THE SALMON RIVER WATERSHED

AN OVERVIEW OF CONDITIONS, TRENDS AND ISSUES

TECHNICAL REPORT

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TECHNICAL REPORT

Prepared on behalf of the:

Salmon River Watershed Roundtable
P.O. Box 3308, Salmon Arm, B.C. V1E 4S1
Tel (604)832-0153/Fax(604)833-4676

by

Michael McPhee
Martin Gebauer
Gary Holman
Gary Runka
Mike Wallis

Quadra Planning Consultants Ltd.
1030 Crestline Road, West Vancouver, B.C. V7S 2E2
Tel(604)926-2080/Fax(604)926-7748

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1.0 INTRODUCTION

This report was commissioned in June 1995 by the Salmon River Watershed Roundtable (SRWR) to assist the Roundtable and citizens of the watershed in preparing a long-term management plan for the watershed. The SRWR is working with government agencies, landowners, First Nations, business and citizens to restore and maintain the social, environmental and economic health of the watershed in sustainable ways. The SRWR has undertaken a series of community meetings throughout the watershed to identify key problems, to develop a common vision and an overall management plan. A watershed-wide workshop was held in December 1995 that provided the basis for enabling citizens and other interests to work jointly on developing strategic directions for the future of the Salmon River watershed.

This report is an overview of conditions, issues and trends in the watershed which will assist the Roundtable in understanding the economic, social and environmental characteristics of the Salmon River watershed. It is not a comprehensive study, but takes a broad view. It is based on information that was readily available within a relatively short period of time. A summary public report, was also prepared in November 1995 for use by the SRWR in their community meetings and watershed-wide workshop.

Background

The Salmon River is located within the interior plateau of south central British Columbia. Its headwaters originate in the vicinity of Tahaetkun and Bouleau Mountains, south of Westwold and northeast of Merritt. From its headwaters, the river flows westward to Salmon Lake and then flows in a northeasterly direction to Salmon Arm Bay of Shuswap Lake. The Salmon River is considered a tributary of the South Thompson River as Shuswap Lake drains into the South Thompson. The Salmon River is approximately 110 km in length and it drains about 1510 sq. km in total. The watershed contains a diversity of landscapes which provide the basis for a variety of land and resource uses such as agriculture in the valley bottoms and lower plateau areas and forest harvesting. Numerous lakes and streams are habitat for fish and other aquatic wildlife. The mix of different forest types and ages provide important habitat for wildlife. The watershed provides many opportunities for outdoor recreation activities.

Despite the relative abundance of natural resources there are serious questions regarding the sustainability of the watershed. Based on the information available, two areas are of particular concern: forestry and water supply. The current levels of harvesting in the Timber Supply Areas (TSA) within the Salmon River watershed are not sustainable over the longer term. In the Okanagan TSA which covers the majority of the watershed, the current level of harvesting can be maintained for 20 years. After that, it must be reduced by 10 percent per decade, until the long term harvest level is reached in 40 years. In the Merritt TSA, the downfall is expected in 110 years.

Water supply in the Salmon River at certain times of the year cannot sustain fish populations as well as meet agricultural irrigation needs. The provincial government has attempted to control water demand by restricting the issuance of new water licences for surface water withdrawals from the Salmon River. However, with no method to regulate groundwater withdrawal, new wells sunk near the Salmon River are likely to impact available water supply in the river.

There has also been a dramatic loss in streamside vegetation along the Salmon River over the years and this has caused higher water temperatures and increased erosion and sedimentation in the river. While the Salmon River has generally been considered relatively "unpolluted", there are indications that nutrient loadings are increasing resulting in higher bacterial contamination. The source of these higher nutrient and bacterial conditions include fertilizers, manure and sewage. The combined effects of low summer flow, high temperature and incremental deterioration in water quality have prompted the Department of Fisheries and Oceans to request that BC Environment (Water Management) issue shutdown orders to some water licensees, thus indicating that current water use practices may not be sustainable.

Based on existing information, it is difficult to determine whether or not the current wildlife diversity and populations are sustainable. The Forest Practices Code should help to ensure biodiversity objectives are recognized in the watershed and steps taken to protect important habitats, particularly those upon which threatened, rare or endangered species depend. It is also important that wetlands in the watershed be thoroughly inventoried and that harvesting and development guidelines put in place to protect significant wetlands. Formal designation may be required in some cases to protect critical wetlands. There may also be opportunities to restore drained wetlands.

Methodology

The study team used several approaches to gather, review, analyze and map information for this technical report. A report by Dovetail Consulting (Dovetail, 1995) for the SRWR which included a list of government agency contacts and summarized issues based on interviews with many of these individuals, was used initially to contact agencies for information. Many additional people were also identified by team members and contacted, either for information or to be interviewed about sustainability issues in the watershed. Census runs from BC Stats and Statistics Canada were undertaken for relevant socio-economic and agriculture information. Where available, existing reports and maps were obtained and reviewed. Two separate two day field trips were made to the watershed by team members to observe aquatic and terrestrial habitat, land use, forestry and agricultural practices. One team member lives in the watershed. During these field trips, team members met with local, regional and provincial agency personnel in Salmon Arm, Vernon and Kamloops. Several team members also met with Scotty Holmes, Upper Nicola Band. Publications of the SRWR were reviewed, including the draft Verbal History of the Salmon River Watershed and the results of the community meetings.

A digital TRIM map base and cadastral map information for the watershed were provided by Environment Canada. Other map information was obtained from provincial, municipal and regional government agencies.

A first draft of the technical report was produced in September 1995. This report was widely distributed to government agencies and other watershed interests for review and comment. Many good suggestions for improving the report were received and the consultants have attempted to incorporate most of these comments into the final draft.

Report Organization

This report is divided into five major sections and several subsections. Section 1 is the introduction. Section 2 reviews current issues and trends in the watershed for the following: socio-economic profile, land use (settlement, forestry, agriculture, recreation, other resource

uses), aquatic and terrestrial ecosystems, water quantity and water quality. Section 3 summarizes the major trends in the watershed. Section 4 discusses the key problems in the watershed from an integrated perspective and Section 5 outlines potential actions necessary to overcome barriers and constraints to achieving sustainablity in the watershed.

Acknowledgements

The study team acknowledges the valuable assistance and thoughtful advice of Neils Christiansen, Chair of the Planning Committee, Salmon River Watershed Roundtable. Thanks also goes to Fred Mah and Cecilia Wong, Environment Canada; Mike Romaine, Fraser River Action Plan and George Butcher and Ron Smith, BC Environment. John Power and Barry Watson, Environment Canada provided digital map information. We are also grateful to many individuals in various government agencies who took the time to provide information, advice, review and comment on the first draft of the report and to meet with study team members.

The study was coordinated by Michael McPhee, Quadra Planning Consultants Ltd. He also prepared the overall land use section and edited the final report. Gary Holman prepared the socio-economic profile. Gary Runka of LandSense Ltd. was responsible for the section on agriculture. Mike Wallis of Wallis Environmental Aquatics Ltd. prepared the sections on the aquatic ecosystem, water quantity and water quality. Martin Gebauer of Enviro-Pacific Consulting prepared the section on terrestrial (wildlife) ecosystems. Janine Robinson assisted with research, writing and report layout and Hans Utzig prepared the graphics.

2.0 CURRENT STATUS AND TRENDS

2.1 Socio-Economic Profile

2.1.1 Economic Profile

Data for the socio-economic profile for the Salmon River watershed is primarily based on 1981-1991 Census information for those Enumeration Areas (EAs) that most closely conform to the watershed boundaries (see Appendix A for a listing of EAs). Enumeration Areas were chosen by examining Census maps to determine those EAs that included the main population centres in the watershed. Several of the selected EAs have boundaries that extended beyond the watershed boundaries, but did not include significant population centres outside the watershed. Those EAs which included some of the Salmon River watershed were excluded if the populations within the watershed portion of the EA were greatly exceeded by EA population outside the watershed.

Data for the three main Indian Reserves in the watershed, corresponding to three Enumeration Areas, were also compiled for the years 1981 and 1991.

The Census data compiled as described above, are considered to yield estimates of socio-economic indicators for the watershed as a whole, and for the rural and Salmon Arm components, which are reasonably accurate in absolute terms for Census years. These data are also reasonably good indicators of trends over the 1981-91 period. Data for individual Enumeration Areas (e.g. for Westwold) or small groupings of Enumeration Areas (e.g. the three Indian Reserves), while still a reasonable indication of socio-economic conditions, have a much higher degree of statistical error. This is particularly true for the data on Indian Reserves due to non-responses.

In order to update Census data to 1995, other information sources had to be used. Data at the level of detail provided by the Census is not generally available, and in most cases inferences must be drawn from data for selected indicators, local knowledge, and existing reports. In some cases, the experience of the study team in analyzing socio-economic trends in similar regions influenced the conclusions drawn from available data.

Population

Historical Trends and Current Status

Population in the watershed is estimated at approximately 7,800 in 1991, of which about 3,400 are in the rural portion, and over 4,400 in the Salmon Arm portion of the watershed. Total population in the watershed has increased slightly since 1981 from about 7,400, equivalent to an annual average growth rate of about 0.5% per year.[1] This increase occurred entirely in the Salmon Arm portion, with population in the rural portion of the watershed being about the same in 1981 as in 1991. Population in the Westwold area declined slightly over the 1981-91 period.

More current population estimates for the District of Salmon Arm and Falkland suggest a higher growth rate in more recent years (Shuswap Economic Development Committee (SEDC)

[1] Population growth in the Watershed was actually negative over the 1981-86 period, and therefore was higher than 0.5% / yr. over the 1986-91 period.

and Community Futures Development Corporation of the Shuswap (CFDCS), 1995). Population in Salmon Arm has increased from about 12,100 in 1991 to an estimated 14,500 in 1995, equivalent to an average growth rate of about 4.6% over this period. Based on strong residential and commercial growth southwest of the downtown area, this rate of growth likely also applies to the watershed portion of Salmon Arm. Total school enrolment in Salmon Arm area schools in District #89 grew at an average rate of over 11 % per year over the 1991-1995 period (SEDC and CFDCS, 1995).

Current population estimates for the Falkland "area"[2] of about 3,800 compared to about 3,300 in 1991, suggests an average annual rate of growth of about 4% over the 1991-95 period (SEDC and CFDCS, 1995). Enrolment in elementary schools in Falkland and Silver Creek increased at slightly less than 4% per year over the 1991-95 period, also suggesting relatively strong population growth in the rural portion of the watershed since 1991 (SEDC and CFDCS, 1995).

For comparative purposes, population growth in nearby communities, the surrounding Regional Districts, and in BC as a whole over the 1981-94/5 period is shown in Table 1 below. As shown in the Table, population growth in the watershed as a whole has been lower than the average for over the 1981-91 period, but higher than for BC over the 1991-94/5 period.[3] Population growth in the Salmon Arm portion of the watershed appears to be higher than for the surrounding region and centres over the entire 1981-1994/5 period, with the exception of Vernon. However, growth in the rural portion of the watershed has only recently been higher than the average for most surrounding areas.

TABLE 1: POPULATION GROWTH IN SALMON RIVER WATERSHED COMPARED TO OTHER REGIONS (1981-94/95)

	Average Annual Rate of Growth (% per Year)	
	1981-91[a]	1991-94/95[b]
Salmon River Watershed	0.5	4.0+
Salmon Arm Portion of Watershed	4.3	4.6
Rural Portion of Watershed	0.0	4.0
Salmon Arm	1.2	4.6
Vernon[c]	1.6	10.2
Kamloops	0.5	2.9
Columbia-Shuswap Regional District	0.4	3.8
Thompson-Nicola Regional District	0.2	2.9
British Columbia	1.8	2.7

(a) 1981 and 1991 Census.
(b) Salmon Arm-Shuswap Economic Profile for Salmon Arm and the watershed. BC Stats for other areas and BC.
(c) Rate of growth for Vernon may be distorted by boundary changes.

[2] The definition of this area may not be consistent with, but is likely indicative of, population growth in the rural portion of the Salmon River Watershed.

[3] A population estimate for BC and the Regional Districts is readily available only for 1994. However, the 1995 estimate for Salmon Arm and the Falkland areas may well be based on 1994 data. If this is the case, then the rate of growth in the watershed is higher than estimated in Table 1.

It appears that much of the population increase in the Salmon River watershed has been due to in-migration. Migrants to the watershed increased from about 35% of the population in 1981 to about 50% in 1991. Many of these migrants appear to be retirees. The 65+ age group increased from 14% to 18% of the population between 1981 and 1991. The Columbia-Shuswap Economic Development Commission (EDC) staff indicated there has been an increase in recent years in the number of "urban refugees", i.e. entrepreneurs or commuters from larger centres migrating to the watershed. These trends are also evident in many other rural areas of BC.

Anticipated Trends

Based on historical trends, the attractiveness of the area and climate, and the continued influx of seniors and "urban refugees", population is likely to continue growing in both the rural and urban portions of the watershed. Growth in the rural portion will be constrained by the Agricultural Land Reserve and rural zoning.[4]

Economic Structure

Historical Trends and Current Status

A detailed breakdown of labour force by industry for the watershed is provided in Tables 2 and 3. In 1991, the government sector (including education, health and other services) is the single most important source of "basic" employment in the watershed as a whole, particularly in the Salmon Arm portion.[5] In the rural portion of the watershed, agriculture is the most important basic employer, although for many this is a part-time occupation.

As shown in Tables 2, 3, and 4, total labour force in goods producing sectors increased slightly, but declined in relative importance from 1981 to 1991. Labour force in business and government services increased significantly in absolute and percentage terms. This trend has continued since 1991 (e.g. construction of the Bastion Place long term care facility, the location of Canadian Tire and K-Mart and a new regional secondary school in Salmon Arm to be completed by 1997). These structural trends are also evident throughout BC.

It is important to consider the structure of an economy from the perspective of income as well as employment. For example, because of relatively high wages in the forest industry and relatively low earnings in agriculture, forestry would likely rank higher than agriculture as an income source. It should also be recognized that employment income accounts for only about two-thirds of total income in the watershed. As shown in Table 2, non-employment sources of income (e.g. including retiree incomes and government transfer payments, but excluding government - related employment) accounted for 33% of total incomes earned in the watershed in 1991. In fact, non-employment sources of income are probably the largest single source of basic income in the watershed.

[4] Forecasts by BC Statistics suggest an average growth rate of about 2.4% per year for the Salmon Arm Local Health Area (roughly consistent with Census Sub-Division C of the Columbia-Shuswap Regional District) over the 1994-2004 period, and about 1.5% per year from 1994 to 2021, due entirely to in-migration. In fact, the natural rate of increase is expected to turn negative in the near future because of declining birth rates and increasing death rates resulting from an aging population.

[5] Basic industries are those which drive the regional economy, and determine activity in non-basic sectors such as retail trade and services. The level of activity in basic industries is determined by external factors such as export markets, or in the case of government, by non-watershed taxpayers.

TABLE 2: SOCIO - ECONOMIC PROFILE: 1991

SALMON RIVER WATERSHED AND OTHER AREAS[a]

	Total Watershed	Salmon Arm in Watershed	Rural Watershed	Westwold	Salmon Arm	Vernon	BC
Population (#)	7,845	4,460	3,384	400	12,115	23,515	3,282,061
0 to 19 yrs (%)	(28)	(26)	(30)	(31)	(27)	(25)	(27)
20 to 64 yrs (%)	(56)	(52)	(58)	(55)	(55)	(54)	(60)
65+ (%)	(18)	(23)	(13)	(15)	(19)	(22)	(13)
Migrants < 5 Yrs (%)	(30)	(29)	(31)	(45)	(29)	(30)	(31)
Labour Force (#)	3,900	2,090	1,810	215	5,820	10,900	1,748,920
Particip. Rate (%)	(65)	(60)	(71)	(74)	(62)	(59)	(67)
Unemploym. Rate (%)	(13)	(13)	(13)	(5)*	(10)	(14)	(10)
Self-Employed (%)	(19)	(14)	(27)	(37)	(14)	(10)	(7)
Work at Home (%)	(19)	(12)	(28)	(45)	(10)	(6)	( )
Work Out of CSD (%)	(36)	(23)	(51)	(14)	(22)	(16)	N/A
LF by Industry (#, %)							
Agriculture & Related	495 (13)	100 (5)	395 (22)	110 (51)	255 (4)	240 (2)	41,290 (2)
Fishing & Trapping	25 (0.6)	25 (1)	0 (0)	0 (0)	25 (0.4)	0 (0)	9,900 (1)
Logging & Forestry	250 (6)	80 (4)	170 (9)	30 (14)	285 (5)	245 (2)	39,275 (2)
Mining, Quarrying	40 (1)	10 (0.5)	30 (2)	0 (0)	20 (0.3)	50 (0.5)	19,550 (1)
Manufacturing	365 (9)	215 (10)	150 (8)	20 (9)	570 (10)	1,455 (13)	193,525 (11)
Construction	325 (8)	150 (7)	175 (10)	0 (0)	510 (9)	735 (7)	129,295 (8)
Transport. & Storage	115 (3)	50 (2)	65 (4)	0 (0)	195 (3)	235 (2)	88,595 (5)
Commun. & Utilities	50 (1)	35 (2)	15 (0.8)	0 (0)	100 (2)	325 (3)	52,955 (3)
Whol. & Retail Trade	620 (16)	410 (20)	210 (12)	20 (9)	1,165 (20)	1,990 (18)	304,455 (18)
Fin., Insur., Real Est.	120 (3)	80 (4)	40 (4)	0 (0)	275 (5)	320 (4)	100,155 (6)
Bus. & Other Services	430 (11)	285 (14)	145 (7.8)	10 (5)	590 (11)	1,380 (12)	231,375 (13)
Accomm. & Food	285 (7)	160 (8)	125 (7)	0 (0)	395 (7)	1,205 (11)	139,085 (8)
Gov't, Health, Educat.	675 (18)	470 (22)	205 (11)	20 (10)	1,320 (22)	2,190 (20)	373,225 (22)
Income ($m)	90.5	50.9	39.6	3.7	150.4	251.9	46,508.2
Avg. ($'000 / Family)	41.0	42.1	39.8	32.6	43.2	39.1	52.4
Employ. Income (%)	(66)	(66)	(66)	(71)	(69)	(63)	(76)
Housing (# Units)	3,095	1,865	1,230	150	4,685	9,835	1,243,895
Owned (%)	(69)	(60)	(83)	(77)	(76)	(57)	(64)

TABLE 2 (cont.)
SOCIO - ECONOMIC PROFILE: 1991
SALMON RIVER WATERSHED AND OTHER AREAS[a]

	Total Watershed	Salmon Arm in Watershed	Rural Watershed	Westwold	Salmon Arm	Vernon	BC
Family Characteristics							
Husband - Wife (%)	(89)	(88)	(91)	(96)*	(89)	(84)	(88)
Children at Home (%)	(54)	(56)	(53)	(43)	(55)	(53)	(60)
Single Parent (%)	(11)	(13)	(9)	(4)	(11)	(16)	(12)
Persons / Household	2.5	2.3	2.7	2.6	2.5	2.3	2.6
Language Knowledge							
English Only (%)	(93)	(92)	(94)	(90)	(94)	(92)	(92)
Other Language (%)	(7)	(8)	(6)	(10)	(6)	(8)	(8)
Religion							
Christian (%)	(65)	(68)	(60)	(65)	(70)	(71)	(63)
Other (%)	(1)	(1)	(1)	(0)	(1)	(3)	(6)
No Preference (%)	(34)	(31)	(39)	(34)	(28)	(26)	(31)
Ethnic Origin							
Aboriginal Peoples (%)	(2)	(1)	(5)	(0)	(1)	(1)	(2)
British (%)	(31)	(31)	(31)	(31)	(29)	(28)	(25)
Other European (%)	(17)	(19)	(14)	(10)	(20)	(21)	( )
Other Single Origins (%)	(2)	(2)	(3)	(2)	(3)	(6)	( )
Multiple Origins (%)	(48)	(48)	(46)	(56)	(47)	(43)	(40)
Education (15+)							
< Grade 9 (%)	(12)	(11)	(13)	(15)	(12)	(13)	(9)
Grades 9 - 13 (%)	(43)	(39)	(48)	(58)	(41)	(43)	(39)
> Grade 13 (%)	(45)	(50)	(39)	(27)	(46)	(44)	(52)
Income Distribution							
Low Income Families (%)	(11)	(11)	(11)	(0)	(9)	(15)	(12)
Owner Expenses > 30% of Income (%)	(10)	(8)	(12)	(0)	(9)	(10)	(13)
Rent > 30% of Income (%)	(28)	(25)	(40)	(67)	(25)	(42)	(33)

(a) Percentages may not add to 100% due to rounding and statistical error.

