Water Quality Summary Report No. 29

PARADISE CREEK

Use Attainability Assessment

Latah County, Idaho

Final Report

Idaho Department of Health and Welfare
Division of Environmental Quality
North Central Idaho Regional Office
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ABSTRACT

Paradise Creek is located in Latah County, Idaho and Whitman County, Washington. The water quality in the creek is influenced by both point and nonpoint sources of pollution. In 1980, Idaho's Department of Health and Welfare, Division of Environmental Quality (DEQ) listed Paradise Creek as protected for agricultural water supply and secondary contact recreation designated beneficial uses in the Idaho Water Quality Standards. In October 1993, DEQ staff conducted a Use Attainability Assessment (UAA) for Paradise Creek. The purpose of the UAA was to evaluate the appropriateness of the current designated uses and to determine whether the creek should be protected for any additional uses. It was determined through the UAA that if the water and habitat quality is improved, Paradise Creek would be capable of supporting salmonid spawning and cold water biota. This designation applies to the portion of the creek flowing through Idaho; however above Mountain View Park the creek is intermittent and these uses would apply only when water is present. Secondary contact recreation and agricultural water supply were confirmed as appropriate designated beneficial uses.

INTRODUCTION

Paradise Creek is a diverse body of water. It is approximately nineteen miles long with its headwaters located in the Palouse Mountain Range northeast of Moscow, Idaho and its confluence with the South Fork of the Palouse River near Pullman, Washington (Figure 1). It is classified as a fourth order tributary of the South Fork of the Palouse River. The upper portion of the creek is intermittent except during the spring runoff period; it becomes perennial at Mountain View Park on the Moscow city limit line. The watershed comprises 22,432 acres (Steiner *et al.* 1985) with 13,888 acres in Idaho (Latah SWCD 1993). The upper portion of the watershed is forested and very steeply sloped, while the middle and lower portions are largely dryland agriculture on moderately steep rolling hills. Approximately two-thirds of the watershed is non-irrigated cropland. The creek flows through two urban centers, the cities of Moscow and Pullman.

In 1980, the Idaho Division of Environmental Quality (DEQ) determined that the beneficial uses of Paradise Creek were secondary contact recreation and agricultural water supply; this designation was based upon best professional judgement and not a scientific evaluation. These beneficial uses were then listed as designated uses in the Idaho Water Quality Standards (IDAPA 16.01.2121,01); designated uses help to define the water quality goals for that particular body of water. In the past few years, public interest in Paradise Creek has increased and prompted a more detailed evaluation of the creek's beneficial uses. This was accomplished through a Use Attainability Assessment (UAA), which is a structured scientific evaluation of the factors affecting beneficial use attainment. A UAA is used to insure consistency in determining attainable uses for Idaho stream segments and to eliminate the need for best professional judgement decisions. Once the attainable uses are determined, they are submitted for inclusion as designated uses in the Idaho Water Quality Standards.

The Idaho DEQ conducted a UAA of Paradise Creek in an effort to evaluate the appropriateness of the current designated uses and to determine whether the creek should be protected for any additional uses. The UAA involved gathering original data as well as using existing data from other studies. A significant amount of water quality information has been collected on Paradise Creek due to its proximity to two major universities and community support for water quality protection. The State of Washington Water Research Center (SWWRC) has monitored various water quality parameters and Dr. Fred Rabe has collected data on habitat quality and the macroinvertebrate communities. DEQ conducted the UAA at sites with existing data from these two studies (Table 1).

DEQ's findings in the UAA will be used in an effort to resolve water quality issues with the State of Washington, as Paradise Creek must meet Washington's standards when it crosses the border. The creek is an interstate water and is protected for different beneficial uses in each state. The portion in Idaho is protected for the least stringent uses: agricultural water supply and secondary contact recreation. In contrast, the portion of the creek that flows through the state of Washington is classified as a Class A water (Chapter 173-201 WAC) and is therefore protected for their most stringent uses: domestic, industrial, and agricultural water supply;

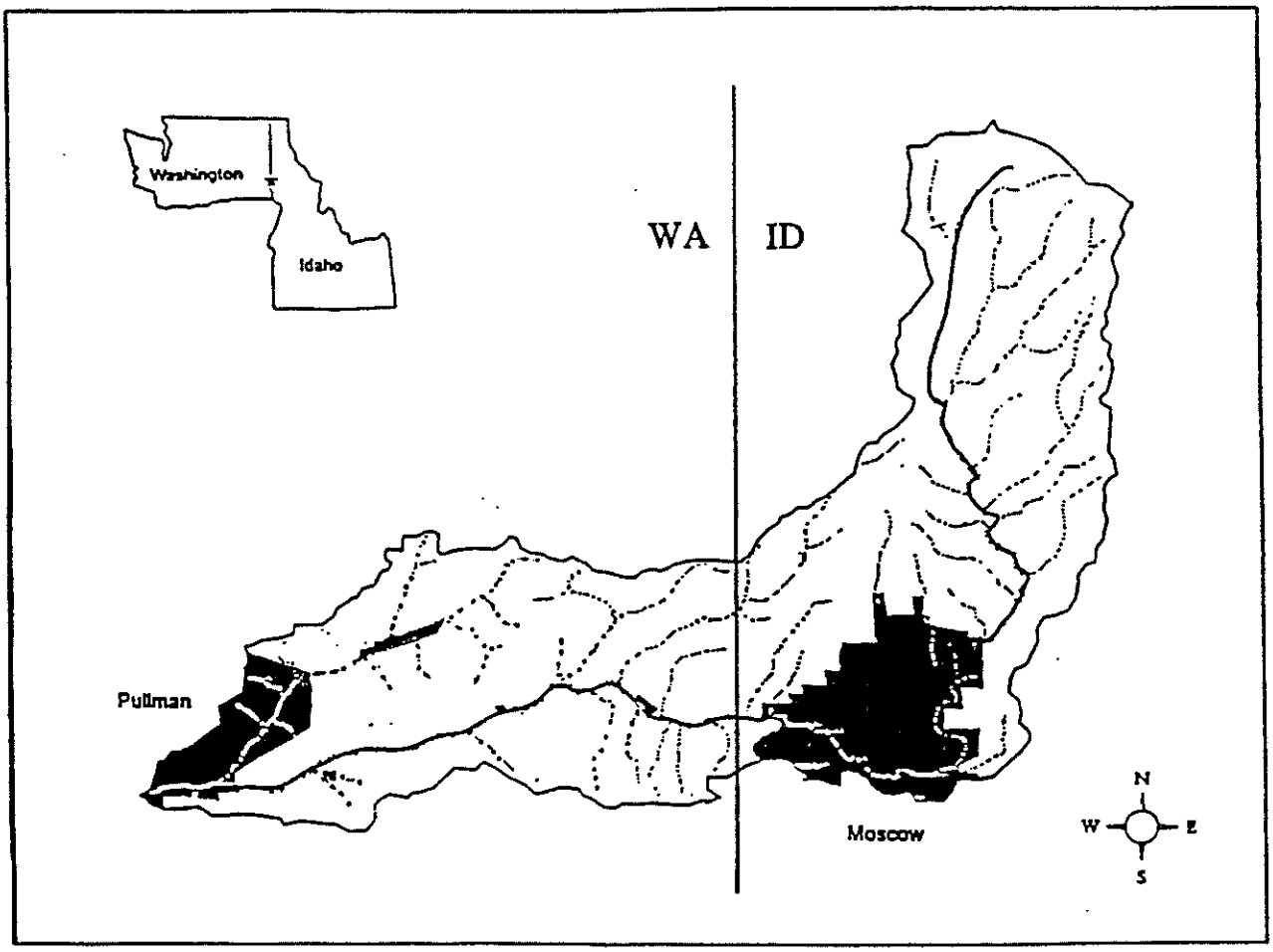

FIGURE 1. Location Map for the Paradise Creek Watershed

Table 1. Idaho Sampling Sites in Previous Studies

Water Quality (collected by SWWRC)
- Idler's Rest Creek
- Mountain View Park
- Sixth Street (east end)
- White Ave. & Troy Hwy.
- Sixth & Deakin
- Abv. Moscow WWTP
- Moscow outfall
- Busch (near border in WA)

Macroinvertebrate/Habitat (collected by Rabe *et al.*)
- Station 1-Mountain View Park
- Station 2-White Ave. & Troy Highway
- Station 3-Sixth & Deakin Street
- Station 4-Busch, .3 miles below Mscw WWTP

* For a description of the parameters in each study refer to the past water quality studies section.
* For site locations refer to Figure 2.

general recreation and aesthetic enjoyment; and salmonid and other fish reproduction, migration, rearing, and harvesting. In both states, the recreation and water supply designated uses are not currently supported because of high bacteria levels (SWWRC 1994). In addition, high sediment loading has increased embeddedness in the stream channel, thereby interfering with fish spawning.

