre-fire	Response
1	7.1	6.1	138	114	1.2	1.0	5.2	5 4	—	—
2	7.1	6.2	129	110	1.3	1.1	4.6	4.7	—	—
3	6.5	5.7	128	108	1.1	0.9	4.8	4.9	—	—
4	6.1	5.4	120	104	1.0	0.9	4.4	4.5	13.3	12.2
Lakewide	6.5	5.7	127	108	1.1	0.9	4.7	4.8	---	—

Chapter VI

Chapter 6.0 Summary, Recommendations and Standards

A quantitative and comprehensive study was conducted on the Big Payette Lake and drainage basin in water years 1995 through 1996. The purposes of this study were to determine the current status and condition of Big Payette Lake and the health of the contributing watershed, identify sources of nutrients that may contribute to eutrophication of Big Payette Lake, and provide a scientific basis for future management recommendations to protect water quality. The results of this Technical Study are intended to support and guide the development of a Lake Management Implementation Plan under development by the Big Payette Lake Water Quality Council. The Lake Management Plan will seek to enact specific best management practices, local ordinances, citizen education and other measures consistent with protection of the lake.

6.1 Summary

6.1.1 Watershed Assessment

Watershed assessments included measurement of the quantity and quality of runoff, identification of the sources and contribution of eroded sediments, the historical sediment accumulation rates within lakes, stream habitat quality within the watershed, recreational impacts, and a creel/ boating use survey. Two major wildfires burned nearly half the watershed in summer 1994 as field investigations for this study were initiated. Effects of the fire had a pronounced impact on the study results and interpretations.

Quantity and Quality of Runoff

Subwatersheds for monitoring were prioritized based on factors such as intensity of past management activity, anticipated future uses, fire history and general conditions of stream habitat quality. Other diffuse land use impacts were also evaluated in and around the recreation and urbanized areas of the watershed adjacent to Big Payette Lake.

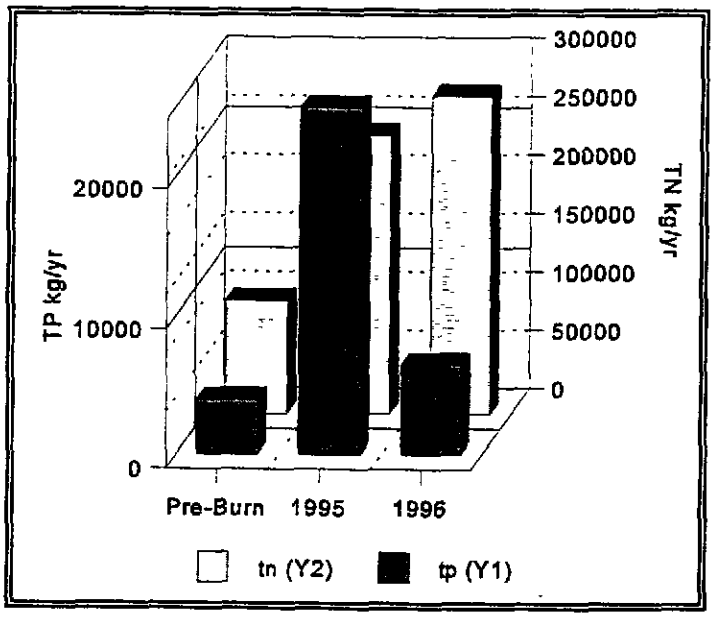
Climatic conditions during the study were wetter than normal and contributed to greater accumulation of snow-pack than the historical average. Runoff in 1995 was approximately 126% of normal and runoff in 1996 was 166%.

Wildfires in 1994 burned roughly 50% of the watershed as field studies were initiated. As a result, significant changes in the export of nitrogen and to a lessor extent phosphorus and sediment were noted in the streamflow of burned watersheds compared to unburned conditions (Figure 6-1). Phosphorus concentrations in streamflow were highest during the first year snowmelt and declined to near background levels the following year. Fall Creek, a burned watershed, contained the highest phosphorus concentrations in streamflow among all monitored watersheds; concentrations

ranged from 1,000 to 2,600 mg/m^3 during snowmelt in 1995. Nitrogen concentrations from burned watersheds, particularly nitrate-nitrogen, were 2 to 3 times greater than unburned watersheds and remained well above background throughout the two year study. A comparison of the water yield among burned and unburned watersheds showed no appreciable difference in the volume of water discharged per unit of watershed area.

As a result of the 1994 fire, nutrient loading to Big Payette Lake increased above the estimated pre-fire loading rates (Figure 6-1). Phosphorus loading roughly doubled the first year following the fire (1995) but was only slightly greater during the second (1996). Nitrogen loading remained well above levels estimated for pre-fire conditions and actually increased the second year due to higher streamflow and concentrations. Pre-fire contribution of nutrient loads and suspended sediments by all streams was estimated based on a unit area export coefficient calculated from unburned watersheds. The resulting annual loading of sediment and nutrients to Big Payette Lake was estimated to be 3,953 kg total phosphorus, 97,399 total nitrogen and 552,696 kg suspended sediments. The corresponding pre-burn annual loading to Upper Payette Lake was calculated to be 1,236 kg total phosphorus, 27,295 kg total nitrogen, and 106,127 kg suspended sediments. Assuming the current fire impacts on the watershed stabilize to their pre-burn status, the impact of a future wildfire of similar extent (i.e., the remaining 50% of the watershed burns) is expected to briefly (2-5 year period) produce a two fold increase in the sediment and nutrient loads over the estimated yields prior to burning. The additional nutrient loading that might result from reoccurrence of wildfires in a previously burned forest could not be estimated.

Figure 6-1.Comparison of the estimated phosphorus and nitrogen loading from watersheds before (pre) and after the 1994 fire

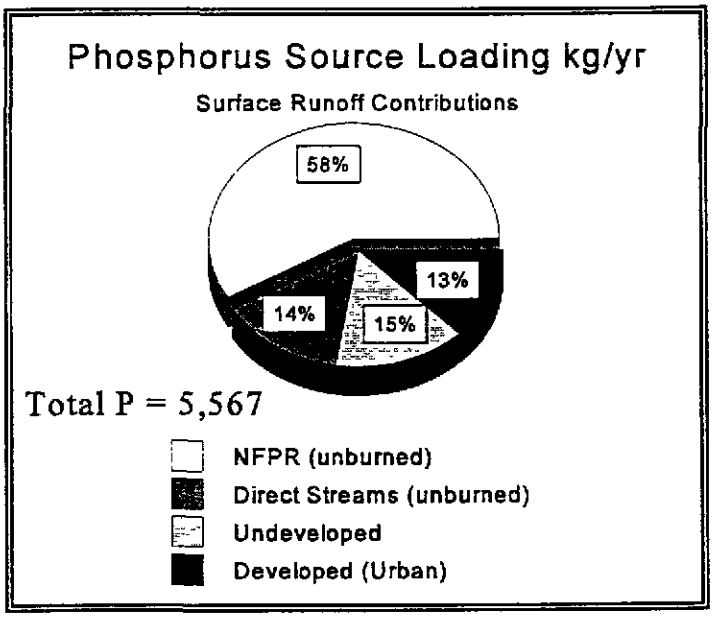


Comparison of the inflows and outflows from Upper Payette Lake revealed this lake is an important sink for nutrients and sediments transported in runoff from the upper basin. Upper Payette Lake retained roughly 11% of the total phosphorus, 22.8% of the nitrogen and 53% of suspended sediments entering the lake in 1995. Similar amounts of phosphorus and slightly lower amounts of suspended sediment (35%) were retained in 1996.

Stormwater runoff from developed areas around the Big Payette Lake shoreline were highly concentrated sources of nutrient and bacteria pollutants. Concentrations of phosphorus in

stormwater runoff were 10 to 100 times greater than typical streamflows, 10 to 15 times greater for nitrogen and 40 to 250 times greater for suspended sediments. Total loading of phosphorus and nitrogen from developed and undeveloped areas directly draining to the lake was estimated to be 700-800 kg TP and 3,000-3,500 kg TN during this study.

Figure 6.2 Source contributions of surface runoff nutrients to Big Payette Lake.



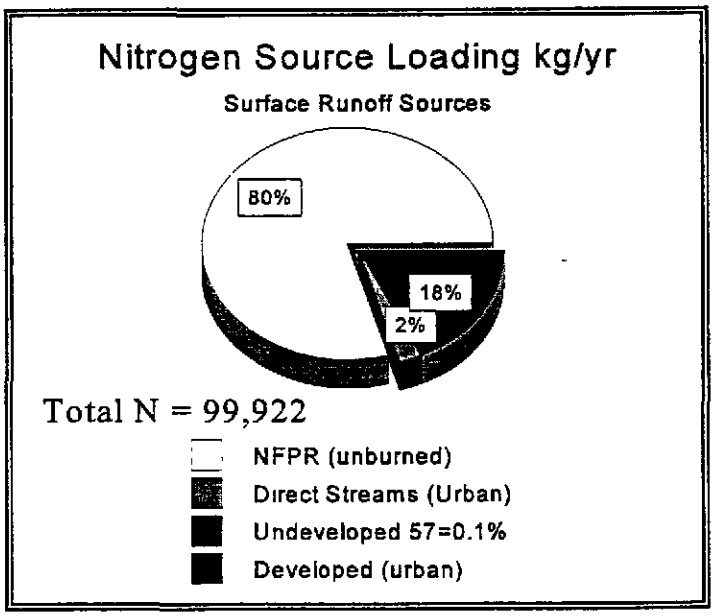


Figure 6-2 compares the phosphorus and nitrogen loading attributed to all the major sources of surface runoff entering Big Payette Lake after adjusting for the fire contributions. The percent contribution of phosphorus attributed to the N.F.Payette River was 58%, with 14% from other direct stream inputs (Fall Creek, Deadhorse Creek, Sylvan Creek, Wagon Bay Creek and Lemah Creek). The remaining land area directly draining to the lake includes developed and undeveloped lands around the lake perimeter. Of this land area, approximately 2,231 hectares of undeveloped land (5,514 acres) contributed 15% of the total phosphorus in runoff while 704 hectares (1,739 acres) of developed (urban) land contributed 14% of the total phosphorus in runoff. Thus, developed (urban) land around the lake perimeter contributed about three times the phosphorus load as undeveloped land. A breakdown of the nitrogen sources shows that the N.F. Payette River contributed the largest proportion of the load, accounting for 80%. Developed (urban) lands were the second largest source and accounted for 18% of the nitrogen loading through surface water runoff.

Sediment Sources and Contributions

Total sediment input from background and other management sources is summarized in Table 6-1. The summary table includes two estimates of background sediment input as described previously, and gives a range of average annual total background input. The sediment input from the 1994 Corral-Blackwell fire is listed separately and includes total input predicted for 1995 and 1996 (not average annual input). Future surface erosion from the fire will be much smaller as burned areas re-vegetate and stabilize. Table 6-1 lists two sediment input rates for harvest: average historical input which averages total input from harvest activities from the 1950's to the present; and the average 1990-1995 input rate which provides more recent rates for comparative purposes.

Table 6-1 includes all sediment produced in the watershed that is delivered to either a stream or lake. It should be noted that all sizes of sediment is included in Table 6-1, however, the larger sized sediments (coarse sand, gravel, cobble, boulder) that make up a portion of the soil creep and mass wasting inputs become part of the bedload of the streams they enter, and do not likely contribute directly to altered water quality in the stream or lakes. The percent of coarse-grained sediment comprising the total from these two sources depends upon the soil types being eroded; it is likely 10 to 40 percent of the total is coarse. Sediment from surface erosion sources (fire, harvest, roads) are generally fine-grained (sand, silt, clay). These sediments will be transported much further in the stream system than the coarse sediments, and can contribute to increased turbidity in streams and lakes.

Table 6-1. Summary of average annual sediment input from background and management sources delivered to streams and lakes (estimated tons/yr).

Subbasin	Background					Management		
	Soil Creep	Alternate Background Estimate	Mass Wasting	Total Back-ground	Total Fire 95-96	Roads	Average Historical Harvest	Average 90-95 Harvest
Box Creek	56	208	333	389-541	39	2	0.3	2.4
Brush Creek	41	212	291	333-503	27	14	0.5	1.1
Camp Creek	36	154	178	199-317		131	1.5	0.1
Copet Creek	12	72	0	12-72		2	-	-
Cougar Creek	39	94	1,388	1,428-1,483	17	5	-	-
Dead Horse	67	121	0	67-121		27	0.6	2.3
Deep Creek	57	110	175	232-267		0	-	-
Fall Creek	79	169	14	93-183	32	24	0.2	-
Fisher Creek	161	450	286	447-736		65	1.2	0.8
Lemah Creek	81	126	0	81126	70	11	0.6	4.7
Middle Payette	48	139	35	83-174		82	-	-
No Name Creek	9	34	0	9-34		0	-	-
Payette Lake	27	463	24	51-487		69	-	-
Pearl Creek	53	128	0	53-128		61	0.5	-
Sylvan Creek	24	53	0	24-53		5	0.8	0.1
Twah Creek	102	181	0	102-181	41	9	0.4	2.9
Twenty Mile	104	400	3,906	4,010-4,306	34	10	0.4	0.1
Upper NF	142	438	612	735-1,030	90	359	0.2	0.1
Wagon Bay	27	54	0	27-54		17	-	-
Total	1,166	3,606	7,242	8,376-10,814	350	892	7.2	14.6

The actual amount of sediment supplied to Big Payette Lake is less than the total listed in Table 6-1 because much of the eroded sediment is stored in other intermediate lakes in the watershed or in low gradient stream valleys. A detailed analysis of sediment retention times in the various-sized lakes and stream channels was not made, however, the following assumptions can be made in order to estimate sediment supplied to Upper Payette Lake and Big Payette Lake:

(1) The majority of sediment supplied to a lake will settle out in that lake. Very little sediment (only the clay sized sediments) will remain in suspension and flow out of the lake. Based on this assumption, it was assumed that sediment from mass wasting supplied to alpine lakes (Table 4-26) did not deliver to either Upper Payette Lake or Big Payette Lake and all sediment supplied to Upper Payette Lake remained in that lake and did not deliver to Big Payette Lake.

(2) An average of 30 percent of the total mass wasting and soil creep sediment supplied to streams was assumed to be coarse grained (coarse sand, gravel, boulders based on soil data reported for land types in the basin). These sediments are stored in low gradient portions of stream channels and floodplains for long periods of time. If this coarse grained sediment does reach a lake, it is deposited in a delta at the upstream end of the lake and does not likely contribute nutrients in sufficient quantity to degrade water quality.

The results of this analysis for historical conditions (reflecting the period of time for which aerial photographs are available and harvest data for about the mid 1940's to the present) are shown in Table 6-2. It should be noted that the road erosion rates listed in Table 6-2 reflect current conditions; data on when individual roads were constructed was not available at the time of this analysis. In the past, there were fewer roads to produce sediment, but the road construction and maintenance practices were not likely as good as at present, so the roads that did exist produced more sediment than they do presently.

The majority of delivered mass wasting in the watershed occurs in the Upper Payette Lake (about 3,000 tons/yr). This is supported by the large delta formed in Upper Payette Lake, indicating large quantities of coarse sediment are supplied to the lake. About half of the total road and harvest sediment is supplied to Upper Payette Lake (about 440 tons/yr). Management-related sediment comprises about 15 percent of the total supplied to Upper Payette Lake. Big Payette Lake receives about 850-2,000 tons of sediment annually from background sources, with comparatively little of the background coming from mass wasting. About 450 tons of sediment (20-35 percent) is delivered to Big Payette Lake from management-related sources each year, primarily road erosion.

Table 6-2. Summary of average annual historical sediment input delivered to Upper Payette Lake and Big Payette Lake (estimated tons/yr).

Subbasin	Background				Management	
	Soil Creep	Alternate Background	Mass Wasting	Total	Roads	Average Historical Harvest
Delivered to Upper Lake:						
Camp Creek	15	65	24	39-88	63	0.1
Cougar Creek	28	662	681	708-746	5	0.1
Twenty Mile Creek	73	280	1,876	1,949-2,156	10	0.7
Upper NF Payette	100	307	241	340-547	359	3.0
Total to Upper Payette Lake	215	717	2,820	3,036-3,358	437	3.9
Delivered to Big Payette Lake:						
Box Creek	39	146	-	39-146	2	0.6
Brush Creek	29	148	-	29-148	14	0.9
Camp Creek	10	43	-	10-43	68	0.1
Copet Creek	8	50	-	8-50	2	-
Dead Horse Creek	47	85	-	47-85	27	1.2
Deep Creek	40	77	86	126-163	-	-
Fall Creek	55	118	7	62-125	24	0.5
Fisher Creek	112	315	132	244-447	48	2.3
Lemah Creek	57	88	-	57-88	11	1.2
Middle Payette	34	97	17	51-114	82	-
Payette Lake	19	324	12	31-336	69	-
Pearl Creek	37	90	-	37-90	61	1.1
Sylvan Creek*	17	37	-	17-37	5	1.6
Unnamed Creek	6	24	-	6-24	-	-
Wagon Bay Creek	19	38	-	19-38	17	-
Twah Creek	72	126	-	72-127	9	0.8
Total to Big Payette Lake	602	1,807	253	855-2,060	438	10

*There is a small lake near the bottom of Sylvan Creek that prevents some sediment from reaching Big Payette Lake.

Stream Habitat Quality

Numerous streams in the Payette Lake watershed were evaluated to determine their relative stability, quality of aquatic habitats and support of aquatic organisms (macroinvertebrates and fish). Information collected by the U.S. Forest Service, Payette National Forest, Idaho Division of Environmental Quality and Idaho Department of Lands was synthesized into a common database. Streams were sampled prior to and after the wildfires in 1994. This report, however, provides analysis of pre-burn conditions. A post-fire assessment is expected to be completed by early summer 1997.

A total of twelve streams were analyzed and results were compared with standards from undisturbed streams in the Northern Rockies Ecoregion, a local stream of high quality, and available State (cold water biota water quality standards) and Federal (INFISH) standards.

Results of these comparisons revealed that stream habitat quality in the Payette Lake Watershed generally falls within the natural range of undisturbed streams but key indices reflect higher levels of impairment related to sedimentation. All streams exceeded state and federal standards for temperature but were generally acceptable for dissolved oxygen content. Most of the streams fell below the INFISH standard for width to depth characteristics and were rated as poor or suboptimal by IDEQ standards except for Cougar and Deadhorse Creek. Streams were generally wider, shallower and less than optimal quality compared to natural conditions streams. Streams also generally contained adequate amounts of woody debris compared with most standards although many were below comparable natural streams surveyed in Idaho. Fall Creek and Box Creek contained the lowest amounts of LWD. Given the availability of LWD, pool complexity was lower than expected compared to undisturbed conditions. Moreover, pools and pool/riffle ratios for streams are generally below optima indicating a scarcity of high quality fish habitat. Sediment filling of pools may be attributed to the lack of pool quality. Fine sediment accumulation within stream substrates was prevalent in many of the streams surveyed. Channel erosion, however, did not appear to be a major contributor of sediment since stream banks were largely rated as highly stable. Exceptions were Landing Creek and Box Creek which scored low on bank stability. These sites also scored low on width to depth ratios.

These abiotic processes were also manifested in the macroinvertebrate and fish data. Common biological indices (% scrapers, taxa richness, %EPT and %Dominance) indicate a majority of streams have macroinvertebrate communities exhibiting some degree of environmental stress, again related to accumulation of fine sediments. The exceptions were Box Creek and Twenty Mile Creek with indices reflecting high water quality and minimal disturbance. Fish densities, as might be expected, appeared to increase among streams with more favorable habitats. Brook trout, rainbow trout and cutthroat trout were widely represented throughout the watershed. However, the number of habitat types (pools/riffles), frequency and complexity is less than optimal.

Further comparisons of habitat quality will be made using post-fire monitoring data from the same stream sites. This analysis will be completed by early summer of 1997. These comparisons will provide additional insight as to the character of the stream habitats altered by wildfires.

Recreation Survey

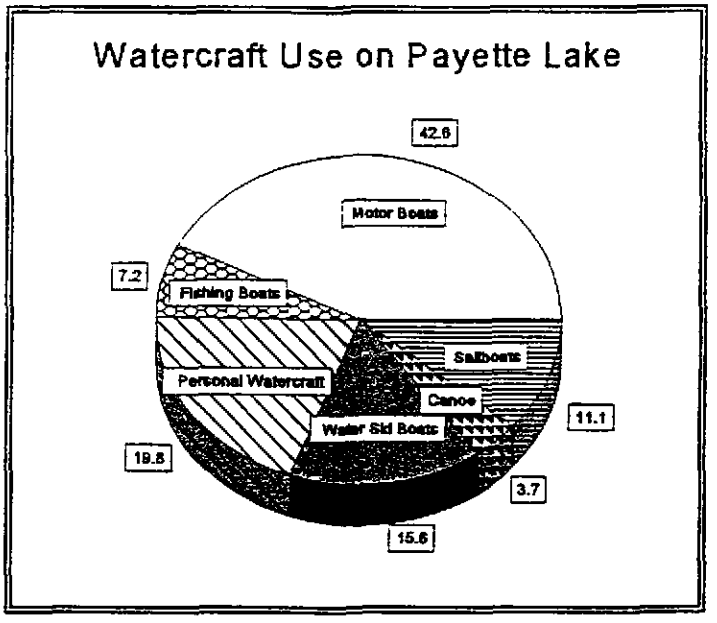


Figure 6-3

With the increased growth of population in Idaho, Payette Lake has become a recreational favorite due to its high water quality, large size, parks and other amenities. Boating use for general pleasure dominates recreational water use (Figure 6-3). On three separate dates, the number of boats on the lake surface exceeded 700 (including boats moored at docks and those in active use). Anglers spent an estimated 11,489 hours pursuing lake trout, kokanee, rainbow trout, and cutthroat trout. Kokanee were the most important species, in numbers, harvested from the lake. An analysis of the kokanee migration and recruitment showed that spawning kokanee run has been adequate to maintain lake population levels. Population numbers have actually increased since 1992 perhaps in response to increased lake productivity or other factors (less predation). Accordingly, the number of spawning kokanee utilizing the N.F. Payette River has increased.

A bacteria survey conducted on several popular camping sites within the watershed indicated surface contamination of streams was prevalent during summer months when recreational activity is greatest. The more undeveloped sites were most prone to soil disturbance and bacteria contamination.

Efforts by the State Department of Parks and Recreation have been made to better equip the primitive camping areas with sanitary facilities and designated parking facilities. Additional facilities are needed to reduce erosion and stabilize surrounding surface areas. As recreational demand increases, the more primitive sites will be prone to additional usage and could increase the potential for bacterial contamination and erosion.

North Fork Payette River Minimum Stream Flows

The IDFG conducted a survey of minimum stream flow requirements necessary to maintain and enhance fish habitat on the N.F. Payette River between Upper and Big Payette Lake. An Instream Flow Incremental Methodology (IFIM) was used to identify critical thresholds of streamflow for resident fish populations. These results indicated that existing low streamflows during late summer fell below levels needed to sustain adequate numbers of pools for fish. It was determined that a minimum baseflow of 60 cfs (as measured at the USGS gauge below Fisher Creek) was required in the mainstem river from July 1 to September 7. This flow rate provided an acceptable minimum quantity of water depth and

pools for rainbow trout and spawning kokanee. Habitat conditions would be improved but would remain below optimal conditions (with respect to water levels). To accomplish this goal, it was determined that 35 cfs discharge from Upper Payette Lake would be required in addition to the base flows provided by tributaries draining to the mainstem N.F. Payette River during this time period.

Maintenance of a minimum flow would enhance other beneficial use requirements such as water quality and river recreation (rafting, canoeing, etc.). Extremely low discharge rates can further degrade water quality in the N.F. Payette River by accelerating the decomposition of periphytic algae that accumulates in the lower reaches of the river. During low discharge periods, additional river bottom is exposed, increasing the potential for accelerated decomposition of organic matter and mineralization of nutrients. These materials are subsequently flushed from the river when water levels later re-flood exposing substrates and are then available to further enhance algal growth within the lake. The availability of sufficient water from upstream sources to meet these needs and associated impacts on other competing water demands was not evaluated.

Sediment Accumulation Rates in Upper and Big Payette Lake

Sediment cores were extracted from Upper and Big Payette Lake to determine the historical rates of surface erosion from the surrounding watershed and other inputs. While all lakes are in a natural state of filling with sediments due to their ability to trap and store these inputs, the natural rate of this filling process can be accelerated by land disturbances within the drainage basin. In addition, nutrients which affect the productivity of lake systems are often attached on eroded sediment particles when transported to the lake. These inputs, in turn can have a profound influence on the limnological processes within the lake, such as depletion of oxygen as deposited organic sediments decompose.

A historical profile of deposited sediments was constructed using lead-210 activity as an estimate of the age when sediment layers were deposited. Cores were extracted from the NE and SW basins of Big Payette Lake and from a single location in Upper Payette Lake. All cores were sampled from the deepest areas within the respective basins to maximize the temporal resolution of sediment accumulation.

Good quality records of lead-210 activity were obtained from each core which allowed dating of sediments to be established beginning around circa 1840. Calculated sediment accumulation rates (SARs) established a background rate of 0.1-0.2 $g/cm^2/yr$ for both the NE and SW basins of Big Payette Lake and 0.3-0.4 $g/cm^2/yr$ for Upper Payette Lake.

Stratigraphy of the cores indicate SARs increased at a steady rate over the next 80-100 years (1920-1940) increased nearly 3 to 4 fold in both Upper and Big Payette Lake. These increases were attributed to non-cataclysmic promoting events such as increased development and utilization of the basin (construction of roads, grazing, early timber extraction and fires).

Approximately 50-60 years ago (circa 1940), SARs changed dramatically in Upper Payette Lake increasing to nearly 5 times the historical background while rates in the NE basin of Big Payette Lake ceased increasing but leveled off at three times the natural background. In contrast, SARs in the SE

basin of Big Payette Lake began declining until present where rates are now equal to those in 1840. The exact cause of these results are difficult to isolate in the broader perspective with continued growth in population of the region, additional road construction in the watershed and development of the lake shoreline. One advent of importance was the concerted effort to harness and manage the region water resources through construction of dams on Upper and Big Payette Lakes as well as other smaller reservoirs in the watershed. Construction of these dams likely altered the hydrology of these water bodies and altered the retention and storage of eroded sediments these lakes receive from the watershed. Trends observed in the changes of SAR in the basins were consistent with what might be expected in hydraulically connected lakes where increased trapping efficiencies have a cascade effect on the removal of suspended sediments and the subsequent downstream transport and deposition of sediments.

Analysis of the nutrient content of deposited sediments showed phosphorus, nitrogen and carbon were highest in deposited sediments in Upper Payette Lake followed by the NE basin and SW basins of Big Payette Lake. Calculated C:N and N:P ratios show these patterns of nutrient content in deposited sediments has likely remained consistent over time. Evidence of increased sediment mobilization of phosphorus and nitrogen resulting from decline in sediment redox (anaerobic conditions) was present in the Big Payette Lake SW basin core stratigraphy. This confirms that oxygen depletion in the lake hypolimnion has promoted release of nutrients from lakebed sediments in this basin (internal recycling).

The enhanced sedimentation of Big Payette Lake above the historical background has likely contributed significant quantities of oxygen demanding substances to the lake. This has resulted in increased demand of oxygen for decomposition processes which in-turn can trigger release of sediment bound nutrients. Future contributions of fire related sediment erosion could further aggravate the oxygen demands on the lake hypolimnion should erosion rates increase.

6.1.2 Lake Assessment

Lake assessments included monitoring of the nutrient inputs and outputs, lake water quality, aquatic macrophyte composition of the shoreline and growth of periphyton in the lake littoral zone. Nutrient and water mass balance budgets were calculated to assess source loadings and subsequently used as input to a lake response model. The model was used to predict potential changes in the trophic status of the lake in response to simulated increases and decreases in the source loading of nutrients. This information will provide inferences concerning the importance of controlling source loads through implementation of best management practices (BMPs) and identify which source load reductions would have the greatest influence on water quality at least cost.

Hydrologic inputs during 1995-96 were larger than the long-term mean and, thereby, reduced the residence time of water in Payette Lake by 22 % in 1995 and 40 % in 1996. Loads of nitrogen and phosphorus delivered to the lake were increased by the larger flows and by the effects of the 1994 forest fires that burned about one-half of the lake's watershed. The percentage contribution of nutrient loads from the lake's primary tributary, the North Fork Payette River during 1995-96 averaged 28.2 % for phosphorus and 70 % for nitrogen. On the basis of two earlier studies of nutrient loads to Payette Lake, this indicates a decrease in the influence of the primary tributary on phosphorus loads and an increase

in the relative contribution from nearshore areas and smaller tributaries draining directly to the lake. A similar conclusion would have been reached for nitrogen if the forest fires had not increased nitrogen loads by a factor of about five.

The trophic state of Payette Lake was oligotrophic during 1995-96, on the basis of concentrations of total phosphorus, total nitrogen, and chlorophyll-a. The forest fires increased total and dissolved concentrations of nitrogen throughout the lake; no such increases were apparent for phosphorus. In that the lake's phytoplankton productivity is strongly limited by phosphorus, the large increase in dissolved inorganic nitrogen did not dramatically increase chlorophyll-a concentrations. Increases in chlorophyll-a concentrations were only about two-fold in comparison to those measured two years prior to the 1994 forest fires.

