# INVENTORY AND RATING OF SALMONID HABITATS IN THE VICINITY OF KAMLOOPS, B.C
## I. Report

Prepared for:

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# 1.0 INTRODUCTION

The Fraser River Action Plan (FRAP), an initiative under the Canadian government's Green Plan, aims to establish a management program that will promote sustainable development and ensure that the health and productivity of the Fraser River Basin's ecosystems are restored and enhanced. In order to accomplish this ambitious task, FRAP is working to build partnerships with the various stakeholders within the Fraser River Basin, to develop a cooperative management program based on the principles of sustainability. An integral part of such an undertaking is to compile inventory data on fish habitats including a rating of their value and identify locations of habitat rehabilitation and enhancement opportunities. This baseline information can then be used to assess, plan and direct land development activities along the streams within the context of environmentally sustainable development.

In 1992, ECL Envirowest Consultants Limited (Envirowest) was retained by the Department of Fisheries and Oceans (DFO) to develop and complete the first baseline inventory project which described, rated and mapped fish habitats along the major watercourses within City of Prince George (Nowotny and Hickey 1993a,b). This information has since been used to assist DFO and the City in directing and controlling development near fish habitats as well as in helping to update the City's Community Plan and Riverfront Trail System.

In 1993, Envirowest was retained by DFO to conduct similar inventories in the vicinity of the cities of Quesnel (Hickey and Trask 1994a,b) and Kamloops, B.C. This report and accompanying map series present the inventory information for the City of Kamloops. The specific objectives of the study were to:

1. conduct a biophysical survey of the Thompson, North Thompson and South Thompson rivers within the study area;

2. identify and classify the major salmonid habitat types (rearing and/or spawning) within the study area;

3. rate individual areas along the watercourses as to their value as salmonid rearing and/or spawning habitat;

4. identify locations of point-sources of pollution which may have an effect on water quality; and

5. identify fish habitat enhancement and restoration opportunities within the study area.

Degradation and alteration of fish habitats along watercourses within the study area has occurred from:

- development activities such as dyking, culverting, armouring streambanks and filling to prevent flooding or erosion;
- activities associated with industrial, commercial, agricultural, residential, and/or recreational upland uses;
- water withdrawals from tributary streams for agriculture or industry; and
- degradation of water quality from effluent discharges, spills of harmful materials, sedimentation from streambank erosion or introduction of contaminants from snow removal and storm runoff.

Due to the importance of these streams for fish rearing and/or spawning, the instream habitats, riparian zones and adjacent uplands must be managed to minimize the impacts of development. This study takes the first step in stemming the loss of productivity within these areas by providing an inventory of, and value ratings for, these habitats along with a listing of restoration and enhancement opportunities.

The study findings are presented in two parts; this report, and an accompanying map series covering the Thompson, North Thompson and South Thompson rivers within the study area. The report outlines the methods employed during the study and provides details on the study results along with a discussion of the findings, and habitat restoration and enhancement recommendations. The map sheets provide a summary of the findings, in particular the habitat value ratings. This cartographic format includes an index map for quick map referencing and a legend defining the symbols used on the map sheets.

## 2.0 STUDY AREA

### 2.1 Description

The project study area extended beyond, but encompassed, the city limits of Kamloops, B.C. (Fig. 1). Kamloops and the surrounding area has a population of approximately 100,000 people and is situated at the confluence of the North and South Thompson rivers in the Southern Interior Region of British Columbia at an elevation of 345 m. Kamloops is located at the junction of the north-south corridor which runs along the North Thompson Valley and the east-west corridor formed by the Columbia and South Thompson valleys.

The major economic activities in the Kamloops area include forestry, which accounts for approximately 40% (Forestry Capital Committee 1993), agriculture, light industry and support services.

Specifically, the study area encompassed 26 km of the North Thompson River from Heffley Creek to the confluence with the South Thompson River, 28 km of the South Thompson River from Monte Creek to the confluence with the North Thompson River and 15 km of the Thompson River from the North/South Thompson River confluence to just west of Tranquille River.

The North Thompson River originates in the Cariboo Mountains and flows in a southerly direction to the confluence with the South Thompson River within the City of Kamloops (Knapp et al. 1982). The North Thompson River at McLure (approximately 15 km upstream of Heffley Creek) drains an area of 19,600 $km^2$ and has a mean annual total discharge of 13.5 million $dam^3$ (1 $dam^3$ = 1,000 $m^3$) (Environment Canada 1991). The peak monthly mean annual discharge occurs in June with the minimum typically being recorded in February. The South Thompson River at Monte Creek (approximately 30 km upstream of Kamloops), drains an area of 16,600 $km^2$ and has a mean annual total discharge of 9.46 million $dam^3$. The peak and minimum monthly mean annual discharges occur in June and March, respectively. The Thompson River at Kamloops, created by the combined flows of the North and South Thompson rivers, drains an area of 37,800 $km^2$, has a mean annual total discharge of 19.6 million $dam^3$, and peak and minimum monthly mean annual discharges which also occur in June and February, respectively.

The South Thompson and Thompson rivers through the study area lie within the Bunchgrass Zone in the biogeoclimatic classification system used by the province of British Columbia (Meidinger and Pojar 1991). The North Thompson River in the Heffley Creek area is in a transition between the Ponderosa Pine and Bunchgrass zones with most of the length of the river within the city limits being situated within the Bunchgrass Zone.

The Bunchgrass Zone includes the grasslands that dominate the lower elevations in the major river valleys of the dry interior in southern British Columbia. This is where the rainshadow effect from the Coast Mountains is the strongest. Periods of drought through the hot, dry summers limits tree establishment and favors the establishment of grassland communities (Nicholson *et al* 1991). Most of the annual precipitation occurs in December and January with a secondary peak occurring in June. The soil moisture deficit begins concurrently with the growing season and water stress increases through the summer.

The distribution of vegetation types within the Bunchgrass Zone reflect minor changes in topography, elevation, exposure and soil moisture patterns. The patterns and balance of plant communities within this zone are poorly understood, largely due to the historical ubiquitous livestock overgrazing. Although relatively

small in areal coverage, this ecosystem type represents the northern limit of the more extensive grasslands to the south. Plant communities within the study area are recognized as fragile, with limited plant productivity and poor soil development. Disturbance generally favors weedy and introduced annuals over native perennials and succession in disturbed sites towards native plant associations is undocumented.

The Bunchgrass Zone supports a high diversity and density of wildlife relative to its size. This is largely due to the range of habitats found in forest, grassland, shrub-steppe and riparian areas. At the northern limit of this type of ecosystem, the occurrence of both southern and northern species over the same areas is viewed as unique. Many of the wildlife species occurring in the Bunchgrass Zone are of provincial and national importance because of their rarity or uniqueness (for a listing see Nicholson *et al.* 1991). The loss of habitat to agricultural, industrial and residential development and the degradation of habitat by extensive overgrazing have contributed to the large number of species that are at risk in British Columbia.

As lakes and streams in the Bunchgrass Zone are open year-round or are among the first to open in the spring they provide important staging and resting areas for migrating birds. Riparian zones along streams and rivers provide natural travel corridors for wildlife as well as habitat for many resident species of mammals, birds, reptiles and amphibians.

The Bunchgrass Zone has a high agricultural resource capability where irrigation allows for production of many fruit and high yield forage crops. Additionally, the grasslands of the Bunchgrass Zone are of high value to the livestock industry.

## 2.2 Salmonid Utilization

Utilization of the study area streams by salmon is primarily as a migration corridor for both adults travelling to spawning areas upstream of the study area and juveniles migrating downstream through the area. Juvenile salmon, primarily chinook salmon, have been documented to spend varying periods of time within the study area primarily during the outmigration period (Stewart et al. 1989). Salmon species utilizing the Thompson River system upstream of Kamloops Lake include chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), sockeye salmon (*O. nerka*), pink salmon (*O. gorbuscha*), and steelhead/rainbow (*O. mykiss*) (Whelen and Lister 1985; Stewart et al. 1989; Farwell et al. 1987). In addition, Dolly Varden char (*Salvelinus malma*) populations occur in both the South and North Thompson river systems (Whelen and Lister 1985; Stewart et al. 1989).

The salmon populations of the South and North Thompson rivers are major contributors to the Fraser River chinook, coho and sockeye salmon stocks. For the period 1983-1992, salmon escapements to areas upstream of the study area comprised 18% of the chinook, 27% of coho, 38% of the sockeye and less than 1% of the pink salmon escapement to the Fraser River system (T. Cone, pers. com.; N. Schubert, pers. com.). Chinook salmon spawning has been noted within the Kamloops city limits on the North Thompson River near the town of Heffley and observed within the study area on the South Thompson River at the mainstem confluences of Campbell and Monte creeks (Berry and Kahl 1982).

### 2.2.1 Thompson River

The Thompson River mainstem within the study area, from Kamloops Lake to the North and South Thompson River confluence, does not contain salmon spawning habitat but does provide some rearing habitat primarily during the May-July outmigration period (Stewart et al. 1989). During this latter period, the level of Kamloops Lake is high and inundates vast areas of the transition zone between the lake and river as well as the vegetated zones along the upper portions of the river banks. Elevated summer water temperatures and poor habitat conditions during low water levels combine to minimize the use of the area by salmonids.

### 2.2.2 South Thompson River

The South Thompson River system contributes approximately 14% of the chinook, 17% of the coho, 38% of the sockeye and an insignificant proportion of the entire Fraser River pink salmon escapement based on 1983-1992 data (T. Cone, pers. com.; N. Schubert, pers. com.). The major spawning populations utilize the South Thompson mainstem, as well as the Adams, Shuswap, Eagle, Little, and Salmon rivers, and Shuswap Lake. Small spawning populations of chinook salmon have been documented within the study area near the confluences of Campbell and Monte creeks and possibly at the confluences of other small mainstem tributaries (Department of Fisheries and Oceans 1994). Fish sampling conducted within the study area between May and October 1985 and 1986 found that chinook juveniles were present and that the peak numbers corresponded to the timing of the annual juvenile outmigration (Stewart et al. 1989). Summer water temperatures can approach 20°C (Stewart et al. 1989) and combined with the lack of quality rearing and overwintering habitats at lower water levels tend to minimize the use of the stream by juvenile salmonids.

### 2.2.3 North Thompson River

Salmon spawning has been documented in the mainstem North Thompson River within the City of Kamloops near Heffley Creek (Department of Fisheries and Oceans 1994). The river within the study area does provide some rearing habitat for salmonids and functions as a migratory route for both adult and juvenile salmon. Fish sampling conducted between May and October 1985 at several sites within the study area captured juvenile salmon with the highest densities recorded during the outmigration period (Stewart et al. 1989). Chinook salmon spawning has been documented in the mainstem river north of the Kamloops city limits from downstream of Little Fort to upstream of Blackpool as well as in thirteen other streams within the watershed (Harding et al. 1994). Coho salmon spawning also occurs in the North Thompson River mainstem between Little Fort and Blackpool, and in some twenty-six other streams in the system from the headwaters (Albreda River) downstream to Louis Creek (Harding et al. 1994). In addition, sockeye salmon spawning occurs in the Little Fort/Blackpool area of the mainstem and in four other streams (Harding et al. 1994). Pink salmon spawning has been recorded on odd years (typical for Fraser River pink salmon stocks) since 1977 (Knapp et al. 1982; Farwell et al. 1987).

## 3.0 MATERIALS AND METHODS

### 3.1 Baseline Data Collection

Prior to initiating the field survey, baseline data (including fish population information), locations of known storm water outfalls, effluent discharges, snow dump sites and sewage outfalls, were compiled from available sources including the City of Kamloops, local industries, BC Environment, and DFO. The information was transferred onto base maps and used for reference during the field survey.

Copies of the 1:2,500 scale BC Ministry of Environment orthophoto topographic/cadastral mapping for the Kamloops city limits was provided by the City engineering department for use during the study. Since these maps did not include portions of the study area outside of the city limits, these maps were supplemented with 1:2,500 and 1:5,000 scale flood plain mapping acquired from Maps-BC (BC Environment 1976). These maps were used to augment field observations of the upper portions of the small mainstem tributary streams and to assist in the description and identification of mainstem habitats, physical features, and upland status. The latter mapping was also used to produce and/or complete the study map sheets based on the BC Ministry of Environment 1:5,000 scale cadastral series available for a majority of the study area.

## 3.2 Field Survey

A biophysical survey of the Thompson, South Thompson and North Thompson rivers in the vicinity of Kamloops was conducted by boat between September 20 and 29, 1993. In addition, the small tributaries which enter the mainstems as well as the seasonally-flooded areas were also surveyed in-land for a sufficient distance to assess the value of the fish habitat present.

Colour 35 mm photographs were taken during the survey to further document the condition of the vegetation communities and shorelines, point sources and any other pertinent conditions. In addition, a helicopter survey of the study area streams was conducted on September 28, 1993. The primary purpose of the flight was to video tape a majority of the study area for future reference, and secondarily, to identify unique features or areas of concern that were not evident from the water or roads.

### 3.2.1 Habitat Variables

Following a review of the scientific literature relating to salmonid stream habitat utilization within upper Fraser River systems and consultation with environmental agency personnel, the following habitat variables were identified as being important in the rating of salmonid habitat values.

| | |
|---|---|
| **Instream Substrates:** | fines (clay, mud, sand), gravels, cobbles, boulders, bedrock or others (i.e. rip rap or other armouring) |
| **Nearshore Flow:** | riffle, run, glide, pool, backeddy, backchannel, lake or dry |
| **Bank Composition:** | fines (clay, mud, sand), gravels cobbles, boulders, bedrock or armoured |
| **Bank Stability:** | eroding or stable |
| **Submergent Vegetation:** | community description |
| **Emergent Vegetation:** | community description |
| **Lower Riparian Vegetation:** | community description |

| | |
|---|---|
| **Upper Riparian Vegetation:** | community description |
| **Upslope Vegetation:** | community description |
| **Upland Use:** | residential, industrial, institutional, agricultural, recreational, linear development (roads, railroads, pipelines, transmission lines, etc.), or undeveloped |

To facilitate identification and rating of salmonid habitats, linear units termed "streambank sections", were defined along the mainstem rivers. Delineation of these sections was based on a subjective determination of the general homogeneity of a given length of shoreline with respect to the above set of habitat variables. Field data were collected for each streambank section. The data collected during the field survey included descriptions of the present upland status, the relative abundance and species composition of vegetation communities, log debris accumulations, bank composition and condition, nearshore stream flow characteristics, predominant and secondary substrate types of the nearshore and bank, locations of storm water outfalls, effluent discharges, and prominent instream structures such as bridges, docks, power/pipelines, intakes and other man-made structures.