TABLE 3: SOCIO-ECONOMIC PROFILE: 1981
SALMON RIVER WATERSHED AND OTHER AREAS[a]

	Total Watershed	Salmon Arm in Watershed	Rural Watershed	Westwold	Salmon Arm	Vernon	BC
Population (#)	7,415	4,030	3,385	420	10,780	19,985	2,744,467
0 to 19 yrs (%)	(33)	(30)	(38)	(36)	(31)	(30)	(31)
20 to 64 yrs (%)	(53)	(53)	(56)	(54)	(54)	(55)	(58)
65+ (%)	(14)	(18)	(9)	(10)	(13)	(16)	(11)
Migrants < 5 Yrs (%)	(35)	(33)	(38)	(34)	(35)	(35)	(31)
Labour Force (#)	3,170	1,675	1,495	265	4,975	9,260	1,390,485
Participation Rate (%)	(57)	(54)	(60)	(68)	(59)	(60)	(65)
Unemployment Rate (%)	(9)	(8)	(10)	(13)	(9)	(9)	(6)
Self-Employed (%)	(13)	(10)	(17)	(19)	(10)	(6)	(6)
Work at Home (%)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Work out of CSD (%)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
LF by Industry (#, %)							
Agriculture & Related	510 (17.0)	145 (9.1)	365 (26.0)	80 (32.7)	275 (5.8)	120 (1.3)	31,360 (2.3)
Fishing & Trapping	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	5 (0.1)	6,405 (0.5)
Logging & Forestry	185 (6.2)	50 (3.1)	135 (9.6)	35 (14.3)	125 (2.6)	140 (1.5)	36,905 (2.8)
Mining, Quarrying	40 (1.3)	5 (0.3)	35 (2.5)	10 (4.1)	20 (0.4)	40 (0.4)	22,550 (1.7)
Manufacturing	335 (11.2)	205 (12.9)	130 (9.3)	0 (0)	690 (14.6)	1,330 (14.5)	197,935 (14.8)
Construction	335 (11.2)	185 (11.6)	150 (10.7)	20 (8.2)	540 (11.4)	720 (7.9)	105,045 (7.8)
Transportation, Storage, Commun., Utilities	165 (5.5)	65 (4.7)	100 (7.1)	15 (6.1)	320 (6.8)	750 (8.2)	122,520 (9.2)
Wholesale & Retail Trade	515 (17.2)	340 (21.3)	175 (12.5)	20 (8.2)	890 (18.9)	1,940 (21.2)	236,370 (17.7)
Finance, Insur., Real Est.	65 (2.2)	50 (3.1)	15 (1.1)	0 (0)	230 (4.9)	490 (5.3)	75,615 (5.7)
Business & Oth. Serv., Accomm. & Food	740 (24.7)	480 (30.1)	260 (18.5)	60 (24.5)	1,425 (30.2)	3,165 (34.5)	407,935 (30.5)
Gov't, Health, Education	110 (3.7)	70 (4.4)	40 (2.8)	5 (2.0)	205 (4.3)	465 (5.1)	95,840 (7.2)
Income ($m)	53.0	30.0	23.1	4.5	88.7	167.5	26,445.0
Avg. ($'000 / Family)	26.5	27.5	25.4	36.0	29.0	30.6	36.3
Employ. Income (%)	(72)	(70)	(73)	(72)	(77)	(74)	(81)
Housing (# Units)	2,660	1,600	1,060	150	3,870	7,775	996,641
Owned (%)	(70)	(59)	(85)	(77)	(75)	(57)	(64)

TABLE 3 (cont.)
SOCIO - ECONOMIC PROFILE: 1981
SALMON RIVER WATERSHED AND OTHER AREAS[a]

	Total Watershed	Salmon Arm in Watershed	Rural Watershed	Westwold	Salmon Arm	Vernon	BC
Family Characteristics							
Husband-Wife (%)	(88)	(87)	(91)	(92)	(90)	(84)	(89)
Children at Home (%)	(62)	(56)	(68)	(64)	(59)	(59)	(63)
Single Parent (%)	(11)	(13)	(9)	(12)	(9)	(15)	(11)
Persons / Household	2.8	2.5	3.2	3.1	2.7	2.5	(2.7)
Language Knowledge							
English Only (%)	(97)	(97)	(98)	(98)	(95)	(96)	(92)
Other (%)	(3)	(3)	(2)	(2)	(4)	(4)	(8)
Religion							
Christian (%)	(78)	(82)	(77)	(71)	(81)	(84)	(75)
Other (%)	(1)	(1)	(1)	(0)	(1)	(1)	(4)
No Preference (%)	(20)	(18)	(23)	(29)	(18)	(15)	(21)
Ethnic Origin							
Aboriginal Peoples (%)	(2)	(1)	(3)	(0)	(1)	(1)	(2)
British (%)	(57)	(56)	(57)	(61)	(58)	(49)	(50)
Other Single Origins (%)	(28)	(30)	(24)	(26)	(30)	(36)	(37)
Multiple Origins (%)	(13)	(13)	(16)	(13)	(11)	(13)	(11)
Education (15+)							
< Grade 9 (%)	(22)	(21)	(23)	(22)	(16)	(19)	(13)
Grades 9 - 13 (%)	(46)	(43)	(50)	(63)	(45)	(45)	(43)
> Grade 13 (%)	(9)	(12)	(7)	(2)	(13)	(10)	(16)
Income Distribution							
Low Income Families	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Owner Expenses > 30% of Income	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Rent > 30% of Income	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

(a) Percentages may not add to 100% due to rounding and statistical error.

TABLE 4: LABOUR FORCE BY SECTOR IN SALMON RIVER WATERSHED: 1981-91

	Total Watershed		Rural Portion of Watershed		Salmon Arm Portion of Watershed	
	1981	**1991**	**1981**	**1991**	**1981**	**1991**
Primary Resources[a]	735 (25)	810 (21)	535 (38)	595 (34)	200 (13)	215 (10)
Manufacturing, Construction	670 (22)	690 (18)	280 (20)	325 (19)	390 (24)	365 (18)
Transportation, Storage, Communication, Utilities	165 (6)	165 (5)	100 (7)	80 (5)	65 (4)	85 (4)
Business / Government Services[b]	1,430 (47)	2,130 (56)	490 (35)	725 (42)	940 (59)	1,405 (68)
TOTAL	3,000	3,795	1,405	1,725	1,595	2,070

(a) Forestry, agriculture, mining, fishing & trapping
(b) Wholesale & retail trade; finance, insurance & real estate; food and accommodation; other business and personal services; health; education; and government administration.

Non-employment sources of income also have increased significantly as a proportion of total income from their 28% contribution in 1981. This trend is partly due to the aging of the population and influx of retirees, as well as the increase in labour force participation (particularly by women[6]) and higher proportion of the labour force drawing unemployment benefits than in 1981. More current data is not readily available, but it is likely that non-employment sources of income are at least as important as in 1991.

As shown in Tables 2 and 3, total income in the watershed has increased in real terms over the 1981-91 period. The percentage of income from employment sources has decreased slightly over this same period, probably due to the decline in the relative importance of higher wage jobs in goods producing sectors, and the increase in the relative importance of service sector jobs and retirees, both with lower than average incomes. More current data is not readily available, but these trends likely have continued in light of continued growth in population and service industries, particularly in the Salmon Arm portion of the watershed.

The unemployment rate in the watershed was higher in 1991 than in 1981. This may be due in part to comparison of data for single years in different parts of the business cycle, although both were recession years. 1991 data also reflects higher labour force participation by women. Unemployment rates were higher in the watershed than in BC as a whole for both 1981 and 1991. The economic consequences of unemployment may not be as severe for families as in the past, given the increasing incidence of two income families and the stabilizing effect of unemployment insurance benefits. The economic consequences of unemployment may not be as severe for the economy as a whole because of the increasing importance of non-employment sources of income.

Nineteen percent of the labour force in the watershed were self-employed in 1991 compared to 13% in 1981. The proportion of self-employed is much higher in the rural portion of the

[6] Census data indicates that total labour force participation in the 15+ age category increased from 57% in 1981 to 65% in 1991. Data by sex is not readily available for the Watershed, but for BC and Canada as a whole, this increase is primarily due to increasing labour force participation by women.

watershed, particularly Westwold. This reflects the importance of agriculture in rural areas. However, given that employment in agriculture increased only slightly over the 1981-91 period, it is likely that the significant increase in the proportion of self-employed is primarily due to new businesses in the service sector, including home-based businesses.[7]

Thirty-six percent of the labour force in the watershed worked outside of their Census Sub-Division of residence in 1991. 51% of the labour force in the rural portion of the watershed worked outside of their CSD of residence, which may reflect commuters to larger centres or workers in resource industries.[8] Data on historical trends is not available, but the proportion of non-CSD workers may be higher currently than in 1981 due to in-migration from nearby population centres.

The proportion of home ownership is relatively high, particularly in the rural portion of the watershed. This has remained roughly constant over the 1981-91 period. Discussions with EDC staff indicate a significant increase in real property values in the watershed. This implies a significant increase in the wealth of the majority of residents, particularly in rural areas where home ownership is more prevalent.

Discussions with Shuswap EDC staff and the relatively low proportion of employment in service industries such as retail trade, suggest that spending leakages outside the rural portion of the watershed to Vernon, Salmon Arm and to a lesser extent, Kamloops, are significant. Growth in service sector employment suggests that local businesses are gradually providing an increasing proportion of local consumer needs. However, the proximity of relatively large population centres less than an hour's drive from most locations in the watershed mean that spending leakages will still be significant in the foreseeable future.

Anticipated Trends

The following general conclusions are based on historical trends for the Salmon River watershed, trends observed by the study team in other regions of BC and discussions with local officials.

Population growth will continue to drive the economy in the watershed, including retiree and commuter incomes and "growth-related industries" such as housing construction, real estate and financial services. Population growth in the rural portion of the watershed will be constrained by the Agricultural Land Reserve and rural zoning.

The retirement "industry" and tourism represent the sectors with the strongest growth potential. These sectors have also been identified as the most desirable and compatible economic development opportunities (SEDC and CFDCS, 1995).

The economy of the watershed will continue to mature and spending leakages from rural areas to population centres will be reduced as more services are provided locally. The proportion of the labour force that is self-employed and home-based businesses will continue to grow. Participation by women in the labour force and as entrepreneurs will also continue to increase.

Overall, employment in resource/primary activities will continue as important drivers of the watershed economy, particularly in the rural portion. However, the two most important resource

[7] Based on discussions with EDC staff and study team experience with other regions in BC.

[8] Only 14% of the labour force in the Westwold area worked outside of their CSD of residence, which reflects the importance of agriculture in the area.

industries- agriculture and forestry- are likely to continue their historical decline as a proportion of total employment in the watershed.

Employment in forestry may also decline as the downfall effect comes into play, reductions are made to the allowable cut as a result of the Timber Supply Review process, and new harvesting constraints are imposed by the Forest Practices Code (ARA, 1994). The geographic location of TSA harvest reductions and of the harvesting and processing operations affected by harvest reductions is not clear at this time. However, the majority of the reductions are likely to occur in the Okanagan TSA as the downfall effect is expected to occur much sooner than in the Merritt TSA .

Agriculture employment income has remained relatively stable historically and is likely to do so in the future, partly because of shifts to smaller, more intensive operations, and also because of the ability of farmers to supplement their incomes from other sources.

There will likely be a trend to higher value wood and agricultural products and more intensive management, as evidenced by historical trends in the watershed and elsewhere in BC. These trends will also be reinforced by government assistance programs (e.g. Forest Renewal).

Over time, some individuals and families in the watershed may be forced to find alternative sources of livelihood, particularly in the rural areas which are more resource dependent. Some resource workers and families may have to move, but this is unlikely to offset population increases from other sources.

While there will be "winners" and "losers" due to economic restructuring, total income in the Watershed will likely increase slowly over time, even after accounting for inflation. Average family incomes may decline slightly due to growth in the relative importance of service industries and decline in resource activities.

Population growth will continue to drive up property values and will increase the wealth of current residents. This may help to offset the income impacts of resource sector employment declines. However, in order to capitalize on these gains, some residents may have to move from the region, buy other lower value property or sell rental property

2.1.2 Social Profile

Family Characteristics, Cultural Diversity, Education and Poverty Levels

Tables 2 and 3 provide a profile of family characteristics, language, religious affiliation, ethnic origin, education levels and indicators of poverty levels within the watershed, for 1981 and 1991.

With respect to family structure, the proportion of husband - wife families remained at close to 90% of all families in the watershed. However, the proportion of families with children at home and the average number of persons per household decreased over the 1981-91 period.

While in 1991, watershed residents are predominantly English speaking Christians of European descent, the cultural diversity of watershed residents (e.g. knowledge of language other than English and non-British ethnic origins) has increased over the 1981-91 period. The proportion of residents who have no religious preference have also increased significantly over this period, as have education levels.

Approximately 11% of families in the watershed are low income families according to Statistics Canada's definition. 28% of tenants paid more than 30% of their income on rent, but only 10% of homeowners had household expenses greater than 30% of their incomes. These income data are not available by enumeration area for 1981, and therefore trends over the 1981-91 period cannot be estimated.

Comparative data in Tables 2 and 3, indicate that the above social trends observed in the watershed are generally also evident for Vernon and BC as a whole. The data also indicate that cultural diversity, education levels and poverty levels are all higher on average in BC relative to the watershed. It is expected that increasing cultural diversity and education levels, as well as declining family sizes observed in the watershed over the 1981-91 period, will continue for the foreseeable future.

Health[9]

There are currently 3 main health care facilities in Salmon Arm:

1. Shuswap Lake General Hospital (46 acute care beds, 25 extended care; there are also 20 beds currently out of service)
2. Bastion Place, a multi-level care facility with 38 intermediate care beds, 38 extended care, and 28 special extended care
3. Pioneer Lodge, an intermediate care facility with 75 beds

There is concern about the lack of extended care beds, particularly over the longer term, as the population ages and more retirees migrate to the area. There are already 10 acute care beds in Shuswap Lake General that are being used for extended care. An aging population also means higher expenditures on health care, although the local governments incur only a portion of these additional costs. Residents in the rural portion of the watershed use facilities in Salmon Arm, Vernon and Chase.

There are approximately 25 General Practitioners in Salmon Arm and a part-time physician who travels from Vernon to Falkland 2-3 times per week. The ratio of physicians per thousand population is higher than average in Salmon Arm compared to other similar communities, and significantly higher than for rural areas. 3-4 new practices were established in 1994, resulting in a ratio of general practitioners (in full time equivalents) of over 15, compared to an average of about 8 for the Columbia-Shuswap Regional District and about 9 for BC as a whole (Ministry of Health and Ministry Responsible for Seniors, 1992). This growth is partly due to the attractiveness of Salmon Arm as a place to live. The number of visits and incomes per physician are lower than average for similar communities. However, there is some concern about the growth in the number of physicians in Salmon Arm while the rural areas of the Watershed have no permanent health facility or residing physician.

There has been a stronger emphasis in the past several years by health administrators on provision of more home services and greater self-reliance, particularly of the elderly. The location of a nurse practitioner in Falkland or at least a more readily accessible contact (e.g. an information number) has been suggested as a way to better service the rural part of the watershed and reduce unnecessary trips to facilities in Salmon Arm or Vernon.

[9] Based on discussion with Eugene Casavant, Hospital Administrator, Shuswap Lake Hospital and Ministry of Health data provided by BC Stats.

Crime

Provincial data on crime rates[10] for Salmon Arm are significantly lower (at about 101 per 1,000 population in 1993) than for BC as a whole (147 per 1,000 in 1993), and compared to nearby population centres such as Kamloops (155) and Vernon (161). Crime rates in the rural portion of the watershed are even lower, for example, at about 50 per 1,000 population for the Falkland area in 1993.

Reports provided by the RCMP detachment in Salmon Arm indicate that the overall number of complaints increased steadily from 425 in 1991 to 544 in 1994. Data for the January - July period in 1995 indicates a further significant increase in complaints over the previous year. Total Criminal Code charges in Salmon Arm have increased only slightly from 1,211 in 1991 to 1,277 in 1994, and data for the first six months of 1995 indicate a significant increase over 1994. The most significant increases appear to be in the categories of vandalism, disturbing the peace and assaults. These increases are attributed to the recent population influx and to increasing problems with youth.

Crime rates tend to fluctuate significantly, and trends depend greatly upon the period of time chosen. For example, provincial data indicate that the overall crime rate in Salmon Arm is similar to levels over the 1989-91 period. Nevertheless, the steady increase in complaints in recent years suggests that the public is becoming increasingly sensitized to the crime issue.

Provincial data for Falkland indicates that overall crime rates have increased in recent years, but are only slightly higher than compared to the mid-80's and much lower compared to the years 1987 and 1988.

Social Assistance

Ministry of Social Services data for the Salmon Arm Local Health Area (LHA) indicates that the proportion of the under - 65 population reliant to some extent on social assistance has increased from about 8.4% in June, 1992 to about 11% in March of 1995. This increase has occurred despite a relatively strong local economy, possibly due to the fact that in-migration growth has exceeded job growth and because of tighter eligibility rules for unemployment insurance. The proportion of the population on income assistance is currently about 9.5% for BC as a whole, an increase from about 8.4% in 1992. In total, about 16% of the population aged 19-64 received income assistance or unemployment insurance benefits in the LHA as of March, 1995.

The proportion of the population on income assistance under the age of 24 (about 15-16%), is higher than for the population as a whole. Area Managers in Salmon Arm and Vernon[11] expressed concerns about an apparent increasing reliance on social assistance among young people, and a culture of dependence that is passed from one generation to the next. There is also concern about a widening gap between the "haves and the have nots" and the development of a permanent "underclass" who have little or no stake in economy.

[10] Source: Ministry of Attorney-General. Includes Criminal Code offences against persons and property, excluding drug, alcohol and motor vehicle accidents.

[11] H. Van Warden, Salmon Arm (acting), Julie Dawson, Vernon.

First Nations Profile[12]

1991 Census data indicates that the number of persons of Aboriginal origin in the watershed increased from about 140 in 1981 to about 195 in 1991. This represents an average annual increase of about 3.4% over the 1981-91 period, much higher than the growth rate for the rest of the watershed.

Most First Nations peoples in the watershed live in the rural portion. Special runs for the 3 main Indian Reserves[13] in the watershed indicate that the population on these Reserves was about 115 in 1991 and that population growth off reserve is higher than on reserve. First Nations population on reserve is much younger, on average, than for the watershed as a whole, suggesting that the relatively high population growth of First Nations peoples in the watershed will continue.

The special Census runs for the three main Reserves indicate that relative to the watershed as a whole:

- labour force participation rates are lower, unemployment rates significantly higher and average family incomes lower despite larger household size
- employment appears to be concentrated in 3 industries: agriculture, manufacturing (probably forestry-related) and accommodation and food
- the proportion of self-employment or home-based businesses is much lower

2.1.3 Linkage of Socio-Economic Factors to Sustainability: Base Case Trends

Economic Factors

In general, there already is a shift in the watershed to a more diversified and sustainable economy (e.g. retirement and tourism industries, adding value to resource products, small businesses in the service sector) that reflects:

- declining resource availability (e.g. timber)
- the growing attractiveness of relatively unspoiled, rural areas with a slower pace of life and lower crime rates than large urban centres
- an aging, relatively wealthy population with pension and investment incomes that are independent of location in BC
- growth in labour force participation by women which supplements and diversifies family incomes
- improved communications and transportation networks
- a maturing rural economy which gradually reduces spending leakages to larger centres

Growth in population and tourism will continue to drive the economy. Public services and government transfer payments (i.e. the "social safety net"), as well as other government

[12] Census data on aboriginal populations are incomplete in many areas due to non-response to the Census. Data and conclusions in the above profile should therefore be regarded with caution.

[13] The three main reserves are Salmon River IR 1, and Switsemalph IR 3 and IR 7. These reserves are also Enumeration Areas (312, 365, 366) in Federal Electoral District 18.

programs such as Forest Renewal, will be significant stabilizing factors in the watershed economy, despite continuing rationalization of the government sector due to concerns about provincial and federal deficits.