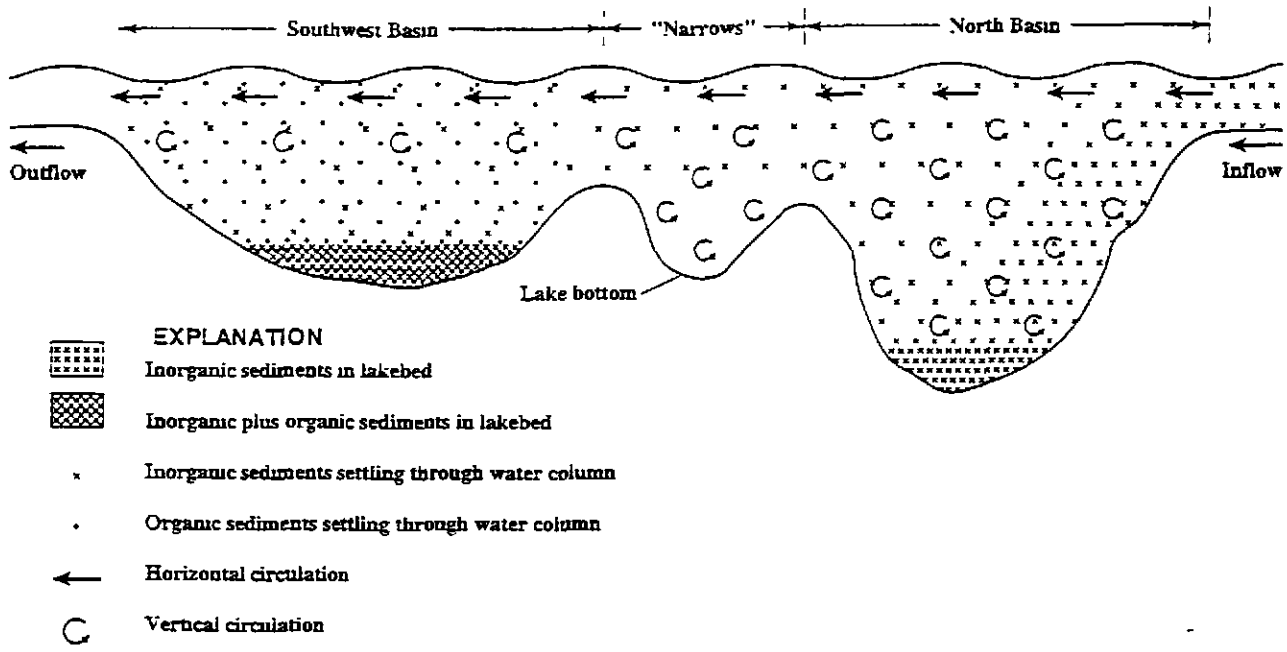
Despite its oligotrophy, Payette Lake did develop anoxia in the lower hypolimnion of the southwest basin for about four months in each year. Substantial oxygen depletion also was measured in this basin under winter ice cover in February, 1996. Low dissolved-oxygen concentrations in the southwest basin were measured in 1981 and 1992-93; thus, they are not a by-product of the 1994 forest fires. Payette Lake has a much larger hypolimnetic dissolved-oxygen deficit than was predicted by the nutrient load/lake response model's empirical relation of hypolimnetic dissolved-oxygen deficit with nutrient and chlorophyll-a concentrations.

Payette Lake's propensity to develop a substantial hypolimnetic dissolved-oxygen deficit is rooted in several factors, not all of which are anthropogenic. Long-term human development of the watershed and the nearshore area has produced small, but cumulative, increases in the lake's nutrient budget and, consequently, increased the lake's biological productivity as shown by the 1975 and 1981-82 studies which concluded the lake was mesotrophic, or moderately enriched. The increased biological production from phytoplankton and periphyton has generated additional organic matter. The portion of organic matter that is not flushed out of the lake exerts an oxygen demand while settling, and is eventually deposited onto the lakebed sediments (See Figure 6-4). The lakebed sediments in the southwest basin contained much more phosphorus than the other three basins. Therefore, one can conclude that the majority of oxygen-demanding organic matter was produced in or transported to the southwest basin because it has the largest amount of nearshore development and is the terminal basin in the lake.

Several non-anthropogenic factors influence the development of the hypolimnetic dissolved-oxygen deficit. The lake's long residence time, as determined by lake volume and outflow volume, facilitates water-column retention of the oxygen-demanding organic matter produced within the lake or delivered to it from terrestrial sources. The lake's depth, especially in its southwest and northern basins, retards water-column circulation and consequent re-aeration of the hypolimnion into December, despite the loss of thermal stratification a month or two earlier. The delay in hypolimnetic re-aeration extends the time over which organic matter exerts an oxygen demand on the hypolimnetic oxygen supply. That oxygen supply is finite in that it is delivered during the spring water-column circulation and is not replenished if thermal stratification persists over the summer. At station 1, the lack of complete re-aeration during spring water-column circulation exacerbates the hypolimnetic dissolved-oxygen deficit problem because

the southwest basin begins the thermal stratification period with an incomplete supply of dissolved oxygen with which to satisfy its hypolimnetic oxygen demands.

Figure 6-4. Relation of natural and human-related processes contributing to the loss of hypolimnetic oxygen in the southwest basin of Big Payette Lake.



Although oligotrophic, the lake accumulates organic matter in its lakebed sediments. When the oxygen supply becomes exhausted at the sediment-water interface, as it was at station 1 from September into December of 1995-96, redox conditions can develop that allow release of nutrients from the sediments into the overlying water column; such releases were measured in 1995 but not in 1996. If anoxia were to become a persistent feature in Payette Lake and extend upward in the hypolimnion, then the release of sediment-bound nutrients would constitute an additional, internal load of nutrients with which to fuel biological production.

The question implied by the title of this report, "Eutrophication Potential of Big Payette Lake, Idaho", should perhaps be re-stated as "Can Eutrophication in Payette Lake Be Reversed?" The substantial hypolimnetic dissolved oxygen deficits and development of anoxia constitute strong symptomatic evidence that Payette Lake has undergone eutrophication, despite its trophic state classification as oligotrophic. The lake's lengthy water residence time and incomplete water column circulation in the spring and autumn have prevented the lake from discharging some portion of its annual biological production. Consequently, a long term build up of nutrients and oxygen demanding substances in the lakebed sediments, coupled with the lake's biological production, has been large enough to create hypolimnetic dissolved oxygen deficits and in some years, anoxia. The calibrations and simulations used in the nutrient load/lake response model indicated the hypolimnetic dissolved oxygen deficit was relatively insensitive to moderate, and realistic, reductions in nutrient loads to the lake. Such insensitivity is due, in part, to the strong limitation by phosphorus of phytoplankton production. Given this insensitivity and low concentrations of phosphorus in the lake, the annual development of hypolimnetic dissolved oxygen deficits may be expected to continue, despite reductions of nutrient loads from nearshore and watershed sources. Conversely, an important water quality management goal may be to prevent increases in phosphorus loads to Payette Lake, given the strong limitation by phosphorus of phytoplankton production.

6.2 Recommendations

The following recommendations are based on the synthesis of information gathered during the technical study and represent the best professional judgement as to practical considerations where actions can enhance water quality protection. There are any number of alternatives that might be considered depending on time and costs.

6.2.1 Implementing Storm Water Controls for Stormwater Water Quality Management

Control of stormwater runoff and associated water quality is often difficult and expensive in urban areas. Homeowners frequently have no restrictions as to the type and amount of chemicals that may be applied to landscapes (fertilizers, pesticides, fungicides and herbicides) or structures which may leach materials during rain storms. Other pollutant sources include road surfaces (greases, gas, oil and heavy metals) and sediments from ground disturbance during construction. Contributions from this latter pollutant source were responsible for high concentrations of suspended sediments, turbidity and phosphorus entering the lake during the course of this study.

There are numerous site control measures or best management practices (BMPs) that can be implemented to address and reduce contributions of these contaminants entering the lake (Table 6-3). Many studies have shown the removal efficiency of specific substances such as sediments, nutrients and bacteria are highly variable depending on local topography, density of commercial and residential use, rainfall, soils and other characteristics. Table 6-4, adapted from Schuller (1987), lists some of the more common pollutant concerns for Big Payette Lake based on monitoring and the potential removal efficiency.

Table 6-3. Comparison of key pollutant removal efficiencies using an array of stormwater runoff control techniques (adapted from ASCE, 1992 citing Schueler, 1987).

BMP Design	Design Event	Suspended Sediment	Total Phosphorus	Total Nitrogen	Trace Metals	Bacteria	Overall Removal Efficiency
Extended Detention Pond	First flush runoff detained for 6-12 *hrs*	60-80%	20-40%	20-40%	40-60%	X	Moderate
	First 1.0 inch runoff detained 24 hrs	80-100%	40-60%	20-40%	40-60%	X	Moderate
	First 1.0 inch runoff detained 24 hrs plus filtration through shallow marsh	80-100%	60-80%	40-60%	60-80%	X	High
Wet Pond	Permanent pool equal to 0.5 inch storage per impervious acre	68-80%	40=60%	20-40%	20-40%	X	Moderate
	Permanent pool equal to 2 5 times the mean storm runoff volume	60-80%	40-60%	20-40%	60-80%	X	Moderate
	Permanent pool equal to 4 times the mean storm runoff = 2 week detention	80-100%	60-80%	60-80%	60-80%	X	High
Infiltration Trench	Exfiltrate first flush; 0.5 inch runoff per impervious acre	60-80%	40-60%	40-60%	60-80%	60-80%	Moderate
	Exfiltrate first 1.0 inch runoff per impervious acre	80-100%	40-60%	60-80%	80-100%	60-80%	High
	Exfiltrate all runoff up to the 2 yr storm event	80-100%	60-80%	60-80%	80-100%	80-100%	High

Table 6-3. Continued - Comparison of key pollutant removal efficiencies using an array of stormwater runoff control techniques (adapted from Schueler, 1987).

BMP Design	Design Event	Suspended Sediment	Total Phosphorus	Total Nitrogen	Trace Metals	Bacteria	Overall Removal Efficiency
Infiltration Basin	Exfiltrate first flush; 0.5 inch runoff per impervious acre	60-80%	40-60%	40-60%	40-60%	60-80%	Moderate
	Exfiltrate first 1.0 inch runoff per impervious acre	80-100%	60-80%	60-80%	80-100%	60-80%	High
	Exfiltrate all runoff up to the 2 yr storm event	80-100%	60-80%	60-80%	80-100%	80-100%	High
Porous Pavement	Exfiltrate first flush; 0.5 inch runoff per impervious acre	68-80%	60-80%	40-60%	40-60%	60-80%	Moderate
	Exfiltrate first 1.0 inch runoff per impervious acre	80-100%	60-80%	60-80%	60-80%	80-100%	High
	Exfiltrate all runoff up to the 2 yr storm event	80-100%	60-80%	60-80%	60-80%	80-100%	High
Filter Strip	20 foot wide turf strip	20-40%	0-20%	0-20%	20-40%	X	Low
	100 foot wide forested strip with level spreader	80-100%	40-60%	40-60%	80-100%	X	Moderate
Grassed Swale	High slope swales with no check dams	0-20%	0-20%	0-20%	0-20%	X	Low
	Low gradient swales with check dams	20-40%	20-40%	20-40%	0-20%	X	Low

Gravity storm drains located along the perimeter of the lake discharge variable quantities of stormwater runoff and pollutants. From a volume pollutant perspective, the Art Roberts Park and Marina storm drains consistently provide the largest volume of runoff and higher concentrations of pollutant measured. The Art Roberts Park drain currently has a sand trap incorporated into the design for removal of larger sized particles. The sand trap has not been maintained, however, and is no longer functional.. The trap also appears to be undersized for the volume of material passing through the system based on field observations during several storm events. An aggressive street cleaning program would significantly reduce the quantity of material washed from the streets during each storm event and reduce finer particle materials that are not retained by the sand trap from reaching the lake.

The Marina site is somewhat unusual in that a low volume discharge from this drain is present throughout most of the spring and summer even in the absence of local storm activity. During storms the discharge rate is greatly increased. These base flows are attributed to groundwater seepage into the system during periods when the groundwater table is high or through drainage of perched wetlands located to the east near the railroad grade. There is no sand trap or other filtration on this system. The existing outfall for this drain terminates at a headwall on the lake shoreline. A large deposit of fine silts and mud have collected in the vicinity of the outfall which re-suspends by turbulence during high flows following storms. Plumes of highly turbid water were observed on two occasions moving toward the lake following storms. Reconstruction of the outlet to reduce turbulence and transport of silts into the lake would be beneficial.

Smaller storm drains along the shoreline convey much smaller volumes of runoff but on a collective basis appear to influence a substantial length of the lake shoreline water quality. During one storm event, the entire shoreline from the dam eastward to the marina site was affected by an intense runoff event that produced a highly turbid plume throughout the shoreline. It was not possible to determine how long this material may remain in the vicinity before it is carried with long shore currents toward the dam outlet or migrates toward the lake. Many of these drains currently spill onto the lake shoreline and promote additional erosion. Additional retrofitting of these pipes may be required to extend the invert into deeper water to reduce turbulent erosion. A final site of consideration is the vicinity of Legacy Park. Several smaller storm drains are located near the public beach. These drains convey small but highly concentrated loads of bacteria and sediments from the downtown street drainage. The City is planning to divert some of this drainage to alternate outfalls as part of the redevelopment project. Diversion of storm drains away from the public beaches is encouraged and would reduce the potential of health risks.

6.2.2 Recommendations to Reduce Management-Caused Sediment Inputs

Two areas in which management activities can influence sediment contributions to streams and lakes in the watershed deal with surface erosion from construction and maintenance of roads and landslides from related road activities.

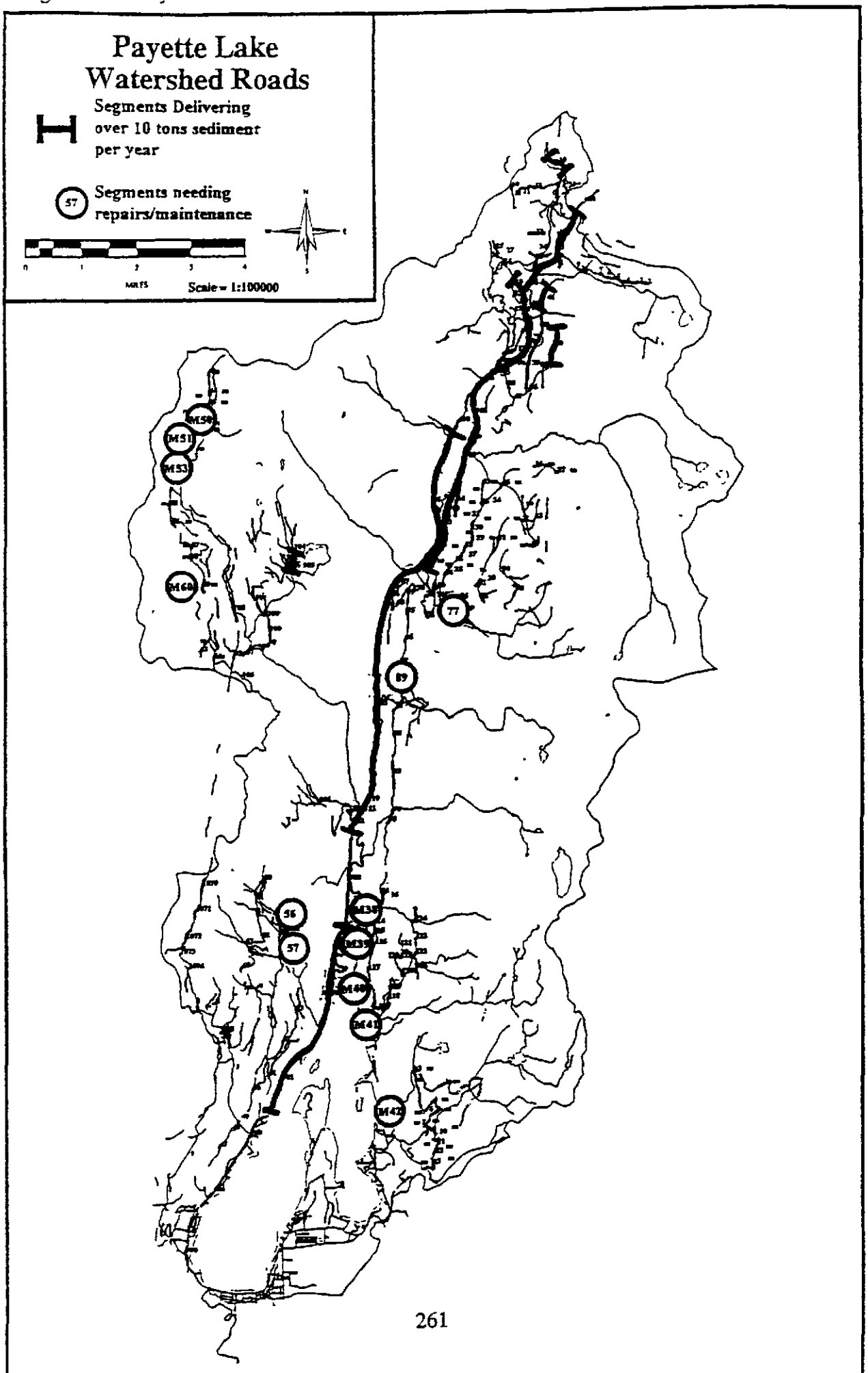
Surface Erosion

The majority of sediment contributed to aquatic systems from management-related sources in the Payette Lake basin is produced from road surface erosion. The USFS has compiled a Watershed Improvement Needs Inventory (WINI), listing sites on USFS land that could be improved to reduce erosion (USFS 1994). Road segments contributing large amounts (over 10 tons/year) of sediment to streams in the basin include: 903, 904, 41, 901, 38, 28, 46, 76, 30, 108, 905, 89, and 17 (Map 4; Appendix B). In addition, during the field work for the present project, road segments that the following road erosion sites were noted (Table 6-5). These sites are also marked on Map 4.

Table 6-5. Road erosion sites.

Road Segment	Road	Comments
56	IDL - Deadhorse Creek	Stream crossing; culvert and road fill eroding.
57	IDL - Deadhorse Creek	Culvert has overtopped, undermining and washing out road tread and fill. Approximately 20 cu yd eroded.
77	USFS 50432	Culvert has plugged, diverting creek down ditch, eroding ditch.
89	USFS 50437	Culvert blocked with debris; overtopped road, washed out road and fill. Approximately 10 cu yd eroded.
M38-M42	Main road E side of Payette Lake (Lake Drive)	Sand and gravel from road delivers directly into creeks and Payette Lake; sand visible in channels.
M50	USFS 50281	Cutslope/fillslope failures; undersized and blocked culverts.
M51	USFS 50281	Undersized culverts, severely eroded road tread.
M53	USFS 50281	Undersized culverts, road washed out.
M60	USFS 51498	Gully erosion

Figure 6-5. Payette Lake Watershed Roads



Lake trout prefer water temperatures less than 10°C (50°F) and depths of 18-53 meters (60-175 feet) for long-term physiological well being (Scott and Crossman, 1973). These conditions exist within the hypolimnion in Payette Lake and account for the good growth and survival of this lake trout population.

Additionally, the current trophy fishing regulation for lake trout in Payette Lake requires that most of the fish caught must be released. Hooking mortality of lake trout increases dramatically when fish are released into water without a well oxygenated thermal refuge. Lee, 1994 found that released fish escape to the bottom to recover from hooking stress. He reported that hooking mortality was 11.7% when a thermal refuge of <12°C with dissolved oxygen levels over 3 mg/l was available. Mortality increased to 87.5% when dissolved oxygen was less than 3 mg/l.

The dissolved oxygen objectives shall include the hypolimnion of Big Payette Lake and shall be measured in the lake's southwest basin at the following coordinates: 44 degrees 55 minutes 50 seconds North, 116 degrees 05 minutes 50 seconds West. Dissolved oxygen concentrations during June through September shall be equal to or greater than 6 milligrams per liter between the lake's surface and the 200 foot depth. Below the 200 foot depth and above 3 feet of the lakebed, the overall average dissolved oxygen concentration from June through September shall be greater than or equal to 3 milligrams per liter.

6.3.2 Nutrient and Chlorophyll Standards

At the present time, Payette Lake productivity is phosphorus limited. The U.S. Environmental Protection Agency (EPA) recommends a phosphate phosphorus standard not to exceed 50 mg/m^3 for surface waters entering lakes to reduce the risk of eutrophication. This limit presumes that inflow concentrations would be further reduced in the receiving lake through dilution and sedimentation of phosphorus so that the resulting lake concentrations would remain below threshold levels that would alter the trophic status. Idaho does not currently have a numerical standard for nutrients or chlorophyll (a photosynthetic pigment in algae that roughly estimates algal biomass or quantity) applied to lakes.

For Big Payette Lake, the median concentration measured in the lake epilimnion, where the majority of algal growth takes place, was 4-6 mg/m^3 total phosphorus and chlorophyll was 0.8-2.4 mg/m^3. Measures of trophic status use a lake concentration of 10 mg/m^3 total phosphorus (TP) as a break-point in determining that higher concentrations of TP would likely result in the classification of the lake as mildly productive (mesotrophic). A median TP standard of 6 mg/m^3 for Big Payette Lake would limit the productivity of the lake from further increases that would significantly alter the trophic status and related beneficial uses. A corresponding median standard for chlorophyll of 3.0 mg/m^3 would provide an acceptable level of productivity without significant impact to existing beneficial uses.

Chapter VII

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INSTREAM FLOW INCREMENTAL METHODOLGY

IFIM

collection of computer models and procedures to predict habitat changes due to changes in flow

allows a systematic evaluation of different water management options

not a 'black box', i.e. doesn't give single answer

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IFIM produces an estimate of the quality and quantity of available habitat based on changes in depth, velocity, and channel index

-estimate of fish habitat is referred to as Weighted Usable Area (WUA)

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PHABSIM
PHYSICAL HABITAT SIMULATION

-collection of computer programs used to relate changes in discharge or channel structure to changes in physical habitat availability

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UNDERLYING PRINCIPLES OF PHABSIM

-each species exhibits preferences within a range of habitat conditions it can tolerate

-ranges can be defined

-area of stream providing these conditions can be quantified as a function of discharge and channel structure

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PHABSIM has four main components

-data entry
-hydraulic simulation
-suitability index curves
-habitat simulation

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Hydraulic Simulation

-simulating water surface elevations and water velocities

-various models-

IFG4--stage/discharge
MANSQ--Manning's equation
WSP, HEC-2--step backwater

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Suitability Index Curves

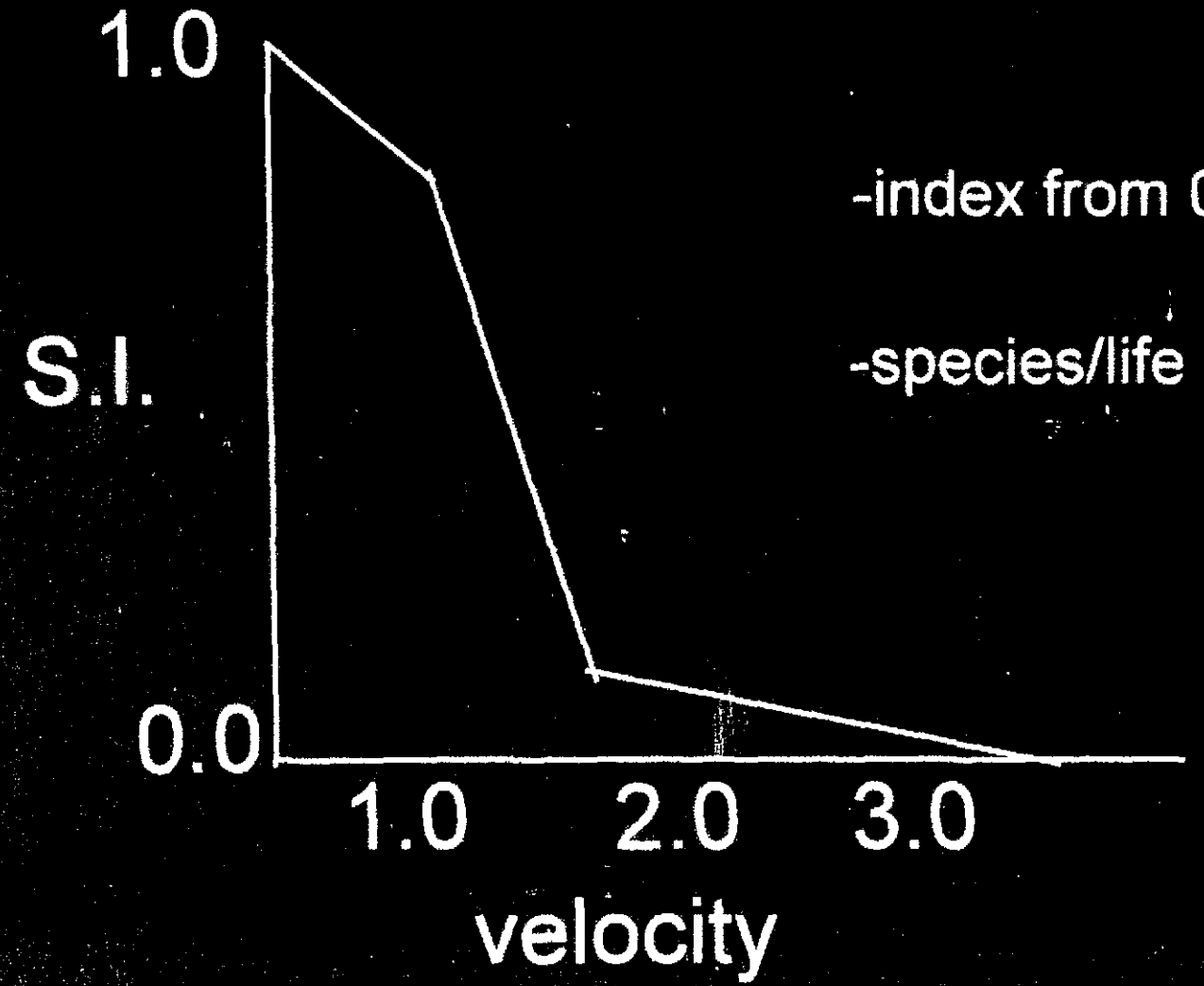
-behavioral characteristics of a species can be defined by a curve

-reflects preference of species for structural and hydraulic characteristics

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Suitablility Curve

Rainbow trout fry



-index from 0.0 to 1.0

-species/life stage specific

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Habitat Simulation

-integrates hydraulic simulation with habitat suitability data sets to produce a measure of available habitat as a function of discharge

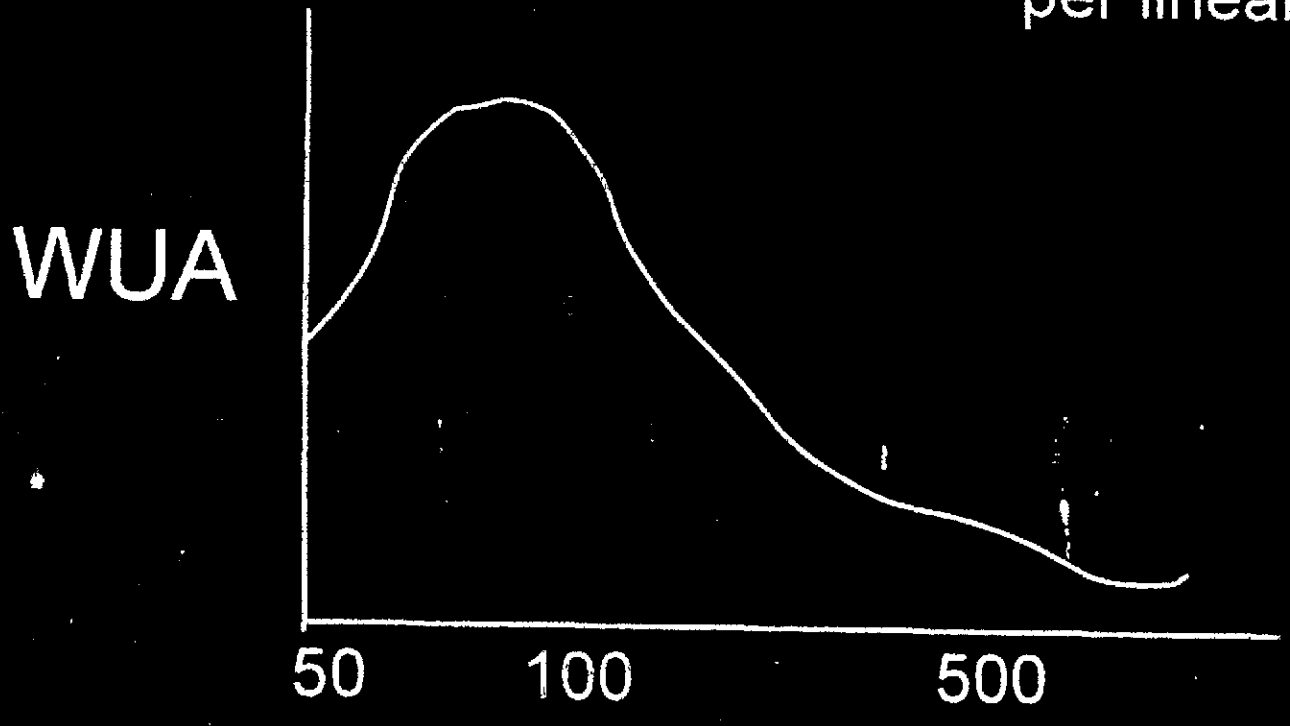
-composite suitability is multiplied by the area of cells to compute WUA