The water quality of Paradise Creek has been severely impacted by both agricultural and urban runoff as well as discharges from the City of Moscow wastewater treatment plant (WWTP). The primary pollutants in the creek are excess sediment, nutrients, and bacteria (IDHW-DEQ 1989). In addition to these sources of pollution there are approximately 124 pipes that discharge into the creek within Moscow's city limits (Thornbrough 1993), the sources of many of these pipes are unknown. There has been direct impacts to the stream channel through channelization and removal of riparian vegetation. Upstream from Main Street, the creek is classified as intermittent by the Idaho Department of Water Resources, therefore any disturbance to the channel does not require a stream alteration permit. Another source of pollution near Paradise Creek is the Puregro industrial site along Sweet Avenue in Moscow. Primary pollutants from this site include pesticides, ammonia, and petroleum; it is likely that these substances entered Paradise Creek for many years. The Puregro site is currently undergoing extensive remediation and approximately $1.5 million has been spent in assessment and cleanup costs (Mann, pers. comm.) The source of these pollutants has been eliminated but it will probably take several years before the pollutants are completely flushed out of the creek.

Paradise Creek has been listed as a Water Quality Limited Segment (WQLS) by the Idaho DEQ and the Washington Department of Ecology primarily because it does not meet bacteria standards. The United States Environmental Protection Agency defines a WQLS as "any segment where it is known that water quality does not meet applicable water quality standards or it is not expected to meet applicable water quality standards even after the application of effluent limitations required by Sections 301 (b)(1)(A) and 301 (b)(1)(B) of the Clean Water Act." Section 303 (d)(3) requires the development of a Total Maximum Daily Load (TMDL) for each pollutant of a WQLS. DEQ's findings in the UAA will be used in part for determining the TMDLs for various pollutants entering Paradise Creek.

PAST WATER QUALITY STUDIES

In 1979, DEQ identified the South Fork of the Palouse River and Paradise Creek as having severe pollution problems due to erosion on dryland farming ground (IDHW-DEQ 1981). A water quality survey was performed which determined that the concentration of sediment and associated pollutants depends on the timing and magnitude of runoff. During high flows the concentration of suspended sediment ranged 1,000-3,000 mg/l, fecal coliform numbers increased downstream and exceeded Idaho water quality standards for secondary contact recreation. Paradise Creek had an overall water quality rating of 99 on a scale of 0-100, with zero being pristine waters and 100 being highly degraded. The survey also concluded that with respect to water quality, most of the surveyed agricultural areas within the Palouse drainage would be considered critical. Due to the severe impacts that agriculture has on Paradise Creek, the Latah Soil and Water Conservation District conducted a planning project to implement best management practices (BMPs) in the Paradise Creek watershed through the Idaho Agricultural Water Quality Program. The District submitted a grant application for implementation in 1981 and 1986, it was rejected both years. (Latah SWCD 1981,1986)

In 1988, DEQ conducted a nonpoint source assessment on the water quality of rivers, lakes, and groundwater in the State of Idaho which are being impacted by nonpoint, point, and toxic pollutants (IDHW-DEQ 1989). Paradise Creek was identified as highly impacted by the following pollution sources: non-irrigated crop production, pastureland treatment, land development, storm sewers, and surface urban runoff. The primary pollutants affecting water quality include nutrients, siltation/sedimentation, thermal modification, flow alteration, habitat alterations, pathogens, and oil and grease.

As the public became aware of the extent of pollution in Paradise Creek, their support of proposed cleanup projects increased. As a result of this strong public support, Paradise Creek was enrolled in the Idaho Adopt-A-Stream Program (PCEI 1990). The Palouse-Clearwater Environmental Institute is responsible for managing the project and organizes activities such as trash removal, revegetation in the riparian zone, and the development of a pedestrian/bicycle path along the creek. PCEI members have also reported discharges into the creek as well as conducting a survey of the pipes which emit these discharges. Each pipe was photographed and its location recorded (Thornbrough 1993).

Since Paradise Creek has been identified as a WQLS, the federal government requires that TMDLs be performed. Limno-Tech, Inc. (1993) has prepared a draft report, the Development of a Demonstration TMDL for Paradise Creek. The objective of this project was to provide guidance on the TMDL process, via case study development of a demonstration TMDL for the Paradise Creek watershed. Waters in this watershed do not meet objectives for suspended particulate matter, nitrogen, and phosphorus. Due to insufficient site-specific data, a phased approach was used in this project. This TMDL consisted of four activities: defining water quality objectives, determining allowable loading and present nonpoint loads, defining necessary load reductions, and allocating loads. This analysis demonstrated that implementation of agricultural BMPs is necessary to achieve the suspended particulate objective and winter nutrient

objectives. The report also concludes that reductions in the Moscow WWTP nutrient loadings will be necessary to achieve the summer nutrient water quality objectives.

In 1993, the City of Moscow conducted a smoke test on the University of Idaho campus in an attempt to determine sources of stormwater inflow/infiltration which discharge into the city's sanitary sewer system (Kimball Engineering, P.A., 1993). These sources contribute to high wastewater flows during storm events, which cause hydraulic and operational problems at Moscow's wastewater treatment plant. A total of 17,775 linear feet of pipe was tested and numerous sources were identified, including manholes, roof drains, and catch basins.

The U.S. Environmental Protection Agency (1993) proposed a draft Paradise Creek Water Quality Assessment. As a WQLS, water quality concerns in the watershed include eutrophication, habitat degradation due to instream sedimentation, ammonia toxicity, dissolved oxygen levels, temperature, and bacterial contamination. Designated beneficial uses for Paradise Creek are not being supported in either state. As part of the pollution control strategy, a TMDL may be developed, as well as the following steps to meet the major water quality concerns: evaluate nutrient removal from the Moscow WWTP, evaluate the need for and potential effectiveness of a Nutrient Management Plan, evaluate available controls via the Palouse Conservation District effort, evaluate the effectiveness of stormwater controls, evaluate the effectiveness of nutrient reductions on dissolved oxygen levels, and address bacterial contamination through programs controlling grazing, concentrated animal feeding operations, and urban runoff.

The State of Washington, Department of Ecology has determined the TMDL of ammonia for the South Fork of the Palouse River (Pelletier 1993). This body of water has often been rated as having the worst water quality in the state of Washington. Three WWTPs discharge water into the SFPR, including the Moscow WWTP via Paradise Creek. The WWTPs have the potential to account for most of the river flow during low flow periods. Nonpoint sources of ammonia were found to be relatively dilute compared to point sources. Ammonia concentrations in excess of chronic criteria were observed in Paradise Creek near the state line in October 1991. Recommended ammonia criteria for Paradise Creek at the state line are the following: April-October chronic criterion 4-day average (1.1 mg/L) and acute criterion 1-hour average (9.4 mg/L), November-March chronic criterion 4-day average (1.8 mg/L) and acute criterion 1-hour average (13.0 mg/L).