For the purposes of this study, the riparian zone was defined as the vegetated area from the lowest point near the waters edge (approximating the average low water level), upslope to the top of the bank including those communities inherently inter-related with the watercourse; i.e. plant communities established on fluvial materials with nutrient, substrate or debris input from slopes adjacent to the watercourse.

### 3.2.2 Habitat Rating Criteria

Mainstem Rivers

The fish habitats surveyed along the mainstem rivers within the study area were rated with respect to their salmonid rearing and/or spawning value. Three rating categories were employed: high, medium and low. The following set of criteria (based on the important habitat variables outlined in Report Section 3.2.1) were developed and applied to the rating of the habitats within the Streambank Sections (Appendices 1-3). It should be noted that all the criteria need not have been met for a particular section

to receive a certain rating but often a combination of habitat qualities and quantities were used to rate a stream section.

**High:**
- overwintering habitat provided by significant quantities of cobble, boulder and large rip rap substrates and/or large organic debris
- significant quantities of high water refuge and rearing habitat within shallow-gradient, low-velocity nearshore areas
- potential for salmonid spawning (gravel substrates and appropriate water velocity)
- stable nearshore and streambanks
- well-developed riparian and emergent vegetation communities which stabilize banks, provide cover (protection) and function as a source of fish food production.

**Medium:**
- limited areas of overwintering habitat among clusters of large substrates
- limited areas of rearing habitat due to excessive flows and/or inappropriate substrates
- limited area and/or non-contiguous riparian zone
- stable to moderately stable nearshore and streambanks
- mixture of substrate types (i.e. gravels with sand and/or mud and/or scattered cobble/boulder)
- general presence of emergent and riparian vegetation; upland vegetation is present if upper banks are unstable.

**Low:**
- general lack of rearing habitat
- predominance of sand or mud substrates
- absence or degradation of the riparian vegetation
- unstable, eroding banks
- extreme water flow conditions (i.e. stagnant area or deep, fast-flowing water)
- lack of spawning potential (inappropriate substrates and/or flow velocities)
- over-abundance of submergent vegetation

Tributary Streams

Tributary streams can provide important rearing areas for the local and

migrant fish populations. In the case of some tributaries, elevated water temperatures in the slow-flowing rearing areas off the mainstem may stimulate rearing salmonids to seek the cooler water temperatures in these streams. This behaviour also enables the fish to avoid the typically higher predator densities in the mainstem and off-channel rearing areas. The following set of criteria (based on the important habitat variables outlined in Report Section 3.2.1) were developed and applied to the tributary streams when assigning habitat value ratings. Again, it should be noted that all the criteria need not have been met for a particular stream or area to receive a certain rating and often a combination of habitat qualities and quantities were used to rate a stream.

**High:**
- flowing water during the entire year;
- provision of extensive rearing habitat;
- clean, flowing water;
- stable streambanks;
- well-developed lower riparian vegetation community;
- no barriers to fish passage; and
- stream gradient not excessive.

**Medium:**
- limited extent of rearing habitat;
- less consistent but often sustained water flow;
- riparian vegetation communities poorly or moderately developed;
- stable to moderately stable banks;
- mixture of substrate types (i.e. gravels with sand or mud); and
- may have barriers to fish passage at low or high flows.

**Low:**
- lack of rearing habitat;
- intermittent flow or stagnant water;
- non-existent or degraded riparian zone;
- poor water quality;
- over-abundance of aquatic vegetation;
- inappropriate substrate types for rearing (i.e. mud, sand or clay); and
- has barriers to fish passage.

### 3.2.3 Vegetation Inventory

The vegetation along the mainstem rivers was inventoried to document the species present and their relative abundance within a given streambank

section. It should be noted that the availability of this information does not eliminate the need for more detailed on-site habitat assessments for any proposed developments. Site-specific detailed species presence and abundance information should be collected and used as baseline information from which appropriate compensation and/or mitigation measures could be prescribed for impacted areas. Other pertinent site-specific biophysical information such as bank substrate composition should be taken into account in determining the likelihood of achieving the prescribed mitigative measures.

Identification of vegetation species was not meant to be exhaustive. In fact, the intention of the vegetation portion of the survey was to identify general community associations among the aquatic, riparian, and to a lesser degree, the adjacent upland habitats. Plant community descriptions relate species presence and abundance to physiographic features and can be used to assess levels of disturbance. The survey was also intended to locate significant areas of aquatic and riparian communities along the river systems. Such descriptions would aid developers, environmental agency personnel, and City staff in identifying any need for, or extent of, vegetation replacement in the event that habitat impacts occur as a result of development or as part of habitat enhancement/restoration projects.

Plants were identified to the species level where possible. Many different plant keys were utilized but the nomenclature follows Vascular Plants of the Pacific Northwest (Hitchcock et al. 1984) where ever possible (see Section 7.0 - References for a listing of the additional references employed).

Five distinct plant communities were recognized within the Kamloops study area and they are described below.

- **Submergent** - species requiring long periods of inundation by water to perpetuate.
- **Emergent** - herbaceous wetland species capable of tolerating complete submersion for short periods of time on a regular basis.
- **Lower Riparian** - species found along the lower banks of the watercourse, seasonally inundated sand/gravel bars and-low-lying flats within the floodplain. The water table is

usually accessible to the root systems and soils may be skeletal or represented by infilled sediments.

- **Upper Riparian** - species found along the upper banks or on elevated floodplain benches, consisting primarily of shrubs and young trees, where inundation is often less frequent. Soils are generally well developed and well drained.

- **Upland** - species found on the slopes above the floodplain benches and high water marks. Soils are well developed. Trees and shrubs are the primary community constituents.

Efforts to identify common species were concentrated within the submergent, emergent and lower riparian zones as these communities play a more prominent role in the provision and maintenance of fish habitat.

The accumulated baseline data were used to prepare maps of the Thompson, South Thompson and North Thompson rivers documenting habitat ratings (high, medium or low) for each of the Streambank Sections.

## 3.3 Mapping

The study area is one of the regions of the province for which 1:5,000 scale, B.C. Ministry of Environment, cadastral mapping is available (Ministry of Environment 1980). A total of forty five maps were used, however, eight 1:2,500 and eleven 1:5,000 floodplain maps and 1:5,000 orthophotos had to be used to attain complete coverage of the study area. Both orthophoto and floodplain mapping appear to utilize the same set of aerial photographs taken in mid-October, 1974. Supplementary aerial photography completed in July, 1975 was used to complete the orthophoto coverage. All of the aerial photography represents an average high water condition based on historical records (Environment Canada 1991). Map production entailed splicing together original maps in order to provide sufficient upland coverage, although some hand-drawing was also necessary. The new map sheets were then screened by 40% to subdue, yet retain, pertinent map features. The geographical referencing points present on the original map sheets were also retained. The aerial photographs of the study area were used as a guide in making pertinent updates to the base maps.

The shorelines of the mainstem rivers, their tributaries and vegetated islands were then redrawn and enhanced to delineate the average high water level as determined from the floodplain mapping, orthophoto review and topographic analysis. Unvegetated sandbars that would be exposed during average fall low water levels, such as those occurring at the time of the field survey portion of this study, were identified using dashed lines. The significance of identifying seasonally inundated sandbars was primarily for purposes of describing the foreshore substrates and conditions to clarify and facilitate rating the salmonid habitat values of the adjoining streambank sections. Efforts to identify temporary and seasonally inundated sandbars were not exhaustive, therefore may contain some discrepancies.

The physical conditions present within each streambank section are displayed using coded labels. The labels identify the habitat value, predominant and secondary substrates composing the nearshore and lower banks, bank stability, and the relative abundances of the five vegetation communities described previously. Lower reaches of mainstem tributary streams were surveyed for a sufficient distance upstream to assess their fish habitat values and these reaches were rated according to the criteria outlined in Report Section 3.2.2 and labelled with the appropriate code (high, medium or low).

Added to each map were; 1) a location map identifying the general location of the area depicted, 2) a legend describing the symbols and codes used, and 3) locations of effluent and storm water outfalls.

A 1:100,000 scale index map covering the entire study area was also produced to enable the reader to easily locate the particular river section of interest. This was accomplished using two Energy, Mines and Resources Canada (Energy, Mines and Resources 1977) 1:100,000 scale topographic map sheets, screening the new map by 40% to subdue, yet retain, the topographic map features and enhancing the shorelines of the mainstem rivers and their tributaries.

# 4.0 RESULTS

## 4.1 Thompson River Biophysical Survey and Habitat Value Ratings

Detailed results of the Thompson River biophysical survey are presented in tabular form in Appendix 1 and cartographically on the accompanying 1:5,000 scale map sheets. A dBase IV format computer data file was created of the Thompson River biophysical data for possible future data integration and Geographic Information System (GIS) applications. A summary of the biophysical information recorded in Appendix 1 is presented below.

Any references made within this report to banks of a particular stream follow the standard convention where "left bank" and "right bank" refer to the sides of the stream while facing downstream.

### 4.1.1 Physical Description

The portion of the Thompson River within the Kamloops study area begins at the confluence of the North and South Thompson rivers and flows in a westerly direction into Kamloops Lake. Its channel is relatively straight and contains one large island at low water. However, at high water, as a result of both elevated water levels in the river and the lake, several high water channels and adjacent agricultural fields become inundated (primarily between May and July). Substrates are almost exclusively composed of sand due to the high bedload being deposited primarily from the North Thompson River. Several long sections of streambank through the developed portions of the city and adjacent to industrial developments have been armoured to prevent erosion.

A total of 93 streambank sections (both shorelines) were identified on the Thompson River covering a total of 39.1 km; derived from the sum of the individual shoreline lengths of the streambank sections. The upland use by streambank section was assigned from field observations and orthophoto review. Although the aerial photography dates back 20 years (1974-1975) and most of the land use designations were determined from field observations, there has been little change in the type and extent of land use adjacent to the riverbanks. The percentage of streambank sections which had linear development upland was 19% (7.4 km). Of the remaining proportion of streambank sections, 21% (8.2 km) of the total was denoted as agricultural, 17% (6.5 km) as industrial, 16% (6.3 km) as undeveloped, 15% (5.9 km) as residential, and the remaining 12% (4.8 km) as recreational.

Nearshore stream flow type was described for each streambank section along the Thompson River. Of the total streambank length surveyed (both shorelines), over half, 54% (21.2 km) was denoted as glide, 19% (7.4 km) as run, 12% (4.7 km) as lakeshore, 5% (2.0 km) as pool, and 3% (1.3 km) as backeddy. The remaining 7% (2.5 km) of streambank was described as back channel with about 2% (0.5 km) being wetted and 5% (2.0 km) being dry at the time of the survey.

Shoreline substrates were described for each streambank section within the total 39.1 km of streambank length surveyed (both shorelines). The

majority (71% or 27.5 km) of the total length of shoreline had fines as the dominant substrate type. In descending order were man-made materials (rip rap and other debris) at 16% (6.3 km), gravels at 10% (4.0 km) and cobbles at 3% (1.3 km).

Bank composition and stability were also recorded by streambank section. Nearly two-thirds (62% or 24.1 km) of the total length of shoreline exhibited fines as the primary bank constituent with man-made materials (rip rap and other debris) comprising 32% (12.7 km), gravels 4% (1.7 km), bedrock 1% (0.4 km) and cobbles <1% (0.2 km). Approximately three-quarters (71% or 27.6 km) of the total length of shoreline surveyed was classified as stable. A significant proportion (46% or 12.7 km) of the shoreline classified as stable was armoured with man-made materials. The remaining 29% (11.5 km) of the total length of streambank surveyed was denoted as eroding.

### 4.1.2 Vegetation Communities along the Thompson River

Vegetation communities along the Thompson River are best described within the context of the type and level of disturbance associated with land use activities adjacent to the river. Plant communities along undeveloped sections of the river are relatively uniform and may be described in relation to distinct parameters, i.e. soils, slope, and exposure. The effects of disturbances to lands adjacent to the river are apparent from the plant species that colonize them. The level of disturbance can be evaluated by examining the degree of contrast in species composition with that of undisturbed communities. Detailed recommendations for the remediation of each of the defined terrestrial riparian zones can be found in section 5.0 Discussion and Recommendations. A complete listing of plant species encountered is presented in Appendix 4.

Submergent Community - Thompson River

The significance of submergent communities in the Thompson River within the study area is largely attributable to the cover they provide for juvenile salmonids during their outmigration in the spring. As water levels are normally high in the spring and early summer, the effective value of submergent vegetation in providing cover and refuge is viewed as supplementary as juvenile salmonids are expected to prefer to utilize the narrow shoreline interface of inundated emergent and lower riparian plant communities for refuge from strong mainstem currents and for foraging.

At times during the year when water levels are lower and the shoreline plant communities are inaccessible to salmonids, submergent communities may represent the only significant cover available in an aquatic environment dominated by a sandy bottom. Salmonid utilization other than during the spring outmigration is expected to be limited to resident fish such as the rainbow trout.