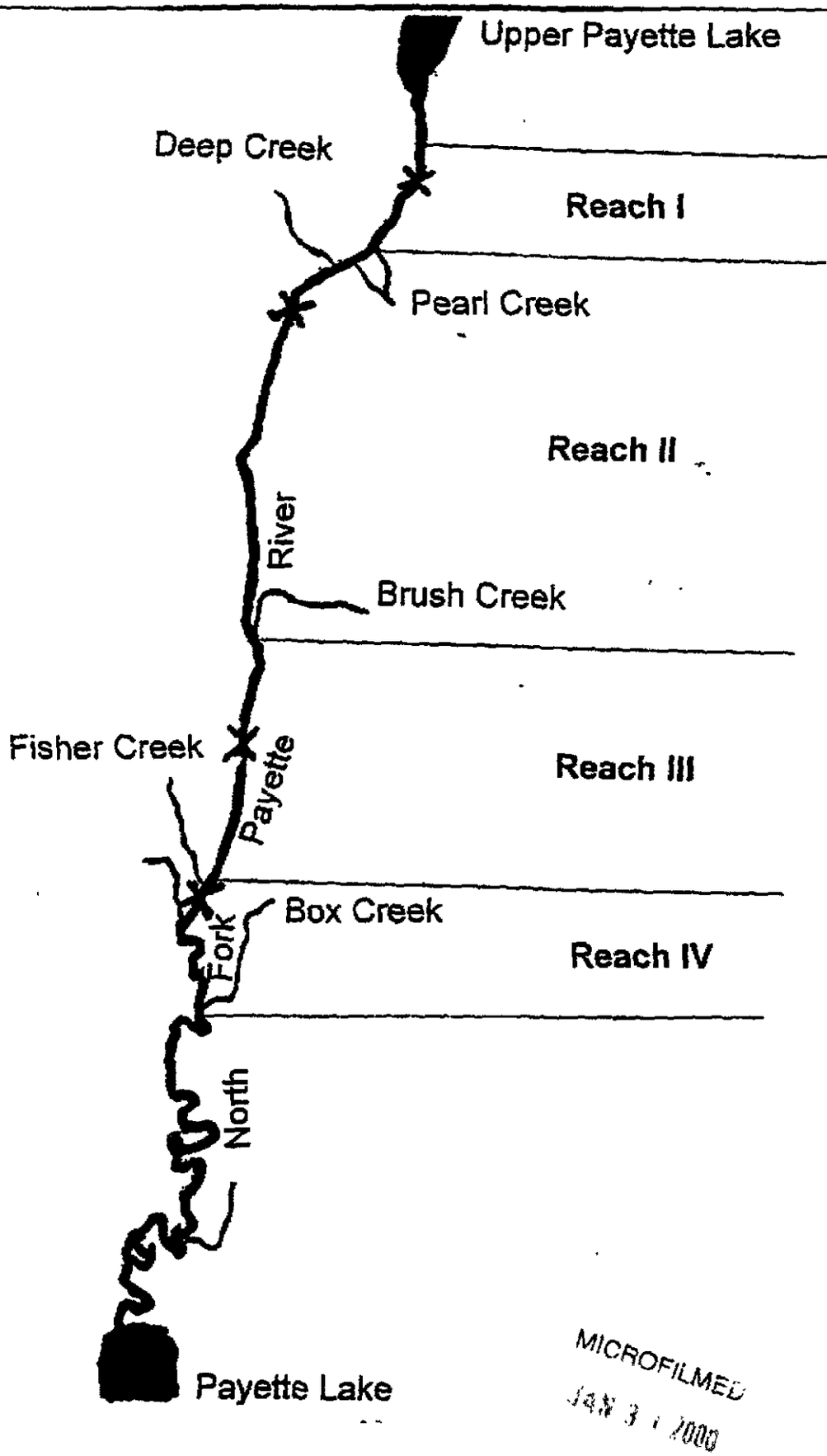
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Weighted Usable Area vs Discharge

weighted usable area--area per lineal distance



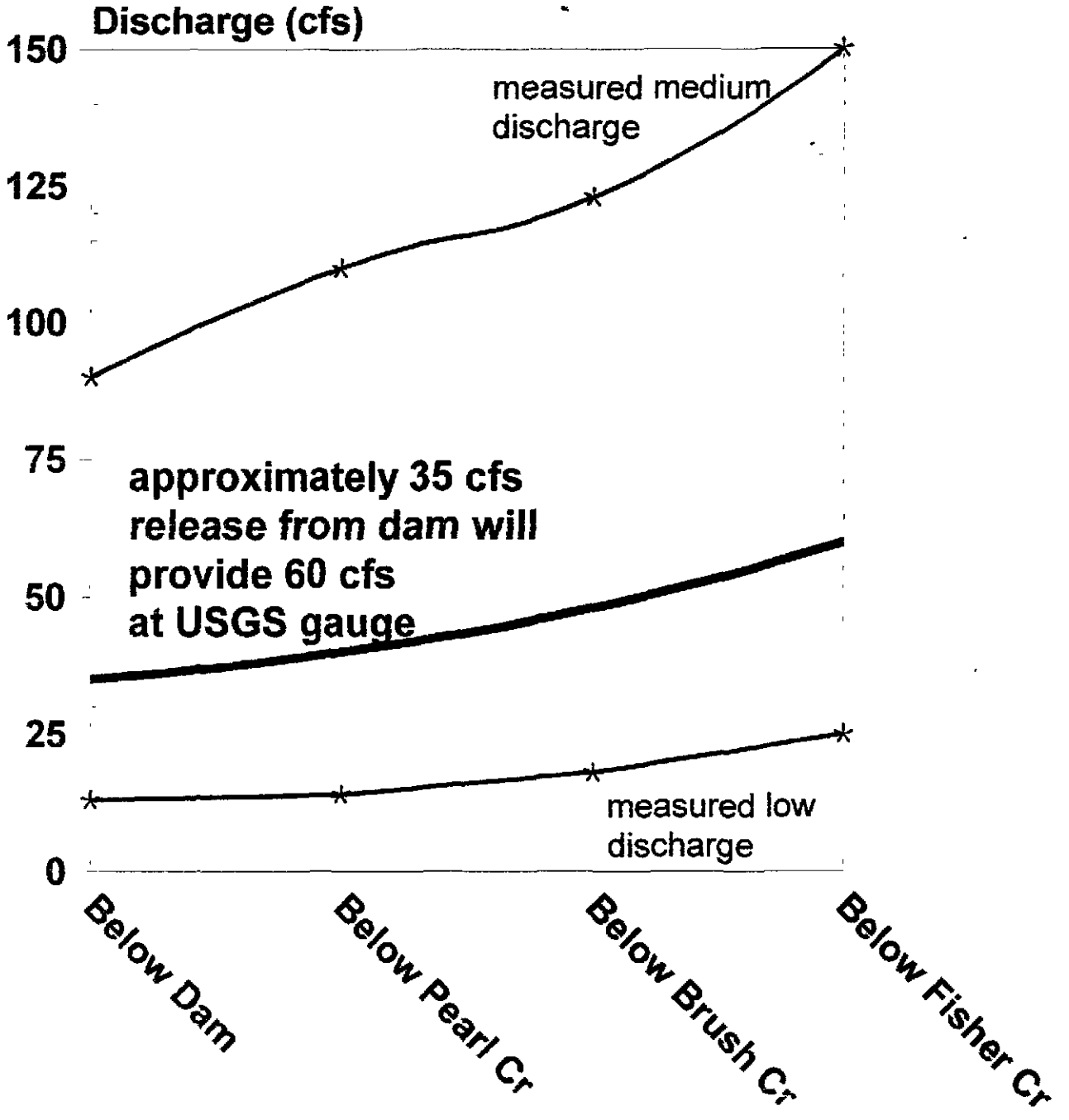


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Figure 2. Map of the upper North Fork Payette River with study reaches. Study sites are marked (X).

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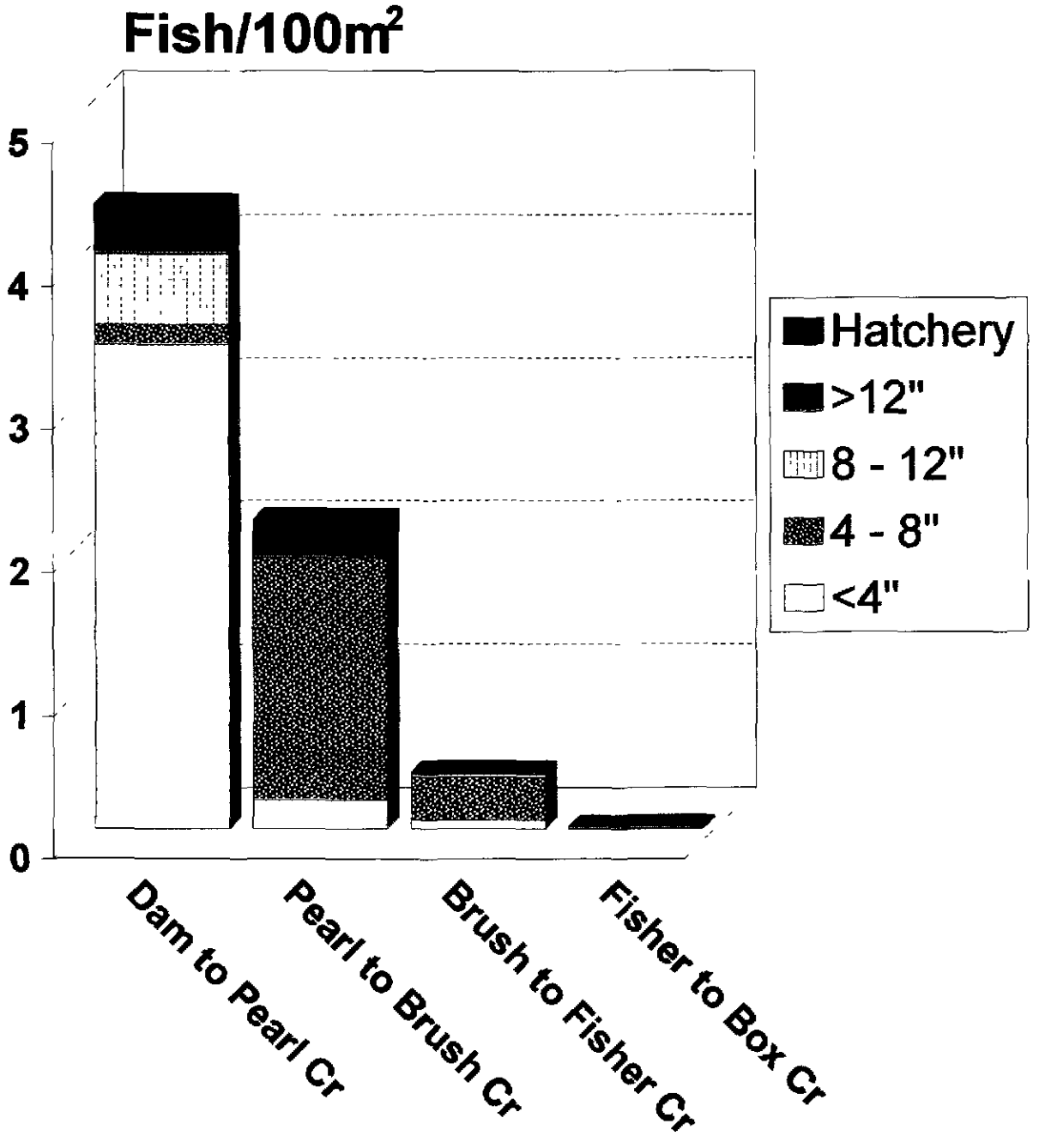
Discharge Relationship
Dam to USGS Gauge



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Exhibit IbP-6 2(b)
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Rainbow Trout Abundance
1996 Snorkel Survey



111 cfs at USGS gauge on July 24

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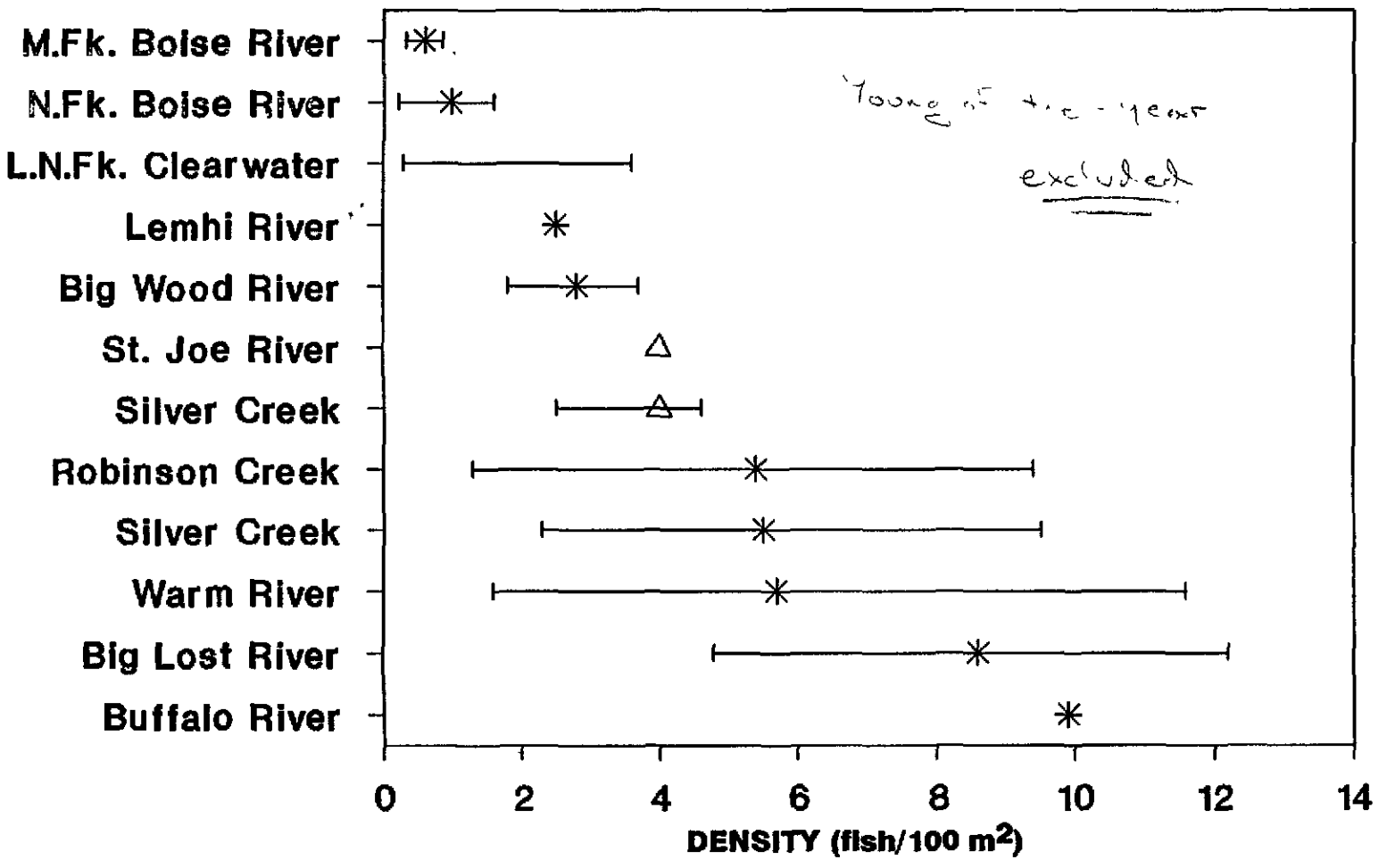


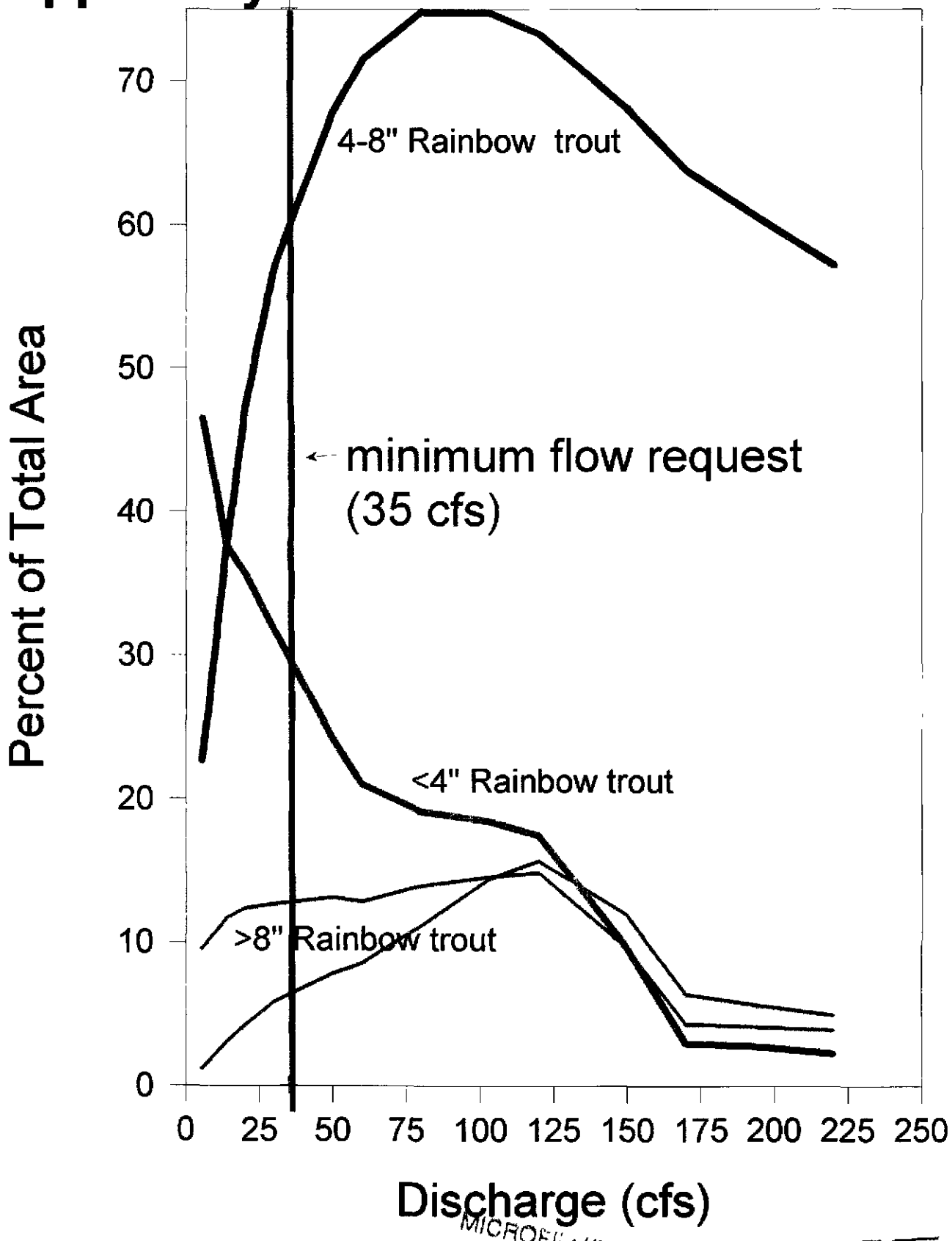
Figure 8. Densities of fluvial wild trout (fish/100 m^2) in Idaho waters from 10 to 50 m in width. Bars depict range of densities at various sites in the same stream. Triangles denote special regulation waters.

Schill, 1991

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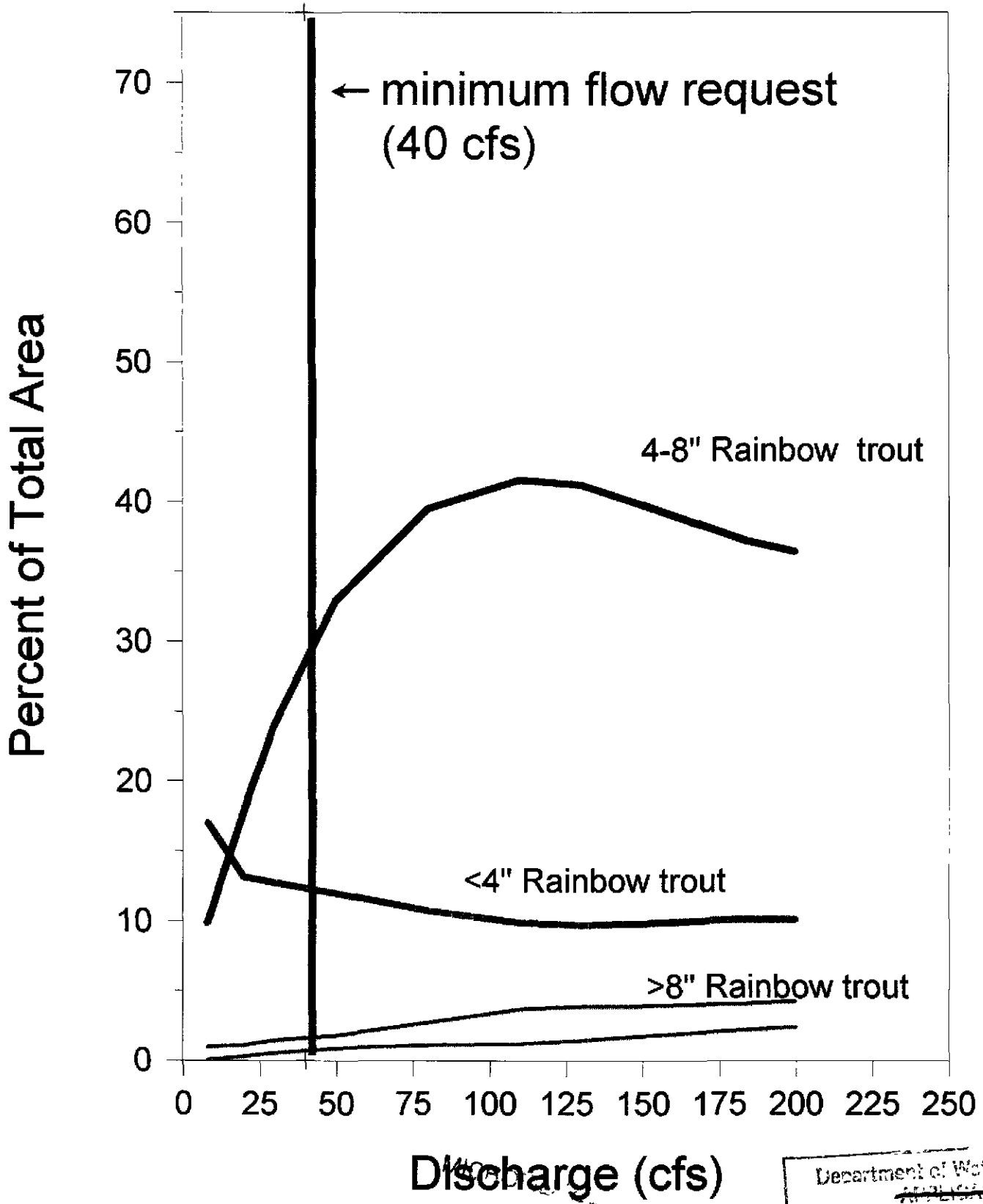
Upper Payette Lake Dam to Pearl Creek



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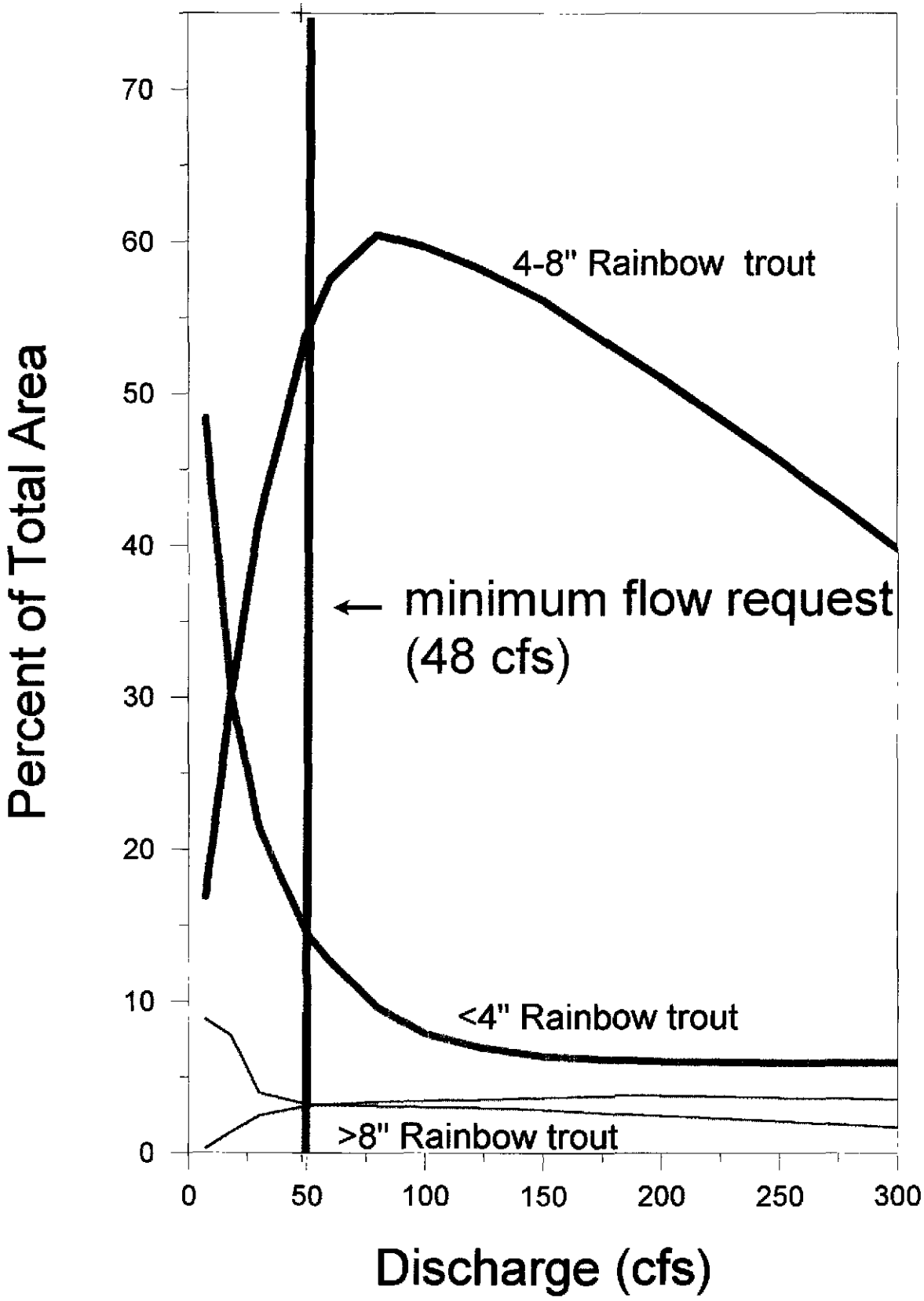
Pearl Creek to Brush Creek



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Exhibit DDP-6 3(k)
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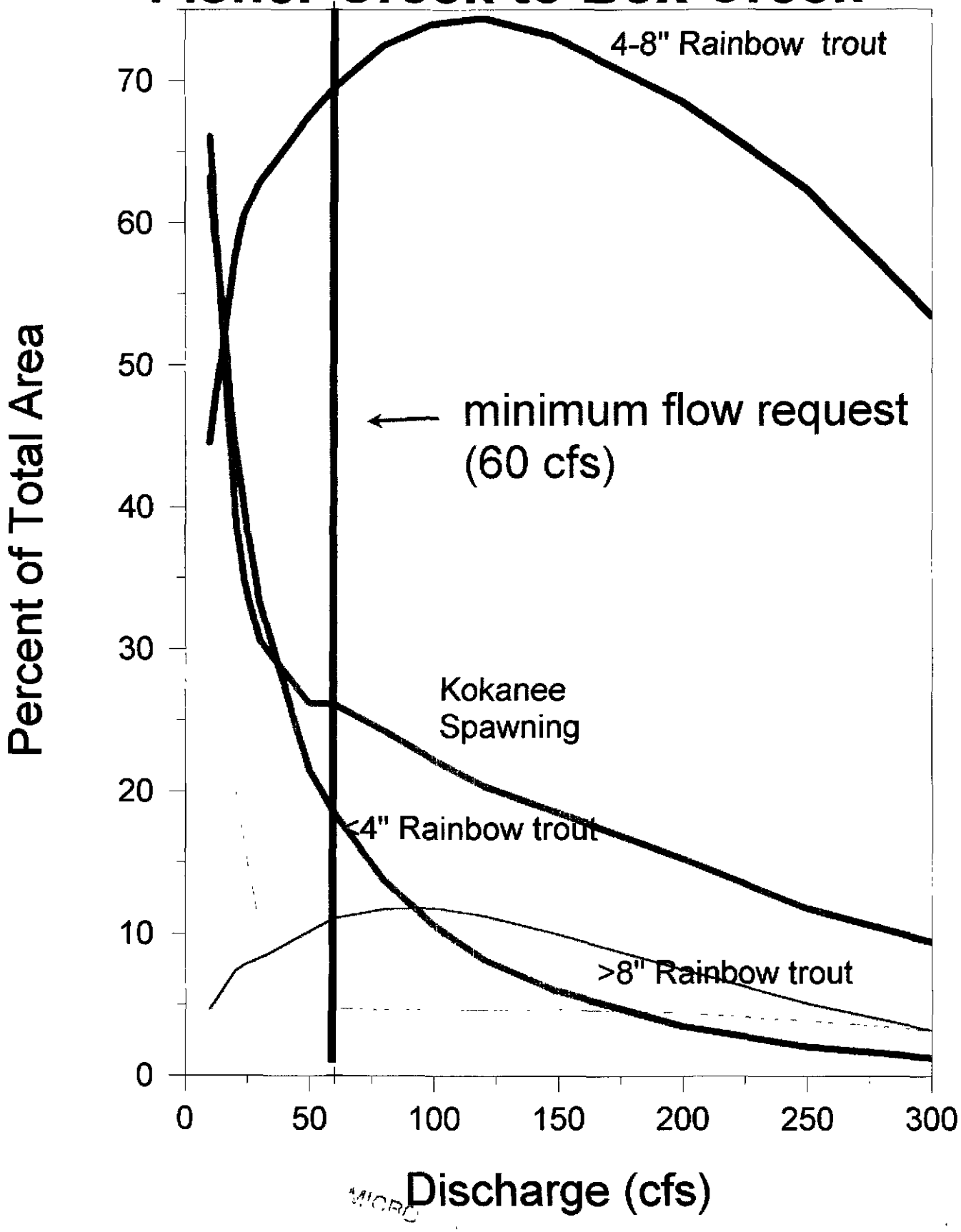
Brush Creek to Fisher Creek



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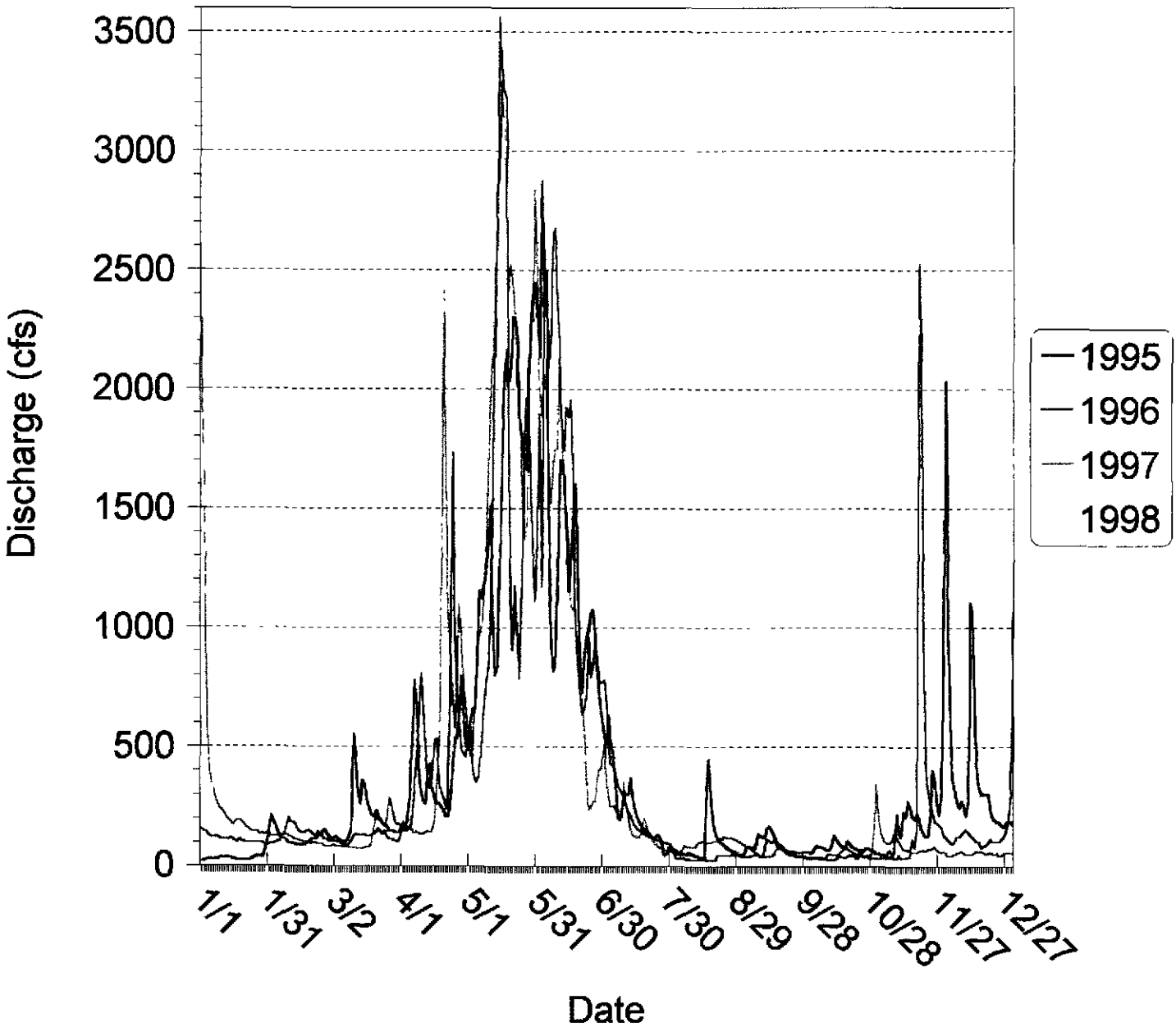
Fisher Creek to Box Creek