Employment in resource/primary activities will likely decline, forcing some individuals and families to find alternative sources of livelihood, particularly in more resource-dependent rural areas of the watershed. It should be recognized that a significant proportion of the labour force in the watershed, particularly in the rural portion, are already working in more than one industry (e.g. farmers). Some families may have to move from the watershed, but overall population will still increase over time. Programs such as Forest Renewal and Skills Now, if continued, will help workers in resource and other industries to find employment in more sustainable activities (e.g. intensive silviculture and value-added).

Value-added activity (e.g. in forestry and agriculture) and import substitution will likely continue to increase over time and may help offset lost employment impacts, in some areas, over the long term. However, these adjustments will require public and private sector investments (e.g. retraining or investments in new technology).

Population growth will drive up property values and the demand for accommodation. This will increase the wealth or rental incomes of the 70% of current residents who own their properties (85% in the rural portion of the watershed). This may offset some of the income impacts for those property owners, in some areas of the watershed, who are affected by resource sector declines. However, to capitalize on these gains, some residents may have to make significant adjustments in their lifestyles (e.g. build rental accommodation, sub-divide or sell their properties).

The resolution of Native claims is likely to generate net economic benefits to the watershed as a whole resulting from First Nations ventures and an increase in investment certainty in the overall economy.

Total income in the watershed will likely continue to increase in real terms (i.e. after accounting for inflation) in the foreseeable future. Average family incomes may decline slightly in real terms due to the shift from higher paying resource activities to lower paying service sector employment.

There will be "losers" in the watershed due to economic restructuring, and to systemic factors. Those most vulnerable from an economic perspective will include those with little education / training, wealth (e.g. equity in property), and those who are faced with significant barriers to employment or retraining (e.g. single mothers). There may be a gradual erosion in diversity of livelihoods and lifestyles, particularly in rural areas, if the "losers" are forced to move to find employment.

Social Factors

In general, population growth, greater cultural diversity, fewer ties to organized religion, extended families and higher unemployment could affect the sense of community in the watershed. There appears to be increasing dependence in recent years on income assistance, including, but not restricted to younger age groups, which raises concerns about a permanent "underclass" with no real stake in the community. Crime rates, while still comparable to levels a decade ago, have increased in recent years, particularly those such as vandalism, involving

younger people. Economic restructuring and unresolved Native claims impose additional stresses on the community.

Similar trends are occurring elsewhere in BC, and the watershed, as evidenced by high in-migration, is still one of the most desirable areas to live in the province. Higher education levels, improved communications and transportation links, greater cultural and economic diversity, and the resolution of Native claims can also create new opportunities for enriching the community.

Social issues include:

- population aging and the possible deterioration of publicly-funded services due to rising health costs
- increasing crime, particularly if the gap between "haves" and "have nots" and lack of economic and training opportunities for young people persists or increases, and deterioration in the social safety net occurs due to rising costs
- rising tensions regarding Native claims, particularly if First Nations become increasingly disenchanted with the negotiations process and if non-Natives perceive that their economic opportunities are being diminished
- increased family stresses due to higher unemployment in resource industries, less extended family support, the increase in two worker or single parent families and lack of daycare
- higher education means greater range of opportunities for young people and older workers who can learn new skills
- in-migration, while it can be disruptive, can also greatly enrich the community with new cultural influences, skills, investment capital and incomes
- the resolution of Native claims would reduce social tensions and could also enrich the community from a social and economic perspective

2.2 Land Use

The Salmon River watershed has been the traditional territory of First Nations for thousands of years. It was not until the early 1800's that major modifications to the landscape began to occur as European settlers arrived to log, trap, prospect and farm. Land was cleared and drained for farming. People settled in the valley bottom where soils were of good quality for farming. The upland areas were used for logging and cattle grazing. The Salmon River provided fish, water for irrigation and drinking and served as a transportation mode for the movement of logs. Railways and roads brought more people and tourists. This settlement and land use pattern still exists today. People are moving into the watershed, although the majority of the growth is in the urban areas and agriculture and forestry continue to be the primary land uses within the rural portions of the watershed.

This section reviews the conditions and trends for the following land uses in the watershed: settlement, agriculture, forestry, recreation and other resource uses.

2.2.1 Settlement

Land use and settlement in the watershed are administered by three Regional Districts and two District Municipalities: Salmon Arm and Spallumcheen. The lower reaches of the watershed fall within the Columbia-Shuswap Regional District (CSRD), the western portion is within the Thompson-Nicola Regional District (TNRD), and a small eastern portion of the watershed, just east of Glenemma, falls within the District Municipality of Spallumcheen in the North Okanagan Regional District (NORD) (Figure 1).

First Nations also administer several Indian reserves within the watershed, including the Upper Nicola Band adjacent to Salmon Lake, the Okanagan Band and Spallumcheen Band east of Glenemma and the Neskonlith Band at the delta of the Salmon River. Only the Spallumcheen Band has filed a statement of intent to negotiate a comprehensive land claim treaty.

The District of Salmon Arm is the only major urban settlement in the watershed. Salmon Arm's economy relies upon a variety of activities, including forestry, agriculture/ranching, government services, retail/tourist commercial and service industries. Semi-urban settlements in the watershed include Westwold, Falkland, Glenemma and Silver Creek. These smaller settlement areas are more dependent upon resource industries, primarily forestry, mining, or agriculture.

Salmon Arm has an abundance of prime residential land, much of it situated with magnificent vistas of lake, mountains and farmland. Housing construction in the District of Salmon Arm is increasing at a more rapid rate than population growth. In recent years, the majority of housing construction has been single family detached, with some townhousing in strata developments.

Salmon Arm's extensive waterfront provides residents and visitors with opportunities for a variety of water-related leisure activities, wildlife observation, nature enjoyment and vistas of lake and mountain. Approximately 90% of the District's foreshore within the watershed is located on lands owned by the Adams Lake and Neskonlith Bands, including lands with environmental and wildlife habitat value and lands with high recreational value. The foreshore is designated as an Environmentally Sensitive and Passive Area within the Official Community Plan (OCP). The Agricultural Land Reserve covers the floodplain of the Salmon River and beyond. Up to thirty metre setbacks are required for all development occurring near watercourses.

Salmon Arm's commercial infrastructure plays a significant role in the watershed and the region. Most of the District's commercial areas are in the central core and to the west on the Trans Canada Highway. There are three industrial areas in Salmon Arm's portion of the watershed. Most of these lands are serviced with water but not sewer. All three have highway access and the one in the central area is the only one with rail access. The urban development area of Salmon Arm has been basically serviced with water and sanitary sewer mains. The District's sewage treatment plant is within the watershed and provides tertiary treatment of sanitary sewage.

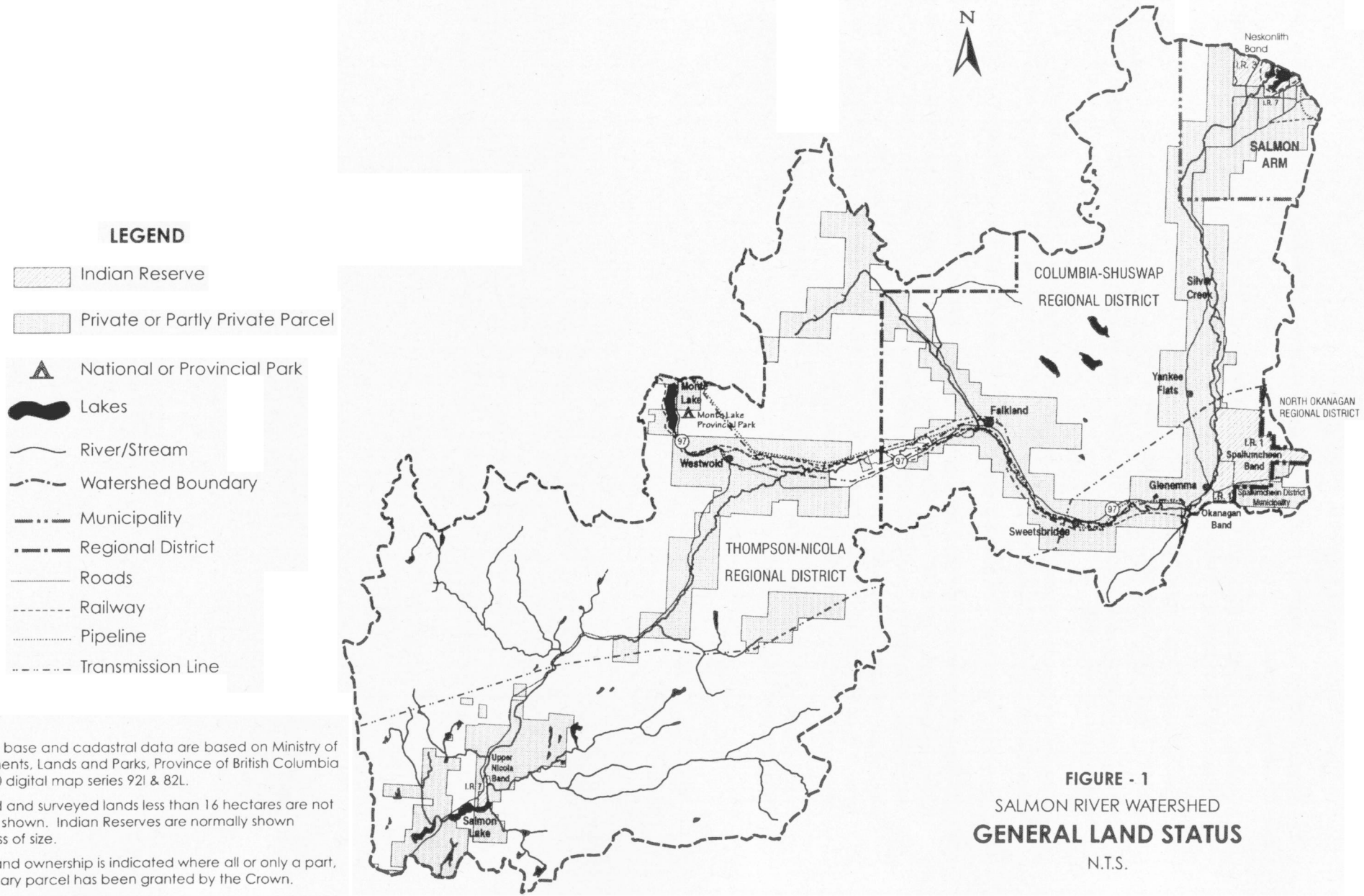
The communities of Westwold and Falkland are located on the Highway 97 transportation corridor between Kamloops and Vernon, and the CNR railway which extends from Kamloops to Armstrong. Glenemma is about 3 km off Highway 97 on the Salmon Valley Road. The valley bottom in these communities is largely owned and operated by larger farm operations, with smaller agricultural and rural holdings operated on a part-time farming basis.

Development patterns in Silver Creek differ from the other rural settlements in that there is a large number of parcels in the 1 to 4 hectare range. The proximity to Salmon Arm and the favourable climate have made the area a desirable environment for rural residential development.

Falkland townsite includes single, two family and multi-family zones in addition to rural residential zones.

The Salmon River watershed is traversed by a network of transportation and utility corridors. Major features include:

- Highway 97 passes through Monte Lake, Westwold, Falkland, and leaves the watershed just before Glenemma, where the river turns northward
- The Trans Canada Highway lies within the District of Salmon Arm and generally follows the curve of Shuswap Lake and leaves the watershed
- Other major roadways include the Douglas Lake Road, Chase-Falkland Road, Yankee Flats Road and Heywood Road
- Canadian National Railway line uses the Salmon River valley bottom, entering the watershed near Monte Lake and Westwold and leaving with Highway 97, just southwest of Glenemma
- Canadian Pacific rail line follows the shore of Shuswap Lake, in the District of Salmon Arm
- BC Hydro power transmission lines also follow the corridor of the river valley between Monte Lake, Westwold, Falkland and Glenemma. Another corridor enters the west side of the watershed near Rush Creek, crosses the Salmon River near Weyman Creek, and continues northeast where it crosses again near Sweetsbridge and once again near Yankee Flats, where it continues in an easterly direction. Another transmission line enters the watershed at the south side of the District of Salmon Arm.
- Gas pipelines distribute energy throughout the watershed, generally following the transmission line corridors



Notes

The map base and cadastral data are based on Ministry of Environments, Lands and Parks, Province of British Columbia 1:250 000 digital map series 92I & 82L.

Reserved and surveyed lands less than 16 hectares are not normally shown. Indian Reserves are normally shown regardless of size.

Private land ownership is indicated where all or only a part, of a primary parcel has been granted by the Crown.

FIGURE - 1

SALMON RIVER WATERSHED

GENERAL LAND STATUS

N.T.S.

A report by the Fraser River Environmentally Sustainable Task Force (1991) estimated the amount of existing transportation and utilities infrastructure in the watershed as follows.

Existing Transportation/Utilities	Linear Extent (km)
Highways	84
Railways	45
Power Lines	112
Pipelines	41

Anticipated Trends

There are several policies which regulate the development of land in the watershed. The TNRD Central Sub-Regional Settlement Strategy and Zoning By-law No 940 covers the land along the river to the south, north and east of the community of Westwold. The Salmon Valley Land Use Bylaw includes the valley bottoms and forested upland in the CSRD portion of the valley and the communities of Falkland, Glenemma and Silver Creek. The NORD administers the Spallumcheen Official Community Plan and Zoning By-law for the small portion of the watershed in this District. The District of Salmon Arm has an Official Community Plan for its boundaries. These policies and regulations encourage preservation of the rural and agricultural character of the area and attempt to ensure the continued viability of economic activities based on agriculture and forestry.

To follow the objective of agricultural preservation established by the governing bodies, further settlement within the watershed is likely to be located within existing settled areas. For example, the CSRD Salmon Valley Land Use Bylaw encourages rural residential use to be concentrated on parcels approximately 1 ha in size and located in areas where there will not be a negative impact on agricultural activities. Falkland, with its two-family and multi-family zones, offers the greatest potential within the rural portion of the watershed for infill and higher densities. However, further residential growth in this area is constrained by the existence of the Agricultural Land Reserve.

The area along the Salmon River within the District of Salmon Arm is designated for agricultural food production in the Salmon Arm OCP. Areas along Foothills Road and on the west side of the Salmon River, outside the agricultural area, are designated as Rural Agricultural. Rural residential development in these areas must be at least two hectares in size with soils capability rating of classes 4, 5, 6 or 7. Closer to existing developed areas, Low Density Residential Areas are designated in the area on the south side of Foothills Road, generally bounded by Foothills, 20th Ave., 10th St. S.E. and 10th Ave S.E. The Trans Canada Highway corridor within Salmon Arm is designated as a Development Permit Area to ensure that all development is compatible with the high profile tourist oriented vehicular traffic.

A “sewer development area” of approximately 1,700 ha has been serviced with main sanitary trunks and water by the District to provide for expansion of the residential and business community. It is estimated that the area contains approximately 185 ha for residential expansion, sufficient to accommodate residential land demand for up to 20 years, depending on the growth rate. Only those areas not designated “Agricultural Land Reserve” are reserved for future development, and only after the Development Areas have been infilled will development occur within the Rural Agricultural Areas.

An estimated 4.5 ha of commercially designated land were undeveloped in 1992. New commercial space can be accommodated in these areas and intensification of the central and west-central areas could occur. Salmon Arm has an adequate industrial land supply for a much larger population. District utilities can handle the forecasted range of population growth (25,000 people over a 10 to 15 year period).

The valley bottom in the Westwold area and south is in the Agricultural Land Reserve (ALR), and is designated Agricultural in the Central Sub-Regional Settlement Strategy of the TNRD. The uplands are designated as Forestry. The community of Westwold is designated as Rural. The communities at Monte Lake and Westwold were identified as having potential for further rural residential subdivision and/or development with some local employment opportunities and as a result of their location on the regional highway network. Areas identified included portions of the Pringle Creek Valley between the south end of Monte Lake and the western entrance to the community of Westwold.

The TNRD has just recently embarked on a Regional Growth Management Strategy which includes those portions of Electoral Areas L and M which lie within the Salmon River watershed. This strategy is to provide a framework to manage regional growth and sustainability over the next 20 years and will replace the Central Sub-Regional Settlement Strategy which was produced in the mid-1980's. This growth management strategy will have direct implications for sustainability in the watershed from a settlement, resource use and environmental perspective. A comprehensive public consultation process is part of the planning process.

The majority of the portion of the watershed within the District of Spallumcheen is within the ALR. There are no plans for any withdrawals from the ALR in this area, and no new growth is anticipated.

The upper watershed is characterized by grazing and farming operations and forestry. While this area is not expected to change substantially in the future, it will be part of the Regional Growth Management Strategy of the TNRD. The Douglas Lake Cattle Ranch operates a fishing lodge at the north end of Salmon Lake and plan to market this area as a year round tourist destination. The Upper Nicola Band have an Indian Reserve to the north of Salmon Lake. This part of the watershed is within the traditional territory of the Band.

Sustainability Issues

Water supply is an important consideration in the future settlement pattern of the watershed. The provincial government has restricted the issuance of any further surface water withdrawal licenses and has on occasion issued shutdown orders to conditional water license holders in the watershed. Past studies (Obedkoff, 1976) have shown critical conflict between human use demand and minimum flow requirements for fish stocks. There is currently no control over groundwater extraction. The TNRD Central Sub-Regional Settlement Plan states that if further residential subdivision or new development is to occur in areas having demonstrated domestic water problems, community water systems may have to be developed where groundwater potential exists or where freshet flow would permit surface water storage. The Salmon Valley Land Use Bylaw requires all land use categories to have a minimum of on-site water supply and on-site sewage disposal. The District of Salmon Arm encourages infilling within the growth area so that existing servicing infrastructure can be utilized.

There will be an increase in the demand for rural residential development, due to the Salmon River valley's proximity to employment centres and the attraction of the climate and character of the area to retired and semi-retired people. There are possible land and water use conflicts

which may arise from an ongoing demand for residential development in rural areas. These include:

- pressure to remove land from the agricultural resource base, including lands within the Agricultural Land Reserve as well as surrounding grazing areas;
- increase in density and change in land use patterns may detract from the rural character of the area;
- land use conflicts between agricultural uses and residential uses;
- land use conflicts between residential uses and wildlife and water resources; and
- continued pressure on facilities and services within the District of Salmon Arm.

New legislation passed in 1995 (Farm Practices Protection [Right to Farm] Act) should be of assistance in reducing some of the rural/urban conflicts with respect to acceptable agricultural practice.

2.2.2 Agriculture

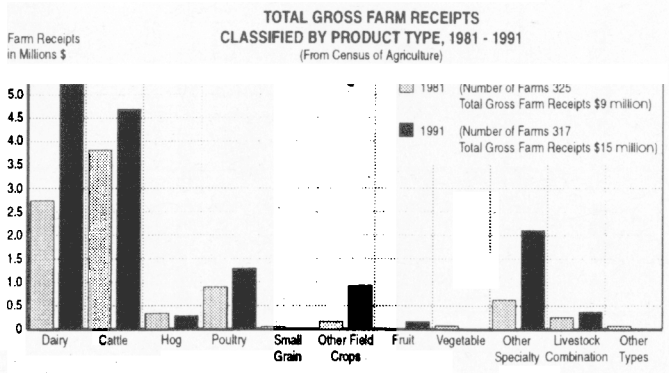
Land Use and Diversity

Dairying, ranching and forage crop production have historically been and remain the major agriculture commodities within the watershed. However, in addition, a wide range of new commodities are also being produced. There are currently greater than 30 different agricultural uses and commodities being produced in the watershed. Approximately 6% of the watershed is in cultivated agriculture. The wide ranging diversity of agriculture use is summarized in observed watershed uses as of July 1995 (Figure 2) and Census of Agriculture (Farm Classified By Product Type - Table 5)

The following are agriculture trends in the watershed from Census Canada 1981 - 1991. Table 6 outlines the 1981 and 1991 Census of Agriculture Agricultural Use Characteristics within the watershed.