Dr. Fred Rabe of the University of Idaho has been studying habitat quality and macroinvertebrate communities at five stations along Paradise Creek and two on the South Fork of the Palouse River (Rabe *et al.* 1993). The sites have each been visited four times in the last year. Reference creeks for the study were Schwartz Creek, Twin Creek, Crumarine Creek, and Idlers Rest Creek. Analysis of all data collected includes habitat assessment at all stations, a qualitative description of stream reaches in Idaho, macroinvertebrate total abundance, species richness, EPT Taxa Richness, EPT Abundance/Total, Hilsenhoff Biotic Index, percent dominant taxa, and macroinvertebrate functional types. This data was used during the UAA process.

The Paradise Creek Restoration Project written by PCEI (1994) is a private/public cooperative proposal to improve water quality in Paradise Creek through watershed restoration and nonpoint source pollution prevention projects. Phase One includes streambank revegetation, the development of a storm water management plan for the City of Moscow, the development of a city-wide erosion control ordinance, and management of the Paradise Creek Adopt-A-Stream Stewardship Project. Phase Two includes the construction of a demonstration wetland area. The wetland will be designed to treat nonpoint source pollution from beef and dairy cattle operations and urban stormwater runoff that currently drains directly into the creek. PCEI is seeking §319 funding to implement these plans.

A Paradise Creek Watershed Characterization Study (SWWRC 1994) was prepared for the Palouse Conservation District by graduate students at the SWWRC, Washington State University. An overview of the watershed examined the following topics: geology, hydrology, soil characteristics, climate, vegetation, wildlife, land use/zoning, population, and water quality problems. The water quality data collected for this study was used in the UAA. Water samples were collected from nineteen sites on Paradise Creek and its tributaries between October 1992 and November 1993. Parameters that were investigated include: temperature, conductivity, pH, dissolved oxygen, alkalinity, suspended solids, ammonia, nitrite, nitrate, total phosphorus, stream flow, fecal coliform, and fecal strep. Agricultural runoff and discharges from the Moscow wastewater treatment plant were identified as the major pollutant sources. Traditional BMPs for construction, riparian, and agriculture were recommended to reduce sediment and nutrient loading to the creek.

METHODOLOGY

Use Attainability Assessment

The primary objectives of this UAA were to re-evaluate the current designated uses for Paradise Creek and to determine whether any additional uses deserve designation. The study was conducted according to DEQ's water quality monitoring protocol report #7: Protocols for Conducting Use Attainability Assessments for Determining Beneficial Uses to be Designated on Idaho Stream Segments (Maret and Jensen 1991). The assessment was performed at the following locations (Figure 2):

1. Mountain View Park
2. White Ave. & Troy Highway
3. Sixth Street & Deakin Street
4. Below the Moscow WWTP near the ID/WA border

These stations correlate with the sites used in previous water quality and macroinvertebrate studies (Table 1). Participants in this assessment used the Protocol's decision trees (Appendix) to determine the proper recreation and aquatic life classifications at each site.

The assessment process took place October 18-19, 1993. This is within the recommended time frame for conducting water quality monitoring as it should be done during the stable, low flow period (June-October) of the hydrologic year.

Fish Monitoring

Electroshocking was conducted during the UAA by the Idaho Department of Fish and Game since there was no existing information on the fish populations at these locations. A backpack electroshocker was used and the length of stream shocked varied from 75-200 meters depending on the conditions at the station.

Habitat Assessment

The habitat assessment portion of the Paradise Creek UAA was performed by Dr. Fred Rabe, Professor Emeritus at the University of Idaho (Rabe *et al.* 1993). The procedure used was modified from Rapid Bioassessment Protocols for Use in Streams and Rivers (EPA, Plafkin *et al.* 1989) and closely correlates with the recommended procedure in Protocol 7. The assessment was performed in October 1992 and February 1993. Nine paramenters were selected which relate to macroinvertebrate criteria, these parameters can be separated into three principal categories: primary (substrate and instream cover), secondary (channel morphology), and tertiary (riparian and bank structure). Listed in Table 2 are the nine parameters and the score ranges for each category.

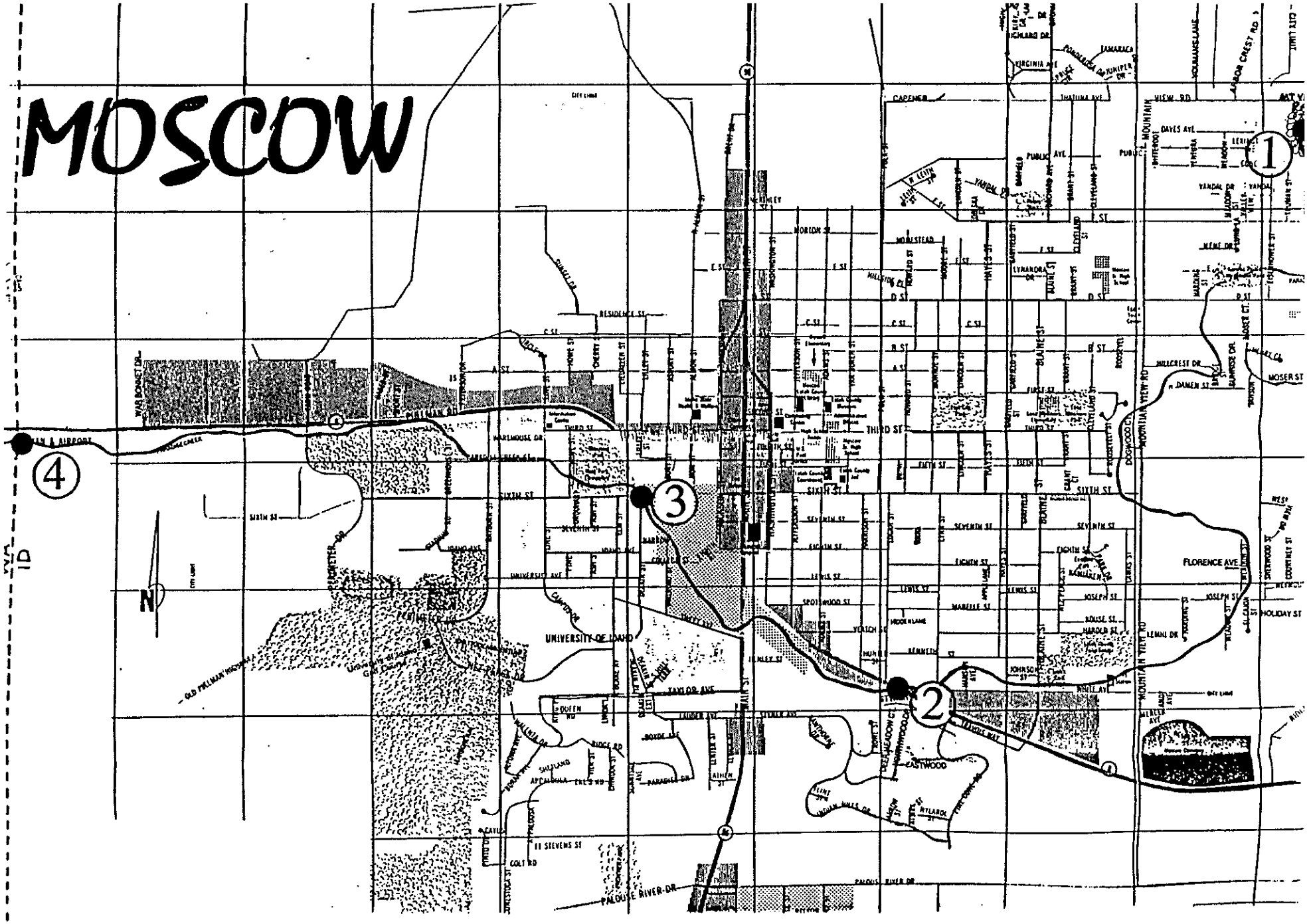

FIGURE 2. Location Map for the Paradise Creek UAA Stations

TABLE 2. Parameters and associated scores for habitat assessment

Parameter	Condition			
	Excellent	Good	Fair	Poor
PRIMARY				
1. Bottom substrate	16-20	11-15	6-10	0-5
2. Embeddedness	16-20	11-15	6-10	0-5
SECONDARY				
3. Channel shape	12-15	8-11	4-7	0-3
4. Riffle/bend ratio	12-15	8-11	4-7	0-3
5. Channel alteration	12-15	8-11	4-7	0-3
TERTIARY				
6. Lower bank stability	9-10	6-8	3-5	0-2
7. Bank vegetation protection	9-10	6-8	3-5	0-2
8. Canopy cover	9-10	6-8	3-5	0-2
9. Width of riparian	9-10	6-8	3-5	0-2

Using best professional judgement, a score was given for each of the nine parameters. These nine scores were then summed to determine a final score for each site.