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IDF&G 2(h)
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North Fork Payette River Discharge
USGS Gauging Station Below Fisher Creek

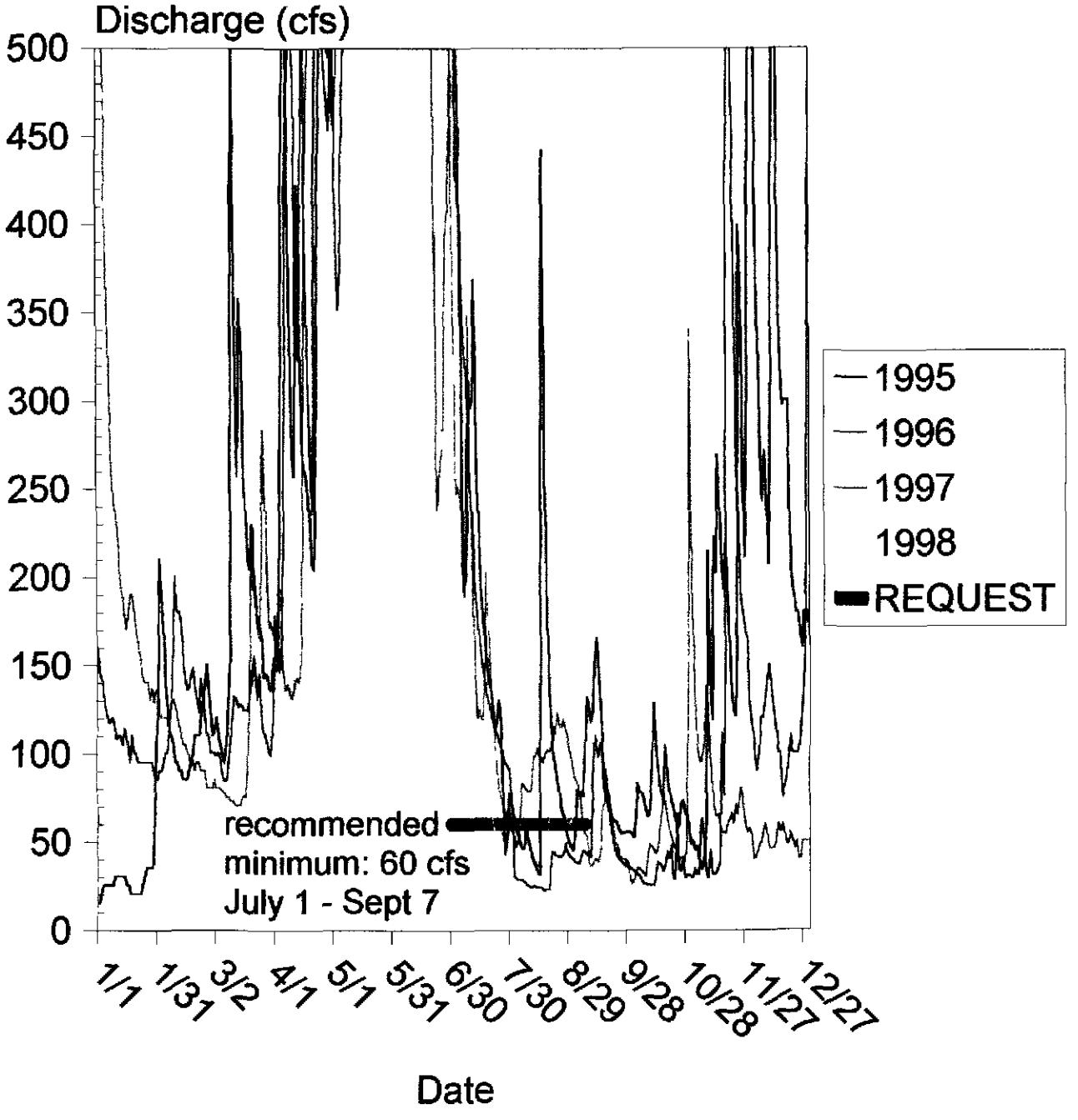


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North Fork Payette River

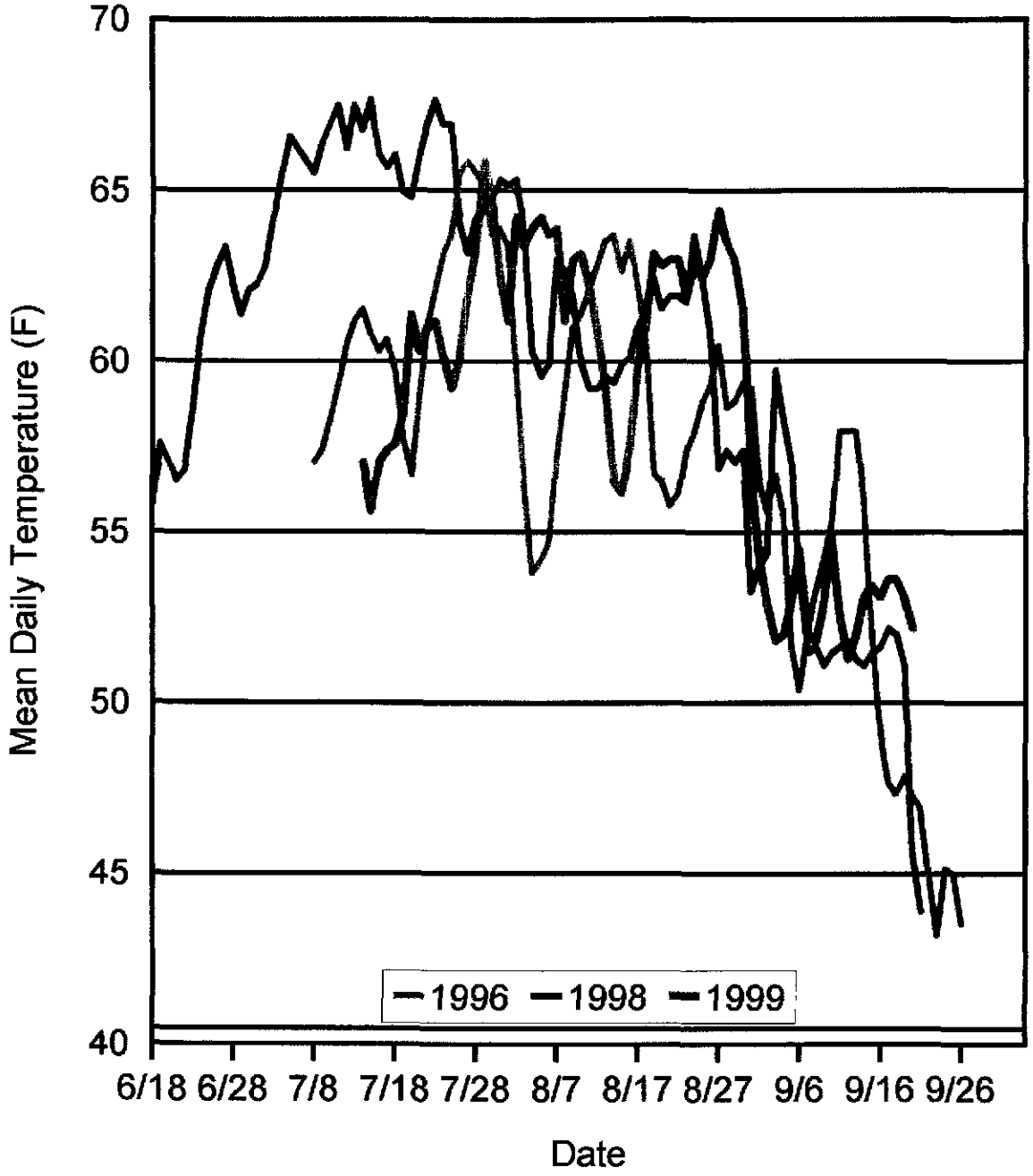
Recommended Summer Discharge at USGS Gauge below Fisher Creek



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2009

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North Fork Payette River
Water Temperature



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2009

Exhibit 10f+a 2(k)
Date Admitted 9-30-99

Instream Flow Study
and
Recommendation for
Minimum Summer Discharge
in the
Upper North Fork Payette River

(excerpted from: Technical Report on the Water Quality of Big Payette Lake: An Integrated Watershed and Lake Assessment, December 1997; by Division of Environmental Quality, Boise)

by

Kimberly A. Apperson
Regional Fisheries Biologist
Idaho Department of Fish and Game
McCall, Idaho

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Exhibit IDF+G 3
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Abstract (Section 6.1.1, p. 250)

The IDFG conducted a survey of minimum streamflow requirements necessary to maintain and enhance fish habitat on the North Fork Payette River between Upper and Big Payette Lake. An Instream Flow Incremental Methodology (IFIM) was used to identify critical thresholds of streamflow for resident fish populations. These results indicated that existing low streamflows during late summer fell below levels needed to sustain adequate numbers of pools for fish. It was determined that a minimum baseflow of 60 cfs (as measured at the USGS gauge below Fisher Creek) was required in the mainstem river from July 1 to September 7. This flow rate provided an acceptable minimum quantity of water depth and pools for rainbow trout and spawning kokanee. Habitat conditions would be improved but would remain below optimal conditions (with respect to water levels). To accomplish this goal, it was determined that 35 cfs discharge from Upper Payette Lake would be required in addition to the base flows provided by tributaries draining to the mainstem North Fork Payette River during this time period.

Introduction (Section 3.7, pp. 83-84)

The Lake Reservoir Company holds 3,000 acre feet of storage in Upper Payette Lake for use downriver near the town of Payette. This irrigation storage is typically released from Upper Payette Lake in late summer so that the company could meet other requirements for irrigation, Payette Lake levels and stream flows below Lardo dam. The minimum streamflow study was prompted by a concern that the needs of fisheries resources in the river below Upper Payette Lake have not regularly been met under past management of releases, and the needed resource flows have not been quantified. Figure 1 shows river discharge at the USGS gauge downstream from Fisher Creek for the period of record. The gauging station began operating October 1, 1994.

Methods (Sections 3.7.1 & 3.7.2, pp. 84-86)

Four reaches were identified in the North Fork of the Payette River from Upper Payette Lake Dam to slack water above Payette Lake based on gradient and frequencies of four habitat types (pools, riffles, runs, and pocketwater): I – Upper Payette Lake Dam to Pearl Creek, II -- Pearl Creek to Brush Creek, III – Brush Creek to Fisher Creek, and IV – Fisher Creek to Box Creek (Figure 2). In July, 1996 one study site was established in each reach. Each study site consisted of two or three transects. The downriver transect at each site was selected just above a hydraulic control that influenced water velocities and depths of the entire site. Streambed elevations were measured along each transect to 0.01 feet relative to a benchmark established at each site. Water

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surface elevation was measured for each transect on three occasions, at relative high, intermediate, and low discharges. Water velocities were measured at the downriver transect of each site on all three occasions. Velocities were measured at all other transects at the intermediate discharge only. Water surface elevation and velocities were measured on July 8 - 9, July 18 - 19, and August 7; at discharges of 310 cfs, 135 cfs, and 27 cfs, respectively (as measured by the USGS Gauge below Fisher Creek).

The computer-based Riverine Habitat Simulation (RHABSIM) program, developed by Thomas R. Payne (Payne and Associates 1995), was used to model the relationship between discharge and available fish habitat. This program is a modification of the Physical Habitat Simulation (PHABSIM) program, a part of the Instream Flow Incremental Methodology (IFIM) developed by the Midcontinent Ecological Science Center, U.S. Geological Survey, Fort Collins, Colorado. This group was formerly known as the Instream Flow Group and was under the administration of the U.S. Fish and Wildlife Service. The reader should consult Instream Flow papers No. 11 (Milhous et al. 1984) and No. 26 (Milhous et al. 1989) for a more in-depth discussion of the methodologies of the programs. I used habitat suitability curves from Cochnauer and Elms-Cockrum (1986) for rainbow trout, and Foster and Bennett's (1995) habitat suitability curves for spawning kokanee to quantify available fish habitat for a given discharge.

Summer water temperatures were monitored with a Hobo electronic temperature recorder (model HTI -5 to +35°C) placed in the river at the USGS gauging station downriver from Fisher Creek.

Fish density and length information was collected at each site by snorkeling on July 24. Five snorkelers moved abreast upstream from the downriver to the upriver transect, recording species, number and length of all salmonids seen. Discharge at the USGS gauge was 111 cfs.

Frequency of pools, riffles, runs, and pocketwater was determined by a "50 pace survey" on July 18 - 19, at a discharge of 135 cfs. To conduct the survey a person, taking uniform steps, walks down the river, and stops at every 50th pace, recording the habitat type at that specific location.

Results and Discussion (Section 4.7.1, pp. 186-190)

Quantity of habitat available for several life history stages of rainbow trout for the range of discharges measured are presented in Figure 3 and Appendix A. Habitat availability for spawning kokanee was also determined for Reach IV, below Fisher Creek. All reaches show similar trends in available habitat as discharge increases.

The two categories of juvenile rainbow trout (<4" and 4-8") are the most sensitive, and

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have the most conflicting, life history stages with respect to quantity of habitat that is available with changing discharge. As discharge increases depths become more suitable for 4-8" fish, then velocities begin to limit habitat when flows exceed 100 cfs. Conversely, conditions are more suitable for fry and yearling trout at low flows because velocities are low and depth >0.5 feet does not limit use.

Peak spawning of kokanee in the river occurs by September 7 (Bennett and Frost 1995). During the two years of their study Bennett and Frost observed kokanee migration onto spawning grounds coincided with increased flows (caused by evacuation of upriver reservoirs), that peaked at an average of 114 cfs. Kokanee continued to spawn through mid-October as flows decreased to 14 cfs. This decrease in flows did not result in a significant number of dewatered redds; and redds that were subsequently dewatered appeared to remain moist throughout incubation. Bennett and Frost stated: (Fry and alevin) "survival in dewatered redds was similar to survival in areas that were watered throughout the incubation period." The authors recommended, however, that "reservoir evacuation should occur over an extended period of time and not be limited to short releases of large amounts of water and should be completed by the end of the first week in September."

To maximize habitat available for 4-8" trout without severely reducing habitat for smaller juveniles, and to provide adequate habitat for kokanee spawning, we recommend a minimum discharge of 35 cfs from Upper Payette Lake, to provide 60 cfs at the USGS gauging station below Fisher Creek from July 1 through September 7. We recommend that the Lake Reservoir Company consider this minimum release from Upper Payette Lake in the management of their reservoir storage, realizing that the avalability of water for this flow is subject to annual water supplies, irrigation demand, and the possible consequences to other uses downstream. The IDFG will also pursue a stream resource maintenance flow, to be held by the Idaho Water Board. This will not effect senior water rights, but will indicate a desire for the maintenance of resource flows in the future.

This flow will maintain the fisheries resources in the upper North Fork Payette River (Figure 4). Available habitat for rainbow trout is higher at lower discharges in the upper reaches vs. lower reaches. This seems reasonable, as critical depth would be maintained in the narrower upper river at lower discharges. The discharge relationship developed from our data shows that approximately 35 cfs released from Upper Payette Lake during summer will provide 60 cfs to the river below Fisher Creek (Figure 5). After September 7 flows should be decreased to base flows to avoid dewatering of kokanee redds. Management of water releases into Fisher Creek from Granite Reservoir was not considered in this study. At this time we leave recommended changes in release management of Granite Lake and Box Lake to the Lake Reservoir Company so they can coordinate releases from the reservoirs to best meet the competing water needs.

Habitat availability for spawning rainbow trout was included merely for interest. An

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analysis of substrate would be necessary to actually quantify spawning habitat.

Water temperatures in the river in 1996 did not exceed 21°C (70°F) and therefore were not limiting to rainbow trout (Scott and Crossman 1979) (Figure 6). We will continue to monitor summer river temperature until data are collected over an adequate range of weather and water conditions.

Fish species observed during the snorkeling survey included rainbow trout, cutthroat trout, mountain whitefish, largescale sucker, sculpin, and dace. Densities were dominated by juvenile rainbow trout (Figure 7). Total densities of naturally produced trout ranged from a high of 4.4 fish/100m^2 at the upper reach to a low of 0.02 fish/100m^2 (one fish observed) in Reach IV. Density of rainbow trout ≥6" were less than one fish/100m^2, low compared with other similar sized rivers throughout Idaho (Schill 1991).

Approximately 5,000 catchable sized rainbow trout (>9") are stocked annually throughout the upper North Fork Payette River from June through August. Another 10,000 rainbow trout are stocked in Upper Payette Lake. We know that some of these fish go downriver. Splake also leave the lake.

Three hatchery reared rainbow trout were observed during snorkeling, and only in the two upper reaches. A few splake were observed during our snorkeling survey of the upper reach, but were outside of the measured area, so densities were not calculated.

In addition to rainbow trout, three juvenile cutthroat trout (4-5") were observed in Reach II; five whitefish (8-10") were observed in Reach I, and three 12" whitefish were counted in reach III. Non-salmonid fishes were noted as present, but not counted.

Habitat frequency data shows the paucity of pools (5% of the total distance) in the upper North Fork Payette River (Figure 8). Autumn pool frequency in a stream between 35% and 65% is considered ideal for adult rainbow trout (Raleigh et al. 1984). Our survey to determine frequency of habitat was conducted at a discharge approximately three fold higher than average fall base flows, but given the relatively steady gradient of the river we do not expect pool frequency to increase significantly with reduced discharge.

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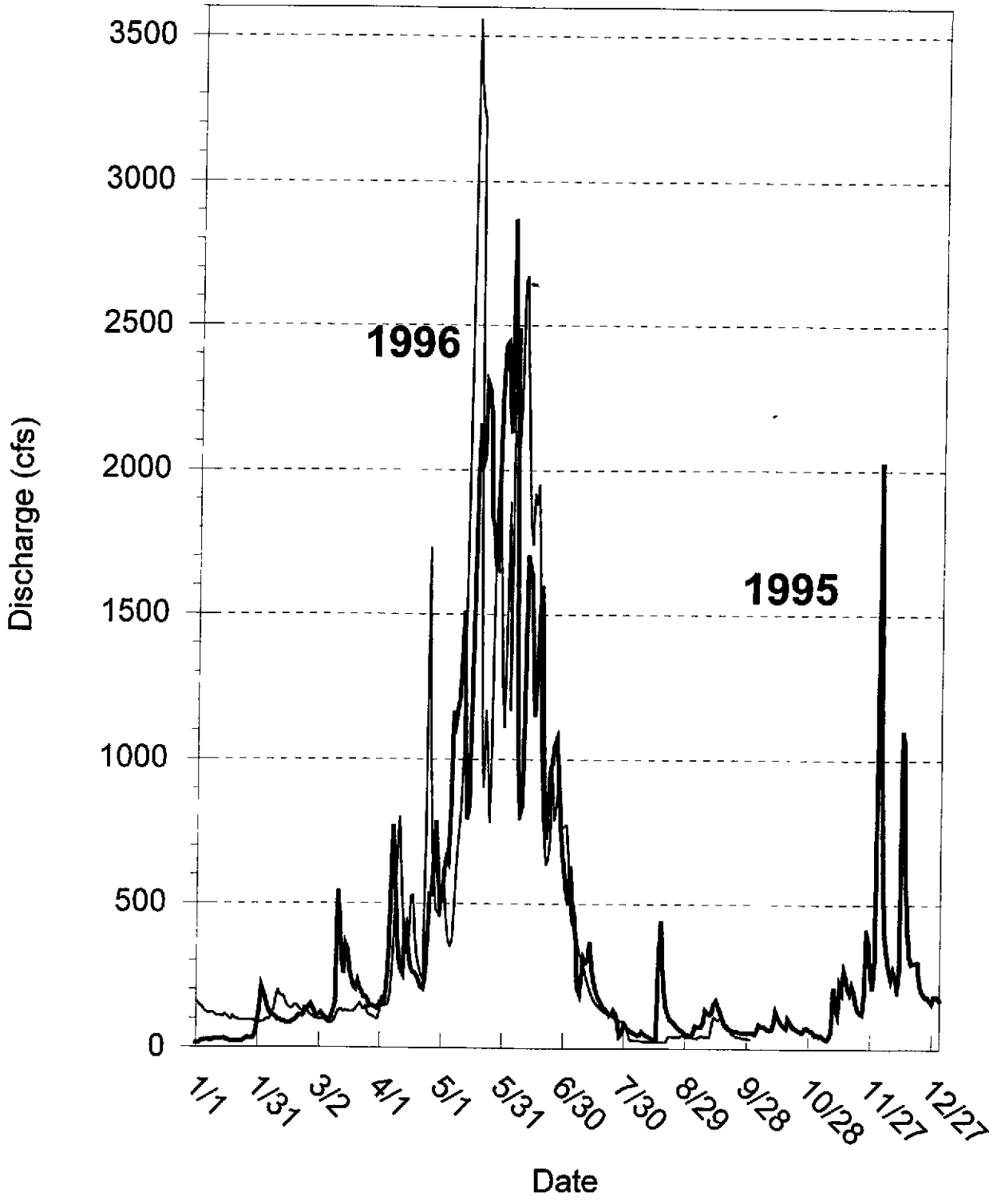


Figure 1. Discharge in the North Fork Payette River at the USGS Gauge below Fisher Creek, 1995 and 1996.

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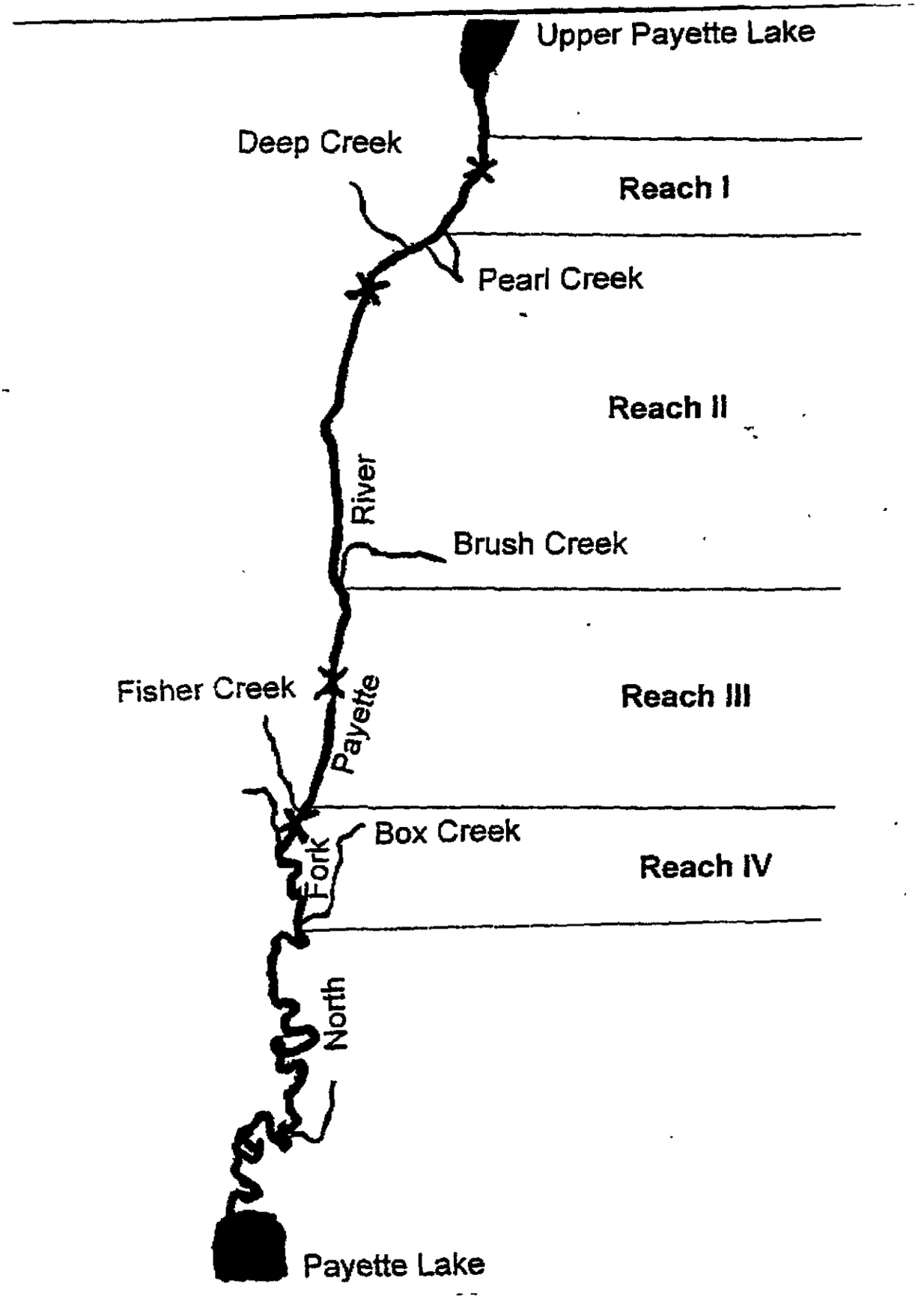


Figure 2. Map of the upper North Fork Payette River with study reaches. Study sites are marked (X).

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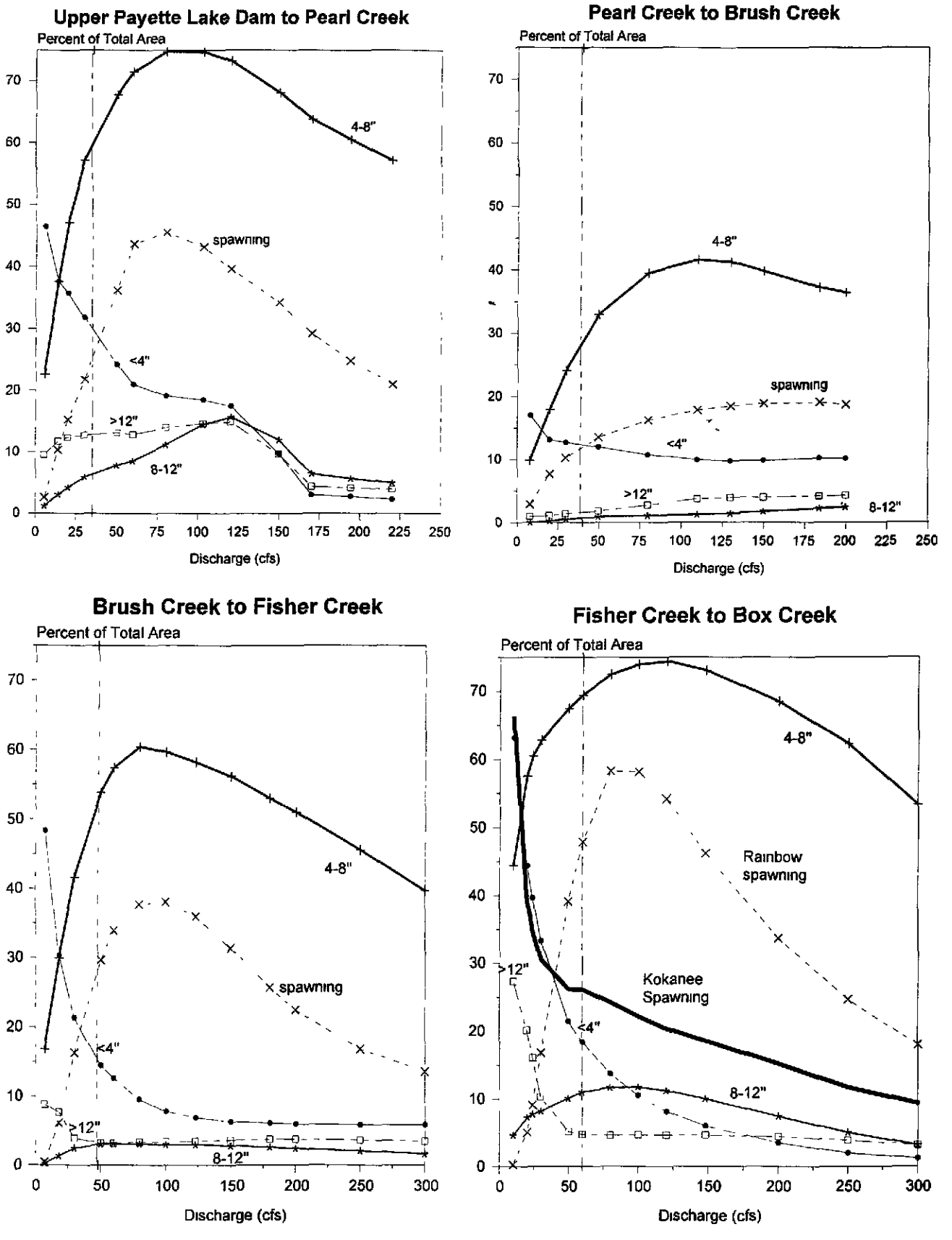


Figure 3 Habitat available to rainbow trout and spawning kokanee at various discharges in the upper North Fork Payette River, expressed as a percent of the total area of each study site. Vertical line in each chart represents recommended minimum discharge for that reach.