- There were 325 farms which occupied an area of 78,753 acres in 1981 and 317 farms which occupied an area of 80,040 acres in 1991
- Cultivated acreage (crops plus improved pasture) is reported to have occupied 30,916 acres in 1981 and 25,359 acres in 1991
- Irrigated acreage is reported to have dropped from 11,271 acres in 1981 to 9,151 acres in 1991 (Table 6) (We are skeptical about the 1991 figure based on our rapid air photo interpretation of irrigated acreage in the watershed)
- Livestock enterprises dominate the agricultural use picture with 58% of farms in 1991, although this is a significant reduction from 74.5% of farms in 1981
- From a commodity perspective, land use for dairying has increased from 1981 to 1991, while beef has dropped dramatically. Hog and poultry enterprises have also declined in numbers. Field crop, tree fruit, vegetable and livestock combination uses remained relatively consistent between the two census years.
- Speciality enterprises have increased from 9.8% to 26.5% from 1981 to 1991

- Agriculture use trends (based on Census of Agriculture data) appear to be away from beef with more emphasis on speciality crops. This trend is probably ‘area specific’ within the watershed and will vary.
- As a recommended waste management practice it is important to note 138 farms occupying 4,446 acres were reported to be applying manure to their land in 1991 (Table 6)



AGRICULTURE FOCUS AREAS

Focus Area	Crops/Use	Livestock
Upper Salmon	-range focus -unimproved pasture -improved pasture -irrigated forage/pasture/hay	-beef -fallow deer -horses
Westwold	-turf -ornamental nursery -irrigated forage: pasture/silage/hay -improved pasture -potatoes -hobby farms (minor) -cereal grains	-fallow deer -horses: breedin -beef feedlot -beef -honey -sheep
Narrow Valley	-irrigated forage -raspberries -strawberries -improved pasture -unimproved pasture -hobby farms -Xmas trees -ginseng -wood products	-horses: breeding/pleasure -dairy (minor) -hogs -poultry -beef -trout farm -llama -sheep
Yankee Flats	-improved pasture -unimproved pasture -irrigated forage (minor) -wood products	-horses: pleasure -beef -ostrich
Hullcar	-irrigated corn silage (major) -irrigated forage	-dairy -beef -sheep
Paxton	-improved pasture -unimproved pasture -dry farmed forage	-horses -beef -sheep
Salmon River Estuary	-ginseng -orchard: apple/cherry (minor) -vegetables: full range -berry fruit: raspberries/blueberries/ strawberries -irrigated corn silage (dominant) -irrigated forage: silage/pasture/hay -improved pasture -Xmas trees	-dairy (dominant) -beef -buffalo -hogs -poultry -emu/ostrich -sheep -goats -horses: breeding/pleasure

FIGURE - 2

SALMON RIVER WATERSHED

AG ICULTURE FOCUS AREAS

N.T.S.

TABLE 5: FARM CLASSIFIED BY PRODUCT TYPE
SALMON RIVER WATERSHED
(From Census of Agriculture)

	1981			1991		
TYPES OF FARMS	NUMBER OF FARMS	PERCENT	TOTAL GROSS FARM RECEIPTS	NUMBER OF FARMS	PERCENT	* TOTAL GROSS FARM RECEIPTS
DAIRY	23	7.1	2,740,728	30	9.5	5,284,450
CATTLE	169	52.0	3,823,783	132	41.6	4,693,014
HOG	8	2.5	338,962	3	0.9	282,000
POULTRY	28	8.6	897,665	8	2.5	1,289,317
SMALL GRAIN	5	1.5	56,379	-	-	-
OTHER FIELD CROP	27	8.3	165,323	26	8.2	929,397
FRUIT	13	4.0	22,624	13	4.1	162,512
VEGETABLE	3	0.9	72,709	2	0.6	-
OTHER SPECIALTY	32	9.8	624,132	84	26.5	2,103,011
LIVESTOCK COMBINATION	14	4.3	260,574	12	3.8	375,440
OTHER TYPES	3	0.9	77,055	7	2.2	-
TOTAL	325	100	9,079,934	317	100	15,119,141

(* as available)

TABLE 6: AGRICULTURAL USE CHARACTERISTICS
SALMON RIVER WATERSHED
(From Census of Agriculture)

DESCRIPTION	1981	1991
Number of Farms	325	317
Total Farms (Acres)	78,753	80,040
Under Crops (Farms)	273	234
Under Crops (Acres)	16,364	15,443
Improved Pasture (Farms)	221	166
Improved Pasture (Acres)	14,552	9,916
Unimproved Pasture (Farms)	-	183
Unimproved Pasture (Acres)	-	45,417
Commercial Fertilizer (Farms)	125	116
Commercial Fertilizer (Acres)	7,526	6,879
Manure Application (Farms)	-	138
Manure Application (Acres)	-	4,446
Herbicides (Farms)	56	44
Herbicides (Acres)	1,783	1,560
Insecticides (Farms)	11	7
Insecticides (Acres)	52	741
*Irrigation (Farms)	178	146
*Irrigation (Acres)	11,271	9,151

Farm Size Change

The interpretation from Table 7 is that although there was not major shifts in farm size from 1981 to 1991 some significant trends appear.

A larger percentage of small parcels (1-2 acres) qualified as farms in 1991 than 1981. The largest numbers of farms continue to fall within the 10 - 69 acre size range. There is a significant drop in the 70 - 129 acre farm size range (11 farms).

TABLE 7: FARM SIZE CHANGE
SALMON RIVER WATERSHED
(From Census of Agriculture)

FARM AREA (ACRES)	1981 NUMBER OF FARMS	1981 PERCENT	1991 NUMBER OF FARMS	1991 PERCENT
1-2	6	1.8	12	3.8
3-9	27	8.3	23	7.3
10-69	125	38.5	131	41.3
70-129	59	18.2	48	15.1
130-179	38	11.7	34	10.7
180-239	14	4.3	11	3.5
240-399	18	5.5	18	5.7
400-559	12	3.7	10	3.2
560-759	7	2.2	11	3.5
760-1119	5	1.5	6	1.9
1120-1599	4	1.2	3	0.9
1600+	10	3.1	10	3.2
TOTAL	325	100	317	100

Agricultural Land Reserve Lands

The watershed contains approximately 63,000 acres of private and Crown land designated as Provincial Agricultural Land Reserve (ALR) under the Agricultural Land Commission Act (Figure 3). These lands are primarily the higher capability soils/climate combinations associated with the watershed valley bottoms plus adjacent high suitability forage lands and range.

Agricultural Land Commission (ALC) application statistics are only available by Regional District (Columbia-Shuswap/Thompson-Nicola/North Okanagan) therefore specific information for the Salmon River Watershed is not available. However, our field interpretation and contact with Agricultural Land Commission staff confirms minimal exclusion of land from the Agricultural Land Reserve since its designation in 1974. Some limited subdivision of larger parcels has been allowed within the Agricultural Land Reserve mostly on low capability agricultural lands.

Regional Districts and Municipal policy, by-laws and plans generally support the provincial Agricultural Land Reserve.

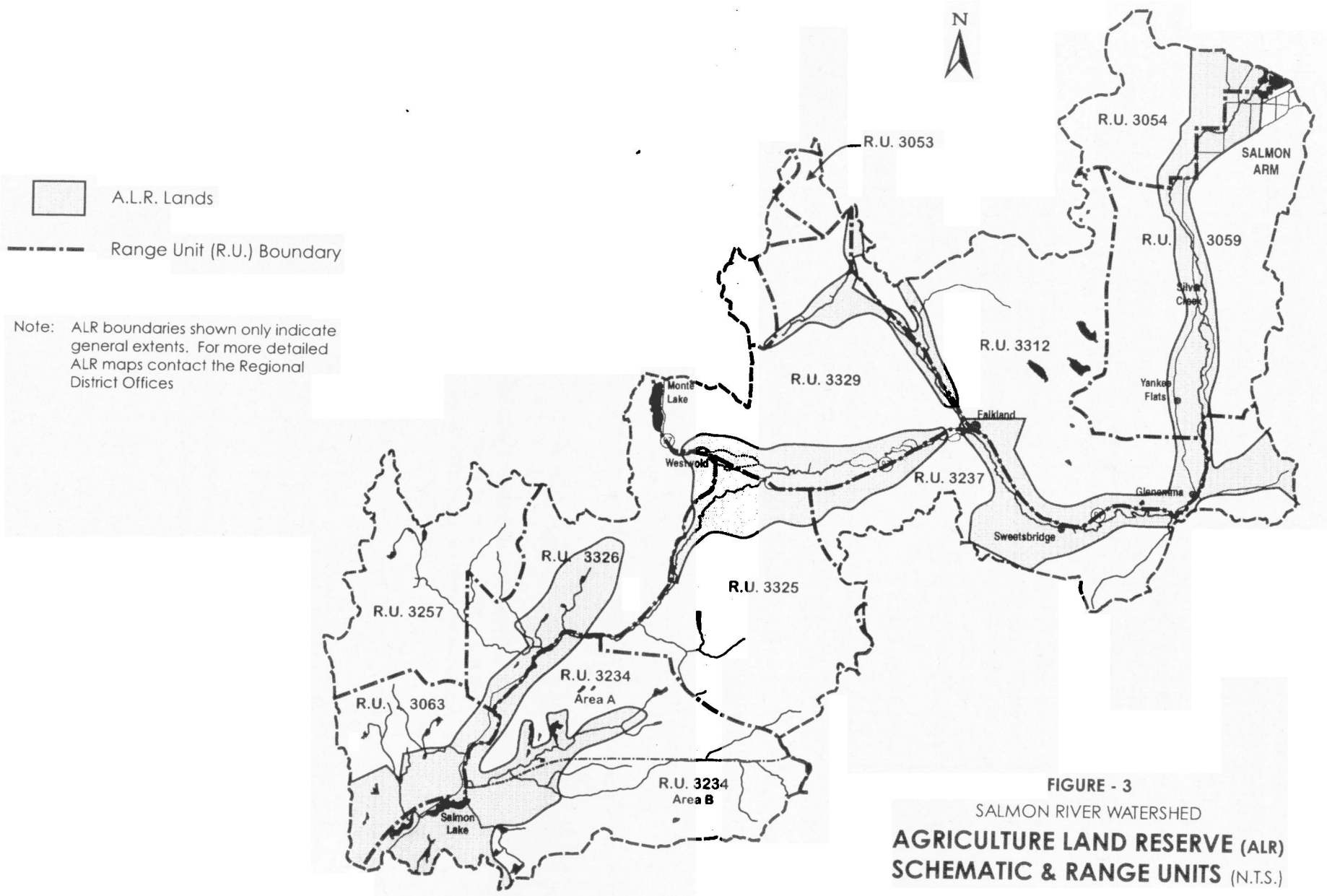


FIGURE - 3

SALMON RIVER WATERSHED

AGRICULTURE LAND RESERVE (ALR) SCHEMATIC & RANGE UNITS (N.T.S.)

The trend appears to be to firmly maintain the Agricultural Land Reserve and only allow exclusion or subdivision within the Agricultural Land Reserve under very special circumstances.

Land Capability and Suitability for Agriculture

Land capability for agriculture is defined as the capability of soil/climate combination to produce a range of crops or a single crop. A Class 1 to 7 system is used with Class 1 having no significant limitations and the widest crop range and Class 7 having very severe limitations and no inherent capability for agriculture. Ratings are applied under irrigated and dry farm conditions.

The Class 1 - 4 capability lands with the best soil/climate combinations and widest range of cropping opportunity, particularly with irrigation, are concentrated in the Salmon River valley bottom, adjacent terraces and lower valley slopes. The uplands contain scattered areas of Class 4 and 5 capability arable lands with significant soil and climate limitations. Class 5 and 6 capability lands associated with the native forage areas of grassed and forested valley slopes and uplands often form a critical component of livestock - forage production for farm and ranch units within the watershed.

Land suitability for agriculture is the climate/soils combination suitability for specific crops given sufficient and appropriate levels of management inputs.

The following is a general description of suitability for specific soil-bound crops.

- High suitability: a low to moderate level of management inputs are required to achieve an acceptable level of production.
- Moderate suitability: a moderate to high level of management inputs are required to achieve an acceptable level of production.
- Low suitability: identified crops are not well suited but can be grown with a very high level of management input.
- No suitability for soil bound agriculture.

Use of agricultural land is often dependent on irrigation to maximize the range of cropping options and yields of specific crops. There are 425 irrigation licenses in the watershed. These licenses allow for an annual withdrawal of approximately 21,000 acre-feet of water. Generally the permitted withdrawal period is April 1 to September 30.

There is a wide range in land suitability for specific crops depending on site specific climate, microclimate and soil characteristics. The widest range of suitability occurs within Salmon Arm municipality on the river floodplain near its outlet to Shuswap Lake and at Westwold. Depending on the specific crop or commodity other valley bottom and lower slope sites have high and moderate suitability for agricultural enterprises. Within the watershed there are some 30 agricultural uses/commodities each of which has different specific requirements.

For the purposes of description we have divided the watershed into seven different agriculturally significant geographic units or focus areas as follows (see Figure 2).

Upper Salmon
Land capability for agriculture ranges from arable Classes 4 and 5 to Class 6 rangeland. Climate is a key limitation to cultivated agriculture.

Moderate suitability for forage-livestock uses. No suitability for other soil bound agriculture use.

Westwold
Land capability for agriculture in cultivated areas is predominantly Class 1 - 3 sometimes associated with arable Class 4 and 5 lands adjacent and Class 6 rangeland on the valley slopes.

Land suitability is high and moderate for a significant range of soil bound crops and associated livestock enterprises (note current uses in Figure 2).

Narrow Valley Components
Land capability for agriculture is highly variable over small distances, but ranges from Class 2 to 7. Predominant capabilities are Class 3 and 4 with irrigation.

Land suitability for specific crops is highly variable with some site specific high suitability complexed with moderate and low suitability within the same farm unit or field.

Yankee Flats
Land capability for agriculture ranges from Class 4 to 6 with less significant areas of Class 3 under irrigation.

There is a narrow range of soil bound agriculture suitability with higher suitability for irrigated forage production.

Hullcar
The area is predominantly Class 2 and 3 land capability for agriculture with adjacent Class 4 and 5 with a relatively wide range of cropping opportunity.

The majority of the area has high or moderate suitability for most climatically adapted soil-bound crops under irrigation.

Paxton
Land capability for agriculture is predominantly Class 4 and 5 under irrigation.
Land suitability is moderate for forage livestock enterprises. The area is not suitable for other soil-bound crops.

Salmon River Estuary
Land capability for agriculture (a most significant area) is predominantly Class 2 with components of Class 3 and some Class 4. This is the largest area of contiguous high capability agriculture land in the watershed.

The area contains the highest suitability lands for a very significant list of soil bound crops (note present use in Figure 2).

Grazing Lands

The drier biogeoclimatic subzones of the watershed including grasslands, dry forest and interface ecosystems, as well as, high elevation areas recently timber harvested have various livestock grazing tenures (leases, licenses, and permits). This tenured area covers approximately two thirds of the watershed. The Fraser River Environmentally Sustainable Task Force (1991) described the watershed as having a livestock density of greater than two animal units per square kilometre.

The following are estimated approximate levels of "animal unit months" of livestock grazing per range unit in 1995 within the watershed supplied by the Ministry of Forests (Figure 3)

Salmon Unit	RU3059	May 15 to Sept. 30	711 AUM's
Charcoal Unit	RU3053	May 15 to Sept. 30	182 AUM's
Fly Hills	RU3054	May 15 to Sept. 30	608 AUM's
Estelkwalan Unit	RU3329	May 15 to Oct. 15	2,180 AUM's
Falkland Unit	RU3312	May 15 to Sept. 30	1,576 AUM's
Six Mile Unit	RU3237	May 15 to Sept. 30	605 AUM's
Woods Unit	RU3325	May 15 to Sept. 30	2,436 AUM's
Stephens Unit	RU3326	May 15 to Oct. 15	1,724 AUM's
Chapperon North			
(Area A) Unit	RU3234	July 1 to Oct. 23	656 AUM's
(Area B) Unit	RU3234	July 1 to Oct. 23	750 AUM's
Peterhope Unit	RU3063	Spring and Fall	1,823 AUM's*
	TOTAL WATERSHED AUM'S		13,251 AUM'S

(* portion in watershed only)

Anticipated Trends

Although there is some opportunity for expansion of existing farm and ranch production units within the watershed it is minor due to a lack of land resource area with agricultural capability and/or the water required to achieve irrigated productivity levels.

It is anticipated that the current distribution, mix and range of agricultural uses within the watershed will remain relatively stable for the foreseeable future with some increased emphasis on speciality and exotic crops and commodities.

With respect to the Agricultural Land Reserve, the trend appears to be to firmly maintain the ALR and only allow exclusion or subdivision under very special circumstances.

Implications For Agricultural Sustainability

Although opportunity for significant expansion of agriculture within the watershed may be limited due to increasing competition for resources, the existing diversity of uses could be expected to vary with market demand and production economics. However, a common need for all watershed agriculture is to use and sustain the land and water resources for crop and animal production in cooperation with other watershed land and water users. The long term sustainable existence of the agricultural industry within the watershed is dependent upon protecting the resource base (soil health, water quantity and quality and general range ecosystem sustainability).

Agriculture practices with shifting uses constantly need review to ensure that farm and ranch management is environmentally sustainable. To this end, Ministry of Environment, Lands and Parks and Ministry of Agriculture, Fisheries and Food developed commodity oriented environmental guidelines and codes of practice which set the framework for moving towards a more sustainable agricultural environment in the province. These Codes of Agricultural Practice are regulations under the Waste Management Act. Key watershed sustainability considerations include:

- maintaining and enhancing water quantity and quality (surface and groundwater) for irrigation and livestock water purposes;
- nutrient management (fertilizer and manure application)
- continuing industry specific activities and initiatives funded and supported by government agencies (i.e., BC Federation of Agriculture Sustainable Practices Fund, Independent Rancher Projects);
- irrigation water use efficiency;
- riverbank erosion and livestock access;
- runoff control and management
- integrated pest management;
- livestock facility siting;
- soil erosion and compaction;
- improving soil organic matter; and
- range resource ecosystem changes.

2.2.3 Forestry

The Salmon River watershed is located entirely within the Kamloops Forest Region, Ministry of Forests. Three Forest Districts within the Kamloops Forest Region are responsible for managing the provincial forest land within the watershed: the Salmon Arm Forest District, the Vernon Forest District and the Merritt Forest District (Figure 4). The majority of the watershed also falls within the Okanagan Timber Supply Area and a smaller area comes under the Merritt Timber Supply Area (in the upper end of the watershed).

Because of the many jurisdictions, time constraints and information availability, historical harvesting information for the watershed was unavailable. However, the following information was derived from existing reports such as the Okanagan and Merritt Timber Supply Area Reviews (note: these reports do not exclusively cover the watershed, they cover much larger areas such as the Timber Supply Areas).

The watershed drains more than 200,000 hectares. Estimates indicate that the total forested area in the watershed exceeds 185,000 hectares. A study completed in 1991 for the Fraser River Environmentally Sustainable Task Force examined resource uses in the South Thompson-Shuswap area. This study estimated the Salmon River watershed inventory as follows:

- Non-forested 134.4 sq km (8.95%)
- Potentially forested 1366.8 sq km (91.05%)
- Recently logged 161.4 sq km (10.75%)
- Older logging 439.1 sq km (29.25%)

- Total area logged 600.5 sq km (40.00%)
- Forest remaining 766 sq km (51.05%)

There are seven provincial forests within the boundaries of the Salmon River Watershed:

- Monte Hills Provincial Forest
- Martin Mountain Provincial Forest
- small portions of Okanagan Provincial Forest
- small portions of Shuswap Provincial Forest
- small portion of Salmon Arm Provincial Forest
- Fly Hill Provincial Forest
- Mount Ida Provincial Forest

There are four major licensees in the Salmon River Watershed. None of these licenses have processing operations in the watershed, therefore all timber harvested in the watershed is processed outside the watershed boundaries.

Riverside Forest Products Ltd. operates TFL 49 and Forest Licence A18667, portions of which are in the Salmon River Watershed. TFL 49 was, at one time, made up of portions of TFL 16 and TFL 32, which date back to the 1930s. TFL 49 was formed as a result of various companies being bought by others. Riverside plans to harvest in TFL 49 for centuries.

Riverside has plans for some clearcut harvesting in 1995-98 on the western side of Weyman Creek, south of Blackwell Lake. There are also some activities planned for the Nash Creek/Sawmill Lake area. Riverside estimates its annual harvest from the watershed to be 610 hectares per year with a volume of 175,000 cubic metres. This volume represents direct employment of approximately 210 and, including spin-off jobs, represents 560 jobs in total (G. Wellburn, Riverside Forest Products in Environment Canada, 1995).