Macroinvertebrates

This data was also collected by Dr. Fred Rabe (Rabe *et al.* 1993). Collection of macroinvertebrates, both insects and non-insects, occured at selected stations along Paradise Creek in October 1992 and February, April, June 1993. Sampling methods used in this study correspond to a qualitative approach to biomonitoring, the purpose of which is to detect the presence/absence of macroinvertebrates which are sensitive or tolerant to perturbation and to obtain information on taxa richness (Klemm *et al.* 1990). Non-random samples were collected from five habitat types: riffles or runs, instream vegetation, bank vegetation, pools, and areas containing coarse particulate organic matter (CPOM). Riffles, runs, and pools were sampled using a kick-net in an area of approximately 0.1 m^2. A D-net was used to collect samples from shore macrophytes and instream vegetation. CPOM samples of leaves and detritus were placed in ziplock bags and together with other live samples, were returned to the lab for identification and enumerations. This data was used to calculate total abundance, species richness, EPT Taxa richness, EPT total abundance, percent dominant taxa, and the Hilsenhoff Biotic Index.

Reference site

Schwartz Creek, a depositional stream near Deary, Idaho, was used as a reference site for the habitat and macroinvertebrate studies. Land use in this watershed is similar to that in Paradise Creek's, one side of the creek is forested and the other side supports agricultural activities. Three montane streams at higher elevations in the drainage (i.e. Idlers Rest, Crumarine Creek, Twin Creek) were secondary reference sites.

RESULTS AND DISCUSSION

These results are a compilation of interagency information. The macroinvertebrate and habitat information was gathered by Dr. Fred Rabe of the University of Idaho, the water quality data was collected by the State of Washington Water Research Center, and the composition of fish species was determined during the UAA conducted by the Idaho DEQ.

Station 1: Mountain View Park

For the purpose of this analysis, DEQ designated Mountain View Park as the point where Paradise Creek becomes a perennial stream. Historically, this area was a wetland and water is almost always present during the low flow periods. Upstream from this point the creek is intermittent except during spring runoff. Paradise Creek is located along the western edge of Mountain View Park. In this section the creek is channelized, has little canopy cover, and the bottom substrate is highly embedded. For these reasons this site is generally considered as a poor habitat for fish. The water quality is the highest of the four sites (Table 3) and is capable of supporting cold water biota; water temperatures are below 20°C and only once was the dissolved oxygen level measured to be below the minimum requirement (6 mg/L) for cold water biota as defined in the Idaho Water Quality Standards.

TABLE 3. Mountain View Park Water Quality Data[1]

Parameter	Winter Values[2]	Summer Values[3]
Temperature (°C)	0 - 5.5	6.9 - 16.0
pH	6.8 - 7.7	6.9 - 7.6
Dissolved Oxygen (mg/L)	7.0 - 13.2	3.9 - 11.8
Conductivity	127 - 218	37 - 385
Alkalinity (mg/L as $CaCO_3$)	27 - 187	40 - 203
Suspended Solids (mg/L)	0.8 - 286.7	4.5 - 112.7
Total Nitrogen (mg/L)	2.27 - 13.87	1.37 - 3.24
NH_3 (mg/L)	0.02 - 0.09	<0.01 - 0.04
NO_3 (mg/L)	0.75 - 12.45	1.21 - 2.71
NO_2 (mg/L)	<0.01 - 0.05	0.03 - 0.04
Total Phosphorus (μg/L)	75 - 388	61 - 350
Fecal Coliforms (CFU/100 ml)	<4 - 152	4 - 433
Fecal Strep (CFU/100 ml)	10 - >6000	42 - 1400
Flow (CFS)	0.05 - 27.49	0.03 - 28.76

1 Collected by the Washington Water Research Center
2 November-April, 8 samples
3 May-October, 6 samples

Station 2: White Avenue & Troy Highway

This station is located close to a major intersection and is surrounded by commercial and residential development. In spite of this, the overall habitat quality is fair. The creek has some sinuousity, undercut banks, gravel bars, and large willow trees on the banks. Cold water biota is supported at this site even though the water quality has begun to decline (Table 4). The dissolved oxygen standard for cold water biota was violated four times and the standard for average ammonia concentrations was violated at least seven times. Idaho has cold water biota standards for both average and maximum ammonia concentrations, the numerical value for these standards depends on the temperature and pH of the sample. In addition to the standards violations, higher conductivity values can be a possible indication of poor water quality. Conductivity is a measure of the amount of ions in the water and higher values could signify that some unknown pollutants have entered the creek. Below this station, there is a pipe under the Troy Highway bridge which frequently discharges unknown quality water into the creek. All of the cold water biota was collected upstream from this bridge.

TABLE 4. White Ave. & Troy Highway Water Quality Data[1]

Parameter	Winter Values[2]	Summer Values[3]
Temperature (°C)	0 - 5.2	6.9 - 18.0
pH	6.8 - 7.6	7.2 - 8.6
Dissolved Oxygen (mg/L)	3.2 - 12.8	2.6 - 13.0
Conductivity	166 - 772	153 - 459
Alkalinity (mg/L as $CaCO_3$)	32 - 189	50 - 169
Suspended Solids (mg/L)	4.0 - 28.6	2.5 - 56.7
Total Nitrogen (mg/L)	0.76 - 13.25	0.64 - 3.24
NH_3 (mg/L)	<0.01 - 0.11	0.02 - 0.06
NO_3 (mg/L)	2.73 - 11.46	0.23 - 2.47
NO_2 (mg/L)	<0.01 - 0.04	0.01 - 0.04
Total Phosphorus (μg/L)	18 - 312	100 - 396
Fecal Coliforms (CFU/100 ml)	6 - >967	8 - 600
Fecal Strep (CFU/100 ml)	20 - 310	80 - >780
Flow (CFS)	0.06 - 24.96	0.03 - 26.48

1 Collected by the Washington Water Research Center
2 November-April, 8 samples
3 May-October, 6 samples

Station 3: Sixth Street & Deakin

This station is located on the University of Idaho campus across from the Student Union Building. It is shaded by large elm trees along Sixth Street and is channelized. The habitat value is fair due to overhanging grass, riffle/pool areas, and gravel bars. The water quality at this site is relatively poor (Table 5), summer conductivity values have increased and the dissolved oxygen standard was violated four times. The ammonia levels have greatly increased from the previous station, possibly due to inputs from the Puregro site. SWWRC data indicates that the standard for average ammonia concentrations was violated in every sample and the maximum concentration was exceeded three times. In August 1993, the City of Moscow installed a new sewer/water pipeline across the creek which resulted in sediment being washed downstream. Additional pollutants appear to be entering the creek through urban runoff and unregulated discharges. Cold water biota is not supported at this site, it is assumed that the biota has been mainly affected by decreased water quality.