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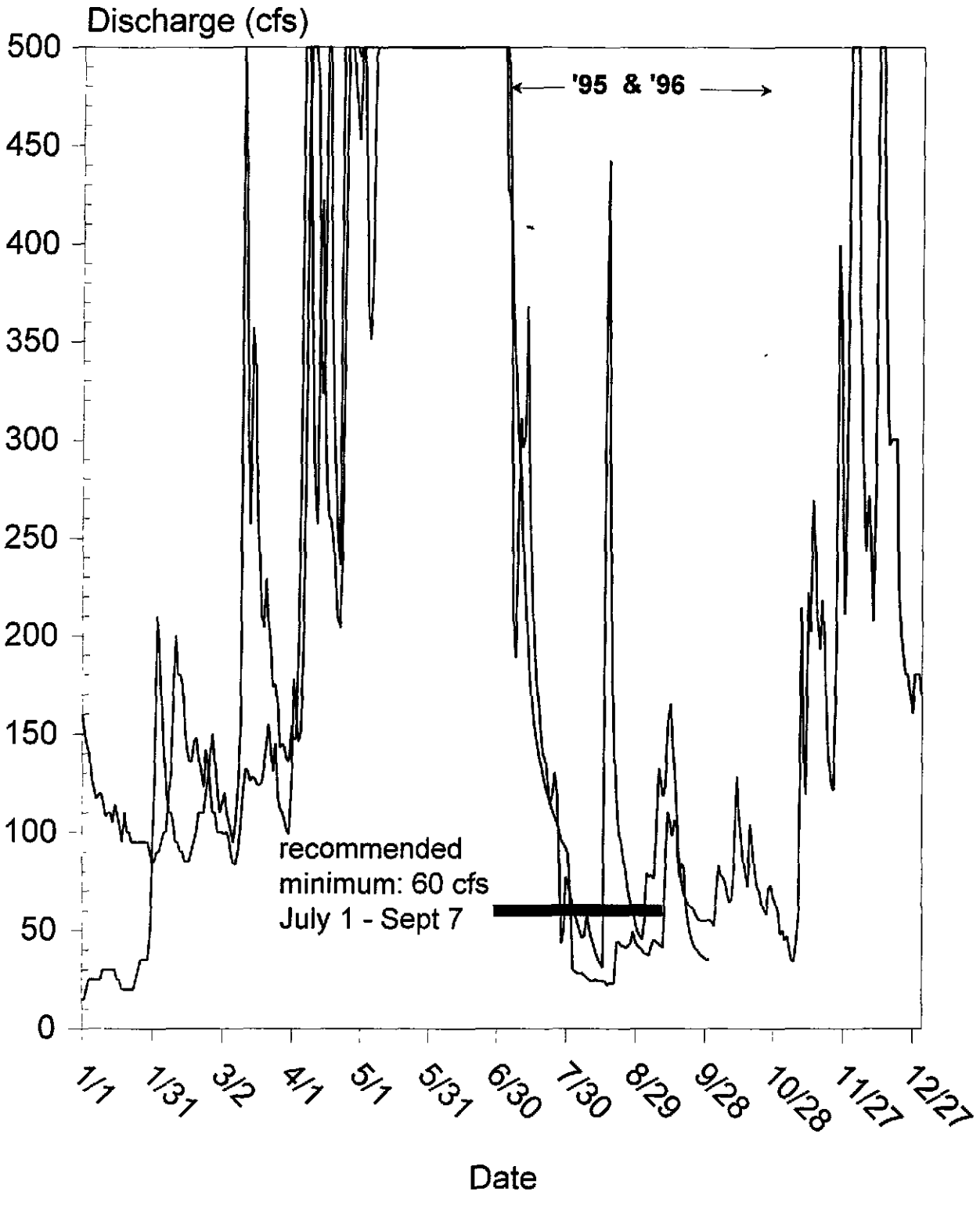


Figure 4. Recommended summer discharge for upper North Fork Payette River, as measured at the USGS gauge below Fisher Creek.

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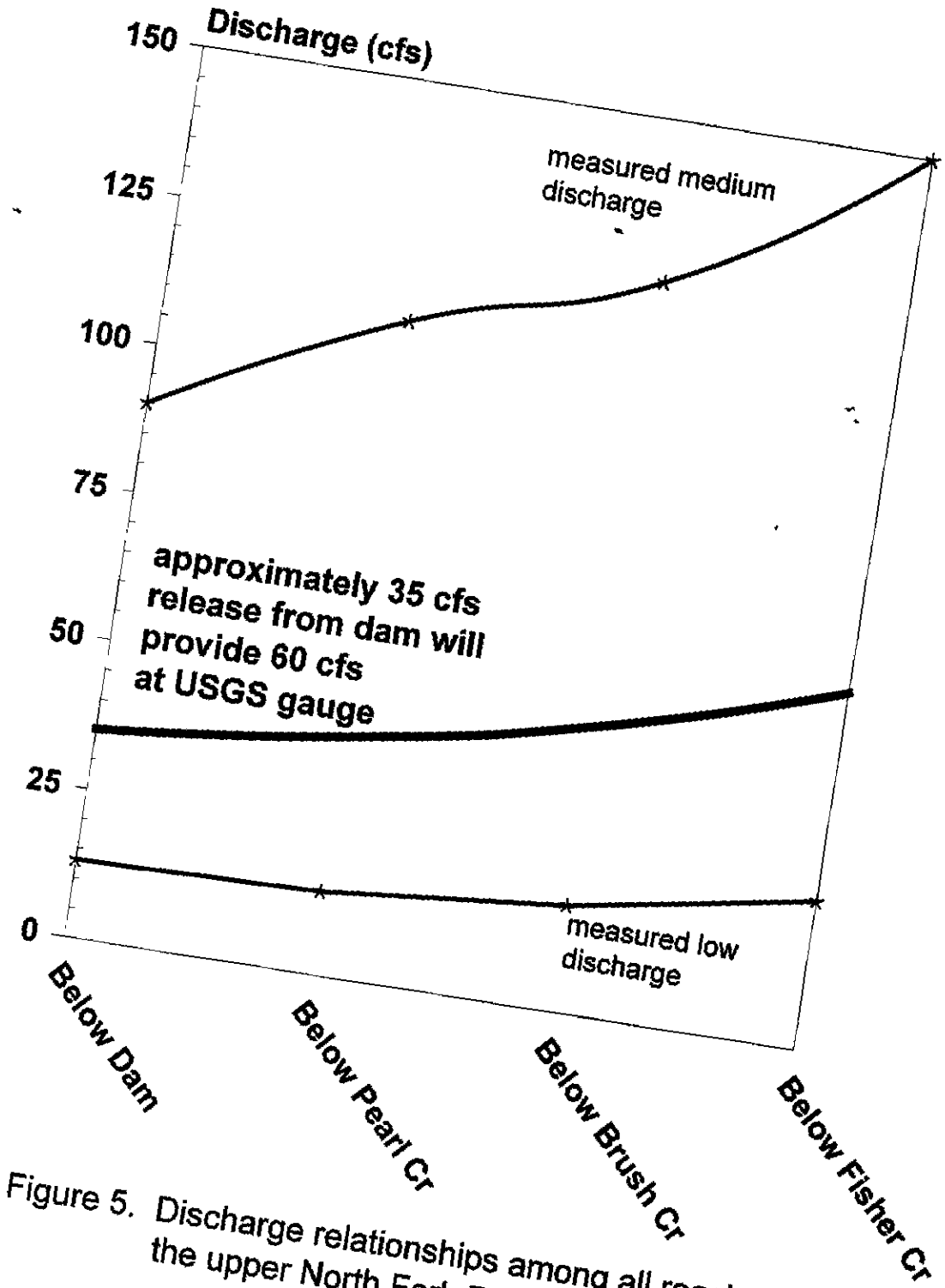


Figure 5. Discharge relationships among all reaches of the upper North Fork Payette River.

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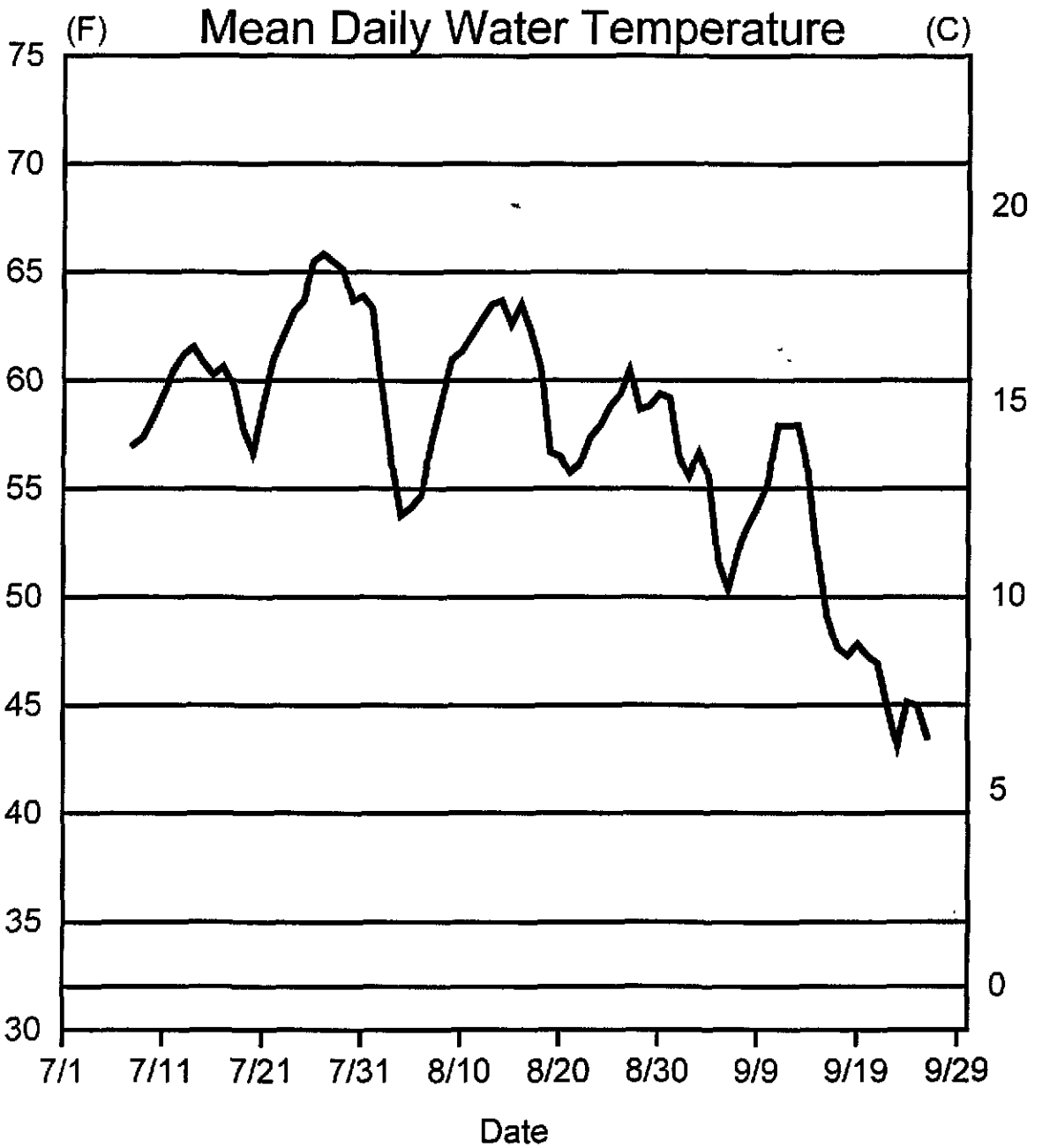


Figure 6. Summer water temperatures in the North Fork Payette River at the USGS Gauge, 1996.

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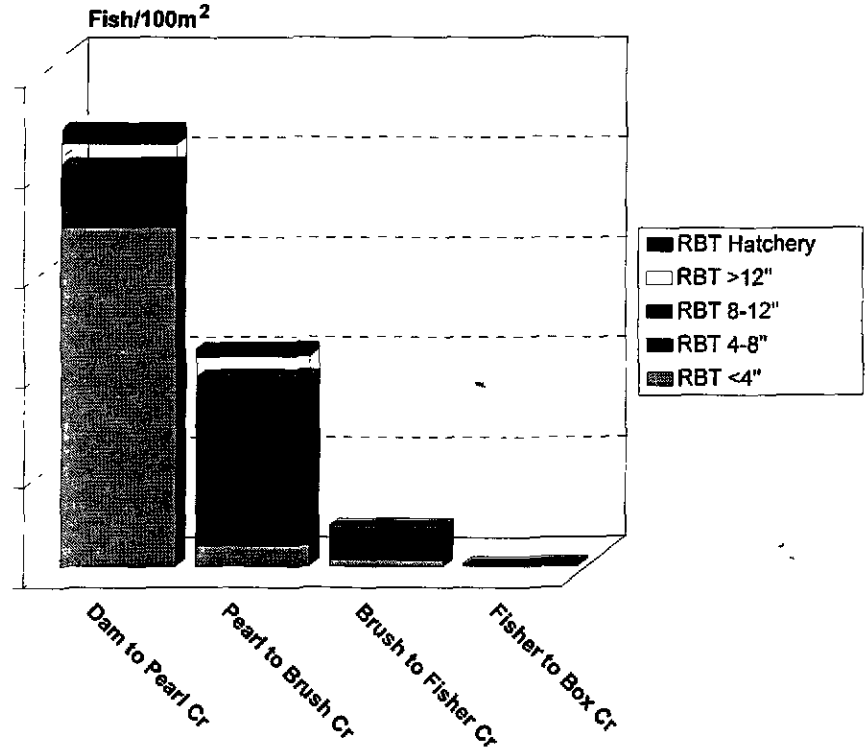


Figure 7 Densities of rainbow trout in study reaches of the upper North Fork Payette River, 1996

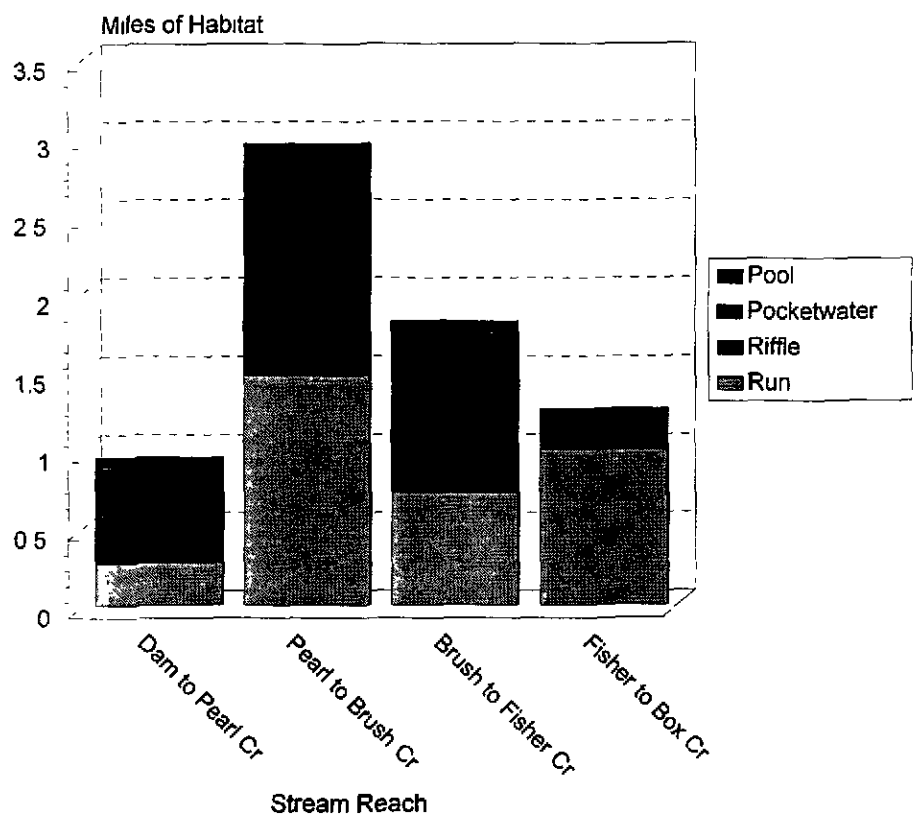


Figure 8 Quantity of habitat types in the upper North Fork Payette River

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Reach I -- Upper Payette Lake Dam to Pearl Creek							
Discharge (cfs)	Total Surface Area of Study Site	Available Habitat as Percent of Total Surface Area					
		Rainbow Trout					Kokanee
		<4"	4-8"	8-12"	>12"	Spawning	Spawning
6	42,563	46.44	22 58	1.18	9.50	2.56	--
14	51,081	37 64	37 60	3 02	11.68	10 28	--
20	52,087	35.73	47.06	4 19	12 31	15.21	--
30	53,266	31.74	57 14	5.84	12.66	21.70	--
50	55,154	24.16	67 78	7 79	13.12	36 19	--
60	55,957	20 96	71.49	8.51	12.82	43.69	--
80	57,358	19.08	74 74	11.14	13.93	45.47	--
103	58,750	18 41	74.71	14.40	14.55	43.16	--
120	59,536	17.43	73.25	15 65	14.85	39.58	--
150	60,443	9.65	68 09	11.89	9.59	34.21	--
170	61,195	2.94	63 76	6 38	4.31	29.17	--
194	62,441	2 72	60.49	5.61	4 11	24.73	--
220	63,244	2.23	57 16	4 92	3 87	20.88	--
ReachII -- Pearl Creek to Brush Creek							
Discharge (cfs)	Total Surface Area of Study Site	Available Habitat as Percent of Total Surface Area					
		Rainbow Trout					Kokanee
		<4"	4-8"	8-12"	>12"	Spawning	Spawning
8	39,142	17 00	9.8	0.00	0 94	2.84	--
20	51,017	13.10	17 92	0 26	1.08	7.64	--
30	55,175	12 70	24 04	0 51	1.40	10.24	--
50	60,778	11 91	32.85	0.84	1.74	13.45	--
80	63,497	10.67	39.42	1.05	2.67	16.16	--
110	64,928	9.85	41.51	1.18	3 64	17.74	--
130	66,460	9.68	41 16	1 39	3.87	18.37	--
150	67,622	9 77	39.74	1.69	3.90	18.79	--
184	69,220	10 09	37.14	2.17	4.05	18.96	--
200	69,908	10 08	36.37	2 36	4.23	18 62	--

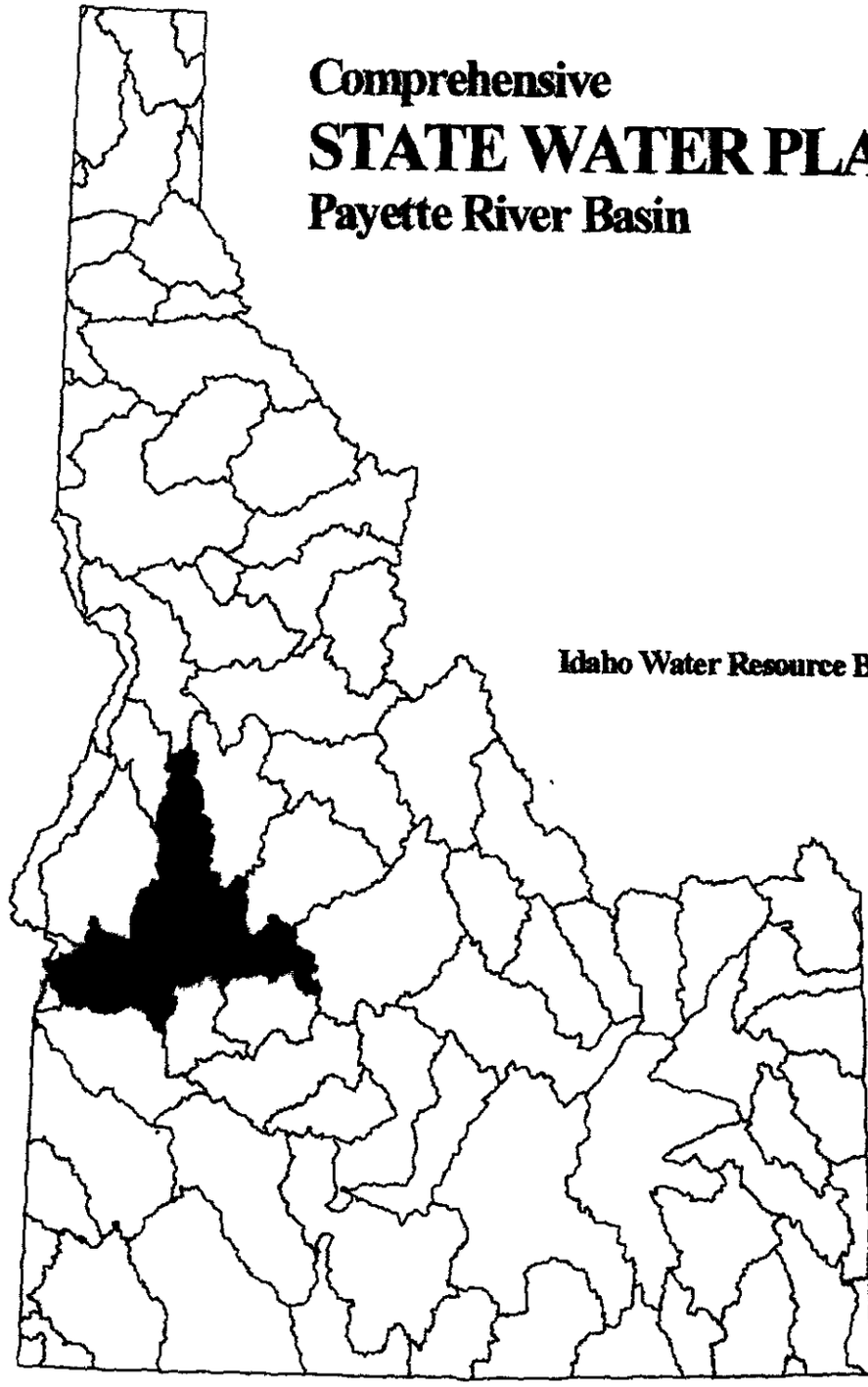
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Reach III -- Brush Creek to Fisher Creek							
Discharge (cfs)	Total Surface Area of Study Site	Available Habitat as Percent of Total Surface Area					
		Rainbow Trout					Kokanee
		<4"	4-8"	8-12"	>12"	Spawning	Spawning
7	56,661	48.37	16.80	0 23	8 77	0.41	--
18	62,019	30.27	29 92	1.32	7 67	6 13	--
30	65,278	21 32	41.59	-2.43	3 91	16.24	--
50	67,519	14.43	53 8	3.06	3.20	29.61	--
60	68,042	12.63	57 43	3 13	3 15	33.91	--
80	69,550	9.57	60 42	3 10	3.36	37 69	--
100	70,380	7 81	59.63	2.99	3 40	38.05	--
123	71,250	6.91	58 19	2 95	3.47	35 92	--
150	71,417	6.32	56 12	2.81	3.63	31.32	--
180	71,584	6 10	52.95	2 57	3 74	25.65	--
200	71,688	5.99	50.98	2.41	3 75	22 43	--
250	71,918	5 89	45.58	2 06	3.63	16.80	--
300	72,125	5.90	39 70	1 64	3 49	13.57	--
Reach IV -- Fisher Creek to Box Creek							
Discharge (cfs)	Total Surface Area of Study Site	Available Habitat as Percent of Total Surface Area					
		Rainbow Trout					Kokanee
		<4"	4-8"	8-12"	>12"	Spawning	Spawning
10	70,086	63 18	44 48	4.65	27 34	0 25	66 04
20	72,632	44.36	57 58	7.31	20.14	5.08	39 48
24	73,684	39 66	60 49	7 77	16.06	9.09	34.59
30	75,782	33.27	62 80	8 22	10.30	16.81	30.53
50	80,090	21.45	67 46	10 11	5 20	39 10	26.18
60	80,762	18.44	69.43	11 04	4.76	47 86	26 12
80	81,523	13 73	72 41	11 69	4 62	58.26	24 23
100	82,147	10.58	73.93	11.78	4 70	58.17	22.19
120	82,680	8 17	74.36	11.24	4 66	54 17	20 36
148	83,329	6.01	73 06	10 04	4.64	46 17	18 58
200	84,360	3 48	68 46	7 45	4.43	33.66	15.24
250	85,169	2.00	62.29	5 06	3.88	24.66	11 77
300	85,860	1.21	53 39	3 16	3.18	18.00	9.38

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IWRB Exhibit A'
(Applicant's)

Comprehensive
STATE WATER PLAN
Payette River Basin



Idaho Water Resource Board
1999

Exhibits

admitted 9-30-99

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Cover — Table of Contents Only

IDAHO COMPREHENSIVE STATE WATER PLAN

Payette River Basin

Prepared by: Idaho Department of Water Resources
Water Planning Bureau

Prepared for: Idaho Water Resource Board

Clarence A. Parr, Chairman
Joseph L. Jordan, Vice-Chairman
J. David Erickson, Secretary
Robert Graham
Erval Rainey
Jerry R. Rigby
L. Claude Storer
Terry T. Uhling



Adopted February 5, 1999

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IWRB Exhibit A-1
(Applicant's

BEFORE THE WATER RESOURCE BOARD
OF THE STATE OF IDAHO

IN THE MATTER OF THE PAYETTE RIVER BASIN COMPONENT OF THE COMPREHENSIVE STATE WATER PLAN) A RESOLUTION

WHEREAS, the Board, pursuant to its planning authorities in 42-1734A and 42-1734B, Idaho Code, has developed a Comprehensive State Water Plan for the Payette River Basin; and

WHEREAS, the Board is directed to identify goals and objectives, as well as make recommendations for improving, developing or conserving the water resources of the planning basin; and

WHEREAS, the Board as part of its planning process is authorized to designate protected river reaches as "natural" or "recreational" and to prohibit certain activities within the stream bed; and

WHEREAS, the Board has sought and received substantial public participation throughout the planning process for the Payette River Basin component of the Comprehensive State Water Plan.

NOW, THEREFORE, BE IT RESOLVED that, having considered the draft plan and the public comment received, the Board hereby adopts the attached Comprehensive State Water Plan – Payette River Basin.

PASSED AND APPROVED this 5th day of February, 1999.

Clarence Parr
CLARENCE PARR, Chairman

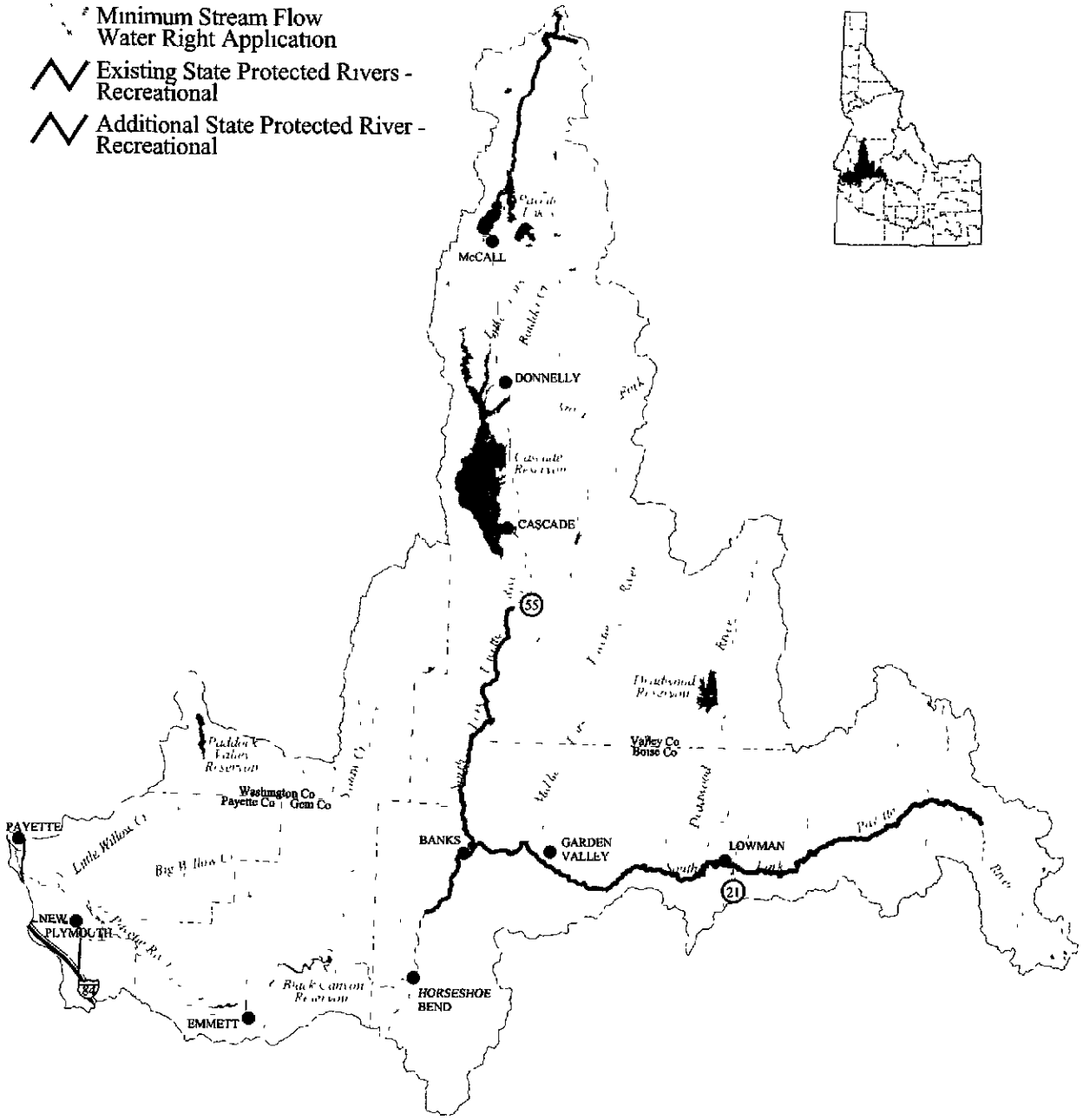
ATTEST:

J David Erickson
J. DAVID ERICKSON, Secretary

admitted 9-30-99

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Map 27. Board Actions



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The following activities are prohibited on these reaches:

- construction or expansion of dams or impoundments,
- construction of hydropower projects;
- construction of water diversion works;
- dredge or placer mining,
- mineral or sand and gravel extraction within the stream bed; and
- stream channel alterations.
-

Exceptions to the above prohibitions include:

- New diversion works shall be limited to pump installations for the following purposes that do not create an obstruction in the river: irrigation of basin lands; stock water; developed rest area, picnic and campground areas; and for domestic, commercial, municipal and industrial needs.
- Stream channel alterations necessary to maintain and improve existing utilities, roadways, managed stream access facilities, and diversion works, and for the maintenance of real (private and public) property.
- Recreational dredge mining is permitted as regulated by the Idaho Department of Water Resources and Idaho Department of Lands.

Alteration of the streambed, except for maintenance and repair of existing diversion works, must comply with the Idaho Stream Channel Alteration Rules and Minimum Standards.

Additional State Protected Designations

The Board considered the impacts of additional protected river designations, and determined it is in the public interest to designate the additional stream reach listed below and depicted in Map 27.

North Fork Payette (23.6 miles): Headwaters (including Cloochman and Trail creeks) to Payette Lake Inlet - recreational

The following activities are prohibited on this reach:

- construction or expansion of dams or impoundments;
- construction of hydropower projects;
- construction of water diversion works;
- dredge or placer mining;
- mineral or sand and gravel extraction within the stream bed; and
- stream channel alterations.

Exceptions to the above prohibitions include:

- Stream channel alterations necessary to maintain and improve existing utilities, roadways, managed stream access facilities, and diversion works, and for the maintenance of real (private and public) property.
- Alterations of the stream channel for installation of fisheries enhancement structures and other activities necessary for fishery management.
- This designation is not intended to restrict current and future operations at Upper Payette Lake by the Lake Reservoir Company, including enlargement of the dam or lake.

Alteration of the streambed, except for maintenance and repair of existing diversion works, must comply with the Idaho Stream Channel Alterations Rules and Minimum Standards.