Although submergent communities are relatively common along the Thompson River the overall abundance of plants is low. The major limiting factors appear to be infilling and bedload movement resulting from the high sand load carried from the North Thompson and Thompson rivers to Kamloops Lake. The common shallow water and/or shoreline species include Canada water weed (*Elodea canadensis*) and water-milfoil (*Myriophyllum spicatum*). In deeper water, white-stalked potamogeton (*Potamogeton praelongus*) and slender-leaved potamogeton (*P. filiformis*) were common. Long-leaved potamogeton (*P. nodosus*) and small potamogeton (*P. pusillus*) occurred less frequently.

Submergent vegetation communities were abundant in the side channel around McArthur Island where water is for the most part impounded by bridge crossing dykes, control structures and a low beaver dam, the latter occurring at the downstream end. A significant proportion of this side channel would be accessible to salmonids from the downstream end during periods of high flow such as those occurring during the spring outmigration. During periods of high flow it is likely that the downstream (accessible) portion of this side channel has a high value in providing refuge from the high flow velocities in the main channel and in providing foraging opportunities for salmonids.

Emergent Community - Thompson River

The emergent plant communities are frequently inundated by water and may remained submerged throughout the high flows of early spring until early summer. This limits the growth of most shrubs and trees and favors more rapidly growing sedges and herbaceous species able to regenerate annually from below-ground parts or from seed. When inundated during above average flows these plant communities likely act as the primary habitats utilized by juvenile salmonids during their outmigration. Juvenile salmonids seeking refuge from the stronger flows of the main channel would follow the shoreline, utilize the submerged vegetation as cover from predators and forage on small insects and invertebrates which are washed or fall into the river from shoreline vegetation.

The prevalence of emergent vegetation along the Thompson River is proportional to the amount of suitable growing sites present. Preferred conditions for the establishment of emergent species include low gradient shorelines or depositional areas where adjacent flows are slow to moderate. Although emergent vegetation was recorded for many Streambank Sections, representation was often limited to a narrow and incomplete strip. More significant communities occurred in areas including back channels, side channels and depressions where the finer organic sediments are trapped; coarse sand particles having settled outside of these areas. **Photograph 1** showing the downstream end of the side channel around McArthur Island is an example of a depositional area where spike-rush and *Carex* sedges occur on accumulated fine sediments. Such areas of abundant emergent vegetation have high salmonid habitat values, particularily when submerged. Factors that limit the distribution and development of emergent communities along the Thompson River include a strongly fluctuating water table, steep and/or rip rapped banks and unstable or transitory sand depositional areas.

The typical emergent community assemblage found along the Thompson River is dominated by creeping spike-rush (*Eleocharis palustris*) and occasionally water horsetail (*Equisetum fluviatile*), both species commonly occurring in pure or intergradient communities. Other less common but predictably occurring species occurring in well developed communities include water parsnip (*Sium sauve*), mackeral-mint (*Mentha spicata*) and small-flowered forget-me-not (*Myosotis laxa*). Less common species occasionally present include field mint (*Mentha arvensis*), slender rush (*Juncus tenuis*) and Torrey's rush (*J. torreyi*), retrorse sedge (*Carex retrorsa*), Crawford's sedge (*C. crawfordii*) and slender beaked sedge (*C. athrostachya*). The occurrence of other species such as the diminutive small spike-rush (*Eleocharis parvula*), wide-fruited sedge (*Carex eurycarpa*), reed mannagrass (*Glyceria grandis*) and wool-grass (*Scirpus cyperinus*) were sporadic. Many of the aforementioned native plant species are important to maintaining the diversity and abundance of insects and arthropods that are a primary food source for fish and are fed on by many species of birds and mammals.

Disturbance events in emergent communities are largely natural such as erosion from high flows. Also significant are disturbances associated with armouring eroding banks and erosion induced by vehicle and livestock traffic. In general, disturbed and degraded emergent communities are poorly vegetated and provide poor habitat for juvenile salmonids. Occasionally, under favourable conditions and without continued

disturbance, it appears many of the naturally occurring plant species will recolonize disturbed sites over time. However, the natural recovery of emergent plant communities is a slow and unpredictable process, hindered by the erosional processes of the river. Mitigation and restoration of naturally occurring emergent plant communities degraded by anthropogenic disturbances should have a high priority to reflect the high value of these communities to fish and wildlife species.

Lower Riparian Community - Thompson River

The lower riparian plant communities of the Thompson River are seasonally inundated with water during periods of high flow (May through July) and function as the shoreline interface with the aquatic environment. It is during these periods of high flow, when juvenile salmonids are on their outmigration, that the greatest salmonid habitat values are realized. hat the lower riparian plant communities andand during. The greater size and rigidity of shrubs and herbaceous perennials that characterize the lower riparian plant communities have a greater ability to reduce nearshore water flow velocity than plant species of the emergent zone and provide refuge areas from both the high flow velocities of the main channel and from predators. Insects and invertebrates washed into the river during high flows are also primary food sources for fish. Additionally, the shrubs of the lower riparian zone are critical in maintaining the integrity and stability of streambanks. **Photograph 2**, showing a typical section of shoreline along the north bank of the Thompson River near Kamloops Lake illustrates the effectiveness of lower riparian shrubs in maintaining the stability of sand dominated banks otherwise prone to erosion. During high water flows the shrubs along the top of the bank in the photograph becomes partially submerged and the woody debris and grasses along the banks become habitat for juvenile salmonids during their spring outmigration.

Disturbances to the lower riparian plant communities most often leads to bank erosion that can progress upslope and affect the upper riparian plant communities. The resilience of native lower riparian plant species to disturbance is low and the process of natural recovery slow. Recovery from disturbance is characterized by the establishment of weedy and introduced grasses and herbaceous species which provide lower fish and wildlife values and have a lower capacity to stabilize streambanks. Unstable and eroding banks are often armoured with rip rap materials to prevent further erosion and loss of land. The salmonid habitat values associated with rip rap armoured banks were typically lower than those for streambank sections with well developed natural plant community assemblages.

Seasonal inundation and frequent disturbance from bedload movement greatly influences plant community composition which is reflected in the early successional status of existing plant communities. Grasses and herbaceous species dominate this zone although shrubs are often common. Trees other than sapling-sized black cottonwoods are not found in this zone, largely because they are easily undermined and toppled as a result of erosion during flood flows.

Species that characterize shallowly sloped shores commonly demonstrate a well defined transition. The common species along the lower limit of this zone is red top bentgrass (*Agrostis alba*) which often occurs in pure colonies. Less common and often mixed with red top are slender hairgrass (*Deschampsia cespitosa*), interior bluegrass (*Poa interior*), Kentucky bluegrass (*P. pratensis*), few-flowered aster (*Aster modestus*), Douglas aster (*A. subspicatus*), prairie sage (*Artemisia ludoviciana*), curly dock (*Rumex crispus*) and sneezeweed (*Helenium autumale*). The occurrence of sandbar willow (*Salix exigua*) generally increases with rising elevation above the water level and it is often the dominant species in the upper portion of the lower riparian zone. Red-osier dogwood (*Cornus stolonifera*) is also present in the uppermost portions of this zone.

Vegetation communities of floodplain benches tend to differ from those of sloping shorelines due to the difference in edaphic conditions (soil nutrients and moisture). Sloping shorelines are areas that are more prone to erosion where floodplain benches tend to be depositional areas. As a result, soil conditions vary in composition, nutrient and moisture availability which is reflected in the composition of each community. Floodplain benches may also be large in area and support highly productive communities. During high flows, it is these extensive communities that have the highest salmonid habitat values. Reed canary grass (*Phalaris arundinacea*) often dominates the lower Thompson River riparian communities that occur on floodplain benches and it normally forms pure communities even when occurring as clumps. Other common species often forming pure communities are common scouring-rush (*Equisetum hyemale*) and red-osier dogwood. Sandbar willow is also common on floodplain benches but tends not to exclude other species of grasses and herbs as described previously for shallowly sloped shorelines. Less common species in the lower riparian zone of floodplain benches include goldenrod (*Solidago canadensis*), asters, prairie sage, varigated horsetail (*Equisetum variegatum*), sneezeweed, toad rush (*Juncus bufonius*) and cockleburr (*Xanthium strumarium*).

Lower riparian communities occurring on relatively steep sloped banks along the Thompson River are generally poorly represented in narrow and discontinuous strips, and restricted by the availability of water and through competition with plants that are better adapted to environmental conditions above and below them. Additionally, considerable lengths of steeper sloped banks occur and are actively eroding, largely due to the disturbance or removal of shrubs and trees upslope, or because they have previously been armoured for erosion protection thus precluding the development of contiguous lower riparian communities. Grasses such as reed canary grass and quackgrass (*Agropyron repens*) are the most successful plants to establish on eroding and recently disturbed sites although the occurrence of the latter is often a result of slumping where quackgrass is also the dominant species upslope. Other species such as goldenrod and white sweet-clover (*Melilotus alba*) also occur on disturbed sites. More stable sloping banks are often dominated by shrubs such as sandbar willow and red osier dogwood.

Lower riparian zone communities occurring on islands and vegetated bars separated from the shoreline by high water channels follow the above descriptions based on the shoreline type. Both gradually sloping and floodplain bench type communities are common.

Upper Riparian Community - Thompson River

The significance of the upper riparian plant communities to salmonids is largely based on the values of tree and shrub species in providing stability to bank materials, shade and overhead cover for salmonids using shoreline habitats. It also acts as the primary source of coarse woody debris and litterfall which provides the structure, cover and food base that are primary constituents of stream ecosystems. Native tree and shrub species are generally viewed as having superior fish and wildlife values over most introduced species including grasses and herbaceous species. The presence and abundance of native tree and shrub species is reflected in the salmonid habitat value ratings for each of the identified Streambank Sections.

The upper riparian community of the Thompson River can be described as being poorly developed. Human induced disturbances and removal of riparian vegetation has occurred along much of its length. The large trees and well developed shrub layers that should dominate this zone are mostly replaced by grasses and weedy species along industrial sections, road and railway allowances and by landscaped lawns present along residential sections. Significant lengths of streambank have been armoured with rip

rap materials, precluding any natural succession towards establishing stable riparian communities.

Relatively undisturbed upper riparian communities occurring where bank slopes are gentle to moderate demonstrate an upslope transition from smaller shrubs to larger shrubs and trees with black cottonwood (*Populus trichocarpa*) usually demarcating the upper limit of this zone. Although no significant examples of this community were present, a number of fragmented sites were used to provide a scale to assess the level of site disturbance and assist in making recommendations for habitat restoration. Red-osier dogwood, whiplash willow (*Salix lasiandra*) and black cottonwood were the dominant upper riparian species in areas of low disturbance, although many other shrub species were present depending on the size of the undisturbed area. Sandbar willow often occurred in the lower part of this zone where bank slopes were relatively shallow. Upper riparian zones dominated by woody vegetation were generally viewed as satisfactory if they expressed the desired fisheries values of shade, food value and bank stability.

Relatively shallowly sloped banks subjected to relatively low and moderate levels of disturbance usually lacked a significant representation of trees and were generally dominated by grasses and frequently by shrubs at sites with less severe disturbance. Black cottonwood was the dominant tree with box elder (*Acer negundo*) occasional to common and ponderosa pine (*Pinus ponderosa*) uncommon. The most common shrub occurring in disturbed areas was Nootka rose (*Rosa nutkana*) with other less common species including whiplash willow, serviceberry (*Amelanchier alnifolia*), snowberry (*Symphoricarpos alba*), black hawthorn (*Crateagus douglasii*), red-osier dogwood and chokecherry (*Prunus virginiana*) present in variable amounts. Quackgrass, slender wheatgrass (*Agropyron caninum*) and rough fescue (*Festuca scabrella*) become more common as the level of disturbance increases as do other herbaceous species such as dogbane (*Apocynum androsaemifolium*) and goldenrod. Other less common species of low and moderately disturbed sites include showy aster (*Aster conspicuous*), chicory (*Cichorum intybus*), white clematis (*Clematis ligusticifolia*), poison ivy (*Rhus radicans*) and cockleburr (*Xanthium strumarium*). In many cases, lower riparian zone species such as reed canary grass, sandbar willow and red-osier dogwood were present in the lower portion of this zone.

Severely disturbed sites such as the long sections of rip rap along the airport and the Mission Flats sewage treatment ponds were poorly vegetated. Quackgrass and slender wheatgrass were the most common

upper riparian plants whose areal coverage approaches that for all other species combined. This is a result of the high frequency of encroachments and disturbances which removed the natural shrub and tree cover. The dominant species at such sites was quackgrass with other weedy species including flixweed (*Descuriana sophia*), knapweed (*Centaurea diffusa*), dragon sagewort (*Artemisia dranunculus*), kochia (*Kochia scoparia*), oyster plant (*Tragopagon dubius*) and crested wheatgrass (*Agropyron cristatum*) present in variable amounts.

Upper Slopes - Thompson River

The value of the upper slope zone to salmonids is primarily in its capacity to buffer the effects of human activities on downslope riparian communities. An intact, fully vegetated upper slope plant community would function to intercept and filter surface water drainage from developed areas thereby preventing the formation of erosion gullies, buffer against the invasion of exotic and weedy plant species, maintain shade to prevent excessive exposure and water stress in downslope riparian communities, and help to maintain the integrity and stability of the river banks, particularly those that are sensitive to erosion. The upper slope zone, being farther removed from the river, is a particularily harsh environment where disturbances cause the decline of natural plant communities resulting in the invasion of exotic and weedy species that possess lower fish and wildlife values. Natural recovery and succession from disturbance in upper slope areas may not occur within an acceptable length of time and restoration of natural communities in disturbed areas would likely require intensive management.

The transition from upper riparian to upslope vegetation communities is distinct, particularily in relatively steeply sloped sections. This transitional area generally occurs at the breaks (top of bank) of the river where they occur within 6 to 8 m above the average low water levels. It is in the upper slope zone that most impacts associated with development occur.

In general, where remnant or isolated natural plant communities occur in the upslope areas, they are dominated by bunchgrass (*Agropyron* spp.) and sagebrush (*Artemisia tridentata, A. firigida*) with occasional stands of ponderosa pine (*Pinus ponderosa*) or Douglas-fir (*Pseudotsuga menziesii*).