TABLE 5. Sixth St. & Deakin Water Quality Data[1]

Parameter	Winter Values[2]	Summer Values[3]
Temperature (°C)	0 - 7.6	6.9 - 13.5
pH	6.8 - 7.7	6.9 - 7.8
Dissolved Oxygen (mg/L)	5.7 - 12.8	5.6 - 11.6
Conductivity	165 - 536	171 - 751
Alkalinity (mg/L as $CaCO_3$)	37 - 201	52 - 225
Suspended Solids (mg/L)	6.0 - 265	3.6 - 203.2
Total Nitrogen (mg/L)	2.12 - 12.21	1.7 - 13.02
NH_3 (mg/L)	0.08 - 2.04	0.08 - 4.84
NO_3 (mg/L)	1.41 - 11.46	0.72 - 4.94
NO_2 (mg/L)	<0.01 - 0.34	0.03 - 0.31
Total Phosphorus (μg/L)	39 - 775	225 - 1060
Fecal Coliforms (CFU/100 ml)	12 - 290	144 - >2000
Fecal Strep (CFU/100 ml)	61 - 420	128 - 2500
Flow (CFS)	0.11 - 24.33	0.07 - 20.09

1 Collected by the Washington Water Research Center
2 November-April, 9 samples
3 May-October, 6 samples

Station 4: Below the Moscow WWTP near the ID/WA Border

Under normal conditions, the Moscow WWTP discharges approximately two million gallons of effluent a day into Paradise Creek. During low flow periods, the flow in the creek increases at least ten fold as a result of this discharge. This water is generally warmer then the creek with an average yearly temperature of 14±3°C (SWWRC 1994). Paradise Creek below the WWTP has higher concentrations of suspended solids, ammonia, nitrate, and total phosphorus due to the discharge (SWWRC 1994). The South Fork of the Palouse River TMDL of Ammonia proposes a four day chronic criterion for total ammonia at 1.1 mg/L in April-October and 1.8 mg/L in November-March. As measured by the SWWRC, the yearly average for ammonia in the WWTP discharge is 4.9±1.8 mg/L. This concentration is reduced to 2.9±1.8 mg/L at the Idaho/Washington border and falls below toxic levels further downstream. According to SWWRC data, the standards for average ammonia concentrations were violated in every sample and the maximum concentration was exceeded ten times. These violations could be partly responsible for the absence of cold water biota below the WWTP in spite of adequate habitat (some sinuousity, a large riffle area, gravel bars, and overhanging grass). The dissolved oxygen standard was violated five times, with the lowest recorded value at 0.9 mg/L.

TABLE 6. ID/WA Border Water Quality Data[1]

Parameter	Winter Values[2]	Summer Values[3]
Temperature (°C)	4.7 - 14.8	9.5 - 17.3
pH	6.6 - 7.7	7.1 - 7.6
Dissolved Oxygen (mg/L)	0.9 - 12.0	1.9 - 10.3
Conductivity	255 - 993	277 - 750
Alkalinity (mg/L as $CaCO_3$)	60 - 176	93 - 183
Suspended Solids (mg/L)	7.8 - 736	4.0 - 35.1
Total Nitrogen (mg/L)	7.56 - 29.49	13.6 - 21.9
NH_3 (mg/L)	1.00 - 7.60	1.33 - 3.10
NO_3 (mg/L)	4.23 - 12.20	3.10 - 10.95
NO_2 (mg/L)	<0.01 - 1.00	0.10 - 0.80
Total Phosphorus (μg/L)	780 - 7250	1060 - 4200
Fecal Coliforms (CFU/100 ml)	11 - >630	84 - 310
Fecal Strep (CFU/100 ml)	7 - 2000	28 - 866
Flow (CFS)	4.7 - 41.61	3.02 - 22.18

1 Collected by the Washington Water Research Center
2 November-April, 9 samples
3 May-October, 6 samples

Habitat Assessment

Table 7 was taken from Rabe *et al.* 1993. The habitat assessment procedure used was modified from Rapid Bioassessment Protocols for Use in Streams and Rivers (EPA).

TABLE 7. Habitat Assessment Scores of Paradise Creek October 1992 and February 1993

Parameter	Mt. View		White&Troy		6th & Deakin			Blw. WWTP		Schwartz	
	Oct	Feb	Oct	Feb	Oct	Feb	Oct[1]	Oct	Feb	Oct'91	Feb'92
Bottom substrate	3	2	3	3	6	4	2	10	3	15	16
Embeddedness	2	2	2	2	7	4	2	12	6	11	14
Channel shape	2	2	5	5	2	2	2	12	12	13	13
Riffle/bend ratio	1	1	1	1	2	2	2	4	4	11	11
Channel alteration	2	2	2	2	2	2	1	5	5	15	15
Lower bank stability	3	3	5	5	5	5	4	6	6	8	8
Bank vegetation protection	4	4	6	6	6	6	6	8	8	10	10
Canopy cover	2	0	7	5	7	5	7	6	4	8	6
Width of riparian	3	0	4	2	4	2	4	8	3	8	8
TOTAL SCORE	22	16	35	31	41	32	30	69	49	99	101

1 October 1993

Based on the parameters chosen in this assessment, the qualitative habitat quality for a stream segment is rated as excellent (101-125), good (67-100), fair (33-66), or poor (0-32). The above results show that the habitat quality at Mountain View Park is poor throughout the year. The bottom substrate at this site is severely impacted with several centimeters of fines covering the gravel at all times (Rabe *et al.* 1993). This site received a relatively low score in all parameters except bank vegetation protection. The Mountain View Park site was historically a wetland and still maintains hydrophilic plant populations such as: sedges (*Carex* sp.), submergent plants, arrowheads (*Sagittaria* sp.), pondweed (*Potamogeton* sp.), and cattails (*Typha latifolia*). This station contains the highest numbers of instream plants, which are attractive to water quality sensitive insects such as caddisworms and mayflies (Rabe *et al.* 1993). The banks are stabilized by an abundance of reed canary grass (*Phalarus arundinacea*). During low flow periods, this site consists of isolated pools covered with large mats of duckweed (*Lemna minor*).

The habitat quality rating at the White Avenue & Troy Highway station is fair. Improvements from the Mountain View Park site include substantial canopy cover, more sinuosity, higher bank stability, and a wider riparian zone. The water depth and velocity increases, rip-rap has been placed in a short section of the channel which creates a riffle, and fairly extensive gravel beds

also exist. Both maples (*Acer* sp.) and willows (*Salix* sp.) grow along the bank and contribute CPOM in the form of leaf fall. The lower reach of the channel contains a fairly dense concentration of macrophytes including pondweed, arrowheads, and duckweed. The banks are more steeply sloped and are stabilized by reed canary grass. Some undercut banks exist in the upper reaches of the channel.

The Sixth Street & Deakin station also received a fair habitat quality rating. Dr. Rabe characterizes this site as an elongated, deep pool containing an accumulation of fines. Below this pool is a riffle area with the bottom substrate comprised of gravel bars alternating with fines. Although the upper bank is eroded in several places, the lower bank is stabilized by reed canary grass. Little submerged vegetation exists at this site. This section of the creek has been channelized, large mature elm (*Ulnus* sp.) trees parallel the creek on both sides and are a source of CPOM. This site is in the middle of Moscow, often times oil slicks were seen on the water surface and a hydrogen sulfide smell existed. This site was impacted by the construction of sewer/water pipes across the stream channel and was re-evaluated in October 1993. It received a much lower score for bottom substrate and embeddedness (Table 7).

In contrast to having the poorest water quality, the station below the Moscow WWTP was given the highest habitat quality score, though it was still scored as fair. The WWTP discharges approximately two million gallons a day into Paradise Creek nearly doubling its flow. This section of the creek is characterized by slight meanders and steep stable banks, some of which are undercut. A large riffle exists where boulders were placed to support a railroad trestle. Reed canary grass grows on the bank and no submergent plants exist. The substrate is largely gravel and is temporarily covered with fines after a large runoff event.

Schwartz Creek, the reference stream, exhibits optimal habitat conditions and received a rating of good. Substrate consists of gravel and small cobble interspersed with submergent and emergent aquatic plants, tree roots, and logs. Undercut banks are also frequent. Embeddedness is highest in the pools where the gradient is reduced. Velocity-depth conditions are diverse with slow deep, slow shallow, and fast shallow habitats present. The dominant vegetation is alder (*Alnus incana*) which provides bank stabilization, shading, and a source of CPOM.