NORTH FORK PAYETTE HYDROPOWER PROJECT PROPOSAL

The Board retains the current state protected designation on the North Fork Payette River that prohibits hydropower projects. Gem Irrigation

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District requested an amendment to this designation so they could construct a hydropower project in the Smiths Ferry to Banks reach. The project proposal is described in the *Hydropower Development* section.

When deciding whether to amend the designation, the Board was guided by the hydropower siting policy (Policy 4E) in the *Idaho State Water Plan* (Idaho Water Resource Board, 1996). This policy states:

> "The Idaho Water Resource Board believes energy conservation and efficiency improvements are the most desirable methods to provide for additional power requirements. The state will be best served through conservation and the upgrading of existing energy systems. The Board prefers that new hydropower resources be developed at dams having hydropower potential that do not currently generate power or do not generate at their maximum potential. New structures should be carefully evaluated to insure that benefits to the state outweigh any negative consequences associated with the proposed development" (Idaho Water Resource Board, 1996).

Public and agency comment about the project identified many concerns, and the need for additional information and studies. The Board requested additional specific information from the project applicant by letter during this planning effort (See Appendix E). The applicant did not provide any information in response to the Board's request, including demonstrating that the project is financially feasible.

Adequate information has not been presented to justify changes to the existing state recreational river designation. Based on the information that is available, the Board concludes that it is not in the public interest to modify the existing state recreational river designation to allow the proposed North Fork Payette hydropower project by Gem Irrigation District. This action is consistent with the Payette River Citizens Group's recommendations concerning the North Fork Payette hydropower project (See pages G4 and G-5).

MINIMUM STREAM FLOWS

It is the policy of Idaho that the Board should seek to appropriate waters in the state for instream flow purposes when it is in the public interest. Idaho Code, Title 42, Chapter 15 provides the authority and spells out procedures for the Board to file applications to appropriate water for minimum stream flows. A minimum stream flow is the minimum instream flow or lake level required to protect fish and wildlife habitat, aquatic life, recreation, aesthetic beauty, navigation, transportation, or water quality in the public interest. By law, a minimum stream flow is not an ideal flow, but the minimum necessary to achieve the objectives. The water right is held by the Board and is junior to all earlier water rights. It is not a guaranteed minimum flow, but is only achieved after senior water rights are satisfied.

In order for the Board to acquire a minimum stream flow, a process separate from the development of a comprehensive state water plan occurs. Studies to determine the quantity and timing of the minimum stream flow may need to be conducted. The Director of the Idaho Department of Water Resources determines whether the minimum stream flow right is granted based on guidance in the Idaho Code. Legislative review of minimum stream flow rights granted by the Idaho Department of Water Resources is then required.

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The Idaho Water Resource Board will take action to obtain a minimum stream flow on the North Fork Payette River at Fisher Creek above Payette Lake. The reach location is depicted on Map 27.

The Big Payette Lake Management Plan established by the Big Payette Lake Water Quality Council and adopted by the Idaho Legislature in 1998 recommends the Board obtain a minimum stream flow for the North Fork Payette River below Upper Payette Lake to protect kokanee spawning and resident trout species. The Idaho Department of Fish and Game conducted a modeling study, using the Riverine Habitat Simulation program, to model the relationship between flow and availability of fish habitat (Apperson, 1998). The suggested minimum stream flow is 60 cubic feet per second at the gage below Fisher Creek from July 1 to September 7.

The available period of record for the gage at Fisher Creek is October 1994 to April 1998, a period of above average streamflows. The calculated flow duration was adjusted using a longer record station at Lake Fork above Jumbo Creek (USGS 13240000) to produce a duration curve that reflects a long-term average (1946-97) (See Appendix F). Based on this adjusted flow duration, the suggested minimum stream flow of 60 cubic feet per second for July through September would be met or exceeded about 59 percent of the time. The Board will file an application for this water right with the Idaho Department of Water Resources.

Recommendations

The Board has the authority to establish water policy for the state of Idaho, and to plan for the improvement, development, and conservation of water resources through development and implementation of the State Water Plan [Idaho Constitution, Article 15, Section 7]. The Board requests that the federal, state, and local agencies and entities referenced work with the Board to implement the recommendations contained in the plan. State agencies are asked to "exercise their duties in a manner consistent with the comprehensive state water plan" [Idaho Code 42-1734B (4)]. Federal agencies are required to consider a comprehensive state water plan, and are encouraged to manage their lands in a manner consistent with the recommendations contained in this plan.

Recommendations contained in the Payette River Basin Plan reflect input received from citizens and agencies. The Payette River Citizens Group submitted recommendations to the Board for their consideration. A copy is provided in Appendix G. In consideration of extensive Citizens Group and agency input and public comment on a Draft Payette River Basin Plan, the Board makes the following recommendations.

PROTECTED RIVER DESIGNATIONS

Federal Wild and Scenic River System

The Forest Service and Bureau of Land Management have found reaches within the Payette River Basin eligible for further study as potential federal wild and scenic rivers. Additionally, three national forests (Boise, Payette and Sawtooth) within the Payette River Basin are reexamining the eligibility of rivers and streams for possible wild and scenic designation as part of the forest plan revision. Suitability studies to determine whether to recommend designation to Congress would occur after forest plan revisions are complete.

The Board recommends that the revised forest plans recognize state protected river designations as the best option for managing and protecting the outstanding resource values of waterways in the basin. The Forest Service and Bureau of Land Management are reminded that state

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No provision of the Comprehensive State Water Plan will limit, restrict, or conflict with approved applications for the appropriation of water or with any vested property rights, i.e. existing water rights, diversion, mineral rights, and other private property rights. It does not restrict the repair, replacement, or continued operation of existing facilities and works. No provision of this plan will prevent a water user or their agent from cleaning, maintaining, or replacing an existing water diversion structure. A water user or their agent may remove any obstructions from the stream channel, if such obstruction interferes with the delivery of, or use of, water under any existing water right.

Management of land adjacent to state protected rivers remains the responsibility of the land owners or managers, and local planning authorities. Designation of waterways as protected rivers will not affect the operation or legal use of any existing hydropower project which does not enlarge existing boundaries or impoundments. It can only prohibit the activities listed above, and does not prevent motorized or non-motorized boating on the river. Designation does not prevent activities outside the stream channel or high water mark such as grazing, timber harvest, or trail activities.

Changes in land use activities in the basin may result in requests for changes in nature of use, place of use, or point of diversion of existing water rights. These activities will require appropriate review and approval by the Idaho Department of Water Resources, and may be prohibited if the Director determines changes are not in the public interest. The state protection designations, in addition to maintaining the outstanding fish and wildlife, recreation, and scenic values identified in the basin, protect the current water uses.

The "recreational" river designation for the North Fork Payette River above Payette Lake protects the water quality of the Lake by reducing sedimentation, and supports the recommendations made in the Big Payette Lake Management Plan (Big Payette Lake Water Quality Council, 1997). Maintaining the water quality protects the drinking water supply for the City of McCall, and helps to sustain the kokanee and lake trout fishery, important to the recreation and tourism economy of the community. Current and future operations of the Lake Reservoir Company at Upper Payette Lake are not impacted.

MINIMUM STREAM FLOW WATER RIGHTS FOR THE NORTH FORK PAYETTE RIVER

The proposed minimum stream flow for the North Fork Payette River below Upper Payette Lake will not interfere with any water right having a senior priority date. Minimum stream flows cannot take away or injure an existing water right. These minimum stream flow water rights, if approved by the Director of the Idaho Department of Water Resources, will not require the release of storage water to meet the minimum flow. They may prevent new water appropriations within and upstream of a river or stream reach.

NORTH FORK PAYETTE HYDROPOWER PROJECT PROPOSAL

Construction of the proposed North Fork Payette hydropower project could result in many environmental impacts. This plan prohibits construction of this project. Numerous questions about the environmental, social, and economic feasibility of the project have been raised, and were not addressed by the project proponent. The uncertainty of the energy market with energy deregulation raises additional questions about project economic feasibility.

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Original

Department of Health and Welfare
Division of Environmental Quality

IN RE: Water Quality Standards and Wastewater Treatment Requirements.) Docket No.) 16-0102-9701)

Exhibit 4
Payette Lake
w/ Qual council
admitted
9-30-99
WJ

BEFORE
LARRY F. WEEKS
Hearing Examiner

October 29, 1997 * 7:00 p.m.

Payette Lake Middle School
111 Samson Trail •
McCall, Idaho 83638

Includes Council response to comments.

Reported by
Jami Dee Woodmanl
CSR No. T-171

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APPEARANCES

For the Staff

Peter Johnson
Kirk Hall
Dianne Plastino Graves
David Simmonds
William Kirk
William Killen
Thomas Kerr

MICROFILMED
JAN 3 1 2000

INDEX

PROCEEDINGS Page

October 29, 1997, 7:00 p.m. 1
Division of Environmental Quality
Payette Lake Middle School
111 Samson Trail
McCall, Idaho 83638

MICROFILMED
JAN 3 1 2000

WITNESSES

WITNESS Page

HERSHENOW, Nick .....

LIMBACH, Cutler .....

SPALDING, Curtis .....

MICRO

MAR 3 1 2000

EXHIBITS

EXHIBIT NUMBER Page

A. Statement of the Big Payette Lake Water Quality Council 1

B. Curtis Spalding's comments 1

C. Nick Hershenow's comments 1

D. Cutler Umbach's speech 1

E. Curtis Spalding's speech 1

F. Sign-in Roster 1

MICROFILMED

JAN 31 2000

Lawyer's Notes

McCALL, IDAHO
Wednesday, October 29th, 1997, 7:00p.m.

MR. JOHNSON: Let me call our meeting to order. It's just past 7 o'clock and we are scheduled to begin at 7 o'clock. My name is Peter Johnson and I am the chairman of the Big Payette Water Quality Counsel. And this is a public meeting where we will be – public hearing where formal comments will be taken in a few moments.

But to begin with, besides welcoming all you folks to this particular session, we're getting very close now to taking the final product to the Idaho Legislature. And a copy of the pre-final lake management plan and plan implementation program have been available to the public, mailed to many folks, some of you likely here, but we're getting close to closure on that particular document.

But there may be questions in any person's mind, clarifications that they would like on what has been written or anything else that has come to your attention too. Before we get into the actual process behind Larry Weeks, our hearing officer, we'd like to again respond to questions

that people might have. It's called an informal discussion for purposes of clarification because it becomes quite strict and formal once we kick off the hearing.

Are there any –

HEARING OFFICER: Mr. Chairman, excuse me, do you want to go off the record for informal comment?

MR. JOHNSON: Yes, this will be off the record.

(Off the record.)

MR. JOHNSON: Let me introduce Larry Weeks, the hearing officer.

HEARING OFFICER: Before we go on the record there is a sign-in roster being passed around here someplace that I'd like to have everybody's name on it. If somebody hasn't signed it could we pass it back to them, please.

(Off the record.)

HEARING OFFICER: There is a roster being passed around with names on it, those who wish to submit formal comments have been requested to do so in writing if they choose to and those have been marked as exhibits. I will first read into the record a formal administrator procedures act

MICROFILM
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Lawyer's Notes

introductory statement after which Mr. Johnson, as chairman, will then read the council's presentation.

Let the record show that I'm Larry Weeks, the designated hearing officer appointed by the Big Payette Lake Water Quality Council. It is 7:15 o'clock p.m. on the 29th of October, 1997. We are in the Payette Lake Middle School, McCall, Idaho.

This is the time and place set to receive oral comments regarding the lake management plan as provided for on the Big Payette Lake Water Quality Act. The purpose of this proceeding is to gather the facts, views, or arguments for all interested persons for consideration by the Big Payette Lake Water Quality Council.

I will accept signed written statements or documents at the hearing tonight. The materials will be included as exhibits in the record, which I will transmit to the custodian of the record following the close of this hearing.

Let the record show that the notice of the hearing appeared in the Idaho Administrative Bulletin, as required by Idaho Code Section 39-6611, on August 6th, 1997.

As an informal proceeding, there's no right to cross-examination a person offering a comment. No objections or procedures of a technically legal nature will be received. As the Hearing Officer, I am the sole regulator of the presentations, including, but not limited to, a determination that the comments are outside the scope of this proceeding or that comments are unduly repetitious. Neither members of Big Payette Lake Water Quality Council nor myself are here to answer questions or to explain any part of the lake management plan on the record, although I, myself, might ask questions to further explore or amplify the information presented.

I've already mentioned that we requested interested persons attending the meeting to sign in on the roster, indicating a desire, if any, to make an oral presentation. After a brief statement made by the chairman of the council, each person will be given an opportunity to speak at least once prior to any person being heard a second time.

At this time the Big Payette Lake Water Quality Council's statement will be read into the record, followed by the oral presentations. Mr. Johnson.

MICROFILM
JAN 3 1 2000

Lawyer's Notes

Page 5

MR. JOHNSON: Thank you, Mr. Weeks. This is a Statement of the Big Payette Lake Water Quality Council at the public hearing on the Big Payette Lake Management Plan, October 29, 1997, McCall.

Pursuant to the requirements of Title 39, Chapter 66, Idaho Code, the Big Payette Lake Water Quality Council has overseen the completion of a scientific study of Big Payette Lake and its watershed performed by the division of Environmental Quality and the United States Geological Survey. In addition and in response to the findings of that study, the council has prepared a Lake Management Plan and Plan Implementation Program to protect, preserve, and improve water quality in Big Payette Lake and its watershed.

The plan and a program have been developed through an open public process which began shortly after the Big Payette Lake Water Quality Act became law in the spring of 1993. The governor has appointed members of nine-member council who represent several interests specified in the Act. The council, in turn, appointed a 24-member Technical Advisory Committee with

Page 6

representatives from all federal, state, county, municipal, private, and public entities with an interest in the watershed. Beginning in the early summer of 1993, the council has met (with notices placed in local newspapers and in the post office bulletin board) in open public evening sessions every two months for over four years. Generally the Technical Advisory Committee has met earlier on that day of the council meetings.

To apprise the public of developments in the scientific study, during August of 1996, the council held a widely publicized open meeting in the Payette Lake Middle School in McCall where several presenters reported their preliminary findings. Then in 1997, broadly noticed public meeting were held in the Payette Lake Middle School in McCall and in the conference room of the Division of Environmental Quality in Boise during June to report and discuss the findings of the scientific study. Again, during September, widely advertised public workshops were held in the same locations to review and discuss early drafts of the Lake Management Plan and the Plan Implementation Program.

Beginning in 1993 bi-annual newsletters

MICROFILMED
JAN 3 1 2000

Page 7

have been mailed to over 500 property owners, lessees, and other interested parties. News coverage by the Star News of McCall and the Advocate of Cascade have been thorough and extensive, and the Idaho Statesman has reported on recent findings of the scientific study. In the last four years KTVB television has run three on-site reports on water quality issues on the Big Payette Lake.

In the fall of 1996, the council formed three working groups consisting of over 40 interested parties, many who were local volunteers, to begin developing the plan and program. These working groups met through the spring of 1997 a total of 12 times during two-hour sack lunch sessions in the McCall Legion Hall.

The council respectfully submits the pre-final Lake Management Plan and the Plan Implementation Program to this public hearing for comment. After the close of comments on November 12th, the council will make modifications as necessary in the plan and program which will then be submitted to the Idaho Legislature on January 12th, 1998. Thank you.

HEARING OFFICER: Thank you, Mr. Chairman,

Lawyer's Notes

Page 8

your comments will be submitted as Exhibit *-00A to the record. To begin I'll call upon persons, in order, who indicated on the roster their wish to be heard. Since these proceedings are recorded by a court reporter, I ask not that you necessarily have to come forward in front of the group, but that you at least address comments to myself or the chairman and make sure that the court reporter can understand what you're saying. And precede your comments with your name and spell your surname, please. And if I could hunt down that roster, I'll do that. Sorry, Ed, I can't read your last name.

MR. ELLIOT: My name is Ed Elliott, E-l-l-i-o-t-t. If I was polite, I would say I think it's quite remarkable, but if I was really candid, I would say it's distressing that we had a meeting about the water qualify of Payette Lake and have just a couple of people attend. If this was a meeting about the sign ordinance or water rates, we'd have a packed house. And on the scale of importance – and or – if we were to grade this issue relative to its importance to this community and to the valley, on a scale of 1 to 10, this is a 10, the water quality of this lake. And the sign ordinance and the water rates are maybe a 1. I'm

MICROFILMED
JAN 3 1 2000

Lawyer's Notes

Page 9

not sure what the reason is there, but the water quality of this lake has an enormous impact on not just McCall, but the entire valley and we should have a full house here.

And I guess therein lies my concern. I haven't read the most recent document about the recommendations by the committee, but Peter and I were involved in the Payette Lake's water and sewer district in the seventies and eighties. Our concern then was that septic systems that virtually every house around the lake had to address sewage. And all it took was for someone to go around the perimeter of the lake and you could see that there was a problem virtually from every house.

In fact, I put in a new sewer - septic system at our house and it complied with all the current regulations at the time and it still was a problem, all it took was a visual inspection. My concern now is that, and I believe the Board, I believe the experts, that if we have a potential water quality problem with Payette Lake, and if, in fact, there is a point where the water quality deteriorates to a point that it is no longer reversible, that we need to take stronger action than what's being recommended. And I don't know

Page 10

specifically right now what that would be, I need to be more familiar with the document.

But I think the lake is so critically important to the well-being of this community and to the valley, that if there is evidence that there's a potential problem with the water quality of this lake, that we need to take very strong definitive mandatory action now. Not in three years, not in ten years, I just think the risk is too great. There are other areas in other communities where there is a lot at stake financially, socially, culturally, whatever, Lake Tahoe is an example. And comparisons are drawn frequently between our lake and Lake Tahoe, and I think it would behoove us to look at exactly what Lake Tahoe has done to address their water quality issues, and it involves some fairly courageous mandatory actions.

But the bottom line is, my concern - my concern is we just - voluntary actions, to me, equate to wishful thinking. I'm a cynic when it comes to voluntary actions. I would like to see mandatory - some kinds of mandatory regulations imposed for the long-term well-being of this community. Thank you.

MICROFILMED
JAN 31 2000

Lawyer's Notes

Page 11

HEARING OFFICER: Thank you, Mr. Elliott. Mr. Chairman, although it's not required, certainly if you would like to respond on the record to any comments from participants in this meeting, that would be fine.

MR. JOHNSON: We can do this at this time, we could respond to Mr. Elliott's comments.

HEARING OFFICER: You may, if the committee – MR. JOHNSON: I would like an opportunity to listen, not only for myself, but for other members of the council.

MR. KILLEN: Personally, I'd like to hear from the people that came tonight and then it may be possible to respond more comprehensively or effectively, plus I'm on a short curfew tonight so I don't want to drag it out.

MR. JOHNSON: I concur on that.

HEARING OFFICER: Okay, Mr. Chairman. Mr. Umbach.

MR. UMBACH: I am Cutler, C-u-t-l-e-r, Umbach, U-m-b-a-c-h. And you have a copy of what I'm going to do so you probably can relax your fingers a little. I'm writing to take advantage of the on-the-record opportunity to make comments on the most recent pre-final Lake Management Plan and

Page 12

Plan Implementation Program. To protect, preserve, and improve water quality in the Big Payette Lake and its watershed. I'm a resident of McCall, living on the west shore of the lake. I've been following the council since its inception. I have three general comments to make for the record.

First, I'd like to compliment the committee and the DEQ for the quality of the process that was followed in developing the plans. The process has been open, well noticed, and suggestions were carefully recorded and often incorporated in the drafts. It has been, in fact, a model of conducting public review to develop public action.

Second, I would like to applaud the decision to use voluntary compliance. Too often we rely on coercion and regulation when voluntary compliance would have been possible. When it is possible, it is much less expensive and intrusive as well as longer lasting then regulation and coercion. In social relations we often get what we expect. If we assume people will not do that which is required to implement the plan, without first trying voluntary compliance, we will find them unwilling to comply. I believe that most of the

MICROFILMED
MAR 3 1 2000

Lawyer's Notes

Page 13

users of the lake want to cooperate to protect it.
I also applaud the back-up of regulatory control and voluntary compliance not at a level that brings about minimum measurable quantitative change. It's a good "carrot and stick" implementation plan.
Finally, I note that the plans include a set of recommendations made to state, county, city agencies and governments, as well as to the individuals living alongside and using the lake. I would like to urge a point of view that this plan, when in its final draft, is just the beginning of action. It is of crucial importance that these recommendations be carefully articulated and communicated with enough force to the target audiences so that they cannot be ignored. To do so will require further work, no doubt. I hope the committee will continue as an attribute to accomplish this important part of the task.
Thanks for the opportunity to go on the record with these remarks.
HEARING OFFICER: Thank you, sir. Your comments will be submitted as Exhibit *-00D to the record. The next individual I have who has indicated the willingness to testify is Curtis

Page 14

Spalding and I have your written comments too, sir.
MR. SPALDING: I'm Curtis, C-u-r-t-i-s. Spalding, S-p-a-l-d-i-n-g. Thank you for this opportunity to comment. I am speaking as a private citizen and as a resident of McCall. I enjoy Payette Lake for its scenic, recreational, and consumptive water usages. In addition, I enjoy the knowledge that the fish, aquatic, and avian ecosystems are in excellent condition.
And indirectly, I benefit from the agricultural value of the water. Therefore, I enjoy five of the beneficial uses and more. I reside a quarter mile south of the lake, and thus my property value partly depends upon a clean, sustainable lake ecosystem. I also enjoy the wildlife values the lake ecosystem supports.
I commend each of the council members and particularly its chairman Peter Johnson for the countless hours expended leading up to this plan. It has been a tremendous contribution to the public interest and the community owes you a big debt of gratitude. I thank each of you.
I have reviewed and thought out the draft plan and implementation program and have two general and several specific comments. But first I

MICROFILMED
JAN 31 2000

Lawyer's Notes

Page 15

have a question that I would like the council to address: Do you believe this plan and program will succeed in meeting the three water quality objectives? And secondly, if it does not, then do you believe the state will take actions sufficient to meet those objectives? And I invite your response later.

My first overall comment, then. This plan is like a mouthful of teeth, but only three of the teeth are sound, some other teeth are missing entirely, and many others are capped with soft foam rubber. We all know that getting good dental work is expensive these days, but an ounce of prevention now can be worth thousands of gallons of cure later. Whether it is politically feasible in the Idaho legislature now is another question, but I think it's important for someone to prescribe the full treatment that Payette Lake needs and not imply that a mild compromise voluntary plan will do the job if we don't believe it will.

My second overall comment, the plan is like a young child with good parents; however, the parents all plan to cease to exist in a couple of years. Their intention is that other parents will be willing to adopt the child and care for it.

Page 16

However, the fact is these other parents, other agencies, have more children than they can handle. The orphan plan is not very likely to find a good home. To survive and grow, the plan really needs its parents or equivalent adoptive parents who watch over it, track its progress, make adjustments, and take some responsibility to assure it survives. The parents can transfer ownership but not responsibility.

Here are several specific comments. In each case, the council should make modifications to strengthen the plan and better protect the lake.

One, a plan without a complete monitoring mechanism is incomplete. The plan has no real monitoring plan outside the three water quality parameters. Having the council go out of existence soon after completing the plan would be a mistake because there would be no entity responsible for monitoring, evaluating, and reporting to the public on the implementation of the many recommendations in the program.

Turning over the pieces of monitoring and reporting to a list of federal, state, and local agencies, all of which are already under-funded and overworked relative to their

MICRO
JAN 3 1 2003

Lawyer's Notes

Page 17

mission, would almost surely ensure failure in implementation. There needs to be a watchdog organization to keep a score card. It should inform the public how many of the several dozen recommendations each agency is implementing, this is implementation monitoring, and how effective each measure is, effectiveness monitoring, in achieving its objectives.

If time reveals that the plan is not being implemented or that the measures are being implemented but are not effective, then the council must be in existence to recommend actions to the agencies and Idaho legislature if necessary. I'm concerned that if you are not here, it will not get done. I recognize that few on the council want this responsibility to continue but firmly believe that if the council does not do it, nobody will. And the water quality of Payette Lake is too important to let that happen. Therefore my suggestion is to identify a qualified organization, preferably this council, but otherwise another ultimately responsible for monitoring, evaluating, and reporting the implementation of a whole plan and the whole program.

The watch dog group needs to have a loud

Page 18

bark, and if the bark doesn't work, good sharp teeth.

Two, it is unfortunate that the water quality standards in the previous plan draft have been watered down to objectives in this draft. The history of Payette Lake lately has been declining in water quality. If there is any body of water that requires strong, binding objectives, it should be Payette Lake. A municipal watershed deserves some of the strongest form of government protection government can provide.

Three, two-cycle engines. Two-cycle engines on jet skis release up to 25 percent of the gasoline fuel into the lake as uncombusted material. This lake is what we drink out of. If nothing else is sacred, seems our drinking water should be. Two-cycle engines on the water do nothing but conflict with the five other beneficial uses also. It is inconceivable to me that a water quality protection plan should not prohibit this ongoing and increasing pollution of a domestic water supply.

The Tahoe Regional Planning Agency recently decided to ban jet skis on Lake Tahoe. The economy there will not suffer. In the

MICRO FILM
JAN 31 2000

Page 19

long-term, neither will ours and ours will improve. There is no valid reason not to prohibit jet skis on Payette Lake.

Another use I make of Payette Lake is to enjoy the osprey population that the lake supports. Each summer I enjoy observing the pair of ospreys that raise one to three young ospreys a short distance from my house. This is not one of the six beneficial uses, but it is another valid reason for supporting excellent water quality. It is another use that jet skis directly and adversely affect.

Four, houseboats. Before they become established and remove options, houseboats should be prohibited from the lake. Watercraft that are dedicated to overnight residential use pose too high a risk of sewage pollution. The council should nip this in the bud or even before there is a bud.

Page 21 refers to floating homes, which is as good as – which is good as far as it goes. It should be expanded to apply explicitly to houseboats or other floating homes whether owned or rented, permanent or trailered, local or visitor. It is simple common sense.

Five, state Protected River Segment. If

Page 20

any body of water deserves state protection and designation, Payette Lake does. To strengthen section 8.6, paragraph 2, which asks the state to consider it, the council's plan should say that it now officially nominates the North Fork Payette River as a State Protected River Segment.

Six, outstanding Resource Waters. As page 2 indicates, the sixth beneficial use is, "Special Resource Water." To recognize the fact that Payette Lake and its tributaries have not only special values but also outstanding natural, social, and economic values, the council should nominate Payette Lake and the North Fork Payette River above the lake for outstanding resource waters.

Seven, Payette River Corridor. The protected river corridor should include more than the limited strips proposed in Maps A and B at the end of the plan, but should include tributary perennial streams as well. Drawing straight lines across sub-watersheds and trying to manage thin slivers of land that cross-cut tributary streams near their mouths, makes for extremely difficult management.

Eight, northeast Portion of the Lake.

Lawyer's Notes

Lawyer's Notes

Although developed lands comprise a small portion of the watershed, they produce 14 percent of the phosphorus into the lake and 18 percent of the nitrogen from storm water. A large portion of the east and northeast portion of lake shore on state lands is primed for extensive residential development, the kind of development that, without strict standards, could exacerbate the nutrient loading problems. The council should strengthen this portion of the plan to ensure this does not happen.

In summary, "The water quality of the Big Payette Lake has deteriorated and is at risk." The longer the community waits before stopping this trend, the harder and more costly it will be to reverse. I believe we need a plan with more teeth to replace some of the recommended and voluntary measures. I support a stronger plan. Thank you very much for this opportunity.

HEARING OFFICER: Thank you, Mr. Spalding. Your comments will be submitted to the record as Exhibit *-00E. While you're standing there, I also have a document with your name on it from September 10 and 18 workshops, comment sheet. Would you also like to have that submitted as an exhibit. It's

been marked.

MR. SPALDING: Why not?

HEARING OFFICER: Your comments from that workshop or at least on a workshop letterhead will be submitted as Exhibit *-00B, as in boy.

I have nobody else indicating that they wish to testify but if anybody does, they certainly may at this time. If anybody else wishes to submit written comments, this would certainly be the time to do it also.

I have one additional exhibit, it's Exhibit *-00C, it's a document entitled Statement and Questions for the Payette Lake Water Quality Commission, signed by Nick Hershenow, I think it is, spelled H-e-r-s-h-e-n-o-w. That will be submitted to the record as Exhibit *-00C. If there's nothing else, Mr. Chairman, I intend to close the formal part of this hearing. Last opportunity.

This hearing, having been called, commenced at 7:15 o'clock p.m. and it is now 7:45 o'clock p.m. and is now closing. The record, together with the exhibits, will be transmitted by me to the custodian of the record for the council. Anyone wishing to submit further comments should

MICRO
JAN 3 1 2008

address them in writing to Peter Johnson, Chairman, Big Payette Lake Water Quality Council, P.O. Box T, McCall, Idaho 83638. All written comments must be received by Mr. Johnson by November 12, 1997.

Thank you, we'll be off the record.

(Proceedings concluded at 9:30 p.m.)