Upslope areas along the Thompson River with direct interactions with the aquatic enviroment are infrequent. However, disturbances that have removed trees and shrubs in the transitional areas with upper riparian zone

have often led to bank instability and subsequently rip rapping in order to compensate. Disturbed sites in upslope areas are largely vegetated with exotic and weedy species with little wildlife value or an ability to stabilize the sand dominated river banks. The combination of erosion induced disturbances and invasion of undesireable plant species into downslope riparian zones identify potential habitat restoration opportunities as found in Appendix 1. Habitat restoration opportunities along the Thompson River most often occur along road and railway right-of-ways which parallel the river.

### 4.1.3 **Salmonid Habitat Value Ratings** - Thompson River

As noted previously, a total of 93 streambank sections were identified on the Thompson River which comprised a total length (both shorelines) of 39.1 km. Twenty-six percent or 10.3 km of this length was rated as having a high value for salmonids. Most of the streambank sections rated as having a high value to salmonids describe the extensive, seasonally flooded low-lying areas in downstream portions of the Thompson River near the Kamloops Lake and those sections characterized by having significant areas of emergent and lower riparian plant communities (Streambank Sections T1-3, T6-9, and T11-13). This reflects the value of these areas in providing escape cover from predators, refuge from strong main channel currents and foraging opportunities for juvenile salmonids during their spring outmigration. These values are also recognized in the side channel around McArthur Island (Streambank Sections T60 and T62).

A total of 39% (15.0 km) of the total streambank length (both shorelines) was rated as having medium salmonid habitat values. Streambank sections having medium salmonid habitat values are generally those where emergent and lower riparian plant communities are somewhat limited in area, are poorly developed, or are threatened by actively eroding banks (T16). This is often the case with more steeply sloped and eroding banks. Streambank sections armoured with rip rap materials were often rated medium if the materials used were of large diameter with large interstices, offering juvenile salmonids escape cover from predators and refuge from the strong river currents. For example, the shoreline of McArthur Park that defines the main channel bank (T60 and T62) is armoured with a variety of rip rap materials, some of which are large enough to provide cover for juvenile salmonids. Streambank sections with significant amounts of woody debris or shoreline structure were also often rated medium where hiding cover and refuge from strong currents would exist during the high flows occurring during the springtime outmigration of juvenile salmonids.

SOUTH THOMPSON RIVER

The remaining 35% (13.8 km) of the total streambank length surveyed (both shorelines) that was rated as low value often described steep and eroding banks with poorly developed plant communities such as those found along the Mission Flats Park and adjacent water treatment ponds (T40, T45, T48, and T50), extensive sand bars (T63, T64, T67, T68, T70, T72, T73, and T77) or rip rap armoured banks where the materials used were of small size and the interstices in the rip rap materials was also small (T50, T57, and T58).

## 4.2 South Thompson River Biophysical Survey and Habitat Value Ratings

Results of the biophysical survey of the South Thompson River are presented in tabular form in Appendix 2 and cartographically on the accompanying 1:5,000 scale map sheets. A dBase IV format computer data file was also created of the South Thompson River biophysical data for possible future data integration and Geographic Information System (GIS) applications.

### 4.2.1 **Physical Description** - South Thompson River

The section of the South Thompson River within the Kamloops study area begins near the Monte Creek confluence and flows west to the confluence with the North Thompson River. Its channel meanders somewhat through the study area and the City of Kamloops but is essentially void of side channel formation. Large sections of streambank have been altered to provide recreational access and views from residential properties. Substrates are typically composed of fines and gravels as a result of the moderating effect on stream flows provided by the large lakes present further up the system.

The upland use was assigned from field observations and orthophoto review for each of the streambank sections identified along the South Thompson River. The significant changes in land use along the river in years following the aerial photography (1974-1975) include new residential developments along the south bank towards Monte Creek, industrial developments along the south bank nearer to the downtown core, and the Rivershore Golf Course on the north bank of the river. The highest percentage of the total streambank length (both shorelines) had linear development in the upland (32% or 19.5 km). The remaining length of streambank surveyed along the South Thompson River (both shorelines) included 31% (18.6 km) of the total denoted as agricultural, 19% (11.7 km) as residential, 6% (3.5 km) as undeveloped, 6% (3.3 km) as

recreational, 5% (2.9 km) as industrial, and the remaining 1% (0.6 km) as institutional.

Nearshore stream flow type was described for each streambank section along the South Thompson River. Of the total streambank length surveyed (both shorelines), almost two-thirds (64% or 38.7 km) was denoted as run, 29% (17.5 km) as glide, 6% (3.8 km) as backeddy, and <1% (0.1 km) as back channel.

Nearshore substrates were described for each streambank section and based on the total streambank length surveyed (both shorelines), the vast majority (79% or 47.3 km) of the length had fines as the dominant substrate type. In descending order were gravels at 17% (10.2 km) and man-made materials (rip rap and other debris) at 4% (2.6 km).

Bank composition and stability were also recorded by streambank section. A majority (91% or 54.8 km) of the total streambank length (both shorelines) exhibited fines as the primary bank constituent with man-made materials (rip rap and other debris) composing 5% (3.2 km), and gravels 4% (2.2 km). Approximately three-quarters (73% or 44.1 km) of the total streambank length surveyed was classified as stable of which 7% (3.2 km) was armoured with man-made materials. The remaining 27% (16.0 km) was denoted as eroding.

### 4.2.2 **Vegetation Communities** - South Thompson River

South Thompson River annual and seasonal fluctuations in water level are lower than those for the North Thompson and Thompson rivers as runoff flows are buffered by the large surface areas of the Adams and Shuswap lakes. The South Thompson River also transports and deposits less coarse sands than either the Thompson or North Thompson rivers. These conditions provide a more stable environment for the development of riparian zone vegetation, particularily in the emergent and lower riparian zones.

Although complete riparian communities are discontinuous, there are relatively long streambank sections with favourable fisheries and wildlife values associated with them (S72 and S162).

In contrast to the North Thompson and Thompson rivers, the South Thompson River submergent plant communities were well developed through most of the length of the within the city limits.

Residential, industrial, and agricultural land uses have impacted a significant amount of the natural riparian zone plant communities. Rip rap armouring and eroding banks also impact and disturb the natural communities in upper riparian and upslope zones. The emergent and lower riparian communities, however, appear more resilient to disturbance.

Submergent Community - South Thompson River

The salmonid habitat values of submergent vegetation in the South Thompson River are equivalent to those described in detail previously for the Thompson River (see Section 4.1.2). However, due to the relative preponderance of submergent vegetation in the South Thompson River, it is expected that a greater number of potential predators such as the northern squawfish (*Ptychocheilus oregonensis*) are supported than in either the North Thompson or Thompson rivers.

Submergent plant communities are common along the South Thompson River and the overall abundance of plants is high. The common shallow water and/or shoreline species include Canada water weed and water-milfoil. In deeper water, white-stalked potamogeton and slender-leaved potamogeton were common. Long-leaved potamogeton and small potamogeton occurred less frequently. Submergent communities were less well developed in areas of steeply sloping banks and shallow gravel or cobble bars.

Emergent Community - South Thompson River

The emergent plant communities of the South Thompson River are well developed, relatively extensive and generally have high salmonid habitat value ratings associated with them. A description of some of the more significant salmonid habitat values associated with emergent plant communities can be found in Section 4.1.2 of this report.

The low floodplain benches and very shallowly sloped shorelines of the South Thompson River support the most productive emergent plant communities. This is likely due to the accumulation of fine organic sediments in depositional areas and to the more stable flow regime resulting from the buffering action of large lakes upstream (eg. Shushwap Lake). With lower fluctuations in water levels, a greater proportion of emergent plant communities benefit from a longer effective growing season than those communities subjected to frequent extremes of flooding and water stress.

The most abundant emergent species were creeping spike-rush and water horsetail with both species occurring in pure or intergradient communities. Other species present in well developed spike-rush/horsetail communities include water parsnip, mackeral-mint, small-flowered forget-me-not, field mint, arrow-grass (*Triglochin maritimum*), slender rush and Torrey's rush, retrorse sedge, Crawford's sedge and slender beaked sedge. **Photograph 3** profiles a complete riparian zone plant community transition for a shallowly sloped shoreline along the South Thompson River with well developed emergent and lower riparian zone plant communities. The occurrence of other species including mare's tail (*Hippuris montana*), small spike-rush, wide-fruited sedge, reed mannagrass and wool-grass were sporadic. Most of the aforementioned plant species have high salmonid and wildlife habitat values, particularily where they are associated with well developed upper riparian plant communities.

The occurrence of mare's tail, a generally semi-aquatic herb requiring at least partial submersion to avoid dessication, suggests a relatively stable low flow regime through the summer growing season. The emergent plant communities benefit from being able to survive relatively long periods of submersion during high flows that act to exclude shrubs and trees. Additionally, high water tables associated with low floodplain benches restrict the rooting depth of shrubs and trees.

The rushes and sedges described for the emergent community are competitive and secure dominance by being able to withstand long periods of submergence and by rapid growth and reproduction, by means of vegetative reproduction as well as by producing large quantities of seed. These conditions give the emergent communities some resilience against physical disturbances and invasion by non-native species and also allows for greater potential success in habitat restoration efforts.

Lower Riparian Community - South Thompson River

The lower riparian plant communities of the South Thompson River are well represented and generally have significant salmonid habitat values associated with them as described in Section 4.1.2 of this report.

Low floodplain benches, shallowly sloped shorelines and depositional areas perched above low water levels are relatively common physiographic features along the South Thompson River and are where lower riparian communities have the highest productivity. Reed canary grass often dominates lower riparian communities that occur on floodplain benches and

shallowly sloped shorelines. Also common are spreading dogbane (*Apocynum androsaemifolium*), common scouring-rush, whiplash willow and red-osier dogwood. The transition from reed canary grass to red-osier dogwood and whiplash willow can be seen in **Photograph 3**. Less common species in the lower riparian zone of floodplain benches include Mackenzie willow (*Salix rigida* var. *mackenzieana*), Russian olive (*Eleagnus angustifolia*), tansy ragwort (*Senecio jacobaea*), goldenrod, asters, prairie sage, variegated horsetail, sneezeweed, asparagus (*Asparagus officinalis*) and showy milkweed (*Asclepias speciosa*).

The development of lower riparian communities occurring on relatively steeply sloped banks is largely restricted by the availability of water, extent of bank erosion and erosion of topsoils. Grasses such as reed canary grass and quackgrass are the most successful plants to establish on eroding and recently disturbed sites although the occurrence of the latter is often a result of slumping where quackgrass is also the dominant species upslope.

Bank instability caused by disturbance to riparian trees and shrubs, rip rapped banks and livestock degradation are the primary causes of poor vegetative development as seen in **Photograph 4** and at a coarse level, in riparian zone descriptions in the attached Appendix 2. Bank erosion as seen in the photograph mediates the formation of steeper banks and perpetuates their instability, particularily with no deep rooted or woody plants to stabilize the sand dominated banks.

Upper Riparian Community - South Thompson River

The salmonid habitat values associated with the upper riparian zone plant communities of the South Thompson River are similar to those described for the Thompson River in Section 4.1.2 of this report.

The relatively undisturbed upper riparian zone communities of the South Thompson River (such as Streambank Section S72, **Photograph 3**) are commonly dominated by woody vegetation, particularily shrubs. Black cottonwood and box elder are relatively common trees although generally not found in great abundance. Whiplash willow, normally classified a shrub, grows to the height of a small tree at its tallest (13 to 15 m) and is generally more common than red-osier dogwood and black hawthorn, although the latter may be dominant in some streambank sections. Black hawthorn appears relatively tolerant to exposure and xeric conditions and appears to persist better in less favourable conditions. Other less abundant but common shrubs in well developed communities include chokecherry,

snowberry and Nootka rose. Although generally uncommon in the well developed shrub dominated communities, the herb layer included several species including star-flowered Solomon's seal (*Smilacina stellata*), spreading dogbane, serviceberry, prairie sage, showy aster and poison ivy. The plant species described here for relatively undisturbed sections have high salmonid and wildlife values associated with them and would be preferred choices for habitat restoration and enhancement programs.

Steeper banks and rapidly drained sites often contain plant associations common to the upslope communities. Some of the more common species include nodding wildrye, big sage, rabbitbrush, quackgrass and slender wheatgrass.

Residential, agricultural and commercial encroachments, powerline and bridge crossings and recreational uses in the upper riparian zone are common along the South Thompson River and have fragmented and degraded the natural vegetation types in many streambank sections. Although some sites show regeneration by native species, most disturbed sites have a significant component of introduced and weedy species. This is true also for many naturally disturbed sites such as naturally eroding cutbanks.

Grasses were often dominant on disturbed sites. Native grass species including rough fescue, slender wheatgrass and nodding wildrye and introduced grasses including as quackgrass and crested wheatgrass were the most abundant.

Common weeds of disturbed sites are largely introduced species such as diffuse knapweed, spearscale (*Atriplex patula*), kochia, dragon sagewort, mullein, field milk-thistle, white and yellow sweet-clover, Oyster plant, oxeye daisy and wormwood.

Upper Slopes - South Thompson River

The upper slopes along the South Thompson River are defined for the purposes of this study as those areas not directly affected by the processes of the river but having the potential to directly affect it. The vegetation of this zone is generally distinctly different from lower riparian zones. The primary fisheries value associated with the upper slope zone is in its capacity to act as a buffer to protect the integrity of the lower riparian communities.

Much of the upslope vegetation described for streambank sections along the South Thompson River occurs on shallowly sloped lands eight or more metres above the average low water level. This zone has the greatest amount of disturbance associated with development and plant communities are largely fragmental.