Macroinvertebrates

Benthic macroinvertebrates are used as environmental indicators because they are relatively stationary and therefore representative of the biological integrity of that particular location. Information regarding changes in the community structure and function enable investigators to determine water quality conditions (Klemm *et al.* 1990). Dr. Fred Rabe *et al.* (1993) have monitored the macroinvertebrate communities of Paradise Creek since 1991. The data used in this study was collected in October 1992 and February, April, June 1993. Samples were collected along the entire length of Paradise Creek and portions of the South Fork of the Palouse River, but only those stations which correlate with the UAA stations are presented below. Schwartz Creek was used as a reference site.

In most of the samples, Chironomidae (midges) was the dominant insect group in Paradise Creek and are therefore ecologically important because of their high densities and diversity. Total midge abundance in excess of 30% probably indicates depressed habitat/water quality (Wisseman 1993). In contrast, midge populations in samples from Schwartz Creek were well below 30% of the total abundance. Other dominant insects included Odonata, the dragonflies and damselflies. In the October samples, high numbers of damselflies were found at White & Troy and Sixth & Deakin. Damselflies are extremely tolerant of impared water conditions and sediment, their ability to climb onto the reed canary grass enables them to partially avoid the water (Rabe et al. 1993). Oligochaeta (aquatic earthworms) had the highest density of the non-insects at the three lower sites. In October, over a thousand individuals per square meter were recorded below the WWTP, this is common below sewage effluent. Other non-insect dominants were Gastropoda (snails) and Hirudinea (leeches).

TABLE 8. Macroinvertebrate Results in Paradise Creek

	Mt. View Park				White & Troy				6th & Deakin				Below WWTP				Schwartz			
Metric Evaluated	Oct	Feb	Apr	Jun	Oct	Feb	Apr	Jun	Oct	Feb	Apr	Jun	Oct	Feb	Apr	Jun	Oct	Feb	Apr	Jun
Total Abundance	213	219	398	380	645	133	131	195	847	77	200	194	1412	478	427	803	146	-	-	56
Species Richness	31	16	31	38	28	19	24	26	23	14	23	14	5	7	6	12	36	34	29	33
EPT-Taxa Richn	2	2	3	4	0	1	0	2	0	0	0	0	0	0	0	0	21	20	18	18
Hilsenhoff B.I.	7.0	4.2	6.7	7.4	7.6	7.9	7.8	8.2	8.9	8.0	8.1	8.4	9.0	9.0	9.0	8.7	3.2	-	-	4.5
%Dominant Taxa	15	41	24	18	32	19	27	21	35	41	16	19	73	87	80	50	7	-	-	-

Perhaps the most important indicator of overall stream health is the EPT Taxa Richness, which includes the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisworms). Many of these species are very pollution sensitive; stations having high EPT numbers are associated with clean water and unimpacted habitat. Table 8 indicates that EPT Taxa Richness was highest at Mountain View Park with values ranging between 2 and 4, although it should be noted that no Plecoptera were found in the creek. This suggests that the water quality is highest at this site and that the large amount of instream vegetation supports the macroinvertebrate populations. EPT Taxa Richness decreases slightly at the White Avenue & Troy Highway site with values ranging between 0 and 2. This indicates that water quality has begun to decrease. By the Sixth Street & Deakin site the water quality has significantly decreased so that EPT populations are no longer supported. On a relative basis, EPT values at the upper sites appears to be fair but when the EPT Taxa Richness values are compared to those of Schwartz Creek, it becomes apparent that Paradise Creek is highly degraded.

The Hilsenhoff Biotic Index (HBI) summarizes the overall pollution tolerances of the taxa collected. Tolerance values for taxa range from 0-10, with taxa assigned higher values to indicate an increased tolerance to organic and sediment pollution. This index can detect nutrient enrichment, high sediment loads, low dissolved oxygen, and thermal impacts. The lowest HBI value (4.2) was recorded a Mountain View Park in April, the highest (9.0) was recorded below

the WWTP. The yearly average for all the sites is as follows: Mountain View Park (6.3), White & Troy (7.9), Sixth & Deakin (8.4), and Below WWTP (8.9). It should be noted that the Chironomidae data was not included in the HBI scores. If it was, the average values for all four stations would have been higher since Chironomids were numerous and are highly tolerant. The HBI results coincide with the EPT Taxa Richness results, indicating that water quality decreases downstream.

The Moscow WWTP has a significant impact on the composition of the macroinvertebrate community at Station 4. The total species richness is less than half of the other sites. Although total abundance is higher than the other sites, these numbers are represented only by a few species. In October, 96% of the individuals were aquatic earthworms and midges, both of which are highly tolerant to poor water quality (Rabe *et al.* 1993). The habitat at this site is fair, so it is thought that poor water quality limits the biological integrity or structural and functional components of the macroinvertebrate community.

Fish Monitoring

Results from fish shocking in Paradise Creek can be found in Table 9.

TABLE 9. Electroshocking Results in Paradise Creek

Species	Amount	Size	Location
Speckled dace (*Rhinichthys osculus*)	>50	1-3"	Mountain View Park[1], White & Troy Hwy., Guy Wicks Field
Bridgelip sucker (*Catostomus columbianus*)	11	3-6"	White Avenue & Troy Highway
Longnose sucker (*Catostomus catostomus*)	1	6"	White Avenue & Troy Highway

1 Shocking recovery estimated at 20% due to large amounts of duckweed on water surface

These three species are typically classified as cold water fish. All of the fish that were recovered appeared to be healthy and two or three different age classes were represented. Two speckled dace were found at Guy Wicks field where the habitat is similar to that below the WWTP; this suggests that the water quality is the limilting factor in supporting fish. The following information was taken from the Fishes of Idaho (Simpson and Wallace 1982). The speckled dace will live in a variety of habitats, but normally prefers shallow, cool, and quiet waters. This fish serves as an important forage fish for trout when both are present in the same stream. The bridgelip sucker prefers colder water of small, fastflowing rivers with gravel to rocky bottoms. However, it may also live in waters with a more moderate current and the bottom is composed of sand and silt. It may be assumed that habitat requirements are similar for the longnose sucker. The major food items for the longnose sucker are algae, midge larvae, and most other bottom-dwelling aquatic invertebrates.

Decision Trees

Decision trees are provided in the UAA procedure to aid the user in determining the proper attainable uses and to insure consistency among the UAAs which are performed.

Aquatic Life Decision Tree

The initial question in this decision tree (Appendix A) refers to the water temperatures of Paradise Creek. If water temperatures seldom exceed 20°C then cold water biota is considered to be an attainable use. According to the SWWRC data, the water temperatures at all four sites do not exceed 20°C. This is surprising given the relatively little amount of shading the creek receives and the hot temperatures on the Palouse during the summer. It is suspected that Paradise Creek has contact with the groundwater at several points, this influx of groundwater would result in lower temperatures. The second question concerning habitat was answered yes for several reasons. At almost all of the stations water depth was sufficient, gravel bars were present, and there was overhanging grass. This grass cover is important because it provides habitat for the macroinvertebrates that the salmonids feed on. A salmonid fishery does not currently exist primarily due to the poor habitat and water quality. There has been rumors that a brook trout population is supported in the upper watershed, particularly Idlers Rest Creek. These fish supposedly survive in the isolated pools during the low flow season. However DEQ personnel could not find any evidence to support this. One critical question asks if natural or human-caused pollution, which would cause more environmental damage to correct than leave in place, preclude cold water biota as a use. At all four sites, it was decided that this human-caused pollution would not cause more environmental damage to correct than leave in place. The implementation of agriculture, urban, and construction BMPs would greatly improve the water quality of Paradise Creek. These controls are not more stringent than those required by §301(b) and §306 of the Clean Water Act and would not result in substantial and widespread economic and social impact.