Riverside's volume harvested from the Salmon River Watershed goes to the mill in Armstrong. The main products are dimensional lumber and plywood. Some volume also goes into pine poles, pulp, and posts and rails. The posts and rails and poles are processed in Monte Lake, just on the boundary of the watershed.

Tolko Industries Ltd. has no active operations within the watershed but it is within their planning area. Tolko's timber licence falls within the watershed in the area just south of Falkland, and on the east side of the Salmon River where it begins to flow directly north. Tolko operates a sawmill and planer mill at Lavington, just east of Vernon and a sawmill in Merritt.

Federated Cooperatives Limited operates a sawmill and plywood plant at Canoe, a few kilometres east of Salmon Arm. Federated Coop does not have any harvesting plans within the watershed for at least the next ten years.

Ardew Wood Products Ltd. operates an independent mill in Merritt. Ardew has a licence in a small area of the watershed around Salmon Lake and Lavigure Lake. There is currently no active harvesting in the area, but Ardew has plans to do some selective cutting in the Lavigure Lake area in three years. Ardew anticipates that they will harvest approximately 80,000 m^3 from the area over the next two decades.

Forest Recreation Sites

1. Blackwell Lake
2. Pratt Lake
3. Weyman Creek Falls
4. Salmon River
5. Jimmy Lake
6. Nugget Lake
7. Woods Lake
8. Pinaus
9. Joyce (Green) Lake
10. Bolean Lake
11. Arthur (Blair) Lake
12. Spa Lake
13. Spanish Lake
14. Kernaghan Lake North
15. Wallensteen Lake

Other Recreation Sites

- Provincial Park
- Private Camp Ground
- Fishing Lodge

Forest District Boundary

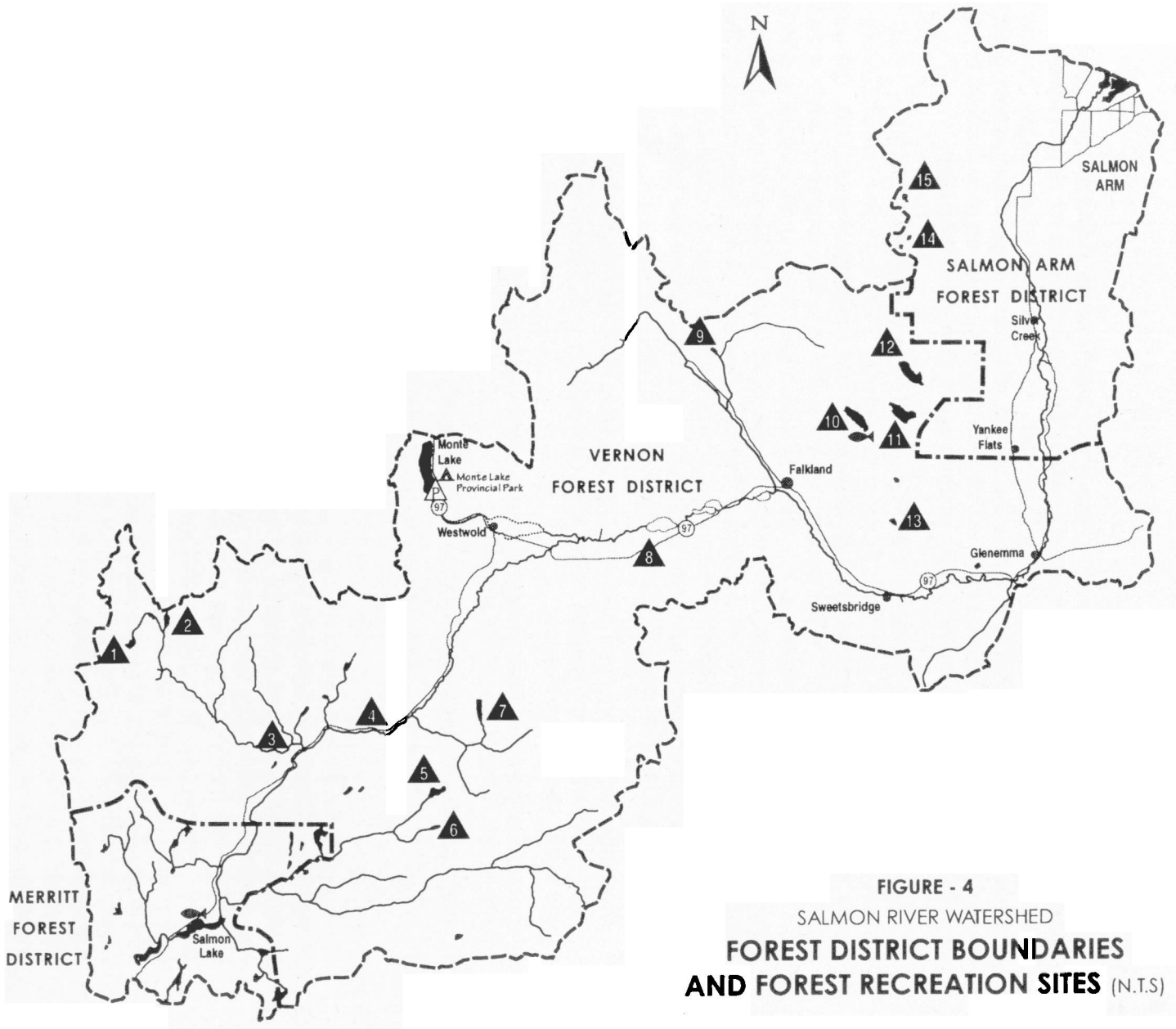


FIGURE - 4

SALMON RIVER WATERSHED

FOREST DISTRICT BOUNDARIES AND FOREST RECREATION SITES (N.T.S)

Anticipated Trends

The Salmon River watershed falls within two timber supply areas (TSAs): Okanagan and Merritt TSAs. By law, B.C.'s Chief Forester must reassess the allowable cuts for all provincially-managed commercial forest areas at least every five years. The current Timber Supply Review (TSR) process was initiated in 1992 to examine the impact of current forest management practices on the timber supply. The TSR also examined the economic, environmental, and social conditions in each TSA as they relate to timber supply, under a variety of harvest scenarios.

The Annual Allowable Cut (AAC) for the Okanagan TSA is currently 2,615,000 m^3. This level of harvest was confirmed by the Chief Forester in January 1996. The BC Forest Service timber supply analysis shows that this level of harvest can be maintained until 2010, followed by a decline at a rate of 10 percent per decade, reaching the long-term projected AAC of 2,022,000 m^3. (This harvest level incorporates the reality of losses from fire and other causes, and the fact that stands are almost always harvested at ages other than those which maximize volume production due to protection of non-timber values.) However, in his determination, the Chief Forester also outlined a number of factors which could exert a downward influence on the timber supply over the short to medium term and which could also reduce the length of time the initial harvest level can be maintained. These include:

- inventory information used in the BCFS analysis does not reflect forest depletion due to harvesting and natural causes since 1990. This means that 5 years of timber supply used in the base case has been used;
- new modelling procedures for visual quality objectives and requirements for visual quality were not incorporated in the BCFS analysis;
- new Forest Practices Code requirements for riparian habitat will restrict harvesting;
- new Forest Practices Code requirements for the retention of wildlife trees were not fully represented in the BCFS timber supply analysis.

In his report, the Chief Forester also notes that hemlock in stands over 140 years old (composed of less than 60 percent hemlock) provide the ability to stabilize the timber supply to the levels indicated in the base case scenario. He also notes that site productivity could reduce green-up and minimum harvestable ages, thereby producing a long-term timber supply. However, he goes on to say that these changes are uncertain and should be assessed. He states *"Given all the current assumptions, it is highly unlikely that harvesting could continue at the AAC I have determined for more than 5 years if harvesting performance does not comply with these conditions (i.e., to resemble more closely the existing forest inventory particularly in the Interior-fir biogeoclimatic zone and the harvesting of hemlock stands). The assessment of performance in this regard will be a significant factor in the next timber supply analysis and AAC determination for this area."* He goes on to state that the recently initiated LRMP for the Okanagan TSA will be an important factor in determining a harvestable land base and hence, future harvest levels.

The AAC set for the Merritt TSA is 1,204,250 m^3, which is the current harvest level. The Chief Forester estimates that this harvesting level can be maintained for 110 years.

A Land and Resource Management Planning (LRMP) has begun in the Okanagan TSA. This process will cover crown lands within the watershed. It will be organized by provincial government agencies and will involve consultation with the public. The plan will establish direction for land use and specify broad resource management objectives and strategies. The

Salmon River Watershed Roundtable made a presentation to the government agencies responsible for the LRMP to argue that approximately 11,000 hectares in the Merritt TSA be included in the LRMP to facilitate preparation of a watershed plan based on ecosystem objectives.

Maintaining Ecological Integrity in the Forests of the Salmon River Watershed

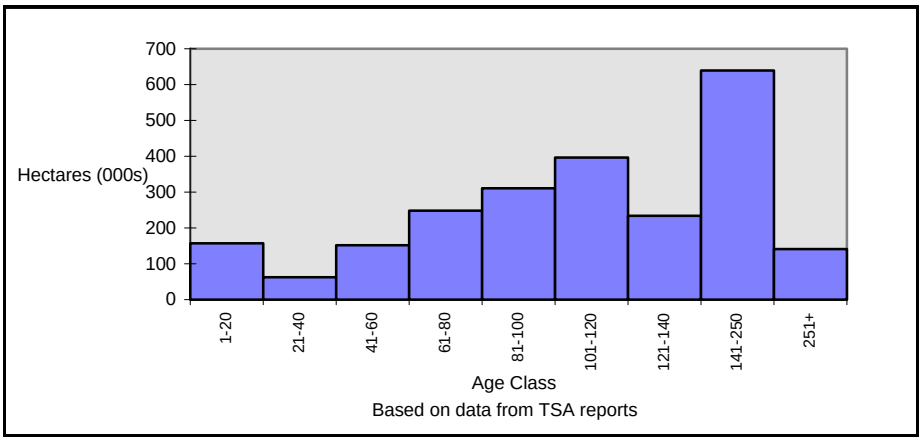
Biodiversity plays an important role in the health of forests. Each stage of forest succession has unique and characteristic distributions and population levels of some species. Maintaining biodiversity in the watershed's forests depends on maintaining ecosystems in all their various stages: early, mid- and late-successional stages (Fraser Basin Management Program, 1995).

One indicator of ecosystem change is the extent to which road access has been created. *"Fragmentation by roads is a measurable index of forest ecosystem change, not only because of the ecosystem attributes it directly affects, but also because it admits other activities" (Fraser Basin Management Program, 1995, quoting Harding 1994).*

In the Salmon River Watershed, all of the land is classified as roaded, according to the Ministry of Forests. There are no primitive or semi-primitive areas within the watershed. According to the Ministry of Forests Recreational Opportunities Spectrum, Roaded Resource Land is within 1 km of a two-wheel drive road with a gravel or dirt surface.

The conversion of natural forests to managed forests can also act as an indicator to ecosystem change. The predominant silviculture system in the watershed is clearcutting followed by replanting. Forests where selective or partial cutting methods have been used tend to retain more qualities of natural forests. The current age distribution profile in the Okanagan and Merritt TSAs (Figure 5) illustrates that the majority of forest stands are more than 100 years old. It must be noted, however, that the Salmon River watershed covers only a limited portion of these two TSAs. Further work is required to determine, precisely, the forest age class distribution for the watershed. Harvesting will initially remove these oldest stands, followed progressively by younger stands, resulting in a more even age class distribution over the next century. This will have implications for biodiversity, both negative (loss of habitat for some species) and positive (increased edge habitat for some species).

FIGURE 5: FOREST AGE CLASS DISTRIBUTION IN THE OKANAGAN AND MERRITT TSAs



Another indicator of ecosystem change is the number of species at risk. The Okanagan TSA Integrated Resource Management Timber Harvesting Guidelines (OkTHG) recognize the

environmental values of the area and require forest management to maintain these values. The guidelines address various issues, including:

- protection of riparian areas, which are very important to fish and wildlife
- restrictions on the rate of harvesting in watersheds with regionally significant fish values;
- designation of a special management zone for ungulates;
- restrictions on the rate of harvest in community watersheds;
- protection of old growth through requiring a minimum of the forest land base designated as old growth.

The OkTHG target of maintaining ten percent of the timber land base as old growth and the incorporation of the Old Growth Strategy and related biological diversity objectives in the Protected Areas Strategy will aid in the preservation of areas for certain species.

A study by the Fraser River Environmentally Sustainable Task Force (1991) examined resource uses in the South Thompson-Shuswap area. The assessment provided a regional overview of impact potential for salmon producing streams from resource uses, including forest harvesting. Past forestry practices were rated as having a high impact in the watershed. The impact of forestry in Bolean Creek, also within the watershed, was rated as having a high impact. The report cautions that it was intended as an overview only and that further assessment work is required along with biophysical surveys.

Implications for Sustainability

According to the Okanagan Timber Supply Area Review, the current level of harvesting in the TSA is not sustainable over the longer term. Reductions to the annual allowable cut will be required in order to meet sustainable objectives in forestry. How these forecasted reductions in harvests will be distributed over the entire TSA is not known at this point in time. All timber licensees may have their allowable harvests prorated according to the reductions in the AAC.

There are eight community watersheds within the Salmon River watershed. These include Rumball Creek, Fowler Creek, Silver Creek, Gordon Creek, Moutell Creek, Palmer Creek, Ingram Creek and Wolfe Creek. Maintenance of the water resource is a primary concern in these watersheds. More restrictive forest management requirements apply within community watersheds. The Okanagan Timber Harvesting Guidelines set a maximum of 20 percent clearcut for the area harvested, compared to the 25 percent maximum in other watersheds in the Salmon River watershed.

To help address cut levels, a joint committee comprised of representatives from the Ministry of Forests, the Ministry of Environment, Lands and Parks, the Federal Department of Fisheries and Oceans, and the forest industry has developed the Southern Interior Watershed Assessment Procedure. The goal was to provide a structured approach for evaluating the overall condition of watersheds within the Kamloops Forest Region. This will be incorporated in the Forest Practices Code's Community Watershed Guidelines, which are scheduled to be released this fall.

The Salmon Arm Forest District has information available which shows the percent denudation (removal of forests) that has occurred in the sub-watersheds of the Salmon River since 1965. The amount of denudation relates to the Equivalent Clearcut Area (below a certain height and stocking level). The total denudation in the Salmon Arm Forest District portion of the watershed is 33 percent, which is above the guideline maximum of 25 percent. Of the six community watersheds, three were under or close to the 20 percent maximum guideline. The three that were well above the

guideline, Gordon Creek (62.3%), Moutell Creek (34.8%) and Palmer Creek (49.6%) were subject to the Gleneden fire in the late 1970s. It is very likely that these burned areas are not considered to be denuded. In the areas directly along the river and in the immediate uplands, 30 percent has been cleared in the Yankee Flats area and almost 50 percent in the area below Mount Ida. Much of these areas are private land that has been cleared. However, this study was not able to discern the extent to which potential negative impacts on forests, soils, wildlife and fish in the Salmon River watershed are the result of logging practices on private or crown lands or agricultural practices. These practices could use further scrutiny as part of a watershed management plan.

Salvage/protection programs (fire, insects, disease, blowdown) account for 6% of the long-term harvest level in the Okanagan TSA. If salvage could further minimize this loss, or if additional protection measures could be taken, the short-term timber supply could be increased.

Another important issue affecting sustainability of forestry in the watershed is mountain pine beetle infestation. At present, the licensees in the watershed are required to harvest infested areas first. Methods for actively fighting beetle attacks include fall and burn, tree baiting and harvest, harvesting attacked trees only and returning the next year to do the same and finally, possibly clearcutting if the attack is extensive.

The Forest Practices Code is a package of legislation, regulations, standards and field guides designed to improve the stewardship of B.C.'s forest resources. The Code guides forest management on public and some private lands. It protects a full range of forest values, including fisheries, wildlife, biodiversity, cultural heritage, soils, timber and community watersheds. The Code reduces the size of cutblocks and requires silvicultural systems to be ecologically appropriate to each site. It restricts clearcutting on steep, unstable slopes, in visually-sensitive areas, and in old growth areas vital to wildlife habitat protection. New regulations establish a management zone - where logging is done in a way that protects fish and wildlife habitat - beside all streams, and a no-harvest zone beside streams in community watersheds and all but the smallest fish-bearing streams.

Established by law in April 1994, the Forest Renewal Plan represents a long-term commitment to restore and protect the health of forests, safeguard thousands of forest-dependent jobs, and increase economic benefits from each tree harvested. The plan will is to ensure that intensive silvicultural projects rehabilitate forests, enhance the timber supply, and create employment. Employment opportunities will also be created by training programs, value-added processing, and economic diversification in forestry-dependent communities.

Forest Renewal BC, the agency charged with implementing the Forest Renewal Plan, has allocated $6 million for enhanced forestry projects, watershed restoration, and other forest-related programs in the Kamloops Forest Region. There is currently one enhanced forestry project and no watershed restoration projects proposed or funded in the watershed. There is a great deal of potential for putting some of the Forest Renewal Plan funds to work in the Salmon River watershed. Proposals to Forest Renewal BC from community organizations in partnership with industry and government are welcomed to provide the basis for environmental improvement, employment, community development, and productive forests.

BC Ministry of Forests participates in three national and international processes working towards the development of criteria and indicators for the sustainability of forests. The Montreal Process developed criteria and indicators which were agreed to by ten non-European countries in March, 1995. The Helsinki Process has aggregated information at a European-wide level, and are at a very initial stage of implementation. The Canadian Criteria and

Indicators initiative, a product of federal and provincial cooperation, is near completion. Information on the Helsinki and Montreal Processes is available. The Montreal Process, entitled “Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests”, resulted in five ecological criteria, one socio-economic criterion and one policy framework criterion. The seven criteria are summarized below (Table 8) to assist the SRWR in the development of ecosystem objectives and environmental health indicators.

TABLE 8: THE MONTREAL PROCESS: CRITERIA AND INDICATORS FOR SUSTAINABLE FORESTS

Criteria	Examples of Indicators
Criterion 1: Conservation of biological diversity	*Ecosystem diversity:* Extent of area by forest type and by age class or successional stage *Species diversity*: The status (threatened, rare, vulnerable, endangered, or extinct) of forest dependent species at risk of not maintaining viable breeding populations *Genetic diversity*: Population levels of representative species from diverse habitats monitored across their range
Criterion 2: Maintenance of productive capacity of forest ecosystems	Area of forest land and net area of forest land available for timber production Annual removal of wood products compared to the volume determined to be sustainable The area and growing stock of plantations of native and exotic species
Criterion 3: Maintenance of forest ecosystem health and vitality	Area and percent of forest affected by processes or agents beyond the range of historic variation, e.g. by insects, disease, competition from exotic species, fire, storm, land clearance, permanent flooding, salinisation, and domestic animals
Criterion 4: Conservation and maintenance of soil and water resources	Area and percent of forest land with significant soil erosion Percent of stream kilometres in forested catchments in which stream flow and timing has significantly deviated from the historic range of variation
Criterion 5: Maintenance of forest contribution to global carbon cycles	Total forest ecosystem biomass and carbon pool, and if appropriate, by forest type, age class, and successional stages Contribution of forest products to the global carbon budget
Criterion 6: Maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies	*Production and Consumption:* Supply and consumption of wood and wood products, including consumption per capita *Recreation and Tourism:* Area and percent of forest land managed for general recreation and tourism... *Investment in the forest sector:* Value of investment, including investment in forest growing, forest health and management... *Cultural, social and spiritual needs and values:* Non-consumptive forest use values *Employment and community needs:* Direct and indirect employment in the forest sector and forest sector employment as a proportion of total employment
Criterion 7: Legal, institutional and economic framework for forest conservation and sustainable management	Extent to which the: • legal framework encourages best practice codes for forest management • institutional framework provides for public involvement activities... • economic framework supports the conservation and sustainable mgmt. of forests through non-discriminatory trade policies for forest products Capacity to measure and monitor changes, including the availability of data, statistics, etc. Capacity to conduct research and development, including enhancement of ability to predict impacts of human intervention on forests

Source: Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests, 1995.