There are two main types of plant communities in this zone. One community is dominated by giant wildrye with relatively few other species interspersed, some of which include other grasses such as quackgrass and slender wheatgrass, pasture sage and rabbitbrush. The other community type becoming more common away from the breaks of the river is a big sage - rabbitbrush - pasture sage association with other species often present including prickly pear cactus, knapweed, chicory and other grasses such as quackgrass and slender wheatgrass.

Ponderosa pine, black cottonwood and other tree species are relatively rare away from the influence of the water table. This differs from both the Thompson and North Thompson rivers and appears to reflect a somewhat drier local condition developing in an upstream direction along the South Thompson River. The implications of this being the situation should affect tree species selection in restoration attempts in upslope areas. Black hawthorn and Nootka rose both appear drought tolerant and would be preferred species in restoration attempts.

Disturbed sites in the upper slope zone contain many aggressive and weedy species including knapweed, dragon sagewort, kochia, quackgrass, Canada thistle, wormwood (*Artemisia absinthimum*), flixweed, alfalfa and cheatgrass (*Bromus tectorum*).

### 4.2.3 **Salmonid Habitat Value Ratings** - South Thompson River

A total of 164 streambank sections (both banks) were identified along the South Thompson River comprising a total of 60.1 km (both shorelines). Eleven percent or 6.6 km of the total length was rated as having a high value for salmonids. This relatively low proportion of the total streambank length surveyed reflects the high frequency of eroding banks, poor instream substrates and poorly developed riparian plant communities found along the South Thompson River within the study area. Streambank sections with high salmonid habitat values associated with them include those with extensive emergent and lower riparian communities that are inundated with water during the high flows of early spring and summer (for example Streambank Sections S72, S111, S112, and S162).

NORTH THOMPSON RIVER

from the Heffley Creek confluence to Rayleigh, approximately half way through the study area, then continues in a fairly straight direction to the South Thompson River confluence. Very little side channel development was evident through the study area. Extensive areas of eroding streambanks along agricultural fields were observed which along with similar sediment inputs upstream of the study area, contribute to the substantial sediment loading of the stream channel. Substrates were primarily composed of sand with occasional gravel deposition occurring predominately in the upstream sections of the study area.

The upland use was assigned to each of the identified streambank sections along the North Thompson River from field observations and orthophoto review. it appears that the only significant changes in land use along the banks of the North Thompson River since the date of the existing aerial photography (1974-1975) have been an increase in residential development and a new golf course along the west bank. The highest percentage (35% or 20.6 km) of the total streambank length (both shorelines) had agricultural land use adjacent to the streambanks. The remaining length of streambank included 27% (15.7 km) of the total denoted as undeveloped, 27% (15.8 km) as residential, 10% (5.5 km) as linear development, 1% (0.9 km) as recreational, and <1% (0.2 km) as industrial.

Nearshore stream flow type was described for each streambank section along the North Thompson River. Of the total streambank length surveyed (both shorelines), almost two-thirds (64% or 37.5 km) was denoted as glide, 23% (13.8 km) as run, 2% (1.2 km) as riffle, 2% (0.8 km) as backeddy, and 1% (0.5 km) as pool. The remaining 8% (4.8 km) were described as back channel with 2% (1.0 km) of the 8% wetted, 2% (1.4 km) isolated and 4% dry at the time of the survey.

Nearshore substrates were described by Streambank Section and based on the total streambank length surveyed (both shorelines), the majority of the length had fines (45% or 26.4 km) or gravels (41% or 24.2 km) as the dominant substrate type. In descending order were man-made materials (rip rap and other debris) at 8% (4.7 km), cobbles at 5% (2.7 km), and boulders at 1% (0.6 km).

Bank composition and stability were also recorded for each of the identified streambank sections. A majority (63% or 37.1 km) of the total streambank length surveyed (both shorelines) exhibited fines as the primary bank constituent with gravels comprising 18% (10.8 km), man-made materials (rip rap and other debris) comprising 12% (6.9 km), and cobbles

comprising 7% (3.8 km). Approximately two-thirds (64% or 37.3 km) of the total streambank length surveyed (both shorelines) was classified as stable, 19% (6.9 km) of which was armoured with man-made materials. The remaining 36% (21.3 km) of the total streambank length surveyed was denoted as eroding.

### 4.3.2 **Vegetation Communities** - North Thompson River

Vegetation communities along the North Thompson River have been significantly degraded by adjacent land use activities. Road and railway rights-of-way and agricultural and residential land developments account for 73% of the upland use along the sections surveyed with the remaining 27% remaining undeveloped. More than one third (36%) of the total length of streambank surveyed was eroding and 19% was armoured with rip rap materials. The combination of these factors act to lower the overall fish and wildlife values of riparian communities.

In contrast to the South Thompson and Thompson rivers, the submergent plant communities were poorly developed through most of the length of the North Thompson River within the city limits. This appears to be a result of high flow velocity and bedload (sand) movement and deposition. Submergent communities were abundant in the side channel near Heffley Creek (Sections N-105, N-106).

The banks of the North Thompson River were also generally steeper than those along the South Thompson and Thompson rivers and correspondingly, emergent plant communities were less extensive. The poorly developed shoreline communities contribute to the high proportion of streambank sections rated as having low salmonid habitat values.

Submergent Community - North Thompson River

Observations of submergent vegetation in the main channel of the North Thompson River within the study area limits were limited to streambank sections N-103 and N-104. These occurrences represent an extension of the abundant communities present in the oxbow near Heffley Creek immediately outside the study area boundary (Sections N-105, N-106). The well developed submergent communities within the oxbow result from flows being restricted by substrate deposition at the upstream end and an access road dyke at the downstream end. This essentially ponds the water in the oxbow during all but high flow levels. Protection from the erosive forces of mainstem flows and higher water temperatures during the summer

months would favour this community type. It is likely that juvenile salmonids would utilize this side channel during their spring outmigration when high flows would permit access. Significant wildlife values are also associated with this side channel.

Emergent Community - North Thompson River

Although generally restricted in presence and abundance, the emergent plant communities of the North Thompson River within the study area exhibit salmonid habitat values equivalent to those described in Section 4.1.2 of this report.

Relatively long sections of steep, eroding and rip rapped banks limit the distribution and development of emergent plant communities along the mainstem of the North Thompson River within the study area limits. Emergent vegetation did not occur in the majority of streambank sections. Where emergent species did occur the communities were generally poorly developed and discontinuous. The common species found in such communities include creeping spike-rush and horsetail. Slender hairgrass and red-top bentgrass were less common. Also occasionally present and found in lesser abundance were slender rush and toad rush.

High water side channels and backchannels where the water table is present or near the surface support emergent plant communities of creeping spike-rush and water horsetail with slender rush, Torrey's rush, retrorse sedge and Crawford's sedge occurring in variable but lesser amounts (Sections N-78, -85). The occurrence of mare's tail and arumleaf arrowhead (*Saggitaria cuneata*) were recorded for single streambank sections (N-105, -106).

Lower Riparian Community - North Thompson River

The lower riparian plant communities of the North Thompson River within the study area limits were generally not extensive. Salmonid habitat values associated with lower riparian communities are described for the Thompson River in Section 4.1.2 of this report and apply to those of the North Thompson River.

Lower riparian communities occurring on relatively steeply sloped banks are generally poorly vegetated, narrow and discontinuous strips, limited by the availability of water and the instability of bank materials. Additionally, previously eroding bank sections that have been armoured with rip-rap

materials preclude the development of contiguous lower riparian communities. Grasses such as reed canary grass and quackgrass are the most successful plants to establish on eroding and recently disturbed sites although the occurrence of the latter is often a result of slumping where quackgrass is also the dominant species upslope. Other species such as common scouring-rush, prairie sage, asters, and goldenrod also occur on disturbed sloping banks. Lower riparian vegetation on more stable sloping banks is often dominated by shrubs such as sandbar willow, wolf-willow (*Eleagnus commutata*) and red osier dogwood.

Shallowly sloped shorelines are less common and generally limited in extent. Seasonal inundation with water and frequent disturbance from bedload movement greatly influence plant community composition which is reflected in the early successional status of existing plant communities. Sandbar willow is usually the dominant species. Grasses and herbaceous species occurring on shallowly sloped banks include red top bentgrass, slender hairgrass, asters, interior bluegrass, prairie sage and sneezeweed. Red-osier dogwood is occasionally present in the upslope portions of this zone.

Floodplain benches, although relatively uncommon, are occasionally significant in extent along the North Thompson River (N-44). These communities are of high fisheries value when inundated during high flows; providing refuge and foraging opportunities for juvenile salmonids. The substrates of floodplain benches largely define the community types found on them. Floodplain benches in upstream portions within the study area are largely dominated by gravels and cobbles, although often overlain with a variable layer of sand and/or fine sediments (Sections N-109, -110).

Lower riparian communities established on coarse substrates often have a significant component of sandbar willow and black cottonwood seedlings. Cottonwood seedlings readily establish in such substrates but are prevented from maturing by the combination of a high water table limiting rooting depth and high flows uprooting them as they increase in size and create more drag in the current. Although cottonwoods would never mature in this zone, their value in stabilizing substrates mediates the establishment of other species through a successional sequence that may, although unpredictably, lead to the development of a more extensive and densely vegetated community. Other species found on floodplain benches with coarse substrates include red-osier dogwood, asters, prairie sage, tickle-grass, interior bluegrass and slender hairgrass.

Reed canary grass often dominates lower riparian communities that occur on floodplain benches where finer substrates dominate and often forms pure communities (N-45, -70, -85). Other common species include sandbar willow, whiplash willow, common scouring-rush and red-osier dogwood. Less common species of floodplain benches with fine substrates include goldenrod, asters, curly dock, prairie sage, sneezeweed, toad rush, common evening primrose (*Oenthera strigosa*) and field mint.

Lower riparian zone communities occurring on islands and vegetated bars separated from the shoreline by high water channels follow the above descriptions for floodplain benches based on the dominant substrate types. Erosion and deposition during high water flows often limits the development of vegetation for such sites.

Upper Riparian Community - North Thompson River

The description of salmonid habitat values associated with the upper riparian plant communities along the Thompson River (Section 4.1.2 of this report) can be applied to those of the North Thompson River within the study area.

Relatively undisturbed upper riparian communities of moderately sloped streambanks and floodplain benches are dominated by shrubs and trees including whiplash willow, black cottonwood, serviceberry, chokecherry, Nootka rose, black hawthorn, snowberry, buffaloberry, black twinberry (*Lonicera involucrata*), highbush cranberry, red-osier dogwood, wolf-willow, smooth willow (*Salix glauca*) and box elder. Understory herbs include star-flowered Solomon's seal, poison ivy, common scouring-rush and white clematis.

Relatively steeply sloping and eroding banks composed largely of sand were common along the North Thompson River. Although the fragile nature of the streambanks imply natural erosion is an inherent process, it is exacerbated by poor land use practices adjacent to the river banks and encroachments into the riparian zone. Natural plant communities are most often poorly represented and trees and shrubs rarely comprise any significant proportion of such communities. Aggressive and weedy species that are quick to invade disturbed sites include spearscale, Canada thistle, field milk-thistle, prickly lettuce (*Lactuca scariola*), chicory, alfalfa, white and yellow sweet-clover, oyster plant, diffuse knapweed, oxeye daisy, wormwood, quackgrass, flixweed, dragon sagewort, kochia, cheat grass and crested wheatgrass.

Upper Slopes - North Thompson River

The salmonid habitat values associated with upslope communities are described for the Thompson River (Section 4.1.2 of this report) and can be applied to those of the North Thompson River within the study area.

The upper slope areas of the North Thompson River as defined as those areas greater than 8 m (approximate) above water level or exhibiting communities characterized by species indicating no influence from the water table or processes of the river, have largely been impacted or developed for a variety of land uses as identified in the physical description Section (4.3.1). Few representative communities of any significant size exist for the purposes of description. However, the areas along the portion of the North Thompson River within the study area are in a transition zone between the Ponderosa Pine-Bunchgrass and Bunchgrass biogeoclimatic zones as described in Section 2.1. The plant associations observed, although fragmented include ponderosa pine - rabbit-brush - yarrow, big sage - rabbitbrush - pasture sage and giant wildrye - quackgrass. Other species occasionally present commonly include prickly pear cactus (*Opuntia fragilis*), dogbane and rose (*Rosa* sp.) and less commonly green-banded mariposa lily and smooth sumac (*Rhus glabra*).

### 4.3.3 **Salmonid Habitat Values** - North Thompson River

A total of 114 streambank sections were identified along the North Thompson River covering a total of 58.6 km (both shorelines). Seventeen percent or 10.0 km of this length was rated as having high salmonid habitat values. One significantly long streambank section with a high rating is N-61 which describes an 1,125 m long, rip rap armoured bank. The value of the rip rap is due to the large size and large interstices in the rip rap and eddies and complexing of the nearshore flows due to its distribution along the shoreline. The combination of these characteristics and sufficient nearshore water depth indicates that section N-61 would provide suitable overwintering habitat for juvenile chinook salmon as well as cover for other salmonids during other times of the year. Other streambank section with high salmonid habitat values include those with significant emergent and lower riparian communities associated with them (Sections N-44, -85, -105, -106) and those with coarse instream substrates which occur largely in the upstream portions of the study area (N-78, -87, -96, -98 -102, -107, -109, -110, -111, -112).

Of the total streambank surveyed along the North Thompson River (both shorelines), 48% (28.2 km) was rated as having medium salmonid habitat values. Although many combinations of characteristics may combine to yield medium values, a generalization of the more common findings indicate that streambank sections with relatively highly vegetated riparian communities are more likely to be rated as having medium values where other limitations including poor instream substrates (sand), unstable banks, or poor flow characteristics are noted. Residential developments adjacent to the river where encroachments have resulted in the fragmentation of riparian vegetation communities and impacted shorelines to various degrees frequently had medium salmonid habitat values associated with them. Examples of where this occurs are described by Section N-45 (2,575 m long) and Section N-55 (2,000 m long).