TABLE 10. Aquatic Life Decision Tree Results

Question	Mt. View Pk.	White & Troy	6th & Deakin	Blw WWTP
a	yes	yes	yes	yes
b	yes	yes	yes	yes
f	no	no	no	no
i	no	no	no	no
l	no	no	no	no

Conclusion: cold water biota and salmonid spawning

Recreation Decision Tree

The first question in the decision tree (Appendix B) refers to the water-based recreation value class as defined in the Pacific Northwest Rivers Study (Allen *et al.* 1986). The recreation value for Paradise Creek was determined as unknown. However secondary contact recreation is a designated use in the 1992 Idaho Water Quality Standards. Since it is currently an existing use, a yes response was given to question b in spite of the fact that normal summer flows (upstream from the Moscow WWTP) are less than one cubic foot per second (SWWRC 1994). A negative response was given to question c because Paradise Creek does not meet these dimensional or flow requirements. The aesthetic quality asked in question d was answered differently for the four sites. The Mountain View Park station was given an intermediate aesthetic quality rating because the creek is located near a park in a relatively undeveloped area. The White Avenue & Troy Highway station received a low aesthetic quality rating because it is in a highly developed area. The Sixth Street & Deakin station was given a low intermediate rating also because of its proximity to development and channelization. However, there are large elm trees overhanging the water and a pedestrian/bicycle path parallels the creek. Paradise Creek was also given an intermediate aesthetic quality rating below the Moscow WWTP because it is mostly surrounded by agricultural land. As stated earlier, secondary contact recreation is an existing use therefore a yes response was given to questions e and g.

Currently the bacteria levels in Paradise Creek are above the Idaho water quality standards for secondary contact recreation. As defined in the Idaho Water Quality Standards and Wastewater Treatment Requirements, waters designated for secondary contact recreation are not to contain fecal coliform bacteria (during the recreation season) in concentrations exceeding:

1. 800/100 ml at any time; and
2. 400/100 ml in more than 10% of the total samples taken over a thirty day period; and
3. A geometric mean of 200/100 ml based on a minimum of five samples taken over a thirty day period.

According to SWWRC water quality data, fecal coliform levels exceeded 800/100 ml four times at the Sixth & Deakin site.

TABLE 11. Recreation Decision Tree Results

Ques.	Mt. View Park	White & Troy	6th & Deakin	Below WWTP
a	unknown	unknown	unknown	unknown
b	yes	yes	yes	yes
c	no	no	no	no
d	intermediate	low	low intermd.	intermediate
e		yes		
g	yes	yes	yes	yes

Conclusion: secondary contact recreation

CONCLUSION AND RECOMMENDATIONS

The designated uses for Paradise Creek are currently listed as secondary contact recreation and agricultural water supply. A Use Attainability Assessment was performed by DEQ personnel in an effort to re-evaluate these uses and to determine if the creek should be protected for any additional uses. The UAA confirmed secondary contact recreation as an existing use, primarily because of its low flow and small channel size. Bacteria levels in Paradise Creek at Station 3 are above the Idaho water quality standards for secondary contact recreation. There appears to be a large input of fecal coliform bacteria from within the Moscow city limits, as well as input from animals in the watershed. Primary sources need to be identified and best management practices need to be implemented in an effort to reduce the high bacteria concentrations.

Agricultural water supply was also confirmed as an existing use. Irrigation pipes were found in the creek near Mountain View Park and it was observed that agricultural animals have access to the water at several points along the creek.

Salmonid spawning was the third attainable use determined in the UAA process. Although not currently an existing use, it is felt that populations could be supported with improved water and habitat quality. At the three lower stations it appears that adequate habitat already exists, although some improvements still need to be made. Mountain View Park was the only station that currently lacks adequate habitat, however it could be improved by increasing sinuousity and revegetating the riparian zone with trees or shrubs.

Cold water biota was the fourth attainable use determined. Data shows that water temperatures seldom exceed 20°C and that cold water biota (i.e. fish and EPT macroinvertebrates) currently exists in the upper portions of the creek. However, cold water biota standards for dissolved oxygen and ammonia are violated at the three lower stations of the creek. Since habitat quality increases downstream, water quality appears to be the major limiting factor for supporting cold water biota populations. This is supported by the fact that healthy fish and macroinvertebrate populations currently exist in the two upper stations where the water quality is fairly good.

In order for these attainable uses to become existing uses in Paradise Creek, water and habitat quality improvements need to take place. This could be accomplished by the following:

1. Implementing agricultural, construction, and urban BMPs
2. Developing a storm water management plan for the City of Moscow
3. Identifying the source and quality of water in the pipes discharging into the creek
4. Upgrading of the Moscow WWTP
5. Revegetating the riparian zone and increasing stream sinuosity

These improvements are not expected to cause social and economic hardships for the community. The Moscow WWTP already plans to upgrade their facilites because they are being asked to meet the Washington water quality standards. It is believed that if these recommendations are implemented, Paradise Creek can once again support healthy trout and macroinvertebrate populations and also contribute to the aesthetic value of the surrounding area.

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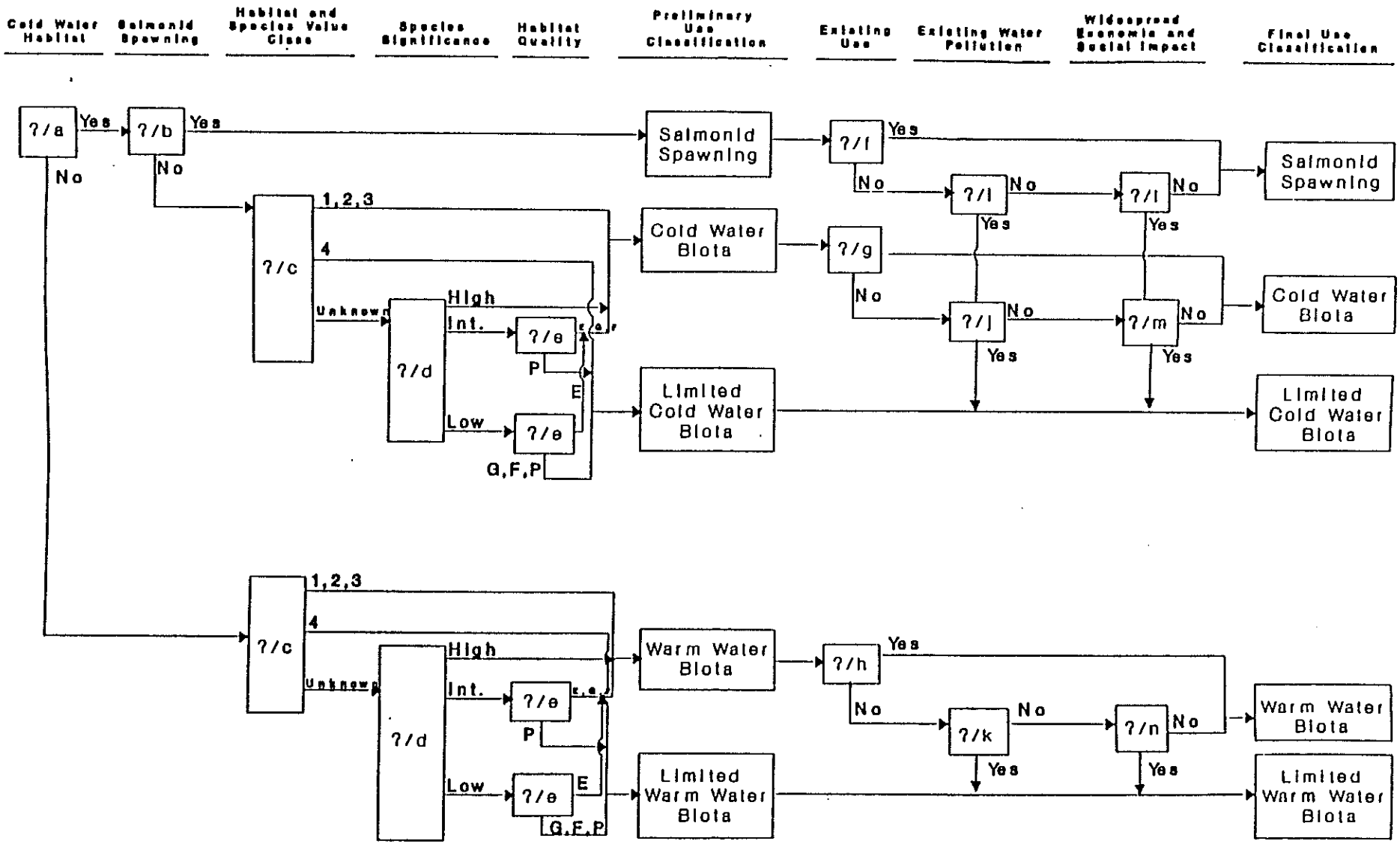
APPENDICES

A. Aquatic Life Decision Tree and Associated Questions

B. Recreation Decision Tree and Associated Questions

Appendix A. Aquatic Life Decision Tree



/a Do water temperatures seldom exceed 20° C or is there a significant occurrence of cold water species? (If salmonid spawning or cold water biota is an existing use, the "yes" decision option should be selected regardless of the existing cold water habitat.)