2.2.4 Recreation

Many outdoor recreational opportunities exist throughout the watershed, including fishing, hunting, wildlife viewing, cross-country skiing, camping, hiking, snowmobiling and horseback riding. The majority of the "backcountry" recreational opportunities in the watershed are found within the Provincial Forest Lands.

Birdwatching/Nature Observation

Excellent opportunities for birdwatching and general nature observation exist in the vicinity of the Salmon River mouth at Salmon Arm. A nature centre located on Salmon Arm Bay provides information and nature interpretation. The nature centre is located on land owned by the B.C. Nature Trust, is managed by BC Environment (BCE) of the B.C. Ministry of Environment, Lands and Parks and is staffed and run by members of the Salmon Arm Bay Nature Enhancement Society (SABNES). The District of Salmon Arm and SABNES are promoting wildlife viewing of both migratory birds and other terrestrial wildlife. Planning for a 'Western Grebe Festival' in 1996, similar to the Brant Festival in Parksville, is currently being undertaken by SABNES, the Chamber of Commerce and other interested parties.

The extensive marshes of Salmon Arm Bay are utilized by numerous waterfowl, shorebirds, herons, passerines and other bird species both during migration and the breeding season. The area is known to be a hotspot for migrant 'rarities' and is visited regularly by birdwatchers (Tom Plath, BCE, Surrey, pers. comm., 1995). A western grebe breeding colony near the river mouth is of particular interest to naturalists because of the western grebe's red-listed designation (i.e., threatened and endangered) in British Columbia (Harcombe et al. 1994) and because Salmon Arm Bay boasts the largest breeding colony in British Columbia (i.e., approximately 60 successful breeding pairs in 1995). Because of limited accessibility, additional opportunities for nature observation are more restricted within the watershed. However, deer are common throughout the watershed and can be seen from trails and roadways, especially during the winter. Monte Lake and more remote wetland areas such as Rush and Salmon Lake provide excellent nature viewing opportunities but are not often visited by the general public.

Sports Fishing

Because of the topography and geology of the Salmon River watershed, fewer angling opportunities (i.e., lakes) exist than in nearby watersheds such as the Nicola River watershed. The Salmon River watershed falls within management units 3-12, 3-20 and 3-26 in Region 3, Thompson-Nicola. Salmon, Spa, Bolean, Blair, Monte, Jimmy and Blackwell Lakes are the larger lakes within the watershed, receiving varying degrees of fishing pressure. Salmon Lake likely receives the heaviest angling pressure because it is easily reached by most vehicles and has cabin facilities operated by the Douglas Lake Ranch. Douglas Lake Ranch is currently in the process of constructing additional cabins. Some angling for trout also occurs on Salmon River, Bolean Creek and other tributaries to the Salmon River. General restrictions on streams include a spring closure from January 1 to June 30 with only single barbless hooks permitted. Special angling restrictions apply to the Salmon River where: a) all rainbow trout and char caught below the Hwy#97 bridge at Falkland must be released; b) bait is banned below the Hwy #97 bridge; and c) a chinook and coho closure is in effect above the CPR bridge near the river's mouth. Special restrictions applying to other waterbodies within the watershed include: a) Blackwell Lake - closed between December 1 and April 30; b) Bolean Lake - trout/char daily quota of 8; c) Jimmy Lake - closed between December 1 and April 30, trout/char daily quota = 1 (none under 50 cm), single barbless hook and bait ban; and d) Salmon Lake - closed between December 1 and April 30, artificial flies, single barbless hook. For further information, see BCE (1994a).

Hunting

Hunting for mule and white-tailed deer, moose, black bear, wolf, coyote, cougar, bobcat, lynx, racoon, snowshoe hare, ducks and other gamebirds is permitted within the watershed. Deer are by far the most common wildlife species pursued by hunters. Healthy populations of deer, particularly mule deer exist throughout the watershed. No hunting or shooting is permitted on the foreshore of Shuswap Lake near the town of Salmon Arm between the wharf and a white marker further to the north (i.e., at north boundary of N.W. 1/4 of S.24, Tp.20, R.10). See BCE (1995a) for further information on bag limits and other restrictions.

Forest Recreation Sites

The Ministry of Forests, through the three Forest Districts, manage 15 forest recreation sites in the watershed (Figure 4). The Vernon Forest District manages thirteen recreation sites in the watershed and the Salmon Arm Forest District manages two sites. There are no recreation

sites in the Merritt Forest District's portion of the watershed. A large portion of the watershed that falls within the Merritt District is private land, which is not inventoried nor managed by the Forest Service. Recreation officers in Vernon and Salmon Arm Districts indicated that use of the recreation sites has been fairly stable over the past 10 to 15 years. There are no plans to expand any of the existing sites nor are there any plans to develop new recreation sites within the watershed.

The main activities at the recreation sites in the watershed are fishing and camping. Other activities in the watershed, as classified by the Forest Districts' Recreation Resource Inventory include hiking, viewing, hunting (large mammal and general), horseback riding, gathering/collecting, driving for pleasure, snow shoeing, heli-hiking and general snow sports.

The Ministry of Forests divides outdoor recreation opportunities into six categories in the Recreation Opportunities Spectrum (ROS) (B.C. Ministry of Forests, 1991):

- *Primitive*: unmodified natural environment; greater than 8 km from a 4-wheel-drive road; non-motorized access; low interaction with other people.
- *Semi-primitive, Non-motorized*: natural or natural-appearing environment; greater than 1 km from a 4-wheel-drive road; some evidence of other people, non-motorized access.
- *Semi-primitive, Motorized*: natural or natural-appearing environment; greater than 1 km from a 2-wheel-drive road; some evidence of other people, motorized access may occur.
- *Roaded Resource Land*: natural environment may be substantially modified; within 1 km of a 2-wheel-drive road with a gravel or dirt surface; moderate interaction with other people; access and travel by motorized vehicle.
- *Rural*: natural environment is culturally modified, e.g., pastoral farmlands and utility corridors; many interactions with other people; access and travel by conventional motorized vehicle.
- *Urban*: a substantially urbanized environment; large numbers of users. (This class is largely not used by the Ministry because it does not need to manage these areas.)

The Salmon Arm Forest District area of the watershed is classed as "Rural" in the valley bottom and "Roaded Resource Land" in the uplands. The area within Merritt Forest District is classified as "Roaded Natural" using new draft standards for recreation classification. Roaded Natural usually occurs within or near the "Roaded Modified" or "Semi-primitive" ROS class. There is moderate to high degree of naturalness in surrounding environment (as viewed from the travel route). The area is within 1 km of a 2 wheel drive road and has no size criteria. Information from the Vernon Forest District was not received in time for inclusion into this report.

Parks

A Class A Provincial Park exists on Monte Lake. However, in the early 1990's the campground and other facilities were removed by BC Parks. The reasons for closing the facilities given by BC Parks staff were that they felt the camping demand was being met by a nearby private campsite, the access to the lake was not good at that particular location and the cost of maintaining the park. There is no intention to change the park designation and it does provide an important green/open space along the lake.

An undeveloped Class C Provincial Park is located at Westwold, which is administered by the Regional District.

Blackwell Lake has been proposed as a Protected Area under the Provincial Government's Protected Area Strategy. This lake is considered to be representative of the grassland plateau type lakes found in the region.

Fishing Lodges

Commercial fishing lodges exist at Salmon Lake, operated by the Douglas Lake Cattle Ranch and at Bolean Lake. Douglas Lake Ranch is currently constructing additional cabins and is marketing the camp as a year round recreational resort.

Future Trends and Implications for Sustainability

As population increases in the watershed, more people can be expected to participate in outdoor recreational activities. Apart from the tourist areas near Salmon Arm and the two fishing lodges, there are few commercial recreational facilities in the watershed. As stated above, there are no major developments planned.

Logging roads provide the majority of the access to the forest recreation sites and many of the lakes and hunting areas in the watershed. One potential issue is the decommissioning of old or abandoned logging roads. Some recreationists would like to maintain these roads for access to recreational areas - trails, etc., while some people argue that these roads could invite greater use of areas that are environmentally sensitive. It depends upon the expected demand and the capacity of these areas to tolerate recreational use.

B.C. Environment manages the fishing lakes and streams within the watershed through fishing regulations which set limits on type of gear and timing. While Salmon and Bolean Lakes receive the most fishing pressure, there does not appear to be a management concern over fish stocks in these lakes. The same applies to hunting in the watershed.

2.2.5 Other Resource Uses

Mining

Based on a limited review of MINFILE map information from the Ministry of Energy, Mines and Petroleum Resources it is apparent that the Salmon River watershed contains rocks with industrial, precious and base metal properties. However, this database is not exhaustive and should not be used as the only basis for predicting the mineral potential for an area.

The only producing mine in the watershed is the gypsum/anhydrite quarry at Falkland owned by LaFarge Canada. The gypsum deposits were first staked in 1894 with production beginning in 1926. Production continued until 1956 during which time 1,133,875 tonnes were produced. During the period 1976-1980 gypsum and anhydrite were mined intermittently from seven quarries and trucked to the Lafarge Canada Cement plant east of Kamloops. Recently, employment at the plant has been 42 in 1992, 1993 and 1994. Production in 1992 was 9,049 tonnes, 1993 - 10,215 tonnes and 1994 - 21,385 tonnes. According to a 1991 MINFILE report, the gypsum is "virtually mined out", however there are still deposits of anhydrite in deeper parts of the quarries.

There was also a rock quarry in the Westwold area which was in production in the late 1960's and early 1970's. This quarry produced marble for stucco dash, roof rock, riprap and driveway rock.

Apart from the active quarry at Falkland and gravel extraction operations for highways and buildings there are no other major producers in the watershed. There is mineral potential in the watershed and several showings have been documented.

Clay and marble deposits have been documented near Westwold and the Fly Hills are known to contain uranium deposits. East of Falkland in the Ferris Creek area there have been showings of copper. Copper has also been seen north of Falkland near Blair Creek. Lead has been seen in the vicinity of Mount Ida.

A promising opal find has been discovered (Klinker) in the McGregor Creek area, which continues to receive a great deal of attention.

In the Douglas Lake Road area and Adelphi Creeks, showings of agate (AE) have been documented.

Based on a quick review of the Assessment Report Index System (ARIS) Maps for December 1994 (NTS 082L NW/SW -Vernon) it appears that there are at least 40-50 valid mineral claims in the watershed. This source of data is a poor indication of the extent of mineral claims, but it does provide a good indication of the amount of exploration that has been done in the past. ARIS is a digital list of reports (with location maps) that have been prepared by exploration companies to document work done on their mineral claims so to keep their title in good standing. It has been beyond the scope of this study to review detailed reports for all the claims and other mineral occurrences in the watershed. However, the Ministry of Energy, Mines and Petroleum Resources does keep this information in the MINFILE (mineral deposit database) and there are other sources such as the overview of commodity mineral potential for the province, and Mineral Claim Reference maps. There appears to be no major activity on claims within the watershed with the exception of the two opal prospects (Klinker and Alpo) and the JG gold skarn prospect (J. Britton, Ministry of Energy, Mines and Petroleum Resources, pers. comm.).

Trapping

Five trapline license areas occur partially or completely within the Salmon River watershed (Figure 6). Trapper license numbers are TR0326T006, TR0326T008, TR0329T005, TR0320T002 and TR0312T002. Wild fur harvest records obtained from BCE (K. Kier, Kamloops) indicate that the wildlife species taken in the five trapline areas between 1986 and 1994 are, in decreasing order of number sold, beaver, coyote, ermine, red squirrel, muskrat, mink, marten, lynx, raccoon, bobcat, fox and striped skunk. See BCE (1995a) for open trapping seasons for furbearers and general restrictions and guidelines.

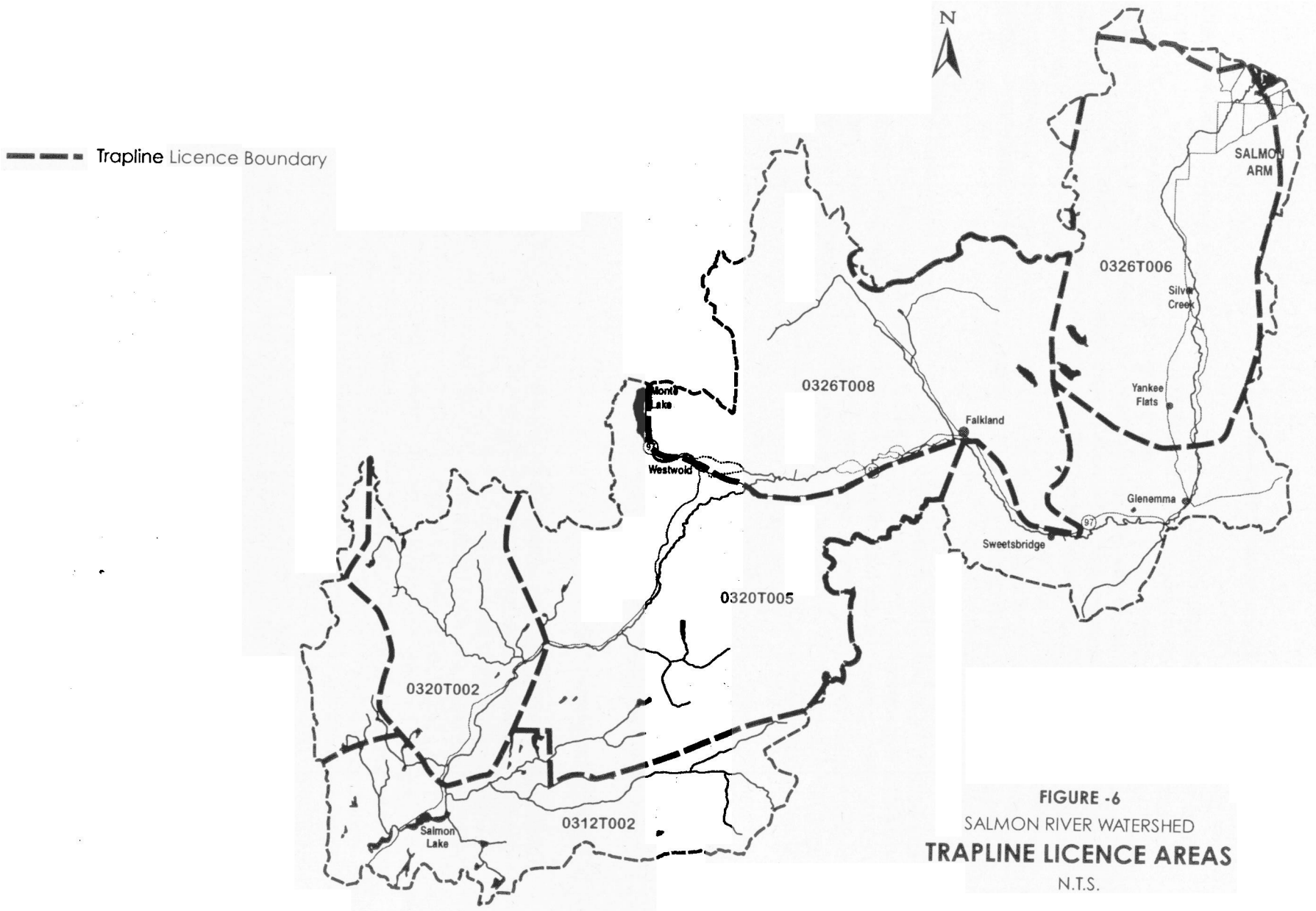


FIGURE -6

SALMON RIVER WATERSHED

TRAPLINE LICENCE AREAS

N.T.S.

2.3 Aquatic and Terrestrial Ecosystems

One of the guiding principles adopted by the SRWR is to develop a multi-stakeholder watershed plan based on ecosystem objectives. The SRWR considers the watershed as an ecological unit. This ecosystem based watershed plan is intended to incorporate ecological, social and economic considerations of the watershed based on issues and concerns raised by broadly based stakeholder representation. Indicators of ecosystem health therefore include a variety of social, economic and ecologically based indicators. Indicators of aquatic ecosystem health are important because of the intense utilization of riparian habitat and the strong interconnection between the health of aquatic and terrestrial watershed components. As such they can be used to help define the condition of both aquatic and terrestrial ecosystem components, ecologically, economically and socially.

The Salmon River watershed consists of a diverse assemblage of ecosystem types, influenced by variations in geography, rainfall patterns, aspect and elevation. Some of the main habitat types include open grasslands on the Douglas Lake Plateau, extensive wetland systems, dry south facing slopes with open forests, wet north facing slopes with dense forests, low elevation agricultural areas along the Salmon River and the broad marshes of the Salmon River delta. These habitats fall within one of the four biogeoclimatic zones represented within the watershed.

2.3.1 Major Biogeoclimatic Zones in the Watershed

The four biogeoclimatic zones that occur within the Salmon River watershed are the Interior Douglas-Fir (IDF), Montane Spruce (MS), Engelmann Spruce-Subalpine Fir (ESSF) and Interior Cedar-Hemlock (ICH) (Figure 7).

Interior Douglas-Fir (IDF)

The majority of the Salmon River watershed lies within the IDF biogeoclimatic zone. The IDF zone occurs where drier climatic conditions are largely the result of rainshadows occurring in the lee of topographic barriers such as the Coast, Cascade and Columbia Mountains. This zone is dominant along the river valleys and part way up the mountain slopes in the Salmon River watershed. Douglas-fir (*Pseudotsuga menziesii*) is the dominant climax species in zonal ecosystems forming moderately closed uneven-aged stands. Other tree species include Ponderosa pine (*Pinus ponderosa*) and lodgepole pine (*P. contorta*), western larch (*Larix occidentalis*), Engelmann spruce (*Picea engelmannii*), trembling aspen (*Populus tremuloides*), black cottonwood (*P. balsamifera*) and paper birch (*Betula papyrifera*). Lodgepole pine is a common seral species in fire impacted areas. Zonal ecosystems are typically dominated by a continuous understorey cover of pinegrass (*Calamagrostis rubescens*) with birch-leaved spirea (*Spiraea betulifolia*). Other common shrub species include saskatoon (*Amelanchier alnifolia*), snowberry (*Symphoricarpos albus*), Oregon grape (*Mahonia aquifolium*) and soopolallie (*Sheperdia canadensis*). Common herb species include kinnickinnick (*Arctostaphylos uva-ursi*), prince's pine (*Chimaphila umbellata*) and twinflower (*Linnaea borealis*).

Biogeoclimatic Zones

- **ESSF** - Engelmann Spruce-Subalpine Fir
- **MS** - Montane Spurce
- **IDF** -Interior Douglas-Fir
- **ICH** - Interior Cedar-Hemlock

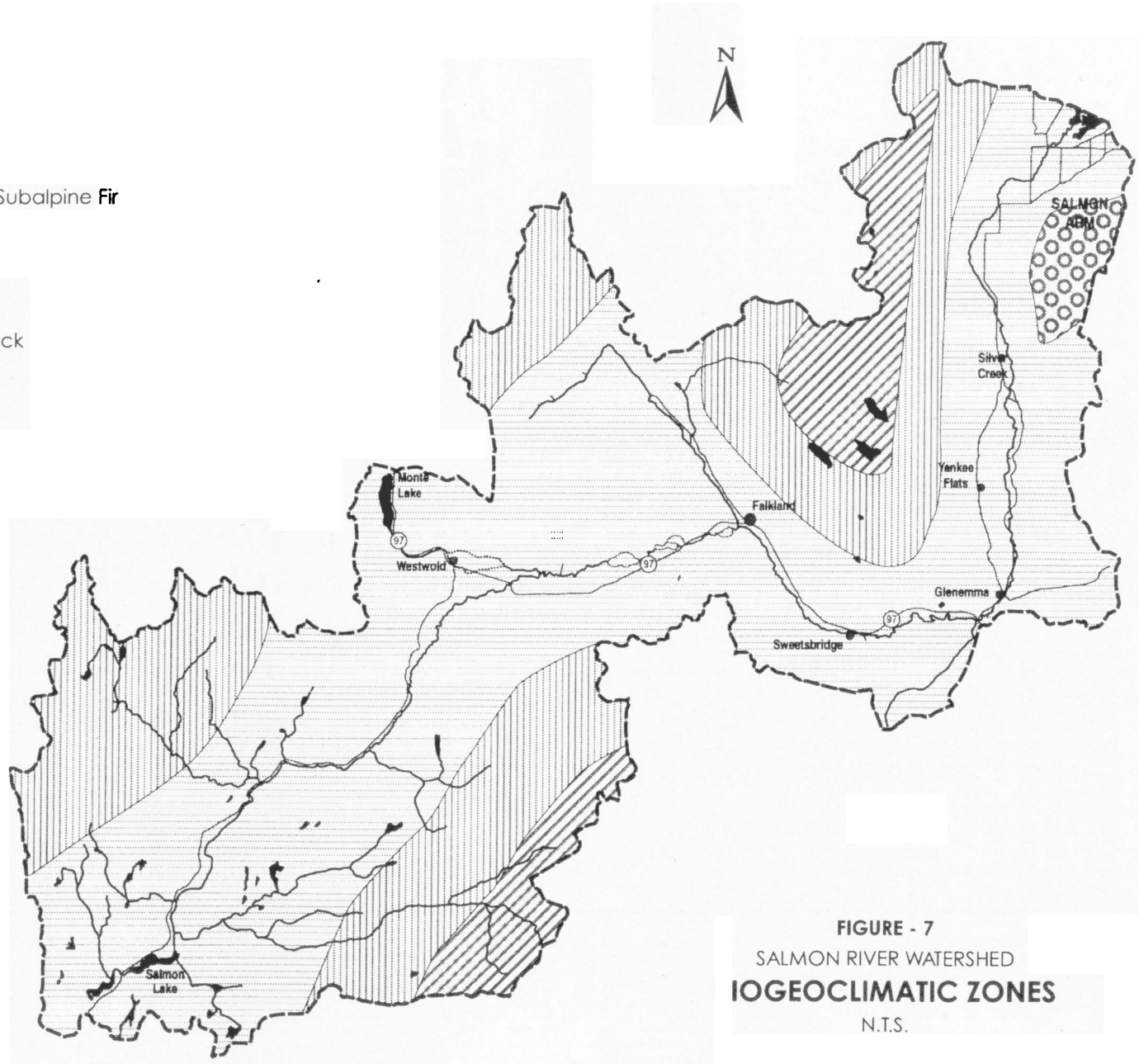


FIGURE - 7

SALMON RIVER WATERSHED

IOGEOCLIMATIC ZONES

N.T.S.