A significant proportion of the total streambank length surveyed was rated as having low salmonid habitat values (35% or 20.4 km). A combination of characteristics that often leads to a low salmonid habitat value includes small diameter rip rap armoured banks lacking significant riparian vegetation. Where this is the case, juvenile salmonids may find some cover in the rip rap materials but the lack of overhead cover, shading and foraging opportunities are limiting factors. A good example of this is Section N-53 (1,325 m long). Low salmonid habitat values are also common to long agricultural sections where the combination of eroding banks and lack of woody riparian vegetation offer little value as shoreline habitats. Some of the more significant examples of agricultural sections that demonstrate such low values include N-38 (1,525 m), N-42 (800 m), N-57 (1,025 m), N-59 (825 m), N-62 (775 m), and N-93 (750 m).

## 4.4 Descriptions of Mainstem River Tributaries

### 4.4.1 Thompson River Tributaries

#### 4.4.1.1 Tranquille River

Tranquille River drains a 596 $km^2$ area on the northwestern extreme of the Kamloops City Limits (Environment Canada 1991). The mainstem flows over 43 km from Tranquille Lake to Kamloops Lake and is fed along the way by several tributary streams and headwater lakes. It supports populations of rainbow trout and coho salmon (Steve Maricle, pers. comm.). Salmonid enhancement projects undertaken within the system include channel improvements at the mouth and construction of a fish

ladder further upstream to improve fish passage, and outplanting of steelhead trout smolts. The success of the latter effort was poor due to flooding in 1991 (Steve Maricle, pers. comm.).

### 4.4.2 South Thompson River Tributaries

#### 4.4.2.1 Peterson Creek

Peterson Creek drains an area of over 103 km$^2$ southwest of Jacko Lake (Environment Canada 1991). The stream flows northwest some 13 km from Jacko Lake to Highway 1 where it is channelized and culverted through Kamloops city centre and reemerges a short distance upstream of the South Thompson River confluence. Flow control is present at the outlet of Jacko Lake and rainbow trout may be present within the system (Steve Maricle, pers. comm.).

#### 4.4.2.2 Unnamed Creek

This 6 km long creek drains the area west of Mount Harper and enters on the northern bank of the South Thompson River across from Dallas. This creek receives flow which is diverted from Paul Creek (a North Thompson tributary) to the north and used for irrigation on the Harper Ranch (Steve Maricle, pers. comm.). Fish use and stream habitat values are considered to be negligible (Steve Maricle, pers. comm.).

#### 4.4.2.3 McGregor Creek

McGregor Creek drains the southern and eastern portions of Mount Harper and is approximately 7 km in length. It enters the South Thompson River from the north across from the Campbell Creek Industrial Area. Fish use and stream habitat values are considered to be negligible (Steve Maricle, pers. comm.).

#### 4.4.2.4 Campbell Creek

Campbell Creek drains an area of over 521 km$^2$ south of Juniper Heights (Environment Canada 1991). The flows some 20 km from either Shumway or Campbell lakes (the two main headwater lakes) to the South Thompson River at the Campbell

Creek Industrial Area. The lower reaches of the stream often dry up due to water removal for irrigation (Steve Maricle, pers. comm.). Falls are present a short distance upstream of the Wildlife Park. Rainbow trout are present within the system's lakes and a significant number of spawners utilize the inlet of Campbell Lake for spawning (Steve Maricle, pers. comm.).

#### 4.4.2.5 Monte Creek

Monte Creek drains an area of approximately 184 $km^2$ south of the South Thompson River just east of the Kamloops City boundary (Environment Canada 1991). Little information is available on the fish populations or habitats in Monte Creek, however, it is anticipated that rainbow trout are present in the system (Steve Maricle, pers. comm.).

### 4.4.3 North Thompson River Tributaries

#### 4.4.3.1 Paul Creek

Paul Creek which drains some 254 $km^2$ northeast of Kamloops originates east of Pinantan Lake and flows from Pinantan Lake into Paul Lake then approximately 15 km, mostly through Kamloops Indian Reserve 1, to the North Thompson River (Environment Canada 1991). Water for the creek is used for irrigation and is partially diverted for that purpose eastward to an adjacent stream by the Harper Ranch. As a result, Paul Creek often dries up during the summer (Steve Maricle, pers. comm.). Paul Lake supports a rainbow trout population and the possibility that under favourable stream conditions, trout may move downstream into the creek (Steve Maricle, pers. comm.).

#### 4.4.3.2 Dairy Creek

Dairy Creek is a small, 11 km long stream which originates in the hills to the west of Rayleigh. It enters the North Thompson River approximately 19 km upstream of the North/South Thompson River confluence. No fish population or habitat information is available for this stream (Steve Maricle, pers. comm.).

#### 4.4.3.3 Heffley Creek

Heffley Creek drains an area of approximately 168 km$^2$ east of the commumity of Heffley Creek (Environment Canada 1991). The creek originates at Andy Lake, flows 4 km to Heffley Lake then 0.5 km to Little Heffley Lake and finally 12 km to the North Thompson River. Heffley Lake supports a rainbow trout population and the possibility exists that fish enter the creek from the lake (Steve Maricle, pers. comm.). Little else is known of the fish populations or habitat in the Heffley Creek system.

## 4.5 Sources of Water Quality Degradation

### 4.5.1 Effluent Discharges

Two effluent discharges were identified within the study area, both within the Thompson River at the upstream extent of Kamloops Lake (Table 1). The first is the effluent discharge from the City of Kamloops sewage lagoons and the second is effluent from the Weyerhauser Pulp Mill. Both these discharges eminate from facilities on the southern shore of the Thompson River in the Mission Flats area. Analysis of the effects of the effluents on local and migrant fish populations was not within the scope of this project, however a number of studies have been conducted on the topic including Langer and Nassichuk, 1975 and Rogers and Mahood, 1983.

**Table 1. Location and description of effluent discharges into the Thompson River within the Kamloops study area**

| DISCHARGE CODE ON MAPS | GENERAL LOCATION | STREAM-BANK SECTION | DESCRIPTION |
|---|---|---|---|
| E01 | Mid-stream across from sewage lagoons | T 18 | Kamloops sewage lagoons |
| E02 | Mid-stream near upstream end of Kamloops sewage lagoons | T 24 | Weyerhauser effluent diffusers |

### 4.5.2 Storm Water Outfalls

Rainfall in urban areas collects chemicals present in the atmosphere prior to accumulating additional contaminants upon reaching the surface. Stormwater runoff mobilizes these contaminants and transports them as dissolved, suspended or bed loads. Dissolved loads include soluble nutrients, bacteria and chlorides, while suspended loads include fine-grained sediments and their associated hydrophobic contaminants such as metals (Cr, Cu, Fe, Pb, Ni and Zn), toxic organics and hydrocarbons. Bed load would include coarser sediment and associated contaminants. The surface flow carries lighter weight materials such as hydrocarbons and debris. Water quality degradation, therefore, tends to be seasonal and sporadic depending upon the volume and duration of precipitation experienced in the area. Within the study area, storm water outfalls discharge directly into all three rivers and tributary streams and adjacent habitats. Outfall locations are denoted on the map sheets which accompany this report.

### 4.5.3 Snow Dumps

The City of Kamloops presently utilizes three snow dumps within the city. The dumps are located in the Brocklehurst area (near Ord Road and Singh Street), near the Hillside Stadium in Dufferin, and near the Weyerhauser Pulp Mill in Mission Flats. All three dumps sites are located a sufficient distance from any watercourses resulting in minimal impacts on the fisheries resource.

### 4.5.4 Other Sources

Other sources of water quality degradation include short-term, localized, random discharges of deleterious substances into the local streams, drainage ditches and storm drains. These discharges often occur by accident or are a result of actions by uninformed individuals but they can have a devastating effect on the stream's aquatic life. This type of discharge can result from activities such as the washing of industrial equipment and allowing the effluent to enter a stream or the emptying of chlorinated swimming pool water into a storm drain. In addition, non-point sources of water quality degradation have been documented within the study area including agricultural, on-site sewage disposal systems and land erosion (Nordin and Holmes 1992).

# 5.0 DISCUSSION AND RECOMMENDATIONS

## 5.1 Fish Habitat Values and Restoration Opportunities

The streambank sections with the highest salmonid habitat values in the Thompson, South Thompson and North Thompson rivers within the limits of the study area are largely those with significant areas of low floodplain benches with well developed plant communities associated with them. At high water levels these benches become inundated and offer refuge and foraging opportunities for juvenile salmonids migrating through the system. During peak flows when even upper riparian zone vegetation may be inundated these areas can be extensive. A significant contribution of woody debris and litter is also introduced into the system from these benches. In general, streambank sections with steeper sloped banks have a lower contribution per unit length, although they are an important source of coarse woody debris. Due to the high proportions of sand in main channel areas, which has virtually no value in providing refuge or foraging opportunities for salmonids, the interface with shoreline plant communities becomes more valuable, particularily during low flows when floodplain benches are inaccessible.

The upland uses identified for streambank sections indicate a significant proportion (73-94%) of lands adjacent to the riparian zone have been modified by development. Encroachments into the riparian zone were common and both direct and indirect impacts to riparian zone vegetation, and associated recommended habitat restoration opportunities were recorded at a coarse level for individual streambank sections in the attached appendices (Appendix 1, 2, 3). All streambank sections within the study area with a minimum length of 100 m and with habitat restoration opportunities associated with them are also identified in Figure 2.

As a significant proportion of streambank substrates are dominated by fines (61-91%), any disturbance to riparian zone plant communities acts to destabilize the banks. This is reflected in the proportion of streambank sections classed as eroding (30-36%) and in the proportion of streambank sections armoured with rip rap materials (6-32%). As bank erosion and rip rap armoured banks preclude the development of significant shoreline plant communities the values associated with the aquatic - terrestrial interface are lost, as reflected by the lower salmonid habitat value ratings for such sections. Coarse rip rap materials do, however offer some refuge for juvenile salmonids where sand has not filled the interstices of rocks; in such cases a somewhat higher salmonid value may have been assigned. Logically then, habitat restoration opportunities designed to increase salmonid habitat values should focus on restoring vigourous shoreline plant communities. General recommendations for the restoration of plant communities specific to each of the identified riparian plant communities follow below:

Emergent Zone

Although direct impacts to riparian zone communities should not occur under current land development guidelines, indirect impacts mediated by bank erosion instigated by disturbance to upper riparian zone plant communities were common.

The distribution and extent of emergent plant communities within the study area is limited by the lack of suitable growing sites. The restoration of emergent communities should only be attempted where suitable conditions exist to do so. The preferred conditions for the establishment of emergent species include areas protected from the erosive forces of mainstem flows and from excessive sand deposition. Backchannels, sidechannels and depressions somewhat removed from the main channel are potentially good sites. Preferred substrates contain fine organic sediments, normally deposited in protected areas where flow velocity is greatly reduced.

Emergent species can tolerate inundation for relatively long periods of time but are rarely very drought tolerant, therefore roots require access to a reasonably stable high water table. The rushes and sedges of the emergent communities are competitive and secure dominance by rapid growth and reproduction, by means of vegetative reproduction as well as by producing large seed crops. These conditions give the emergent communities some resilience against physical disturbances and invasion by non-native species and also allows for greater potential success in habitat restoration efforts.

Seeding denuded or exposed sites would likely be unsuccessful without some above-ground vegetation to provide shade and substrate stability to encourage germination and promote seedling survival. Whole plant transplants would have a much higher probability of success. As suitable donor sites are limited in the Kamloops area it is suggested that seed stock be collected from local plant populations and reared under nursery conditions, which would require early planning. Larger plants and high planting densities are recommended to increase the potential for survival.

Protection from the erosive forces of high flows may be necessary to protect freshly planted sites. This may be achieved by the strategic placement of energy dissipators such as coarse rock, snow fence, or chain-link fencing. Caution should be used in the placement of such structures to protect against potential erosion of adjacent bank sections. These protection measures will also probably encourage higher sediment deposition rates and should removed when plants have securely rooted. Suitable native plant species recommended to be used for the restoration of emergent communities are identified in Appendix 5.

Lower Riparian Zone

Direct impacts to lower riparian plant communities should not occur under current land development guidelines. Disturbance to this community type is most often caused by eroding sections of bank. With sand as the major bank substrate, any disturbance to the tree or shrub layer promotes the destabilization of the bank. The grasses that are the dominant early successional species of disturbed sites do not have extensive root systems capable of stabilizing sand banks and are easily eroded most commonly resulting in steep, unvegetated and unstable banks. In such cases where impacts are unavoidable (i.e. bridge piling footprints) the restoration of these communities can be expected to be difficult due to the sensitivity of the banks and plant species to disturbance.

Revegetation attempts at these sites should first address bank stability. While large rip rap materials may be the best materials to stabilize eroding banks they often preclude the development of any significant riparian vegetation. Efforts should be made to restrict armouring to the lower portions of the bank. Creating a berm of large rip rap materials at the toe of the slope would act to confine slumping materials and would permit concurrent regrading of banks towards achieving a minimum 2:1 slope to allow planting with riparian shrubs to naturally stabilize the banks. Constructing low benches contained by rip rap materials on the river side and shallowly sloped banks on the upslope side would increase the extent to which lower riparian vegetation could be developed and maximize the interaction with the aquatic environment during high flows. Although this procedure may not always be applicable due to site conditions, it is preferrable where the objective is to restore or enhance riparian vegetation values for fisheries, wildlife and water quality reasons.

Where conditions are such that the application and distribution of rip rap materials must be extensive, it is suggested that efforts are made to incorporate pockets or strips of vegetation, preferably shrubs and trees. Recent bank armourment projects in the Lower Mainland area have successfully incorporated such "ecopockets" into lower riparian zones.

The plant communities of the lower riparian zone are well developed on low floodplain benches and shallowly sloping shorelines, the most extensive communities being found along the Thompson and South Thompson rivers. Sloping shorelines are more prone to erosion where floodplain benches tend to be depositional areas. As a result soil conditions vary in composition, nutrient and moisture availability which is reflected in the community composition for each. Therefore, species selected for revegetation attempts should be chosen based on shoreline type.