Lawyer's Notes

MICRO
MAR 3 1 2003

*

*-00A 8:1
*-00B 22:5
*-00C 22:12, 16
*-00D 13:23
*-00E 21:22

1

1 8:23, 25
10 8:23, 24; 21:24
12 7:15
12th 7:21, 24
14 21:2
18 21:3, 24
1993 5:21; 6:4, 25
1996 6:11; 7:10
1997 1:2; 3:7, 25; 5:4; 6:15; 7:14
1998 7:24

2

2 20:3, 8
21 19:19
24-member 5:25
25 18:13
29 5:4
29th 1:2; 3:7

3

39 5:6
39-6611 3:25

4

40 7:11

5

500 7:1

6

66 5:7
6th 3:25

7

7 1:5, 6
7:00p.m 1:2
7:15 3:7; 22:21
7:45 22:21

8

8.6 20:3

A

above 20:14
accept 3:17
accomplish 13:19
achieving 17:8
across 20:21
act 2:25; 3:13; 5:21, 24
action 9:24; 10:8; 12:14; 13:13
actions 10:18, 20, 22; 15:5; 17:12
actual 1:24
addition 5:12; 14:7
additional 22:11
address 8:7; 9:11; 10:16; 15:2
adjustments 16:7
Administrative 3:23
administrator 2:25
adopt 15:25
adoptive 16:5
advantage 11:23
adversely 19:11
advertised 6:21
Advisory 5:25; 6:8
Advocate 7:4
affect 19:11
again 1:25; 6:20
agencies 13:9; 16:2, 24; 17:13
agency 17:5; 18:23
agricultural 14:11
almost 17:1
alongside 13:10
already 4:15; 16:24
although 4:12; 11:2; 21:1
amplify 4:13
anybody 22:7, 8
Anyone 22:25
appeared 3:23
applaud 12:15; 13:2
apply 19:21
appointed 3:5; 5:22, 24
apprise 6:10
aquatic 14:8
areas 10:10
arguments 3:14
around 2:15, 21; 9:11, 12
articulated 13.14
assume 12:22
assure 16.7
attend 8:18
attending 4:16
attention 1:23
attribute 13:18
audiences 13:16
August 3:25; 6:11
available 1.16
avian 14:8

B

B 20:18
back 2:18
back-up 13:2
ban 18:24
bark 18:1, 1
became 5.21
become 19:12
becomes 2:3
began 5:20
begin 1:6, 11; 7:13; 8:2
Beginning 6:3, 25; 13:12
behind 1:24
behoove 10:15
believe 9:19, 20; 12:25; 15:2, 5, 20; 17:16; 21:16
beneficial 14:12; 18:18; 19:9; 20:8
benefit 14:10
besides 1:11
better 16:12
bi-annual 6:25
Big 1:7; 3:6, 12, 15; 4:9, 22; 5:2, 3, 7, 9, 16, 20; 7:8; 12:2; 14:21; 21:13
binding 18:8
board 6.6; 9:19
body 18:7; 20:1
Boise 6:18
bottom 10:19
boy 22:5
brief 4:18
brings 13:4
broadly 6:15
bud 19:17, 18
Bulletin 3:24; 6:6

C

C-u-r-t-i-s 14:2
C-u-t-l-e-r 11:20
call 1:4; 8:2
called 2:1; 22:20
came 11:13
can 8:8; 11:6, 22; 15:14; 16:2, 8; 18:11
candid 8:16
capped 15:11
card 17.3
care 15:25
carefully 12:11; 13:14
carrot 18:4
Cascade 7:4
case 16:19
cease 15:23
certainly 11:2; 22:7, 9
chairman 1:7; 2:6; 3:2; 4:19; 7 25; 8:7; 11:2, 18; 14:18; 22:17
change 13:5
Chapter 5:7
child 15:22, 25
children 16:2
choose 2:23
citizen 14:5
city 13:8
clarification 2:2
clarifications 1:21
clean 14:14
close 1:13, 18; 3:21; 7:20; 22:18
closing 22:22
closure 1:18
Code 3:24; 5:7
coercion 12:17, 21
commenced 22:21
commend 14:17
comment 2:8; 4:3; 7:20; 14:4; 15:8, 21; 21:24
comments 1:10; 2:22; 3:11; 4:7, 8; 7:20; 8:1, 7, 10; 11:4, 7, 24; 12:6; 13:23; 14:1, 25; 16:10; 21:21; 22:3, 9, 25
Commission 22:14
Committee 5:25; 6:8; 9:7; 11:8; 12:8; 13:18
common 19:24
communicated 13:15
communities 10:11
community 8:22; *10:4,* 25; 14:21; 21:14
comparisons 10:13
complete 16:13
completing 16:17
completion 5:8
compliance 12:16, 18, 24; 13:3
complied 9:16
compliment 12:7
comply 12:25
comprehensively 11:14
comprise 21:1
compromise 15:19
concern 9:5, 10, 19; 10:19, 20
concerned 17:14
concur 11:17
condition 14:9
conducting 12:13
conference 6:17
conflict 18:18
consider 20:4
consideration 3:15
consisting 7:11
consumptive 14:7
continue 13.18; 17:16
contribution 14:20
control 13:3
cooperate 13:1
copy 1:14; 11:21
Corridor 20:16, 17
costly 21:15
Council 3:6, 16; 4:10, 19; 5:3, 8, 13, 23, 24; 6:4, 9, 12; 7:10, 17, 21; 11:11; 12:5; 14:17; 15:1; 16:11, 16; 17:11, 15, 17, 21; 19:16; 20:12; 21:9; 22:24
council's 3:2; 4:23; 20:4
Counsel 1:8
countless 14:19
county 6:1; 13:8
couple 8:18; 15:23
courageous 10:17
court 8:5, 8
coverage 7:3
critically 10:3
cross-cut 20:22
cross-examination 4:2
crucial 13:13
culturally 10:12
cure 15:14
curfew 11:15
current 9:17
Curtis 13:25; 14:2
custodian 3:20; 22:24
Cutler 11:20
cynic 10:21

D

day 6:9
days 15:13
debt 14:21
decided 18:24
decision 12:16
declining 18:6
dedicated 19:15
definitive 10:8
dental 15:12
depends 14:14
DEQ 12:8
deserves 18:9; 20:1
designated 3:5
designation 20:2
desire 4:17
deteriorated 21:13
deteriorates 9:23
determination 4:7
develop 12:13
developed 5:19; 21:1
developing 7:13; 12:9
development 21:7, 7
developments 6:10
difficult 20:23
directly 19:11
discuss 6:19, 22

MICRO

discussion 2:2
distance 19:8
distressing 8:16
district 9:9
division 5:10; 6:18
document 1:19; 9:6; 10:2; 21:23, 22:12
documents 3:18
dog 17:25
domestic 18:21
done 10:16; 17.15
doubt 13:17
down 8:11; 18:5
dozen 17:4
draft 13:12; 14:24; 18:4, 5
drafts 6:22; 12:12
drag 11:16
Drawing 20:20
drawn 10:13
drink 18:15
drinking 18:16
during 6:11, 18, 20; 7:15

E

E-l-l-i-o-t-t 8:14
each 4:19; 14:17, 22; 16:11; 17:5, 7; 19:6
earlier 6:8
early 6:3, 22
east 21:5
economic 20:12
economy 18:25
ecosystem 14:15, 16
ecosystems 14:9
Ed 8:12, 13
effective 17:6, 11
effectively 11:15
effectiveness 17:7
Eight 20:25
eighties 9:9
ELLIOT 8:13
Elliott 8:13; 11:1
Elliott's 11:7
else 1:22; 18:16; 22:6, 8, 17
end 20:19
engines 18:12, 13, 17
enjoy 14:5, 7, 12, 15; 19:5, 6
enormous 9:2
enough 13:15
ensure 17:1; 21:10
entire 9:3
entirely 15:11
entities 6:2
entitled 22:12
entity 16:18
Environmental 5:11; 6:18
equate 10:21
equivalent 16:5
established 19:13
evaluating 16:19; 17:22
even 19:17
evening 6:6
every 6.7; 9:11, 14
everybody's 2:16
evidence 10:5
exacerbate 21:8
exactly 10:15
example 10:13
excellent 14:9; 19:10
excuse 2:6
Exhibit 8:1; 13:23; 21:22, 25; 22:5, 11, 12, 16
exhibits 2:24; 3:19; 22:23
exist 15:23
existence 16:17; 17:12
expanded 19:21
expect 12:22
expended 14:19
expensive 12:19; 15:13
experts 9:20
explain 4:11
explicitly 19:21
explore 4:13
extensive 7:5; 21:6
extremely 20:23

F

fact 9:15, 22; 12:12; 16:1; 20:9
facts 3:14
failure 17:1
fairly 10:17
fall 7:10
familiar 10:2
far 19:20
feasible 15:15
federal 6:1; 16:23
few 1:10; 17:15
final 1.13; 13:12
Finally 13:7
financially 10:12
find 12:24; 16:3
findings 5:13; 6:15, 19; 7:6
fine 11:5
fingers 11:23
firmly 17:16
first 2:24; 12:7, 23; 14:25; 15:8
fish 14.8
five 14:12; 18:18; 19:25
floating 19:19, 22
foam 15:11
folks 1:12, 17
followed 4:24; 12:9
following 3:21; 12:5
force 13:15
Fork 20:5, 13
form 18:10
formal 1:10; 2.3, 22, 25, 22:18
formed 7:10
forward 8:6
four 6:7; 7:7; 19:12
frequently 10:14
front 8:6
fuel 18:14
full 9 4; 15:18
further 4:13; 13:17; 22:25

G

gallons 15:14
gasoline 18:14
gather 3:14
general 12:6; 14:25
Generally 6:7
Geological 5:12
given 4:20
goes 19:20
good 13:5; 15:12, 22; 16:3; 18:1; 19:20, 20
government 18:10, 11
governments 13:9
governor 5:22
grade 8:21
gratitude 14:22
great 10:10
group 8:6; 17:25
groups 7:11, 14
grow 16:4
guess 9:5

H

H-e-r-s-h-e-n-o-w 22:15
Hall 7:16
handle 16:2
happen 17:19; 21:11
harder 21:15
hasn't 2:17
haven't 9:6
hear 11:12
heard 4:21; 8:4
hearing 1.9, 24; 2:4, 6, 13, 14, 20; 3:5, 18, 21, 23; 4:5; 5:3; 7:19, 25; 11:1, 8, 18; 13:22; 21:20; 22:3, 18, 20
held 6:12, 16, 21
Hershenow 22:14
high 19:16
history 18:6
home 16:4
homes 19:19, 22
hope 13:17
hours 14:19
house 8:20; 9:4, 11, 14, 16, 19:8
houseboats 19:12, 13, 22
hunt 8:11

I

IDAHO 1:1, 14; 3:9, 23, 24; 5:7; 7:5, 23; 15:16; 17.13
identify 17:20
ignored 13:16
impact 9:2
implement 12:23
implementation 1:15; 5:15; 6:23; 7:19; 12:1; 13:6; 14:24; 16:20; 17:2, 6, 23
implemented 17:10, 11
implementing 17:5
imply 15:19
importance 8:21, 22; 13:13
important 10:4; 13:19; 15:17; 17:19
imposed 10:24
improve 5:16; 12:2; 19:1
inception 12:5
include 13:7; 20:17, 19
included 3:19
including 4:6
incomplete 16:14
inconceivable 18:19
incorporated 12:12
increasing 18:21
indicated 8:3; 13:25
indicates 20:8
indicating 4:17; 22:6
indirectly 14:10
individual 13:24
individuals 13:10
inform 17:4
informal 2:1, 7; 4:1
information 4:14
inspection 9:18
intend 22:17
intention 15:24
interest 6:3; 14:21
interested 3:15, 4:16; 7 2, 12
interests 5:23
into 1:23; 2:24, 4:23; 18:14; 21:3
introduce 2:12
introductory 3:1
intrusive 12:19
invite 15.6
involved 9:8
involves 10:17
issue 8:22
issues 7:8; 10:17

J

January 7:23
jet 18:13, 24; 19:2, 11
job 15:20
JOHNSON 1:4, 7; 2:9, 12; 3:1; 4:25; 5:1; 11:6, 9, 17; 14:18
June 6:19

K

keep 17:3
kick 2:3
KILLEN 11:12
kind 21:7
kinds 10:23
knowledge 14:8
KTVB 7:7

L

lake 1:15; 3:6, 8, 11, 12, 16; 4:10, 11, 22; 5.2, 4, 7, 9, 14, 16, 20; 6:13, 16, 23; 7:9, 18; 8:17, 24; 9:2, 11, 13, 21; 10:3, 7, 12, 14, 14, 16; 11:25; 12:2, 4; 13:1, 10; 14:6, 13, 15, 16; 15:18; 16:12; 17:18; 18:6, 9, 14, 15, 24; 19:3, 4, 5, 14; 20:2, 10, 13, 14, 25; 21:3, 5, 13; 22:13
Lake's 9:8
land 20:22
lands 21:1, 6
large 21:4
Larry 1:24; 2:12; 3:4
last 7:7; 8:12; 22:18
lasting 12:20
lately 18:6
later 15:7, 15
law 5:21
leading 14:19
least 4:20; 8:7; 22:4
legal 4:4
Legion 7:16
Legislature 1:14; 7:23; 15:16; 17:13
less 12:19
lessees 7:2
letterhead 22:4
level 13:3
lies 9:5
likely 1:17; 16:3
limited 4:6; 20:18
line 10:19
lines 20:20
list 16:23
listen 11:10
little 11:23

living 12:4; 13.10
loading 21:9
local 6:5; 7:12; 16:24; 19:23
locations 6:22
long-term 10:24; 19:1
longer 9:23; 12:20; 21:14
look 10:15
lot 10:11
loud 17:25
lunch 7:15

M

mailed 1:16; 7:1
makes 20:23
manage 20:21
management 1:15; 3:11; 4:12; 5:4, 14; 6:23; 7:18; 11:25; 20:24
mandatory 10:8, 18, 23, 23
many 1:17; 7:12; 15:11; 16:21; 17:4
Maps 20:18
marked 2:24; 22:1
material 18:15
materials 3:18
may 1:20; 11:8, 13; 22:8
maybe 8:25
McCALL 1:1; 3:8; 5:4; 6:13, 17; 7:3, 16; 9:3; 12:3; 14:5
measurable 13:4
measure 17:7
measures 17:10; 21:18
mechanism 16:14
meet 15:6
meeting 1:4, 9; 4:16; 6:12, 16; 8:17, 19; 11:4; 15:3
meetings 6:9
members 4:9; 5:22; 11:10; 14:17
mentioned 4:15
met 6:4, 8; 7:14
Middle 3:8; 6:13, 16
might 2:1; 4:13
mild 15:19
mile 14:13
mind 1:21
minimum 13:4
missing 15:10
mission 17:1
mistake 16:18
model 12:13
modifications 7:21, 16:11
moments 1:10
monitoring 16:14, 15, 19, 22; 17:6, 7, 22
months 6:7
more 10:2; 11.14; 14:12; 16:2; 20:17; 21:15, 16
most 9:6; 11:25; 12:25
mouthful 15:9
mouths 20:23
much 12:19; 21:19
municipal 6:2; 18:9
must 17:12
myself 4:10, 12; 8:7; *11:10*

N

name 1:6; 2:16; 8:10, 12, 13; 21:23
names 2:21
natural 20:11
nature 4:4
near 20:23
necessarily 8:5
necessary 7:22; 17:13
need 9:24; 10:1, 7; 21:16
needs 15:18; 16:4; 17:2, 25
Neither 4:9; 19:1
new 9:15
News 7:2, 3
newsletters 6:25
newspapers 6:5
next 13:24
Nick 22:14
nine-member 5:22
nip 19:17
nitrogen 21:4
nobody 17:17; 22:6
nominate 20:13
nominates 20:5
nor 4:10
North 20:5, 13
northeast 20:25; 21:5
note 13:7
nothing 18:16, 18; 22:17
notice 3:22
noticed 6:15; 12:10
notices 6:4
November 7:20
nutrient 21:8

O

o'clock 1:5, 6; 3:7; 22:21, 22
objections 4:3
objectives 15:4, 6; 17:8; 18:5, 8
observing 19:6
October 1:2; 3:7; 5:4
off 2:3, 7, 9, 11, 19
offering 4:2
office 6:5
officer 1:25; 2:6, 13, 14, 20; 3:5; 4:5; 7.25, 11:1, 8, 18; 13:22; 21:20; 22:3
officially 20:5
often 12:11, 16, 21
on-site 7.8
on-the-record 11:24
once 2:3; 4:20
One 16:13; 19:7, 8; 22:11
ongoing 18:21
only 11:10; 15:9; 20:10
open 5:19; 6:6, 12; 12:10
opportunity 4:20; 11:9, 24; 13:20; 14:4; 21:19; 22:19
options 19:13
oral 3:11; 4:18, 24
order 1:5; 8:3
ordinance 8:19, 25
organization 17:3, 20
orphan 16:3
osprey 19:5
ospreys 19:6, 7
others 15:11
otherwise 17:21
ounce 15:13
ours 19:1, 1
out 11:16; 14:23; 16:16; 18:15
outside 4:7; 16:15
outstanding 20:7, 11, 14
over 6:7; 7:1, 11; 16:6, 22
overall 15:8, 21
overnight 19:15
overseen 5:8
overworked 16:25
owes 14.21
owned 19:22
owners 7:1
ownership 16:8

P

p.m 3:7; 22:21, 22
packed 8:20
Page 19:19; 20:8
pair 19:6
paragraph 20:3
parameters 16:16
parents 15:22, 23, 24; 16:1, 5, 5, 8
part 4:11; 13:19; 22:18
participants 11:4
particular 1:12, 18
particularly 14:18
parties 7:2, 12
partly 14:14
pass 2:17
passed 2:15; 21
past 1:5
Payette 1:7; 3:6, 8, 12, 16; 4:9, 22; 5:2, 3, 7, 9, 16, 20; 6:13, 16; 7:9; 8:17; 9:8, 21; 12:2; 14:6; 15 18; 17:18; 18:6, 9; 19:3, 4; 20:2, 5, 10, 13, 13, 16; 21:13; 22:13
people 2:1; 8:18; 11:13; 12:22
percent 18:13; 21:2, 3
perennial 20:20
performed 5:10
perimeter 9:13
permanent 19:23
person 4:2, 19, 21
person's 1:21
Personally 11:12
persons 3:15; 4:16; 8:2
Peter 1:6; 9:7; 14:18
phosphorus 21:3
pieces 16:22
place 3:10
placed 6:5
plan 1:15, 15; 3:12; 4:12; 5:4, 14, 14, 18; 6:23, 23; 7:13, 18, 18, 22; 11:25; 12:1, 23; 13:6, 11; 14:19, 24; 15:2, 9, 19, 21, 23; 16:3, 4, 12, 13, 14, 15, 17; 17:9, 23; 18:4, 20; 20:4, 19; 21:10, 16, 18
Planning 18:23
plans 12:9; 13:7
please 2:18; 8:11
plus 11:15
point 9:22, 23; 13:11
polite 8:14
politically 15:15
pollution 18:21; 19:16
population 19:5
Portion 20:25; 21:1, 4, 5, 10
pose 19:15
possible 11:14; 12:18, 19
post 6:5
potential 9:20; 10:6
pre-final 1:14; 7:18; 11:25
precede 8:9
preferably 17:21
preliminary 6:14
prepared 5:14
prescribe 15:17
presentation 3:3; 4:18
presentations 4:6, 24
presented 4:14
presenters 6:14
preserve 5:15; 12:1
prevention 15.13
previous 18:4
primed 21:6
prior 4:20
private 6:2; 14:4
probably 11:22
problem 9:14, 18, 21; 10:6
problems 21:9
procedures 2:25; 4:3
proceeding 3:13; 4:1, 8
proceedings 8:4
process 1.24; 5:19; 12:9, 10
produce 21:2
product 1:13
program 1:16; 5:15, 18; 6:24; 7:13, 19, 22; 12:1; 14:24; 15:2; 16:21; 17:24
progress 16:6
prohibit 18:20; 19:2
prohibited 19:14
property 7:1; 14:14
proposed 20:18
protect 5:15; 12:1; 13:1; 16:12
Protected 19:25; 20:6, 17
protection 18:10, 20; 20:1
provide 18:11
provided 3:12
public 1:8, 9, 16; 5:3, 19; 6:2, 6, 10, 15, 21; 7:19; 12:13, 14; 14:20; 16:20; 17:4
publicized 6:12
purpose 3:13
purposes 2:2
Pursuant 5:6
put 9:15

Q

qualified 17:20
qualify 8:17
Quality 1:8; 3:6, 13, 16; 4:10, 23; 5:2, 8, 11, 16, 21; 6:18; 7:8; 8:24; 9:2, 21, 22; 10:6, 16; 12:2, 8; 15:3; 16:16; 17:18; 18:4, 7, 20; 19:10; 21:12; 22:13
quantitative 13:4
quarter 14:13
quite 2:3; 8:15

R

raise 19:7
rates 8:19, 25
read 2:24; 3:2; 4:23; 8:12; 9:6
real 16:15
really 8:15; 16.4
reason 9:1; 19·2, 9
receive 3:11
received 4:4
recent 7:6; 9:6, 11:25
recently 18:24
recognize 17:15, 20:9

MICROFILMED
OCT 3 0 2000

recommend 17:12
recommendations 9:7; 13:8, 14; 16:21; 17:5
recommended 9:25; 21:17
record 2:7, 10, 11, 14, 19, 25; 3:4, 19, 20, 22; 4:12, 24; 8:2; 11:3; 12:6; 13:21, 24; 21:21; 22:16, 22, 24
recorded 8:4; 12:11
recreational 14:6
refers 19:19
regarding 3:11
Regional 18:23
regulation 12:17, 20
regulations 9:17; 10:23
regulator 4:5
regulatory 13:2
relations 12:21
relative 8:22; 16:25
relax 11:22
release 18:13
rely 12:17
remarkable 8:15
remarks 13:21
remove 19:13
rented 19:23
repetitious 4:9
replace 21:17
report 6:19
reported 6:14; 7:5
reporter 8:5, 8
reporting 16:20, 23, 17:23
reports 7:8
represent 5:23
representatives 6:1
requested 2:22; 4:15
require 13:17
required 3:24; 11:2; 12:23
requirements 5:6
requires 18:8
reside 14:13
resident 12:3; 14:5
residential 19:15; 21:6
Resource 20:7, 9, 14
respectfully 7:17
respond 1:25; 11:3, 7, 14
response 5:12; 15:7
responsibility 16:7, 9; 17:16
responsible 16:19; 17:22
reveals 17:9
reverse 21:16
reversible 9:24
review 6:22; 12:13
reviewed 14:23
right 4:2; 10:1
risk 10:9; 19:16; 21:13
River 19:25; 20:6, 6, 14, 16, 17
room 6:17
roster 2:15, 20; 4:17; 8:3, 11
rubber 15:12
run 7:7

S

S-p-a-l-d-i-n-g 14:3
sack 7:15
sacred 18:16
same 6:21
saying 8:9
scale 8:20, 23
scenic 14:6
scheduled 1:6
School 3:8; 6:13, 16
scientific 5.9; 6:11, 20; 7:6
scope 4:8
score 17:3
second 4:21; 12:15; 15:21
secondly 15:4
Section 3:24; 20:3
seems 18:16
Segment 19:25; 20:6
sense 19:24
September 6:20; 21.23
septic 9:10, 15
session 1:12
sessions 6:6; 7:16
set 3:10; 13:8
Seven 20:16
seventies 9:9
several 5:23; 6:14; 14:25; 16:10; 17:4
sewage 9:11; 19:16
sewer 9:8, 15
sharp 18:1
sheet 21:24
shore 12:4; 21:5
short 11:15; 19:7
shortly 5:20
show 3:4, 22
sign 4:16; 8:19, 24
sign-in 2:15
signed 2:17; 3:17; 22:14
simple 19:24
six 19:8; 20:7
sixth 20:8
skis 18:13, 24; 19:2, 11
slivers 20:22
small 21:1
social 12:21; 20:12
socially 10:12
soft 15:11
sole 4:5
somebody 2:17
someone 9:12; 15:17
someplace 2:16
soon 16:17
Sorry 8:12
sound 15:10
south 14:13
Spalding 14:1, 2, 3; 21:20; 22:2
speak 4:20
speaking 14:4
Special 20:9, 11
specific 14:25; 16:10
specifically 10:1
specified 5:23
spell 8:10
spelled 22:15
spring 5:21; 7:14
stake 10:11
standards 18:4; 21:8
standing 21:22
Star 7:3
state 6:1; 13:8; 15:5; 16:23; 19:25; 20:1, 3, 6; 21:5
statement 3:1; 4:18, 23; 5:2; 22:12
statements 3:17
States 5:11
Statesman 7:5
stick 13:5
still 9:17
stopping 21:14
storm 21:4
straight 20:20
streams 20:20, 22
strengthen 16:12; 20:2; 21:9
strict 2:3; 21:8
strips 20:18
strong 10:7; 18:8
stronger 9:24; 21:18
strongest 18:10
study 5:9, 13; 6:11, 20; 7:6
sub-watersheds 20:21
submit 2:22; 22:8, 25
submits 7:17
submitted 7:23; 8:1; 13.23; 21:21, 25; 22:5, 16
succeed 15:3
suffer 18:25
sufficient 15.5
suggestion 17:20
suggestions 12:11
summary 21:12
summer 6:4; 19:6
supply 18:22
support 21:18
supporting 19:10
supports 14:16; 19:5
sure 8:8; 9:1
surely 17:1
surname 8:10
Survey 5:12
survive 16:4
survives 16:8
sustainable 14:15
system 9:16
systems 9:10

T

Tahoe 10:13, 14, 16; 18:23, 24
target 13:15
task 13:19
Technical 5:25; 6:8
technically 4:4
teeth 15:9, 10, 10; 18:2; 21:16
television 7:7
ten 10:9
testify 13:25; 22:7
Thanks 13:20
Therefore 14:11; 17:19
therein 9:5
thin 20:21
thinking 10:21
thorough 7:4
thought 14:23
thousands 15:14
three 7:7, 11; 10:8; 12:6; 15:3, 9; 16:15; 18:12; 19:7
thus 14:13
times 7:15
Title 5:6
together 22:23
tonight 3:18; 11:13, 15
took 9:12, 18
total 7:15
track 16:6
trailered 19:23
transfer 16:8
transmit 3:20
transmitted 22:23
treatment 15:18
tremendous 14:20
trend 21:15
tributaries 20:10
tributary 20:19, 22
trying 12:24; 20:21
turn 5:24
Turning 16:22
two 6:7; 14:24; 18:3
two-cycle 18:12, 12, 17
two-hour 7:15

U

U-m-b-a-c-h 11:21
ultimately 17:22
Umbach 11:19, 20, 21
uncombusted 18:14
under-funded 16:25
unduly 4:9
unfortunate 18:3
United 5:11
unwilling 12:25
up 14:19; 18:13
upon 8:2; 14:14
urge 13:11
usages 14:7
use 12:16; 19:4, 11, 15; 20:8
users 13:1
uses 14:12; 18:19; 19:9
using 13:10

V

valid 19:2, 9
valley 8:23; 9:3; 10:5
value 14:11, 14
values 14:16; 20:11, 12
view 13:11
views 3:14
virtually 9:10, 14
visitor 19:23
visual 9:18
voluntary 10:20, 22; 12:16, 17, 24; 13:3; 15:19; 21:17
volunteers 7:12

W

waits 21:14
watch 16:6; 17:25
watchdog 17:2
Water 1:8; 3:6, 12, 16; 4:10, 22; 5:2, 7, 16, 20; 7:8; 8:17, 19, 24, 25; 9:1, 8, 21, 22; 10:6, 16; 12:2; 14:7, 11; 15:3; 16:15; 17:18; 18:3, 7, 7, 16, 17, 19, 22; 19:10; 20:1, 9; 21:4, 12; 22:13
Watercraft 19:14
watered 18:5
Waters 20:7, 15
watershed 5:10, 17; 6:3; 12:3; 18:9; 21:2
Wednesday 1:2
Weeks 1:24; 2:12; 3:5; 5:1
welcoming 1:11
well-being 10:4, 24
west 12:4
what's 9:25
whole 17:23, 24
widely 6:12, 20
wildlife 14:16
willing 15:25
willingness 13:25

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JAN 3 1 2008

wish 2:21; 8:3; 22:7
wishes 22:8
wishful 10:21
wishing 22:25
without 12:23; 16:13; 21:7
work 13:17; 15:12; 18:1
working 7:11, 14
workshop 22:4, 4
workshops 6:21; 21:24
worth 15:14
writing 2:23; 11:23
written 1:22; 3:17; 14:1; 22:9

Y

years 6:7; 7:7; 10:9, 9; 15:24
young 15:22; 19:7

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REPORTER'S CERTIFICATE

STATE OF IDAHO)
) ss.
County of Ada)

I, Jami Dee Woodman, an Idaho Certified Shorthand Reporter, hereby certify:

That I am the reporter who took the proceedings had in the above-entitled action in machine shorthand and thereafter the same was reduced into typewriting under my direct supervision; and

That the foregoing reporter's transcript contains a full, true, and accurate record of the proceedings had in the above and foregoing cause, which was heard at Boise, Idaho.

IN WITNESS WHEREOF, I have hereunto set my hand this 17th day of November, 1997.

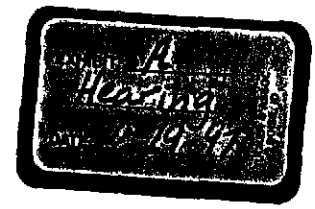
Jami Dee Woodman
CSR No. T-171

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JAN 3 1 2000

LAWYER'S NOTES

Page	Line	

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STATEMENT OF THE BIG PAYETTE LAKE WATER QUALITY COUNCIL
AT THE PUBLIC HEARING ON
THE BIG PAYETTE LAKE MANAGEMENT PLAN
October 29, 1997, McCall, Idaho

Pursuant to the requirements of Title 39, Chapter 66, Idaho Code, the Big Payette Lake Water Quality Council has overseen the completion of a scientific study of Big Payette Lake and its watershed performed by the Division of Environmental Quality and the United States Geological Survey. In addition and in response to the findings of that study the Council has prepared a Lake Management Plan and Plan Implementation Program to protect, preserve and improve water quality in Big Payette Lake and its watershed.

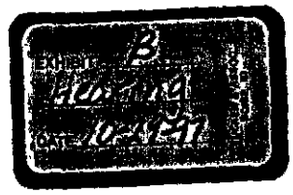
The Plan and the Program have been developed through an open public process which began shortly after the Big Payette Lake Water Quality Act became law in the Spring of 1993. The Governor has appointed members to the 9-member Council who represent the several interests specified in the Act. The Council in turn appointed a 24-member Technical Advisory Committee with representatives from all major federal, state, county, municipal, private and public entities with interests in the watershed. Beginning in the early summer of 1993, the Council has met (with notices in local newspapers and on the Post Office bulletin board) in open public evening sessions every two months for over four years. Generally the TAC has met earlier on the day of Council meetings.

To apprise the public of developments in the scientific study, during August of 1996 the Council held a widely publicized open meeting in the Payette Lake Middle School in McCall where several presenters reported their preliminary findings. Then in 1997, broadly noticed public meetings were held in the Payette Lake Middle School in McCall and in the conference room of the Division of Environmental Quality in Boise during June to report and discuss the findings of the scientific study. Again, during September, widely advertised public work shops were held in the same locations to review and discuss early drafts of the Lake Management Plan and Plan Implementation Program.

Beginning in 1993 bi-annual newsletters have been mailed to over 500 property owners, leasees, and interested parties. News coverage by the STAR NEWS of McCall and the ADVOCATE of Cascade have been thorough and extensive, and the IDAHO STATESMAN has reported on recent findings of the scientific study. In the last four years KTVB television has run three on-site reports on water quality issues on Big Payette Lake.

In the fall of 1996 the Council formed 3 working groups consisting of over 40 interested parties (many local volunteers) to begin developing the Plan and Program. These working groups met through the spring of 1997 a total of over 12 times during two-hour sack lunch sessions in the McCall Legion Hall.

The Council respectfully submits the Pre-Final Lake Management Plan and the Plan Implementation Program to this Public Hearing for comment. After the close of comments on November 12, the Council will make modifications as necessary in the Plan and Program which will then be submitted to the Idaho Legislature on January 12, 1998.



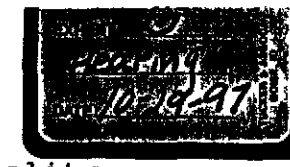
BIG PAYETTE LAKE WATER QUALITY COUNCIL
September 10 and 18 Workshops
Comments:

1. I HAVE A CONCERN THAT 1/1/08 MAY BE WAITING TOO LONG TO TAKE MANDATORY ACTIONS. WOULDN'T IT MAKE SENSE TO ALLOW CERTAIN HIGH-PRIORITY ACTIONS TO GO INTO EFFECT SOONER?
2. ANOTHER CONCERN IS THAT THE PROBLEM OF HIGH CONTAMINANTS (SUCH AS COLIFORM) ARE PRESENT AT POPULAR SWIMMING AREAS (SUCH AS ART ROBERTS PARK). CAN THE COUNCIL ADDRESS THIS?
3. I'D LIKE TO SEE THE PLAN MORE FULLY ADDRESS THE INCREASING PROBLEM OF GASOLINE AND OIL EMITTED INTO THE LAKE BY MOTORIZED CRAFT ESPECIALLY "PERSONAL WATERCRAFT" AND OTHER 2-CYCLE ENGINES.