Montane Spruce (MS)

The MS biogeoclimatic zone is located throughout the watershed between the IDF zone at lower elevations and the ESSF zone at higher elevations. Climax stands are dominated by Engelmann spruce with smaller components of subalpine fir (*Abies lasiocarpa*) and Douglas-fir. Other common tree species include western larch and lodgepole pine. Typical understorey shrub vegetation includes green alder (*Alnus viridus*), boxwood (*Pachistima myrsinites*) and birch-leaved spirea. Herb species include pinegrass, prince's pine, twinflower, bunchberry (*Cornus canadensis*), rattlesnake plantain (*Goodyera oblongifolia*) and Queen's cup (*Clintonia uniflora*).

Engelmann Spruce-Subalpine Fir (ESSF)

The ESSF zone occurs at higher elevations within the watershed such as at the headwaters of the Salmon River and in the Fly Hills area to the west of the Salmon River. Climax tree species are Engelmann spruce and subalpine fir. Lodgepole pine occurs in disturbed and fire impacted areas. White-flowered rhododendron (*Rhododendron albiflorum*) and black huckleberry (*Vaccinium membranaceum*) are common components of the understorey. Common herb plants may include one-sided wintergreen (*Orthilia secunda*), five-leaved bramble (*Rubus pedatus*), foamflower (*Tirella trifoliata*), Sitka valerian (*Valeriana sitchensis*) and Indian hellebore (*Veratrum viride*). The moss layer is usually well developed.

Interior Cedar-Hemlock (ICH)

The ICH biogeoclimatic zone has the smallest representation within the Salmon River watershed. This zone lies east of the communities of Silver Creek and Yankee Flats near Mount Ida Provincial Forest. Zonal climax ecosystems are dominated by western hemlock (*Tsuga heterophylla*) and western red-cedar (*Thuja plicata*). Other common tree species include Douglas-fir, western larch, lodgepole pine, western white pine (*Pinus monticola*) and Engelmann spruce. Zonal vegetation is typically dominated by bunchberry, black huckleberry and a moss cover. Other common shrub species include boxwood and oval-leaved blueberry (*Vaccinium ovalifolium*). Herb species include prince's pine, Queens cup, twinflower, one-sided wintergreen, pink wintergreen (*Pyrola asarifolia*), five-leaved bramble and foamflower.

2.3.2 Aquatic Ecosystems

Overview of Major Fish Resources/Populations, Distribution and Seasonality

Resource information

Most of the fisheries resource studies conducted in the Salmon River watershed have emphasized salmonid species. The cultural and commercial industrial values attributed to salmonid species in British Columbia likely account for this preferential interest. The SRWR has ostensibly adopted salmon abundance as an indicator of ecosystem health. The ecological importance of the non-salmonid species in the Salmon River are less understood, even as they pertain to salmonid ecology. Some inventory and enhancement work has been done on trout species in the system. A larger amount of monitoring and enhancement effort has been directed towards chinook, coho and sockeye runs in the Salmon River system.

A study by Whelen et. al. (1982) listed 16 fish species found in the Salmon River during 1981 trapping activities. Five species were salmonids (including mountain whitefish) and 11 species were non-salmonids. A 1994 study by Vadas et. al. (in prep) verifies continued presence of at least 10 of these species and other fisheries work such as Federal Department of Fisheries (DFO) sponsored fish fence counts verify continued presence of one other. [14]

TABLE 9: FISH SPECIES PRESENT IN THE SALMON RIVER
(after Whelen et.al.1982)

COMMON NAME	SCIENTIFIC NAME
Salmonid species	
chinook salmon	*Oncorhynchus tshawytscha*
coho salmon	*Oncorhynchus kisutch*
sockeye salmon	*Oncorhynchus nerka*
rainbow trout	*Oncorhynchus mykiss*
mountain whitefish*	*Prosopium williamsoni*
Non-Salmonid Species	
redside shiner	*Richardsonius balteatus*
northern squawfish	*Ptychocheilus oregonensis*
slimy sculpin	*Cottus cognatus*
prickly sculpin	*Cottis asper*
carp	*Cyprinus carpio*
longnose dace	*Rhinichthys cataractae*
leopard dace	*Rhinichthys falcatus*
lake chub	*Couesius plumbeus*
burbot	*Lota lota*
large scale sucker	*Catostomus machrocheilus*
peamouth chub	*Mylocheilus caurinus*

*Taxonomically Mountain whitefish are members of the family Salmonida.

Distribution

DFO and the Provincial Ministry of Environment, Lands and Parks (BCE) staff have been aware of a historical difference in trout versus salmon utilization of the upper versus the lower portion of the river respectively. BCE work done by Bison et. al, (1991) described extensive utilization by rainbow trout fry and parr of Bolean Creek near its confluence with the Salmon River mainstem. DFO and Environment Canada sponsored a study in 1994 utilizing an existing fish counting fence near Silver Creek[15] which indicated that Rainbow trout from Shuswap Lake do not utilize the Salmon River to a significant extent as spawning habitat. Upper watershed rainbow trout populations are considered as a sport fishery resource. Current fishing regulations for the Salmon River and its headwater areas provide for recreational fishing of whitefish, burbot and trout, but a trout and char release restriction applies in the Salmon River below the Highway 97 bridge at Falkland (1995 Provincial Fish Regulations, p. 32). Trout fishing occurs in the upstream portion of the river subject to provincial regulations. No sport

[14] It is likely that all species previously noted under the Whelen et. al. study still exist in the system and would be found present if an extensive inventory of fish species were undertaken.

[15] Structure is located on Eugene Peutz property approx. 1 km downstream from Silver Creek

fishing of Salmon species (including all anadromous salmon species) is currently permitted in the Salmon River. Douglas Lake Ranch, located at the headwaters of the watershed has embarked on a project in cooperation with BCE to enhance trout populations in Salmon Lake using an existing diversion point upstream of Salmon Lake as a spawning channel (pers. comm. Duncan Stewart).

DFO officers have surveyed the Salmon River on a regular basis since the 1940's to monitor salmon population abundance and distributions. From the 1970's until installation of an adult fish fence in 1984, escapement surveys were fairly rigorous, consisting of two or three surveys per year each consisting of two or three days of river walking from Falkland to Salmon Arm (B. Kurtz, DFO, Salmon Arm, pers. comm.). Since installation of the fish fence, escapement estimates have been based on fish counted as they were released upstream from the fence and adjusted to account for probable utilization of spawning areas located downstream of the fish fence (Cross, DFO, Vancouver, pers. comm.). These findings are summarized in the Stream Summary Catalogue, Subdistrict # 29K (DFO, 1990) along with other pertinent information regarding seasonality and distribution.

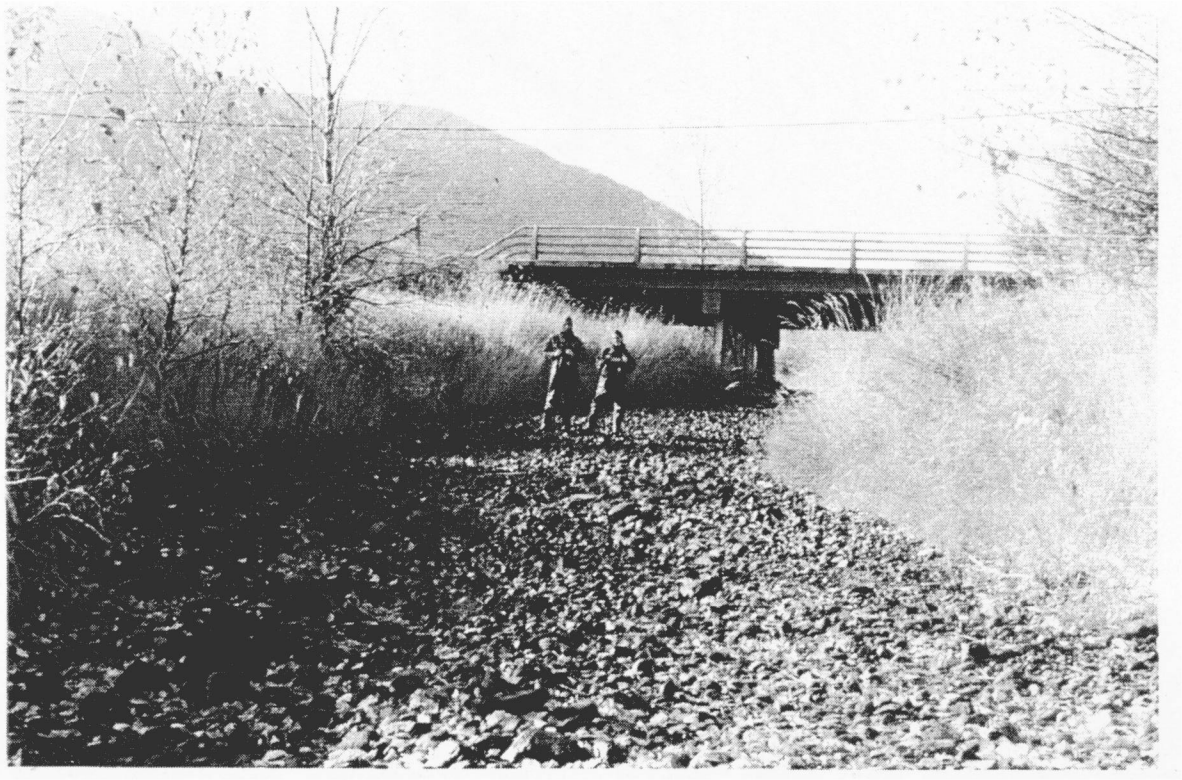
During the pre-1984 river walks, fisheries officers routinely noted river locations where there was high utilization by spawning salmon and patterns became apparent. Sockeye were found in small numbers throughout the lower half of the river while chinook and coho concentrated their spawning activity between Silver Creek to a location upstream of Falkland.

The hydro-geomorphology of the Salmon River basin is unusual in that the surface flow of the Salmon River disappears, flowing below ground level for a distance of up to 12-13 km around Westwold (Figure 8). This remnant stream characteristic is highly relevant to fish population distributions on the Salmon River system. The seasonally "dry" reach of the river begins approximately 8 km upstream of Westwold and extends approximately 5 km downstream of Westwold towards Falkland and is usually dry except during a 2.5 to 3.0 month period at freshet (Obedkoff, et. al., 1976). Surface flows continue over a distance of approximately 80 km to Shuswap Lake.

This 12-13 km "dry" reach is considered a natural barrier to migrating salmon and the river upstream of this location is not generally considered to be salmon bearing . Thus, of the total 150 km length of the Salmon River, the downstream 80 km length has historically been and still is to a limited extent, salmon bearing. Portions of the upper 70 km stretch of the river extending from Westwold to the headwaters in the area of Boleau Mountain are probably important trout habitat. Also, major tributaries, particularly Bolean Creek, provide important trout habitat. Figures 9 and 10 show the location of the river section which runs dry most years following spring freshet as well as the location of salmonid habitat in terms of best spawning and rearing habitat.[16]

[16] Based on data from Burt and Wallis, 1995 which was collected at the October 1994 discharge. Rearing habitat estimates would be more accurately reflected if other flow regimes were also sampled

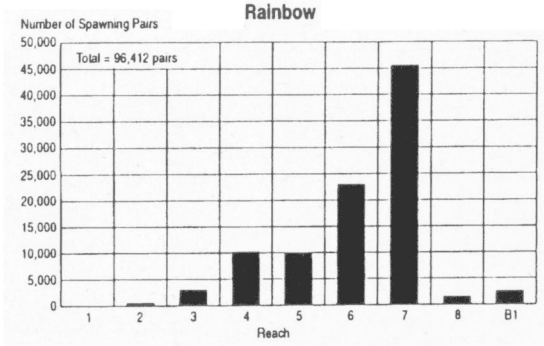
FIGURE 8: SALMON RIVER - DRY REACH NEAR WESTWOLD, OCTOBER 1994

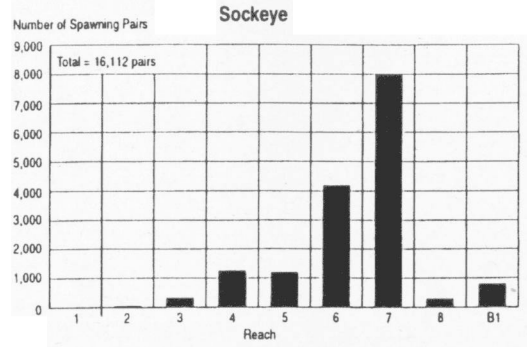


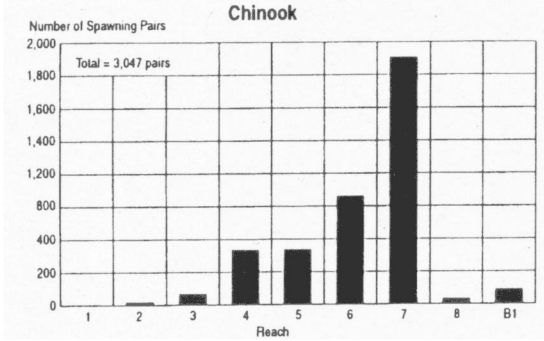
Spawning Potential

Estimated spawning capacities (pairs) by reach for salmonids in the Salmon River Watershed

Source: Burt & Wallis 1995 (Oct. 94 flows)







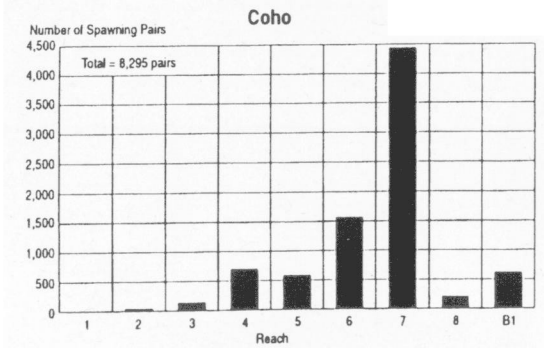


FIGURE - 9

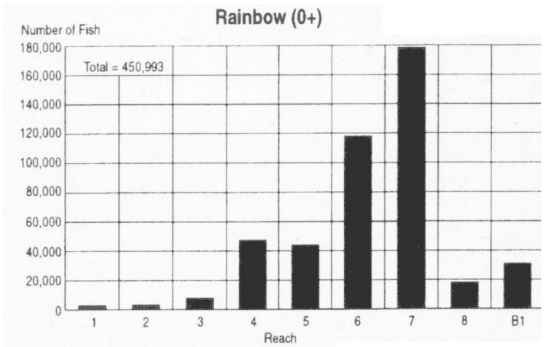
SALMON RIVER WATERSHED

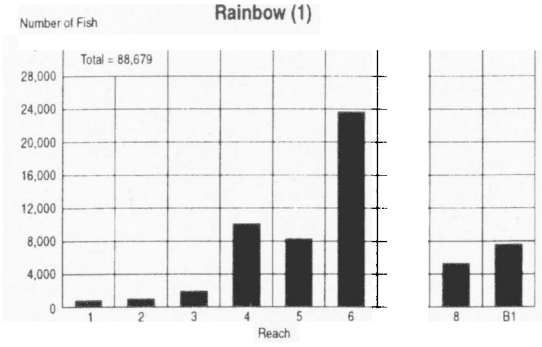
BEST SPAWNING HABITAT FOR SALMONIDS

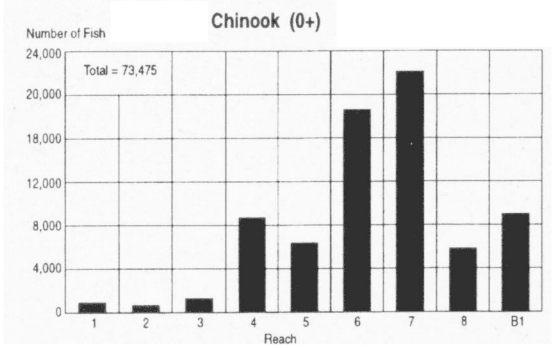
N.T.S.

Rearing Potential

Estimated rearing capacity of salmonids in the various reaches in the Salmon River Watershed
Source: Burt & Wallis 1995 (Oct. 94 flows)







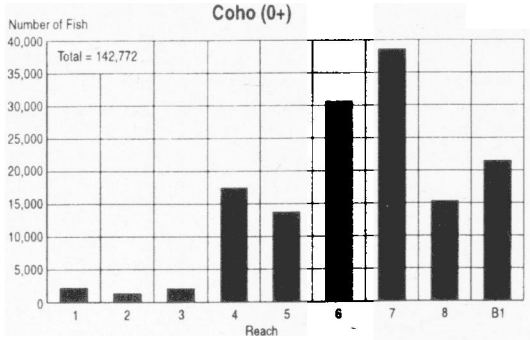


FIGURE - 10

SALMON RIVER WATERSHED

BEST REARING HABITAT FOR SALMONIDS

N.T.S.