Reed canary grass often dominates lower riparian communities that occur on floodplain benches and normally forms pure communities even when occurring as clumps. Although reed canary grass is an introduced species (some 100-200 years ago) it has been used in revegetation projects with satisfactory results. Other common species often forming pure and occasionally extensive communities are water horsetail, common scouring-rush and red-osier dogwood. Sandbar willow is also common on floodplain benches but tends not to exclude other species of grasses and herbs. These species and others identified in Appendix 5 are suitable for revegetating floodplain benches.

Low gradient shorelines are most frequently dominated by sandbar willow with other species of grasses and herbs, (as described in the relevant descriptions earlier in this report) present in lesser amounts. Sandbar willow, sometimes referred to as coyote willow, is a relatively common nursery species used in the Kamloops area and is a preferred species for revegetating and stabilizing banks in lower riparian areas with shallow gradient shorelines. Additional recommended species are presented in Appendix 5.

Upper Riparian Zone

Most of the impacts to riparian zone plant communities occur in the upper riparian and upslope zones. Current land development guidelines recommend that no disturbances should occur within 15 m of the top of the bank (*Land Development Guidelines for the Protection of Aquatic Habitat*, Department of Fisheries and Oceans and Ministry of Environment, Lands and Parks, 1992). The objectives of restoration attempts associated with impacts to the plant communities of the upper riparian zone should reflect the desire to maintain fisheries values associated with riparian vegetation and to maintain the stability of riverbanks prone to erosion.

In order to effect a successful planting program the stability of existing bank conditions must first be evaluated. Bank slopes greater than 2:1 would be difficult to revegetate where the dominant substrate type was sand or fine materials due to topsoil erosion from rainfall and high water levels. As erosion may progress from either the lower or upper bank slopes it is important to address the stability of both. Lower bank slopes may require armouring with large rip rap materials along sections prone to erosion such as the outside bank at a bend in the river. Erosion in upper bank areas may require regrading to decrease slope angle. Where regrading is not an option the bank may be armoured with rip rap materials in such a manner that partitions or sections are created with trenched or bermed rip rap materials. Where the banks are steep and cannot be regraded it may be necessary to rip rap much of the bank slope. When this is the case it is suggested that leaving open pockets as planters ("ecopockets") for shrubs and trees would maximize

salmonid habitat values. Various types of geotextile mats are also used in combination with seeding and planting to stabilize steeper slopes. Such mats are of two general types. One is composed of biodegradable cocoa fibers which act as a suitable substrate for the grass seed embedded in it. Another less biodegradable type is a monofilament type mesh.

Mitigation or restoration to achieve naturally occurring plant assemblages would involve planting native tree and shrub species commonly occurring in this zone. The species list in Appendix 5 should be used as a guide in selecting native species for restoration projects. Trees and shrubs are of the greatest importance to bank stability and should be retained whenever possible. The size of the tree or shrub and the planting density should vary with the abundance and vigour of competing weedy and herbaceous species. The dry, nutrient poor conditions that prevail in most streambank sections would limit the success of planting cuttings. Greater success would be achieved by rooting the cuttings under nursery conditions. Planting older shrubs and trees with younger ones in their shade is feasible but may yield limited success where competition for water is a limiting factor. If weed control is deemed necessary to facilitate the establishment of planted species, the use of mechanical methods would be preferred over the use of herbicides.

Caution should be taken in species selection. For example, south facing banks will tend to be drier, limiting the range of suitable species to drought resistant plants such as black hawthorn and rose. The south facing banks of the South Thompson River exhibit the greatest water deficiency and plantings may require some periodic watering over the course of the first summer or two until the fine root hairs have recovered from damage inherent in the planting excercise. It may also be feasible to excavate a relatively deep hole for planting where sawdust, fine wood chips or other suitable water absorbing substrates can be used to line the hole.

Upper Slopes

The upper slope zones suffer the greatest development associated impacts. Restoration attempts in upper slope areas would primarily serve to provide protection against disturbance to lower riparian zone plant communities. The plant communities of the upper slope areas are varied in type and distribution. Upslope areas in upstream sections of the North Thompson River contain higher proportions of ponderosa pine and occasionally Douglas-fir where the communities of the South Thompson River are mostly dominated by giant wildrye or big sage - rabbitbrush associations (see relevant sections in this report for detailed descriptions). These differences in plant associations reflect differences in local climate and should be used as a guide in species selection for restoration efforts. Recommended species may be found in Appendix 5.

Many fallow and unmaintained upslope areas are dominated by aggressive weedy species with little wildlife value. These weedy species are able to outcompete native species under the extreme climatic conditions (primarily drought) and effectively preclude their re-establishment in disturbed areas. Subsequently weedy species proliferate adjacent to the riparian zone providing a proximal vector for invasion of disturbed sites. A progressive and intensive planting program using native species would be required to restore naturally occurring plant associations.

### 5.1.1 Land Use and the Potential Limitations of Habitat Restoration Efforts

The upland uses identified for streambank sections indicate approximately 84% of total length of properties adjacent to the riparian zone have been modified by development along the Thompson River, 94% along the South Thompson and 74% along the North Thompson rivers (Figure 3). Encroachments into the riparian zone were common and both direct and indirect impacts to riparian zone vegetation were recorded (see Appendices 1, 2 and 3). Bank erosion and rip rapping are the primary causes of degradation in the plant communities of the riparian zones.

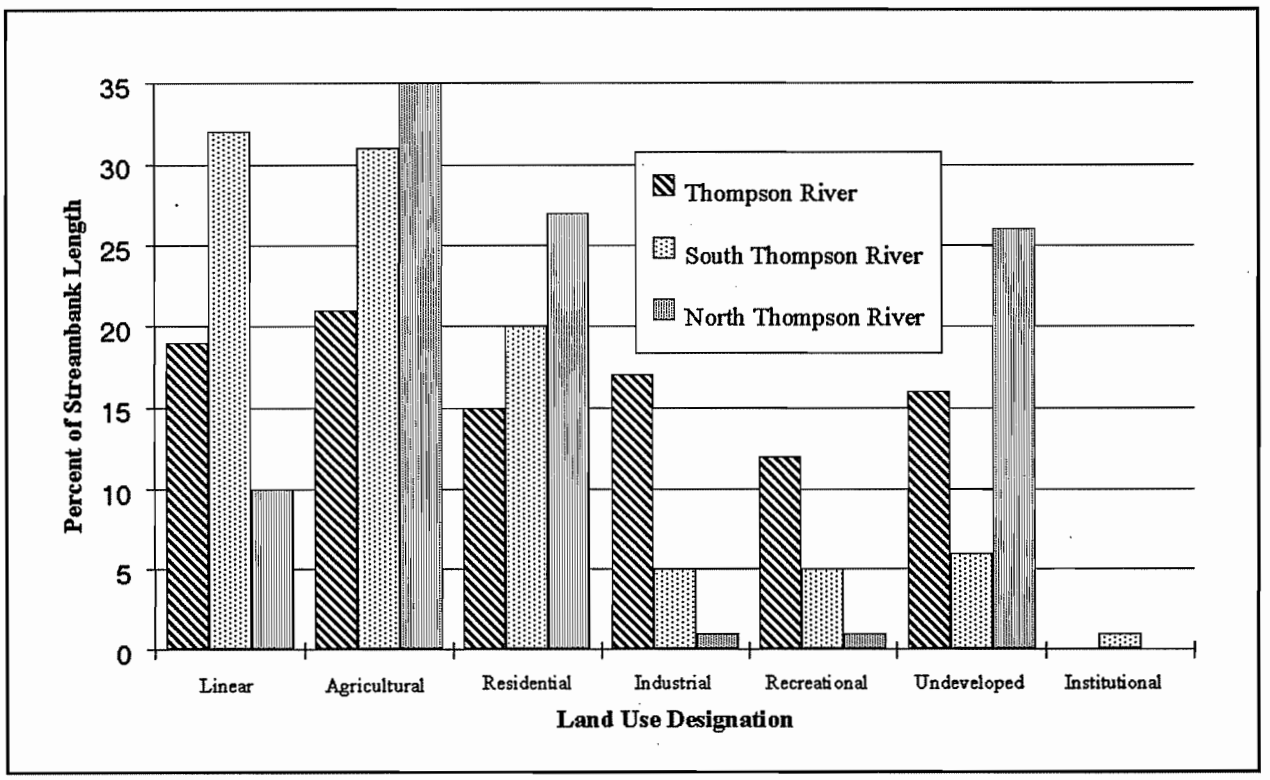


**Figure 3.** Land Use Adjacent to Streambanks Within The Study Area, Kamloops, B.C.

As the degree and types of impacts to riparian zone vegetation appear to vary in accordance with the type of adjacent land uses, restoration efforts should vary to address the limitations associated with the various land uses. For example, road and railway rights-of-way must be maintained for safety reasons, precluding any long term restoration attempts to restore mature trees. For these reasons, recommendations for restoration efforts are made in the context of the type of adjacent land uses occurring along the Thompson, South Thompson and North Thompson rivers as follows:

Linear Developments

The percentage of streambank which had linear development upland, primarily road and railway rights-of-way, was 19% (7.4 km) along the Thompson River, 32% (19.5 km) along the South Thompson and 10% (5.5 km) along the North Thompson rivers. Encroachments to the top of the banks were frequent (see Appendices 1, 2 and 3) and disturbances to riparian vegetation and bank stability have resulted from physical removal of vegetation through construction and maintenance activities, rip rap placement to prevent or mitigate against bank erosion and by fill placement to achieve grade specifications (**Photograph 5**).

The requirements for maintenance and safety standards within rights-of-way precludes the planting of trees. As the root systems of grasses and herbaceous species have a limited capability in stabilizing bank substrates, particularily those dominated by sand, it is suggested that shrubs be planted along the river-side of rights-of-way where bank stability is in question. An agreement should be sought with City and railway maintenance departments to define acceptable planting standards. Maintenance practices should allow for limited brushing or pruning to ensure survivability of planted shrubs. It is suggested that brushing or pruning frequency might be limited to every second or third year and should be conducted in the fall after leaf-drop to limit stress on the plants. A minimum pruning or brushing height should be established to maximize the survivability of planted species.

Agricultural Lands

Approximately 21% (8.2 km) of the total length of streambank sections along the Thompson River, 31% (18.6 km) along the South Thompson and 35 % (20.6 km) along the North Thompson rivers were denoted as agricultural. The removal of riparian vegetation to the top of the streambank is a common agricultural practise along all three rivers with the

goal of maximizing the area of operable land. Long sections of eroding streambank fronting agricultural lands were found along all of the river systems within the study area and resemble that shown in **Photograph 6.**

The impacts to lower riparian zone vegetation communities largely result from the removal of shrubs and trees from the banks which subsequently causes the instability of the banks due to the fragile nature of bank substrates. Once destabilized and bank erosion initiates, the slope of the banks general increases, lowering the possibilities for the establishment of native shrub and tree species which would encourage streambank stability.

To achieve restoration of natural riparian plant associations it is necessary to first address bank instability. Where sections of eroding bank are relatively steep it may be necessary to construct a berm of large rip rap materials along the bottom of the bank with concurrent regrading of the bank to achieve a minimum 2:1 slope. As the streambanks are generally fairly high (> 5m), regrading to a 2:1 slope may involve relatively large dedications of shoreline (> 10 m from the waters edge). While greater benefits would be provided by larger riparian zones, it may be difficult to secure large parcels of land where, due to the height of the bank, regrading would require large dedications. In such cases where an agreement with the land owner cannot be reached to secure large dedications, alternatives should be pursued towards reaching a compromise that still affords a reasonable re-establishment of riparian communities. One such compromise could include creating a low riparian bench with steeper rip rapped banks upslope. This would decrease the overall width of riparian restoration but in doing so offers a compromise or basis for negotiations with land owners to achieve riparian dedications.

Constructing a series of 2 or more steps, contained by berms of rip rap materials, would allow limited riparian planting in the different riparian zones which would provide the vertical stratification found between the herbaceous and shrub species of the lower riparian zone and larger shrubs and trees of the upper riparian zone. Using large rip rap materials (to gain height over a short distance) may allow for a somewhat narrower riparian dedication than that of a 2:1 slope but would again allow room for negotiation or compromise with land owners. These procedures would be preferred over more extensive rip rapping to achieve bank stability as they allow for better development of plant communities. Additionally, land owners may be convinced to support and possibly participate in restoration efforts that would ultimately protect against the loss of land due to erosion.

Lands used as pasture or range-land were denoted as agricultural. Livestock damage to riparian plant communities was noted where animals were provided access to the river for the purposes of watering and foraging (Appendices 1, 2 and 3). Due to the fragile nature of bank substrates (largely sand), there is often more damage done to plant communities from bank erosion mediated by livestock traffic than by the actions of foraging. Revegetation attempts along bank sections degraded by livestock should incorporate the methods described above. Further protection of re-established communities would require limiting livestock access into the riparian zone. This may be accomplished through fencing and granting water licences to allow water for livestock to be pumped from the river to upslope watering troughs.

Residential Properties

Residential developments account for approximately 15% (5.9 km) of the total length of streambank along the Thompson River, 20% (11.7 km) along the South Thompson and 27% (15.8 km) of the North Thompson rivers within the study area. Encroachments into riparian zone plant communities were common and land clearing, landscaping and rip rapping along the banks were the primary sources of degradation to natural plant communities. The large variety of materials and methods used in landscaping efforts and in armouring eroding bank sections necessitates providing general prescriptions for the reestablishment of riparian zone plant communities.