/b Is the existing habitat (excluding human-caused pollution) capable of supporting salmonid spawning or is salmonid spawning an existing use?

/c What is the habitat and species value class as defined in the Pacific Northwest Rivers Study? (If, as appropriate, cold or warm water biota is an existing use, the 1,2,3 decision option should be selected regardless of the defined habitat and species value class.)

/d What is the significance (High, Intermediate or Low) of the species present?

/e What is the rating (Excellent, Good, Fair or Poor) of the existing aquatic habitat?

/f Is salmonid spawning an existing use?

/g Is cold water biota an existing use?

/h Is warm water biota an existing use?

/i Does natural or human-caused pollution, which would cause more environmental damage to correct than leave in place, preclude salmonid spawning as a use?

/j Does natural or human-caused pollution, which would cause more environmental damage to correct than leave in place, preclude cold water biota as a use?

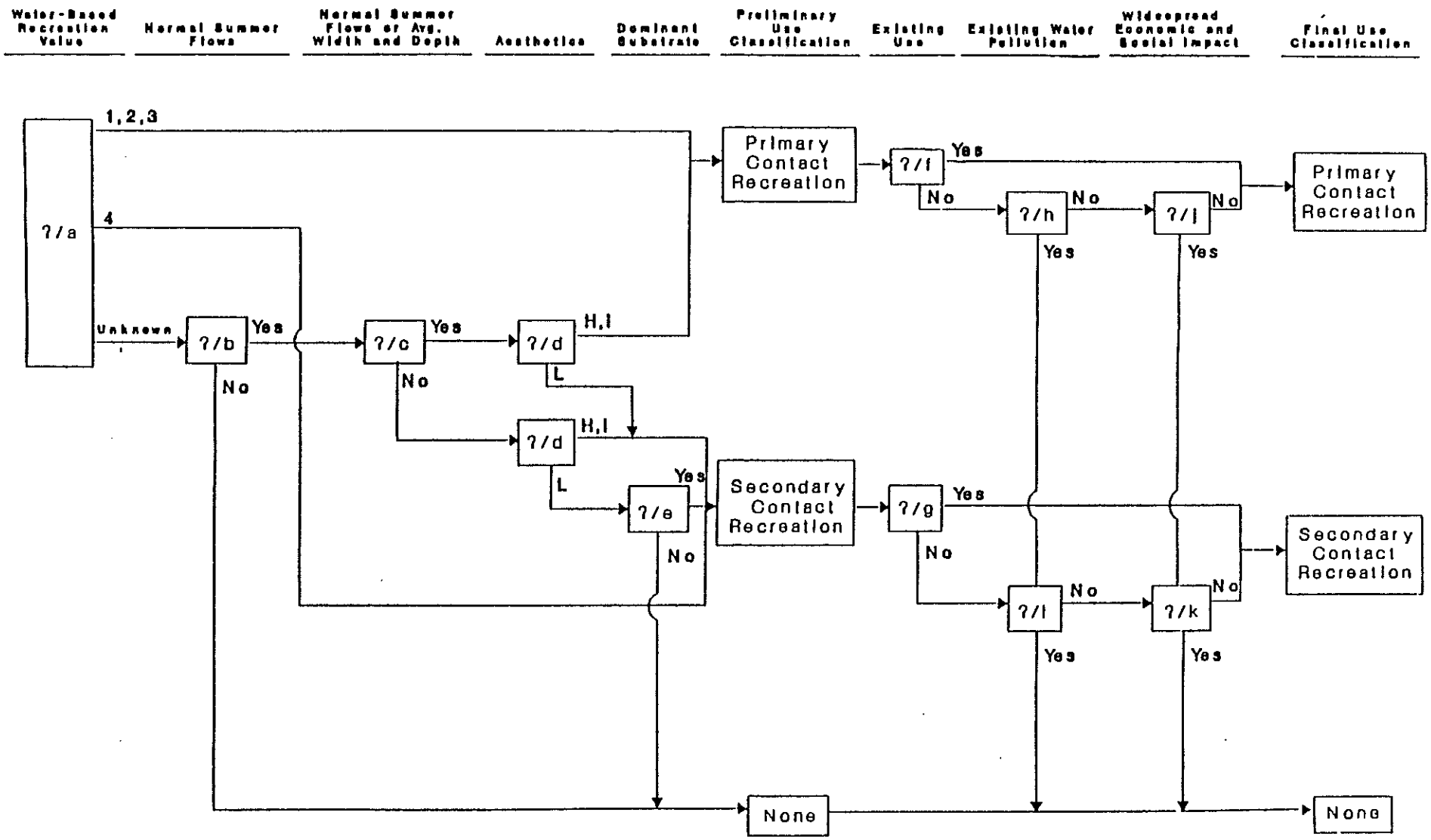
/k Does natural or human-caused pollution, which would cause more environmental damage to correct than leave in place, preclude warm water biota as a use?

/l Are controls more stringent than those required by Sections 301(b) and 306 of the CWA necessary to support a salmonid spawning use and would these controls result in substantial and widespread economic and social impact?

/m Are controls more stringent than those required by Sections 301(b) and 306 of the CWA necessary to support a cold water biota use and would these controls result in substantial and widespread economic and social impact?

/n Are controls more stringent than those required by Sections 301(b) and 306 of the CWA necessary to support a warm water biota use and would these controls result in substantial and widespread economic and social impact?

Appendix B. Recreation Decision Tree



/a What is the water-based recreation value class as defined in the "Pacific Northwest Rivers Study"? (If primary contact recreation is an existing use, the 1,2,3 decision option should be selected regardless of the defined recreation value class.)

/b Are normal summer low flow $\geq$ 1 cfs? (If secondary contact recreation is an existing use, the "yes" decision option should be selected regardless of the normal summer flow.)

/c Are normal summer flows $\geq$ 5 cfs or is the average stream width $\geq$ 25 feet and average depth $\geq$ 1 foot?

/d Is the aesthetic quality rating of the stream segment high, intermediate, or low?

/e Is the dominant substrate of the stream segment $\geq$ sand? (If secondary contact recreation is an existing use, the "Yes" decision option should be selected regardless of the dominant substrate.)

/f Is primary contact recreation an existing use?

/g Is secondary contact recreation an existing use?

/h Does natural or human-caused pollution, which would cause more environmental damage to correct than leave in place, preclude primary contact recreation as a use?

/i Does natural or human-caused pollution, which would cause more environmental damage to correct than leave in place, preclude secondary contact recreation as a use?

/j Are controls more stringent than those required by Sections 301(b) and 306 of the CWA necessary to support a primary contact recreation use and would these controls result in substantial and widespread economic and social impact?

/k Are controls more stringent than those required by Sections 301(b) and 306 of the CWA necessary to support a secondary contact recreation use and would these controls result in substantial and widespread economic and social impact?