"AN OUNCE OF PREVENTION IS WORTH A HUNDRED GALLONS OF CURE."

Name: CURTIS SPALDING
Address: 304 BURNS / BOX 1362 MCCALL ID 83638

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JUN 3 1 2008



Statement and Questions for the Payette Lake Water Quality Commission

I am concerned that far too little is being done to address water pollution problems associated with substantial increases in motorized recreation on Payette Lake. My concerns are based on the following:

- The use of watercraft powered by two-cycle engines is growing exponentially and shows no sign of abating. Dozens of these watercraft are out on the lake at any given time on a summer weekend afternoon.

- I understand that personal watercraft lose about 25% of their fuel, apparently through inefficient combustion. If this is so (and apparently even the personal watercraft industry does not dispute this statistic), dozens, perhaps hundreds of gallons of fuel are being spilled into our lake every weekend.

- On most weekend afternoons and sometimes during the week as well, the town beaches and Ponderosa Park beaches smell like a gas station.

- Mainly because of their contribution to water pollution, all two-cycle watercraft have been recently banned from Lake Tahoe. This, however, is only after significant degradation of water quality.

These observations give rise to the following questions:

- What information has the Water Quality Commission gathered about the effects of motorized recreation on water quality in Payette Lake, and what projections can you make about future impacts should current user trends continue?

- Even if data specific to Payette Lake is lacking, what information have you gathered about impacts of motorized recreation on water quality in general? Why is motorized use prohibited or severely limited on most surface waters in the United States that provide domestic water supplies?

- How does the volunteer-compliance plan deal with the effects of motorized recreation on water quality and the probable continued increases in motor usage on the lake? What voluntary measures are you anticipating that will have an effect on this usage or the pollution resulting from it?

Nick Hershenow

- Nick Hershenow

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JAN 3 1 2000

October 29, 1997



Chairman
Big Payette Lake Water Quality Council
PO Box T
McCall, Idaho 83638

Good Day –

I am writing to take advantage of the "on the record" opportunity to make comments on the most recent "Pre-Final Lake Management Plan and Plan Implementation Program" to protect, preserve and improve water quality in Big Payette Lake and its watershed. I am a resident of McCall, living on the west shore of the lake. I have been following the work of the Council since its inception.

I have three general comments to make for the record:

First, I would like to compliment the Committee and the DEQ for the quality of the process that was followed in developing the plans. The process was open, well-noticed, and suggestions were carefully recorded and often incorporated into the drafts. It has been, in fact, a model of conducting public review to develop public action.

Second, I would to applaud the decision to use voluntary compliance techniques. Too often, we rely on coercion and regulation when voluntary compliance would have been possible. When it is possible, it is much less expensive and intrusive as well as longer-lasting than regulation and coercion. In social relations we often get what we expect. If we assume people will not do that which is required to implement the plan, without first trying voluntary compliance, we will find them unwilling to comply. I believe that most of the users of the lake want to cooperate to protect it.

I also applaud the backup of regulatory control if voluntary compliance is not at a level that brings about minimum, measurable quantitative change. It's a good "carrot and stick" implementation plan.

Finally, I note that the plans include a set of recommendations to be made to State, County, City, agencies and governments, as well as to individuals living alongside and using the lake. I would like to urge a point of view that this plan, when in its final draft, is just the beginning of action. It is of crucial importance that these recommendations be carefully articulated and communicated with enough force to the target audiences so that they cannot be ignored. To do so will require further work, no doubt. I hope the committee will continue as an active group to accomplish this important part of the task.

Thank you for the opportunity to go on the record with these remarks.

Yours Sincerely,

Cutler Umbach
PO Box AN
McCall, Idaho 83638

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P.O. Box 1362
McCall ID 83638

October 29, 1997

Big Payette Lake Water Quality Council
McCall ID

re: Lake Management Plan

Dear Council Members:

Thank you for this opportunity to comment. I speak as a private citizen and resident of McCall. I enjoy Payette Lake for its scenic, recreational, and consumptive water uses. In addition, I enjoy the knowledge that the fish, aquatic, and avian ecosystems are in excellent condition. And indirectly, I benefit from the agricultural value of the water. Therefore, I enjoy all five beneficial uses, and more. I reside a quarter mile south of the lake, and thus my property values partly depend on a clean, sustainable lake ecosystem. I also enjoy the wildlife values the lake ecosystem supports.

I commend each member of the Council and especially its chairman Peter Johnson for the countless hours expended leading up to this plan. It has been a tremendous contribution to the public interest, and the community owes you a big debt of gratitude. I thank each of you.

I have reviewed and thought about the draft plan and implementation program, and have two general and several specific comments. But first, I have a question I would like the Council to address: do you believe this Plan and Program will succeed in meeting the three water quality objectives? And secondly, if it does not, then do you believe the State will take actions sufficient to meet those objectives? I invite your response.

My first overall comment: this plan is like a mouthful of teeth. But only three of the teeth are sound. Some other teeth are missing entirely, and many others are capped with soft foam rubber. We all know that getting good dental work is expensive these days, but an ounce of prevention now can be worth thousands of gallons of cure later. Whether it is politically feasible in the Idaho legislature is another question. But I think it is important for someone to prescribe the full treatment that Payette Lake needs, and not imply that a mild, compromise, voluntary plan will do the job if we don't believe it will.

My second overall comment: the plan is like a young child with good parents. However, the parents all plan to cease to exist in a couple years. Their intention is that other parents will be willing to adopt the child and care for it. However, the fact is these other parents (other agencies) have more children than they can handle. The orphan plan is not very likely to find a good home. To survive and grow, the plan really needs its parents or equivalent adoptive parents who will watch over it, track its progress, make adjustments, and take some responsibility to assure it survives. The parents can transfer ownership but not responsibiity.

Here are several specific comments. In each case, the Council should make modification to strengthen the Plan and better protect the Lake.

1. A plan without a complete monitoring mechanism is incomplete. Having the Council go out of existence soon after completing the Plan would be a mistake because there would be no entity responsible for monitoring, evaluating, and reporting to the public on the implementation of the many recommendations in the program. Turning over the pieces of the monitoring and reporting to a list of federal, state, and local agencies all of which are already underfunded and overworked relative to their mission would almost ensure failure in implementation. There needs to be a watchdog organization to keep a scorecard. It should inform the pubic how many of the several dozen recommendations each agency is implementing (this is implementation monitoring), and how effective each measure is (effectiveness monitoringves in achieving its objectin. If time reveals that the plan is not being implemented, or that the measures are being implemented but are not effective, then the Council must be in existence to draft recommended actions to the agencies and Idaho legislature if necessary. I recognize few on the Council want this responsibility to continue, but firmly believe that if the Council does not do it, nobody will. And the water quality of Payette Lake is too important to let that happen.

Therefore, my suggestion is to identify a qualified organization, preferably this Council, but otherwise or another, ultimately responsible for monitoring, evaluation, and reporting the implementation of the Plan and program. The watchdog group needs to have a loud bark, and, if the bark doesn't work, good sharp teeth.

2. It is unfortunate that the water quality standards in a previous plan draft have been watered down (pardon the choice of words) to objectives in this draft. he history of Payette Lake lately has been declining water quality. If there is any body of water that requires strong, binding objectives, it should be Payette Lake. A municipal watershed deserves some of the strongest form of government protection government can provide.

3. Two cycle engines. Two cycle engines on jet skis release up to 25% of their gasoline fuel into the lake as uncombusted material. This lake is what we drink out of. If nothing else is sacred, it seems our drinking water should be. Two cycle engines on the water do nothing but conflict with the five other beneficial uses. It is inconceivable to me that a water quality protection plan should not prohibit this ongoing and increasing pollution of a domestic water supply. The Tahoe Regional Planning Agency recently decided to ban jet skis on Lake Tahoe. The economy there will not noticeably suffer. In the long term, ours will improve. There is no valid reason not to do so on Payette Lake.

Another "use" I make of Payette Lake is to enjoy the osprey population the lake supports. Each summer I enjoy observing the pair of ospreys that raise 1-3 young ospreys a short distance from my house. This is not one of the six beneficial uses, but is another valid reason for supporting excellent water quality. It is another use that jet skis directly and adversely affect.

4. Houseboats. Before they become established and remove options, houseboats should be prohibited from the lake. Watercraft that are dedicated to overnight residence use pose too high a risk of sewage pollution. The Council should nip this in the bud, or even before there is a bud. Page 21 refers to floating homes, which is good as far as it goes. It should be expanded to apply explicitly to houseboats and other floating homes whether owned or rented, permanent or trailered, local or visitor. It is simple common sense.

5. State Protected River Segment. If any body of water deserves state designation and protection, Payette Lake does. To strengthen section 8.6, paragraph 2, which asks the State to

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consider it, the Council's Plan should say that it now officially nominates the North Fork Payette River as a State Protected River Segment. Again, if a major municipal watershed and recreation attraction does not qualify, what does?

6. Outstanding Resource Waters. As page 2 indicates, the sixth beneficial use is "Special resource water." To recognize the fact that Payette Lake and its tributaries have not only special values but also outstanding natural, social, and economic values, the Councuil should nominate Payette Lake and the North Fork Payette River above the lake for Outstanding Resource Waters.

7. Payette River Corridor. The protected river corridor should include more than the limited strips proposed in Maps A and B, but should include tributary perennial streams as well. Drawing straight-lines across sub-watersheds and trying to manage thin slivers that crosscut tributary streams near their mouths makes for extremely difficult management.

8. Northeast Portion of the Lake. Although developed lands comprise a small portion of the watershed, they produce 14% of the phosphorus into the lake and 18% of the nitrogen from storm water. A large portion of the east and northeast portion of the lake shore on State lands is primed for extensive residential development, the kind of development that without strict standards could exacerbate the nutrient loading problems. The Council should strengthen this portion of the Plan to ensure this does not happen.

In summary, "the water quality of the Big Payette Lake has deteriorated and is at risk" (Plan, page 2). The longer the community waits before stopping this trend, the harder and more costly it will be to reverse. I believe we need a plan with more teeth to replace some of the recommended and voluntary measures. I encourage a stronger plan.

Sincerely, Curtis Spalding

Curtis Spalding

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SIGN-IN ROSTER FOR PUBLIC HEARING

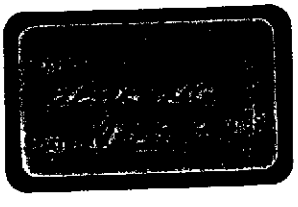
Big Paylette Lake Management Plan

LOCATION: **Payette Lake Middle School, 111 Samson Trail, McCall, Idaho**

DATE: **October 29, 1997**

NAME (PLEASE PRINT)	MAILING ADDRESS	ORGANIZATION REPRESENTED (IF ANY)	DO YOU WISH TO TESTIFY? (YES/NO)
CRAIG SHEPARD	1445 N. ORCHARD BOISE, ID 83706	DEQ	No
TOM TURCO	707 N. ARMSTRONG PLACE BOISE, ID 83704	Central District Health	NO
Ed Elliott	Box 326 McCall	NONE	YES
Kirk Hall	Box 1943 McCALL, ID	WATER QUALITY CNCL	NO
Jeanne Heins	PO Box 4337 McCall ID 83638	Star-News	NO
John Kwader	34 Ilia Lane McCall, Id 83638	Technical committee	
Rep Twila Horbeck	808 LAKE Granville 83530	Dist 8	No
Cutler Umbach	PO Box A-N McCall, ID 83638	none	yes
Earl Dodds	Box 156 McCall ID 83638	None	No
Doyle Wilde	Box 984 McCall 83638		No
CURTIS SPAULDING	Box 1362 McCALL 83638	No	Yes
Wayne Allen	box 723 McCall 83638	None	No

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Chair Peter Johnson
PO Box T
McCall, ID 83638

11/11/97

Dear Peter;

I'd like to thank members of the Big Payette Lake Water Quality Council for the many volunteer hours spent developing the Payette Lake Management Plan. I'm sorry to say, though, that in terms of actually protecting water quality in Payette Lake, or even laying the groundwork so that we might someday protect it in the future, the plan strikes me as very inadequate. The following are two shortcomings the Council still could correct:

1) The plan depends entirely on volunteer compliance with a number of "best management practices". However, no mechanism is proposed for monitoring compliance with these BMPs. So three years from now, while we may know whether or not certain water quality parameters have improved or deteriorated, we'll have no idea whether or not the recommendations contained in the plan had anything to do with it, because we won't know to what extent the recommendations were followed.

2) The Plan proposes to monitor only certain pollutants, specifically, those associated with nutrient loading and eutrophication. However, these are not the only pollutants affecting the lake. Increased motorized recreation use of the lake may well be having a significant detrimental effect on water quality, but there's no proposal to monitor the pollution associated with this use.

On most summer week-ends now, and increasingly on week days too, much of Payette Lake smells like a gas station. Just a few years ago this wasn't the case, and it's odd how quickly people seem to have come to accept this as the norm. Maybe everyone is starting to associate the smell of lake-borne gasoline fumes with summer fun on the water, in the way that we associate the smell of charcoal lighter (also a pollutant) with a delicious summer barbecue. But we ought to remember that the main reason for the smell is that gasoline is being constantly spilled in the water. My understanding is that personal watercraft lose about 25% of their fuel, due to the inefficient combustion inherent in two cycle engines. If this figure is correct it means that on a busy summer weekend hundreds of gallons of gasoline are spilled into Payette Lake.

Actually the plan does acknowledge that this is probably a serious problem; it just doesn't propose to do anything about it. The report states that "Scientific studies have proven that two cycle engines emit high concentrations of pollutants... and contribute to the deterioration of water quality". And the Council "discourages" the use of two cycle engines – a statement that is really quite pointless, since no means of discouragement are ever proposed.

We're told that the plan as written is all we can hope to achieve, because the legislature won't approve anything stronger. Does this mean that our political climate is so oppressive that we can't even speak of a major threat to our water quality, and begin to monitor it (let alone take action to curb it), because powerful interests would be offended?

It wouldn't surprise me if this is the case. I guess if it is, though, I'd just like to have it publicly acknowledged, so that we know where we stand and don't have to pretend that we've dealt with the problem, or that we have the power and the will to deal with it. And if it's not the case, then please, make a few changes in the plan. At a

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minimum, the Council should broaden the water quality study to include all the pollutants that threaten Payette Lake. And you should establish some way to track implementation of the recommendations, so that we can have some idea of whether the plan makes any difference at all in the way people treat the lake.

Sincerely,

Nick Hershenow

Nick Hershenow
PO Box 278
McCall, ID 83638
634-3230

MICRO...
JAN 3 1 2000

P.O. Box 1362
McCall ID 83638

November 11, 1997

Big Payette Lake Water Quality Council
attn: Peter Johnson
P.O. Box T
McCall ID 83638

re: Comments on Lake Management Plan

Dear Council Members:

Thank you for the opportunity to comment at your October 29 public hearing, and for the subsequent discussion. This letter takes the discussion one step further.

If comments after the public testimony are any indication, there is a lack of Council enthusiasm to strengthen the Plan either with mandatory requirements, or to monitor and report the Plan's implementation. This is understandable, but unfortunate because both areas could be strengthened and the Plan made more likely to succeed.

1. Mandatory vs. Voluntary. I still believe voluntary requirements are a poor idea because they have little chance for success. Highway speed limits are mandatory, not voluntary. "Voluntary" tends to mean "optional". Given the choice, many people will elect not to comply, and others will remain unaware of the requirements. The consequences will be three years of continued degradation of water quality. Instead, I suggest selected mandatory requirements backed up by a coordinating "watchdog" organization (explained below).

2. Monitoring and Reporting. I still believe the Plan needs a comprehensive monitoring program for all elements of the Plan--not just the three water quality parameters (nitrogen, chlorophyll, and dissolved oxygen), but also the dozens of recommendations in the Plan. I just counted 88 recommendations/requests/action items in the Plan. (Not even including the 51 Stewardship Ethics items!) I agree with them and commend the Board. One of the recommendations, interestingly, is:

> *"As part of this schedule of activities, the City should incorporate a monitoring program to evaluate the effectiveness of the retrofits."* (Plan, p. 16).

By the same logic that the Council believes the City should begin a monitoring program for part of the Plan, the Council should establish and conduct a monitoring program to track implementation and effectiveness of the entire plan. Otherwise, nobody will ever know which parts of the Plan got implemented, and which didn't; let alone how effective those parts were that did get implemented.

Without systematic monitoring and reporting, the Plan will be forgotten.

3. Monitoring Responsibility. Who is going to see the Plan through? With the Council phasing out in two years, nobody will be clearly responsible for implementing and monitoring the Plan. This is unfortunate.

For the sake of planning, please fast forward three years and imagine that it is January 2001. The Council has been out of existence for a year. The USGS reports that all three water parameters are not met. Then what? In retrospect, what should we have done over the past three years to prepare for this? (Systematic monoitoring results of implementation of the Plan's implementation.) Realistically, what are the odds that the Board of Health and Welfare will *"promulgate rules, as necessary, in conformance with Idaho Law to maintain and preserve the Lake's water quality"* (Plan, p. 5)?

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Not good.

The Plan claims (p. 32) that, "*... the responsibility to modify as necessary and continue implementing the Plan falls to the responsible agencies.*" But realistically, what is the likelihood the agencies will accept this responsibility? (It's not their plan.)

Not good.

There still needs to be an entity to watchdog and prompt responsible parties to act. My first choice is your Council as you have the expertise and commitment; but I understand that may not be possible. Another idea is a non-profit organization; but that has no authority except that of persuasion, and it sends the message that it's the organization's job to protect the lake, not the agencies' or the people's.

I would suggest studying useful precedents around the west. Eagle Lake in northeast California is the second largest natural lake entirely within that state. Lying in a closed basin, Eagle Lake has extremely sensitive water quality threatened by poor land use, logging and grazing, forest fire runoff, watercraft, subdivisions, etc. (much like Payette Lake). To help protect the lake, the several federal, state, and local agencies in the basin voluntarily came together to form an interagency coordinating council to work cooperatively in lake and watershed management. The "Eagle Lake Interagency Board of Directors" consists of:

U.S. Forest Service
U.S. Bureau of Land Management
State Fish & Game
State Department of Lands
Lassen County Government.

The Interagency Board has been a real success. Closer to home, the Henry's Fork Watershed Council in eastern Idaho has been a well-known success story in which all interested parties are represented. Therefore, I encourage you to consider adding something similar to your final Plan. A Payette Lake Watershed Coordinating Council, consisting of:

U.S. Forest Service
Idaho Department of Lands
Idaho Department of Fish and Game
Idaho Department of Parks and Recreation
Valley County
City of McCall
Payette Lake Reservoir Company

You may consider adding two public members as well. The council could have a technical team of staffers, much like the present Council. Such an organization would work primarily by coordination, cooperation, and public information, but also by "peer pressure". Agencies would want to comply with the Plan. Individually and collectyively, they would be accountable to the people. This council would help achieve functions of monitoring and reporting (item #2 above), and would be the logical entity to trigger the request to the Board of Health and Welfare in three years.

Please give this suggestion due consideration. Thank you for your hard work in helping protect our water quality through a strong and effective plan that will pass the test of time.

Sincerely, Curtis Spalding

Curtis Spalding

PHOENIX, AZ
OCTOBER 23, '97

DEAR PETER.

I HAVE REVIEWED THE "RE FINAL" LAKE MANAGEMENT PLAN YOU SENT AND HAVE NO SUBSTANTIVE COMMENTS - CONGRATS ON A JOB WELL DONE!

YOU MIGHT CONSIDER AN ADDITION TO THE INTRODUCTION TO THE EFFECT THAT:

"SHOULD ANY FEDERAL, STATE OR LOCAL AUTHORITY ESTABLISH MANAGEMENT PRACTICE STANDARDS, APPLICABLE TO BIG PAYETTE LAKE, THAT ARE MORE STRINGENT THAN THOSE SET FORTH IN THIS PLAN, THE MORE STRINGENT STANDARDS SHALL APPLY."

THIS MAY ALREADY BE COVERED AND I'VE MISSED IT.

WE HAVE BOUGHT OUR "PERMANENT" HOME IN THE AHWATUKEE FOOTHILLS OF PHOENIX. WE'LL MOVE IN THE END OF THIS MONTH. PLEASE NOTE NEW ADDRESS. PHONE NUMBER IS UNCHANGED.

WE HOPE TO SEE YOU HERE DURING THE WINTER

BEST WISHES.

BOB C.

R.B. CHRISTENSEN
3329 E TANGLEWOOD DR.
PHOENIX, AZ 85044
PH: (602) 706-4221

MICRO
1 9 1 2000

Curtis Spaulding

P.O. Box 1362
McCall ID 83638

October 29, 1997

Big Payette Lake Water Quality Council
McCall ID

re: Lake Management Plan

Dear Council Members:

Thank you for this opportunity to comment. I speak as a private citizen and resident of McCall. I enjoy Payette Lake for its scenic, recreational, and consumptive water uses. In addition, I enjoy the knowledge that the fish, aquatic, and avian ecosystems are in excellent condition. And indirectly, I benefit from the agricultural value of the water. Therefore, I enjoy all five beneficial uses, and more. I reside a quarter mile south of the lake, and thus my property values partly depend on a clean, sustainable lake ecosystem. I also enjoy the wildlife values the lake ecosystem supports.

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1. A plan without a complete monitoring mechanism is incomplete. Having the Council go out of existence soon after completing the Plan would be a mistake because there would be no entity responsible for monitoring, evaluating, and reporting to the public on the implementation of the many recommendations in the program. Turning over the pieces of the *monitoring* and reporting to a list of federal, state, and local agencies all of which are already underfunded and overworked relative to their mission would *almost ensure* failure in implementation. There needs to be a watchdog organization to keep a scorecard. It should inform the pubic how many of the several dozen recommendations each agency is implementing (this is implementation monitoring), and how effective each measure is (effectiveness monitoringves in achieving its objectin. If time reveals that the plan is not being implemented, or that the measures are being implemented but are not effective, then the Council must be in existence to draft recommended actions to the agencies and Idaho legislature if necessary. I recognize few on the Council want this responsibility to continue, but firmly believe that if the Council does not do it, nobody will. And the water quality of Payette Lake is too important to let that happen.

Therefore, my suggestion is to identify a qualified organization, preferably this Council, but otherwise or another, ultimately responsible for monitoring, evaluation, and reporting the implementation of the Plan and program. The watchdog group needs to have a loud bark, and, if the bark doesn't work, good sharp teeth.

2. It is unfortunate that the water quality <u>standards</u> in a previous plan draft have been watered down (pardon the choice of words) to <u>objectives</u> in this draft. he history of Payette Lake lately has been declining water quality. If there is any body of water that requires strong, binding objectives, it should be Payette Lake. A municipal watershed deserves some of the strongest form of government protection government can provide.

3. Two cycle engines. Two cycle engines on jet skis release up to 25% of their gasoline fuel into the lake as uncombusted material. This lake is what we drink out of. If nothing else is sacred, it seems our drinking water should be. Two cycle engines on the water do nothing but conflict with the five other beneficial uses. It is inconceivable to me that a water quality protection plan should not prohibit this ongoing and increasing pollution of a domestic water supply. The Tahoe Regional Planning Agency recently decided to ban jet skis on Lake Tahoe. The economy there will not noticeably suffer. In the long term, ours will improve. There is no valid reason not to do so on Payette Lake.

Another "use" I make of Payette Lake is to enjoy the osprey population the lake supports. Each summer I enjoy observing the pair of ospreys that raise 1-3 young ospreys a short distance from my house. This is not one of the six beneficial uses, but is another valid reason for supporting excellent water quality. It is another use that jet skis directly and adversely affect.

4. Houseboats. Before they become established and remove options, houseboats should be prohibited from the lake. Watercraft that are dedicated to overnight residence use pose too high a risk of sewage pollution. The Council should nip this in the bud, or even before there is a bud. Page 21 refers to floating homes, which is good as far as it goes. It should be expanded to apply explicitly to houseboats and other floating homes whether owned or rented, permanent or trailered, local or visitor. It is simple common sense.

5. State Protected River Segment. If any body of water deserves state designation and protection, Payette Lake does. To strengthen section 8.6, paragraph 2, which asks the State to

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consider it, the Council's Plan should say that it now officially nominates the North Fork Payette River as a State Protected River Segment. Again, if a major municipal watershed and recreation attraction does not qualify, what does?

6. Outstanding Resource Waters. As page 2 indicates, the sixth beneficial use is "Special resource water." To recognize the fact that Payette Lake and its tributaries have not only special values but also outstanding natural, social, and economic values, the Councuil should nominate Payette Lake and the North Fork Payette River above the lake for Outstanding Resource Waters.

7. Payette River Corridor. The protected river corridor should include more than the limited strips proposed in Maps A and B, but should include tributary perennial streams as well. Drawing straight-lines across sub-watersheds and trying to manage thin slivers that crosscut tributary streams near their mouths makes for extremely difficult management.

8. Northeast Portion of the Lake. Although developed lands comprise a small portion of the watershed, they produce 14% of the phosphorus into the lake and 18% of the nitrogen from storm water. A large portion of the east and northeast portion of the lake shore on State lands is primed for extensive residential development, the kind of development that without strict standards could exacerbate the nutrient loading problems. The Council should strengthen this portion of the Plan to ensure this does not happen.

In summary, "the water quality of the Big Payette Lake has deteriorated and is at risk" (Plan, page 2). The longer the community waits before stopping this trend, the harder and more costly it will be to reverse. I believe we need a plan with more teeth to replace some of the recommended and voluntary measures. I encourage a stronger plan.

Sincerely, Curtis Spalding

Curtis Spalding

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December 2, 1997

On December 1, 1997, the Technical Advisory Committee and the Big Payette Lake Water Quality Council met to review the comments received during the public comment period. The following is the response to comments including changes made to the *Plan Implementation Program.*

Response to Public Comments

Voluntary vs. Mandatory Action:

The principal comment during the public comment period questioned whether the Council had provided enough future protection for the Lake with the reliance on voluntary rather that mandatory actions. The Council was created by State Law to review the condition of Big Payette Lake and the watershed and make recommendations to the Idaho Legislature. The Council's recommendations are a mixture of voluntary activities and recommendations for actions by agencies or governments that, if implemented, result in mandatory requirements. For example, the Council recommended the adoption of stormwater ordinances by the city of McCall. This step has been taken by the city and the ordinances are now in place. As another example, the Council has recommended that the State Department of Lands and the Department of Parks and Recreation establish a Memorandum of Understanding (MOU) transferring management of lands identified in the Water Quality Corridor to the Department of Parks and Recreation. This recommendation can be easily monitored for compliance. Once this MOU is in place the Council then recommends that Parks and Recreation promulgate rules for the Corridor as set forth in the Plan Implementation Program Those rules would be enforced.

Based upon comments received from government entities during the public process, it was the Council's opinion that many of the recommended actions were not appropriate ones for the Idaho Legislature to adopt as standards. In some instances, the appropriate government organization was the City of McCall or Valley County. The Council directed a recommendation for action to the appropriate authority. It is understood that the responsibility to accept and act upon the recommendations of the Council rests with each political body. However, membership on the council has included representatives of the city and the county.

MICRO
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The Council considers the Plan and Implementation Program the beginning of a systematic, long–term approach to protect the water quality of the Lake and the watershed. Looking to the future, the Council believed that the voluntary approach would produce an educational benefit and enhance understanding of an individual's impacts on the Lake. While seemingly insignificant, many daily acts by individuals do pose a risk to the Lake, an example being the use of fertilizers near the Lake. Voluntary actions lead to a greater public awareness and; consequently, support of future requirements, if needed. As with the TRPA at Lake Tahoe, if the Council sought mandatory actions in areas not understood as impacting the water quality of the Lake, disagreements would likely ensue leading to disputes and even litigation pitting citizens against authorities.

The Council made no changes to the Plan or Implementation Program.

Monitoring and Trend Analysis:

Comments questioned the lack of monitoring for compliance with or the effectiveness of recommended actions. The Council will exist, by law, for a two year period following the submission of the Plan and Implementation Program to the legislature During that period, the Council's principal responsibility will be to follow implementation of the Plan and Program. One comment recommended the creation of an entity to follow the implementation of the recommendations and watchdog the responsible parties. The suggestion is well taken and the following is added to Section 2.4·

The Council recommends that the following authorities implementing portions of the Plan Implementation Program assemble annually to discuss progress towards the Council's objectives:

US Forest Service
Idaho Department of Lands
Idaho Department of Parks and Recreation
Idaho Department of Fish and Game
Idaho Department of Transportation
Idaho Department of Water Resources
Idaho Division of Environmental Quality
City of McCall
Valley County
Lake Reservoir Company
Payette Lake Water and Sewer Company

The date and location of this review will be established by the Division of Environmental Quality and should occur within 30 days after the completion of the annual report of the findings of the monitoring and trend analysis. The review shall be a duly noticed public meeting.

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Two Cycle Engines:

Comments were received requesting action by the Council concerning two cycle engine use on the Lake. Scientific information provided to date did not enable the Council to reach a definitive conclusion concerning the risk posed by the use of two cycle engines on the Lake. Recent scientific studies suggest that the impact of hydrocarbons on a lake are more extensive than previously thought The *Plan Implementation Program* has been changed to include the following recommendations:

In Chapter IV item 2 Lake Surface Restrictions: *This Study should also evaluate the impact of hydrocarbon contaminants on the Lake.*

In Chapter IV, item 3 Two Cycle Engines: *The Council recommends that the DEQ assess the level and distribution of hydrocarbon contaminants in the Lake. Manufacturers have designed economical four cycle engines that are now commercially available for watercraft. The Council recommends four cycle engines to owners and buyers of jet skis and outboard motors.*

Water Quality Objectives:

Comment was received that the plan proposes to monitor a limited set of pollutants, those associated with nutrient loading and eutrophication, but does not include monitoring for hydrocarbons or other contaminants. To ensure a successful long term monitoring program, before the scientific study began, the Council requested the Technical Advisory Committee to recommend those key indicator substances that would give us a sense of the health of the Lake at a reasonable cost. Those recommended are total phosphorus, dissolved oxygen and chlorophyll–a. The estimated cost of monitoring for these elements is approximately $40,000 per year. Incorporating monitoring for hydrocarbons and other contaminants would greatly increase this annual expense Other State and Federal Agencies have responsibilities to monitor contaminants that affect health and safety. The Council believes that the three elements to be monitored will provide the needed information to measure the trophic condition of the Lake.

See the preceding section **Two Cycle Engines** for the Council's response.

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Big Payette Lake Management Plan