The practise of maintaining lawn as far down the bank as possible was observed along residential properties on all three rivers. **Photograph 7** depicts a short section of bank along the South Thompson River illustrating residential encroachment removing riparian vegetation. As lawn grasses provides very little protection from erosion where bank slopes are relatively steep, many properties have suffered losses in land into the river channel or have had to import fill to mantain their lot size. This can be seen in most cases by orthophoto review where property lines are shown to overlap the margins of the river channel. This results in the fragmentation of natural riparian plant communities over relatively long sections of streambank where residential developments are concentrated along various locations of all three rivers. The restoration of natural riparian plant communities along such sections would involve reaching an agreement with the property owners to dedicate a portion of their properties to this purpose. A number of tax incentives have been proposed as possible compensatory measures for land owners. If an agreement

cannot be reached with property owners to fully dedicate lands to the complete restoration of riparian zone plant communities, some less formal agreement to encourage partial restoration would be desireable. It is suggested that many landowners would express an interest in improving or enhancing their properties for the benefit of our fish or wildlife resources. Based on this premise, a pilot program could be set up to inform land owners along the riverbanks how this could be achieved with little cost or effort by them. To this end it may be suggested that such a program would focus on restoring pockets or short sections of naturally occurring riparian plants which can be easily established through the use of propagated cuttings for trees and shrubs and limited transplanting of plugs for the rushes and sedges of the emergent zone. The participation of local ministry agencies in providing the direction for such a program would be appropriate.

Perhaps more common along individual residential properties was the occurrence of rip rap armoured banks, gabions and retaining walls as measures of erosion protection. The restoration of natural riparian zone plant communities would be difficult along most of these properties, due largely to the limited available of suitable rooting substrates and would require on-site evaluations on a property by property basis for appropriate prescriptions. The small diameter rip rap materials shown in **Photograph 8** provide poor establishment sites for native vegetation and the small interstices between rocks offer little protection or cover for juvenile salmonids as reflected by the low salmonid habitat value assessed for this section.

Recreational Areas

The portion of the total length of streambank denoted as recreational was approximately 12% (4.7 km), 6% (3.5 km) and 1.6% (850 m) along the Thompson, South Thompson and North Thompson rivers (respective) within the study area limits.

The two main recreational areas along the Thompson River are the McArthur Island and Mission Flats parks. The Mission Flats Park is more extensive and contains many sections with eroding banks. Although bank erosion is a natural process of rivers, disturbances to the banks along the Thompson River exacerbate the rate of erosion due to the fragile nature of bank substrates. Pedestrian and recreational vehicle traffic and landscaping activities are the primary sources of disturbance to the riparian communities along the park.

Controlling access points and decommisioning trails in riparian zones would encourage the restoration of riparian plant communities through natural seed and vegetative propagation from the existing fragmented areas of natural vegetation. Additional plantings of shrubs and trees along sections of the upper banks currently dominated by grasses would promote the stabilization of banks. The width recommended in the current *Land Development Gudelines for the Protection of Aquatic Habitat* (DFO, MOELP, 1992) for riparian zone leave strips is 15 m from the top of bank, or first significant break in bank slope. A strip of this width vegetated with shrubs and trees is recommended as a long term erosion control measure. It is recognized that recreational areas along the river provide opportunities for the public to interact and learn about the aquatic environment, therefore public access should be maintained. However, limiting access points and controlling pedestrian traffic may be necessary measures to protect the more fragile emergent zone plant communities. A well identified and maintained trail system could be developed to both encourage public use and minimize the impacts to riparian plant communities.

Much of the length of streambank along McArthur Park has been armoured with rip rap materials to protect against erosion, limiting the development of riparian plant communities. The restoration of plant communities would involve excavating areas to remove rip rap and permit planting. The banks are generally moderately to steeply sloped, therefore planting efforts would be more effective along bank sections with shallower gradients, therefore less susceptible to erosion.

Along the South Thompson River the primary recreational areas adjacent to the river with significant impacts to riparian zone vegetation include a golf course and Riverside Park. Riparian zone vegetation has been removed along much of the length of the golf course (Streambank sections S-150, S-151) with limited and scattered plantings of horticultural varieties or trees and grasses occurring along the eroding banks.

The restoration of naturally occurring riparian plant communities would first involve stabilizing the lower banks along the golf course where erosion was most prevalent. This could be achieved by distributing large rip rap materials along the base of the slope to protect against erosion and contain slumping bank materials. The bank slopes are generally shallow enough to allow riparian planting without regrading. Additional plantings should utilize native riparian tree and shrub species chosen from the recommended species list in Appendix 5.

The impacted areas in Riverside Park are relatively limited. Short sections occur where encroachment of maintained lawn areas extend to upper portions of the lower riparian zone. Habitat restoration efforts would involve additional plantings of trees and shrubs in the upper riparian zone to increase the width of the riparian zone.

Industrial Properties

Industrial properties adjacent to the Thompson, South Thompson and North Thompson rivers comprise 17% (6.5 km), 5% (2.9 km) and <1% (100 m) of the total length of streambanks of each river, respectively. The primary sources of disturbance to riparian communities along industrial properties are removal of vegetation during land clearing and by rip rap armouring bank slopes. This is most prevalent sites of disturbance occur along the effluent treatment ponds and Kamloops Airport property along the Thompson River. Long sections of streambank have been armoured with rip rap materials and riparian vegetation is sparse and dominated by grasses and weedy species. As much of the rip rap materials are large and significant in quantity, suitable rooting substrates are largely unavailable to plants. Restoration of natural riparian plant communities along these sites would involve removing rip rap from short sections or pockets to gain access to the underlying substrates. As the substrates under the rip rap are probably coarse fill it would be necessary to import suitable topsoil materials. Enough soil material should supplied to fill to near the average height of rip rap materials. To protect against erosion and the dissemination of soil materials through the rip rap, planted areas should be small in size and any large interstices against the fillied area packed with fine gravels. As planting sites would be in exposed sites, drought tolerant species such as rose and black hawthorn are recommended.

## 5.2 Fish Habitat Enhancement Opportunities

Salmonid habitat enhancement projects generally involve improving instream substrates and habitat features (structure), controlling flows, creating or improving off-channel habitats and supplementing natural riparian vegetation. It should be noted that the latter does not refer to riparian planting that has been recommended to restore natural vegetation where it has been impacted by development. Of these enhancement efforts, most potential instream enhancement approaches would be limited by the prevalence of sand substrates in all three rivers. As the present use of habitats along these river systems by salmonids is primarily by juveniles migrating downstream, enhancement efforts would best be suited to projects that would enhance habitat values for juvenile salmonids. The most valuable habitat

component for juvenile salmonids is refuge areas, where foraging opportunities would also be present.

### 5.2.1 Thompson River

Much of the sand and fine sediments carried by the North and South Thompson rivers is deposited along the reaches of the Thompson River immediately upstream of Kamloops Lake, where the channel is relatively wide and water velocities decrease as they merge into the Lake. The resulting depositional areas are very large, often resulting in the infilling of valuable shoreline or back-channel habitats (**Photograph 9**) and during low flows the channel mostly meanders between large areas of exposed sand. The salmonid habitat values are, therefore, only realized during high flows when significant areas of well-developed lower riparian zone plant communities are inundated and accessible to salmonids. Additionally, the plant communities in these large areas are of significant value to birds and wildlife. Based on the value of this type of habitat it is recommended that consideration be given to the expansion of existing vegetated lower riparian areas into large areas of exposed sands. It may be feasible to create this type of habitat with little effort. Initially all that may be required is to construct a berm using large rip rap materials to enclose the area desired to be infilled. The fundamental premise of such works is that the ultimate elevation of created communities would prevent all but high water flows from inundating them. The height of the berm would then be limited to that of adjacent lower riparian communities to allow the natural infilling by sediments carried in the water column during high water flows. A series of strategically placed and properly aligned log-piling walls could have a similar effect towards infilling and subsequently encouraging the expansion of lower riparian plant communities while also maintaining higher water velocities in the main channel to prevent its' infilling. As such works would inherently affect flow patterns and containment volumes it would be necessary to account for their potential hydraulic impacts. The potential number of sites for works of this type is large in the lower Thompson River area.

The downstream portion of the side channel around McArthur Park is accessible to juvenile salmonids during periods of high flow and would be utilized as a refuge area away from the mainstem flows as well as a foraging area. At present, a beaver dam near the downstream end of the side channel could trap salmonids in the side channel as flow levels drop during the summer (see Photograph 1). High summer water temperatures may subsequently contribute to fish mortality. It is recommended that this

beaver dam be removed. Recognizing the propensity of beavers to rebuild dams, it may be necessary to monitor the site periodically as late-spring/early summer peak flows subside.

### 5.2.2 South Thompson River

No habitat enhancement opportunities were identified along the South Thompson River. The major limiting factor is a lack of suitable sites.

### 5.2.3 North Thompson River

Streambank sections N-80 and N-81 describe a 450 m long shallow embayment with a series of five log-piling walls extending perpendicular from the banks out into the river channel (**Photograph 10**). Although some infilling has occurred due to backeddies formed on the downstream sides of each wall, the areas between the walls are unvegetated. To encourage the establishment of lower riparian vegetation, a berm of large rip rap materials could be constructed to an appropriate elevation above the average low flow level to support lower riparian species. The berm would be aligned such that it would be continuous between banks and intersect with the ends of each wall. Through the process of natural sediment deposition during high flows, the areas behind the berm (bank side) should infill to the desired height and over the course of years may naturally revegetate.

The banks between the bases of the log-piling walls are mostly eroding and could be partially stabilized by essentially creating the low floodplain bench that could increase the height of the toe of bank significantly; as sediment accumulation continues and as the bench becomes more vegetated. In any case it is reasonable to assume that by simply encouraging an existing process (sedimentation), a natural successional sequence (revegetation) can be accelerated. Of course, at the expense of importing fill and planting the site, enhancement works could be completed within a single season. Regrading eroding portions of the existing banks to the minimum 2:1 slope needed for planting riparian shrubs and trees is recommended as a means of reestablishing upper riparian zone communities. Additional plantings extending for 15 m away from the top of the bank would fulfil the recommended leave strip width in the current *Land Development Gudelines for the Protection of Aquatic Habitat.*

Streambank Section N-88 describes a high water side channel that is partially backwatered at moderate flows but essentially inaccessible at low

flows. Habitat enhancement in this channel is feasible and would involve excavating the downstream portion of the channel to permit backwatering during low flows. A wing wall, abutment, or berm of large boulders could be placed at the upstream end of the side channel so as to deflect most of the energy of high flows and prevent the infilling of excavated portions. The channel would then still retain its existing refuge value during high flows but also provide rearing habitat for juvenile rainbow trout still present in the system during summer low flows. Additional enhancement works could involve creating refuge areas in the excavated channel arranging large boulders to leave large interstices in which juvenile salmonids could hide from predators and find shade from the hot summer sun. Such a project would, however require careful planning and expert technical input.

## 5.3 Land Management Recommendations

Both recent and historical land development practices have been conducted along riverbank areas in the Kamloops area without due regard for the protection of aquatic and riparian zone habitats. It is recommended that immediate action is taken to adopt and enforce land management mandates current with the following:

Habitat Referral System

During the course of this study it was noted that many developments along the banks of the Thompson, South Thompson and North Thompson rivers have impacted on the streambanks and/or riparian zone plant communities. Similar impacts were noted for many of the study area streams. These developments had apparently proceeded without any attention paid to preserving or reinstating the streambank habitat or riparian vegetation. As with many other municipalities in British Columbia, a habitat referral system should be developed and instituted for development projects which occur in or around watercourses. This would allow the municipal planning and/or engineering departments and the fisheries agencies to work together with the developer towards protecting the remaining valuable habitats along undeveloped or undisturbed streambank sections.

Riparian Leave Strips

Riparian leave strips encompass the land and vegetated zones adjacent to watercourses as well as the upland habitats which influence the streambank. These areas are to remain in an undisturbed state throughout and following any development. Leave strips serve to protect the riparian zone, which is critical to the maintenance of a healthy aquatic environment and directly influences the value of the adjacent aquatic habitats. Specifically, riparian zones supply fish food items, detritus upon which fish food organisms depend, contribute large organic debris which complexes the aquatic habitat, provide water temperature regulation, a buffer

zone from upland runoff, stream cover, and contribute to streambank stability. Under the joint federal and provincial Land Development Guidelines for the Protection of Aquatic Habitat, the suggested minimum leave strip width (measured from the top-of-bank) is 15 m for residential/low density areas and 30 m for commercial/high density areas (Chilibeck 1992). It is recommended that these guidelines be adopted within the City Kamloops in order to protect the quality and quantity of the remaining aquatic habitats.

## 6.0 SUMMARY

A total of 371 discrete, relatively homogenous streambank sections were recognized comprising a total linear distance of 156.6 km (including both streambanks) along the Thompson, South Thompson and North Thompson rivers in the vicinity of Kamloops. A detailed inventory of pertinent instream and riparian zone characteristics were recorded for each streambank section and summarized in Appendices 1, 2 and 3. Salmonid habitat value ratings were determined for each streambank section based on the overall values and interactions of the identified habitat characteristics in the context of known salmonid utilization patterns. The dominant riparian zone plant associations were described for each of the identified streambank sections including those of degraded riparian communities (Appendices 1, 2 and 3). Fish habitat restoration opportunities and potential habitat enhancement opportunities were identified and described. A series of twenty-two 1:5,000 scale maps were produced identifying streambank section locations, providing an overall salmonid habitat value rating for each section and summarizing the major instream and riparian zone characteristics.

The majority of streambank sections identified had some level of disturbance to riparian zone plant communities associated with them. Relatively few streambank sections within the city limits of Kamloops could be described as being undeveloped. High salmonid habitat value ratings often correspond to streambank sections with well developed riparian zone plant communities. Significant values to many bird and wildlife species are also associated with riparian zone plant communities which, in turn, are a unique component in a landscape otherwise dominated by dry ecosystem plant associations. For these reasons and in the light of future development proposals affecting the remaining undeveloped lands adjacent to the riparian zones of these rivers, it is recommended that a planned and systematic approach is taken to ensure the protection of remaining intact riparian communities and restore as much streambank as possible to a natural and more productive state.

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