Population information

Historical abundance

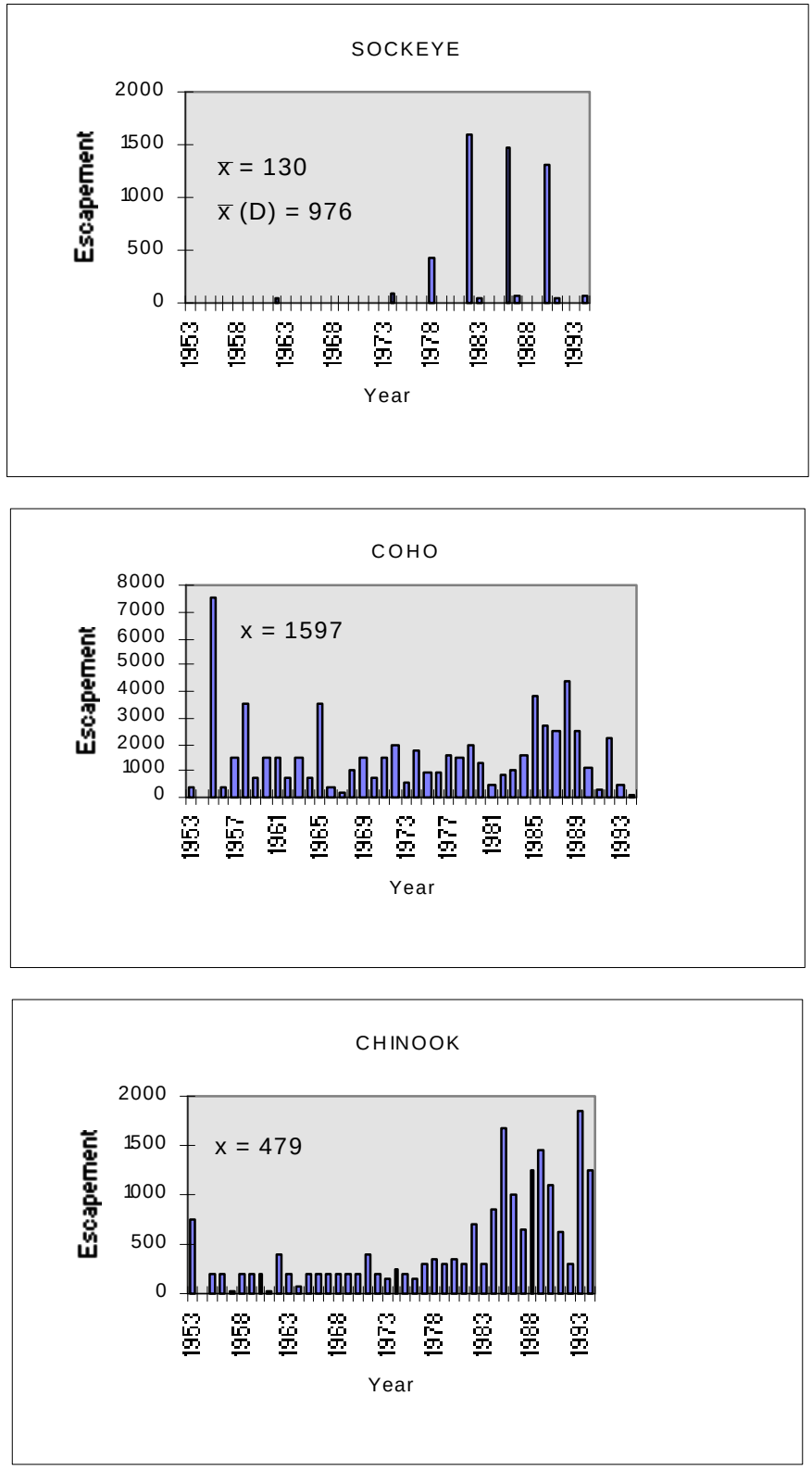
As mentioned there is more information available regarding salmon stocks on the Salmon River than trout and non-salmonid species. Available information regarding historical salmon runs in the Salmon River is summarized below.

Historically the river supported runs of pink, coho, chinook and sockeye salmon populations (Burt and Wallis, 1995). Sockeye runs were by far the dominant, with large runs occurring prior to 1913 (Anon, DFO, 1954). A 1905 account recorded by a DFO officer named David Salmond Mitchell refers to sockeye so densely schooled around his rowboat in the Salmon River when he awoke one late summer morning that the river ran red with a squirming, flapping mass so numerous that they crowded one another out of the river, up the banks and as they panicked and crowded downstream made the noise of thousands of ducks rising from a lake, followed downstream by a succession of waves as they rushed past (Anon, DFO, 1954 and Hume, 1992)[17]. These fish were important to Shuswap (Secwepemc) First Nations people who traditionally caught sockeye, chinook and coho from September to the end of October, "usually by spearing them in the river either from a canoe or from shore" (Neskonlith Fisheries Crew, 1993). They also became important to the marine fishing industry, along with many other runs which contributed to large but currently declining commercial catch of pacific salmon.

Fish abundance estimates are available from DFO escapement estimates for the three salmon species (coho, chinook and sockeye) currently utilizing the river system (Table 10 - Stream Survey Catalogue). Currently, approximately 1500-3000 salmon return to the Salmon River to spawn annually. Average annual returns for chinook, coho and sockeye since 1953 were 479, 1597 and 130 respectively. No chum or pink salmon have been seen in the system during that period. The escapement estimates for 1994 for chinook, coho and sockeye were 1262, 129 and 78 respectively, indicating a below average return during 1994 and an all time low in returning coho since 1955. Escapement records with four year moving averages superimposed are shown in Figure 11 and Table 10 (Burt and Wallis, 1995).

[17] paraphrased from Hume, 1992

FIGURE 11: ESCAPEMENT ESTIMATES FOR THE SALMON RIVER, 1953-1994



Source: Burt and Wallis, 1995

TABLE 10: ANNUAL SALMON ESCAPEMENT ESTIMATES FOR THE SALMON RIVER, 1953-1994

YEAR	SOCKEYE	COHO	PINK	CHUM	CHINOOK
1953	0	400	0	0	750
1954	-2	-2	-2	-2	-2
1955	0	7500	0	0	200
1956	0	400	0	0	200
1957	0	1500	0	0	25
1958	0	3500	0	0	200
1959	0	750	0	0	200
1960	0	1500	0	0	200
1961	0	1500	0	0	25
1962	45	750	0	0	400
1963	0	1500	0	0	200
1964	0	750	0	0	75
1965	0	3500	0	0	200
1966	0	400	0	0	200
1967	0	200	0	0	200
1968	0	1000	0	0	200
1969	0	1500	0	0	200
1970	0	750	0	0	200
1971	0	1500	0	0	400
1972	0	2000	0	0	200
1973	0	600	0	0	150
1974	92*	1800	0	0	250
1975	0	900	0	0	200
1976	0	900	0	0	150
1977	0	1588	0	0	300
1978	434*	1500	0	0	350
1979	0	2000	0	0	300
1980	0	1300	0	0	360
1981	0	500	0	0	300
1982	1602*	800	0	0	700
1983	50	1000	0	0	300
1984	0	1550	0	0	850
1985	0	3800	0	0	1670
1986	1465*	2700	-1	-1	1000
1987	75	2476	0	0	641
1988	0	4405	0	0	1252
1989	-1	2517	-1	-1	1456
1990	1300*	1070	-1	-1	1100
1991	41	308	-1	-1	616
1992	0	2250	-2	-2	300
1993	0	500	-2	-2	1850
1994	78	129	-2	-2	1262
TOTALS	5182	65493	0	0	19632

Note: -1 unknown -2 stream not inspected

* Sockeye are thought to be strays from the Adams River run rather that remnants of the Sockeye native to the Salmon River

Seasonality

Information regarding utilization of the Salmon River by various life stages of salmon is provided in the Stream Summary Catalogue (Anon, DFO, 1990), Whelen et. al. (1976) and in Burt and Wallis (1995). Table 11 summarizes this information.

TABLE 11 : LIFE HISTORY TIMING (SEASONALITY) OF SALMONID SPECIES IN THE SALMON RIVER[18]

Species	Life Stage	Utilization of Salmon River
		Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Chinook	migration	
	spawning	
	incubation	
	rearing	
Coho	migration	
	spawning	
	incubation	
	rearing	
Sockeye[19]	migration	
	spawning	
	incubation	
	rearing	
Rainbow[20]	migration	
	spawning	
	incubation	
	rearing	

An excerpt from Burt and Wallis, 1995 summarizes available information as follows: “In general sockeye use the river for spawning and incubation but not rearing. Adult sockeye generally migrate into the river in September and spawn from October to early November. Spawning is generally further downstream than for chinook or coho. Annual returns exhibit a 4-year cycle of peak abundance, which is strongly correlated with the 4-year cycle of the Adams run. After emergence most sockeye fry emigrate from the river and rear in Shuswap lake or points downstream for a year. The following spring the fish emigrate to the ocean as yearling smolts”. Capture of underyearling sockeye in August, and a few yearlings in spring by Whelen et. al. (1982) indicate that some sockeye rear in the river for various amounts of time. The original natural sockeye stocks which dominated the Salmon River until 1913 are thought to be extinct. Currently, sockeye returns are closely correlated with, and believed to be strays from the Adams River run.

Coho salmon use the Salmon River for spawning, incubation and rearing. Spawning generally occurs during the latter half of October through November. Spawning distribution is mainly from Silver Creek to Falkland. After emergence in April, most coho rear in the river for one

[18] information obtained from DFO Stream Summary Catalogue, Subdistrict # 29K, July 1990
[19] most sockeye fry emmigrate to Shuswap lake or points downstream to rear
[20] information from Burt and Wallis, 1995

year, and migrate to the ocean as yearling smolts the following spring. Sampling by Whelen et. al. (1982) indicated that a portion of the coho population emigrates from the river as underyearlings, and a small number of post-yearlings. The Whelen et. al. study also found that downstream migration of coho smolts and underyearlings was associated with decreasing discharge following spring freshet. They indicated that emigration was likely completed by the end of May.

Chinook salmon use the Salmon River for spawning, incubation and rearing. Migration of adults into the river occurs during July and August with spawning occurring primarily in September. Spawning is primarily from Silver Creek to Falkland. Fry emerge from the gravel in April. Rearing strategy of juvenile chinook appears variable. The study by Whelen et. al. (1982) indicated that some chinook emigrate from the river as underyearlings while others remain for the winter and emigrate as yearling smolts the following spring. The presence of an overwintering population was suggested by a sizeable catch of underyearlings in the upper reached in August, and the capture of 19 yearlings. Scale analysis of chinook adults from Whelen and Olmsted (1982) indicated that most Salmon River chinook smolted as yearlings. Thus, most chinook that emigrated from the Salmon River as underyearlings continued to rear in fresh water in other locations before smolting the following spring. The relative proportions of Salmon River chinook stock that emigrate as underyearlings versus as yearlings is unknown.

Little is known about the life history patterns of rainbow trout in the Salmon River. The Stream Catalogue indicates “spawning throughout”. Bison (1991) found high densities of spawning rainbow trout fry and parr in Bolean Creek, and in the mainstem near the confluence of Bolean Creek. Much lower densities were found at other mainstem locations. There is likely good spawning in Bolean Creek to account for the densities observed by Bison. Scott and Crossman (1973) describe rainbow trout as being spring spawners, mainly from mid-April to late June. Hatching occurs 4-7 weeks later, and emergence from the gravel after another 3-7 weeks. Emergence can occur between mid-June and mid-August for May-June spawners. They indicate that fry of lake resident spawners migrate to the lake almost immediately, or by Autumn, or some may remain in the river for 1-3 years before returning to the lake. In contrast, most stream-resident spawners remain in the stream. It would appear that most Salmon River rainbow are the stream-resident type. Evidence for this is the relatively few rainbow adults counted at the adult enumeration fence (4 in 1994), and the relatively few juveniles captured during the downstream trapping by Whelen et. al. (1982).[21]

Critical Habitats for Fish Sustainability

The areas critical to non-salmonid fish species in the Salmon River are not well understood. There is more information regarding critical habitat areas for the salmonids, albeit an incomplete understanding in itself. The observed abundance of trout and suitable trout habitat (Bison, BCE., Kamloops, unpublished data) indicate critical trout habitat in the Bolean Creek sub-basin. Issues of land use have not been actively pursued in the Bolean Creek drainage as yet by the SRWR due to resource shortages, however it would appear that effort toward protecting riparian habitat in Bolean Creek may be critical to sustenance of the resident trout population currently existing in the Salmon River at large.

The importance of the upper Salmon River, upstream of Salmon Lake and McInnis Creek and other tributaries such as Ingram and Nash Creeks, also needs to be addressed so these

[21] from Burt and Wallis, 1995

areas can be put into perspective, relative to perceived priorities in Bolean Creek. Co-operative research between BC Environment and the Roundtable may offer some resolution to this information shortfall.

A recent study by Burt and Wallis (1995) builds upon work by Whelen et. al.(1982), Pitre and Cross (1993) and others to assess current habitat availability and constraints to salmon spawning and rearing activities in the Salmon River system. The purpose of the 1994 field project (Burt and Wallis, 1995) was to begin assessing critical salmon habitats in the Salmon River in terms of minimum flow and carrying capacity. The study was to be conducted at 3 or 4 indicative flow regimes in order to build an interpolative database. As yet, data has only been collected at one flow regime (26% Mean Annual Discharge - MAD). One data set at 80% MAD, one at 40% MAD and a provision to add a data set representing a low flow of 10% MAD when such a low flow situation occurs are required to complete the original intent of the study. To date funding for study continuation has not been procured and it is uncertain whether it will be completed.[22] As a result it is not yet feasible to determine the salmon carrying capacity of the Salmon River. Nevertheless, in the interim, there are several useful conclusions regarding river character and salmon habitat reported by Burt and Wallis (1995) based on the single 26% MAD data set collected during October, 1994 which are summarized as follows.

Critical elements to salmon spawning and rearing habitat that are in short supply include undercut banks, large organic debris, large gravel and cobble substrate free of fine silt and sufficient cool water. The greatest usable area for rearing salmon was in reaches 4,6,7,8 and Bolean Creek (Figure 10). Reaches 1,2,3 and 8 contain high sediment bedloads "which diminish the suitability of rearing habitat through reduced insect production and infilling of interstitial cover spaces for rearing fish". Habitat complexity in reaches 1,2,3 and 8 was lacking in terms of riffle and pool habitat. Spawning habitat appears best in reach 7 and is also important in reaches 4,5 and 6. Pool habitat was notably scarce in the Salmon River consisting of 0-17% of reach areas. The apparent shortage of this critical habitat type is likely diminishing the river's rearing capacity particularly for juvenile chinook and coho. Reaches 6 and 7 were identified as having the greatest rearing capacities for all salmonid species, with lesser but significant capacities in reaches 4,5,8 and Bolean Creek. Reach 7 had the greatest potential spawning area followed by Reach 6 with similar but lesser amounts in Reaches 4 and 5. Figure 9 illustrates this.

A comparison of chinook, coho and sockeye escapement (return spawners) with estimates of currently available spawning habitat[23] for salmon indicated that the "…available spawning habitat is highly under-utilized. Failure of the Salmon River salmon runs to rebuild themselves despite sufficient spawning habitat suggests that production is being curtailed during a life stage other than spawning. Rearing habitat appears to be significantly more limiting than spawning habitat for rainbow, chinook, and coho…" (Burt and Wallis, 1995)

The amount of rearing habitat for chinook appears to be extremely limited, to the extent that it is sufficiently re-seeded by the current number of returning adults. However, in the case of coho, current returns do not appear numerous enough to fully re-seed existing rearing habitat. In most of the Salmon River the proportion of fine sediments in the river is higher than suitable

[22] At the present time continuation of this study is not viewed as a priority by DFO

[23] it is important to reiterate that these conclusions are provisional, as they are based on one third of the data base which should be used for drawing such conclusions. The data available is for 26% MAD flow regime (a relatively low flow) taken during October (a spawning season). The information is therefore more representative of the spawning scenario than the rearing scenario in the river and at any rate should be strengthened with other data sets before definitive statements are made.

for healthy egg development. Outside bends in the river, where undercut banks would normally develop in well vegetated riparian zones, lack sufficient vegetative cover to provide bank stability and as a consequence are actively eroding and sloughing away. The rate of loss has been up to 7-8 meters per year according to some landowner reports. In some locations of the river, cattle were observed trampling over fresh redds. The report by Burt and Wallis (1995) concluded that the top priority of the Salmon River Watershed Roundtable to restore a riparian corridor along the river is well assigned. The Salmon River appears to have tremendous fish potential. It has about 80 km of channel that is free from an excessively high gradient, and stream velocities that are generally favourable for rearing life stages. It has large expanses of gravel suitable for spawning and if the fines could be reduced, the river could support an abundance of spawners. Restoration of a riparian corridor and other habitat initiatives may go a long way to increasing fish production in the system.

Critical information gaps which have been identified in previous studies include: high summer water temperature effects on rearing, and effects of sedimentation on egg survivorship. Also, additional information is needed regarding rainbow and non-salmonid populations occurring in the watershed. As pointed out in Aquametrix (1995) there is a need to determine the inter-species habitat and predator/prey relationships operating between the non-salmonid and salmonid species. A restoration priority list proposed by Burt and Wallis (1995) is as follows:

- riparian corridor to provide cooler water, insect abundance, bank stabilization and lower oxygen demand
- pool habitat to increase rearing capacity irrespective of flow
- more data sets to enable an assessment of riffle habitat under different flow regimes.

A summary of critical habitats to salmonids and a reach by reach breakdown of the spawning and rearing habitat potential (measured at October, 1994 discharges) in the Salmon River system, are summarized in overview form in Figures 9 and 10 (after Burt and Wallis, 1995). Most of the spawning and rearing habitat for salmon lies within reaches 4, 5, 6 and 7. Of these reaches, 6 and 7 currently offer the greatest amount of useful spawning and rearing habitat. In this respect, the reaches contain critical habitat areas. Reaches 4 and 5 would benefit greatly from restoration as they appear to offer the greatest potential for habitat improvement.[24] Rainbow trout appear to concentrate in Bolean creek and probably also in reaches of the river upstream of the “dry reach” at Westwold, particularly in the canyon between the Salmon Valley and the Chapperon Valley physiographic subdivisions. A decision must still be made by the stakeholders of the SRWR whether maintenance of current fish stocks is a watershed management plan priority. If so, a closer look at summer low flow and maximum temperature data is important to better understanding of critical sites for habitat restoration. In the interim, restoration projects are underway at some key locations on the river (SRWR, 1995).

A recently completed study by Miles (1995) assessed channel stability in the Salmon River downstream of Westwold. The results of this analysis indicate that 42.6 km (or 28%) of the 154 km river bank between Salmon Arm and Westwold has little or no bank vegetation. An additional 33.5 km (or 22%) has a woody bank vegetation which is less than approximately half a channel width wide. In total, 76.1 km (or 50%) of the classified channel between Salmon Arm and Westwold is either unvegetated or poorly vegetated.

[24] assuming that upstream and downstream portions of the watershed do not interfere with use of this habitat by salmon.

Miles (1995) infers from Ralph (1975) that the reduced riparian cover has resulted in loss of stream shade, increased summer water temperatures and sediment load. Miles (1995) further states that wetland and backchannel areas in the valley bottom have been reduced due to development and that "these habitat alterations are of sufficient magnitude that they significantly affect the availability and diversity of fisheries habitat in Salmon River". Miles (1995) further classified 13% of the river bank between Salmon Arm and Westwold as actively eroding in 1990. Of that proportion, 65% of the eroding bank consisted of unvegetated river bank and a total of 71% was associated either with unvegetated or poorly vegetated riparian habitat.

The lack of information regarding non-salmonid fishes of the Salmon River is a potential issue for consideration by the SRWR since the entire system, including species assemblages, is comprised of linked ecological components. A greater understanding of non-salmonid species in the system and some of their linkages may improve understanding of the watershed as an ecosystem. Ongoing studies and projects being carried out within the watershed, discussed elsewhere in this document, regarding water quantity (Section 2.4) and water quality (Section 2.5) include the following studies:

- DOE ecosystem objectives monitoring program (Culp, Cash and Halliwell project)
- DFO 1995 water temp data collected using in-situ meters (Deep River Science Academy project) MOELP 1995, water quality data (Deep River Science Academy project)
- CWS/SFU 1994-95 Comparison of ecological stability at forested versus non-forested sites in the Salmon and Nicola Rivers (B. Vadas project)

Once completed it is expected that these projects will contribute to the understanding of fisheries habitat and other ecosystem health needs in the watershed.

Wetlands

Wetlands are important ecological components to a watershed ecosystem. They act as physical and ecological transition zones between upland and aquatic habitats. They serve many functions and provide stability to surrounding ecosystems. Some of the roles of wetlands which are becoming understood include:

- water level moderation
- water filtration
- water storage
- provide productive waterfowl, wildlife, insect, fish, reptilian, amphibian and plant habitat
- hydraulic energy absorption

Within the Salmon River watershed there are lacustrine (associated with lakes), riverine (associated with rivers) and palustrine (marsh, swamp or bog) wetlands. Most species which exist within a watershed rely on wetland or riparian areas at specific life stages. Even though wetlands are significant ecological components within the Salmon River watershed they are not well inventoried. Ducks Unlimited Canada have conducted inventories at some key locations which have recently been made available to the Salmon River Watershed Roundtable (I. Barnett, Ducks Unlimited Canada, pers. comm.).
Some of the significant wetlands existing within the watershed include:

- a wetland located in the delta area at Shuswap Lake supports a large diversity of species (see Section 2.3.3)
- an extensive drained wetland area located in upper watershed along the Salmon River exists with remaining adjacent wetland habitat supporting a wide variety of species
- remnant pocket wetlands along the Salmon River amongst developed farmland
- wetland areas surrounded by forested areas in upper watershed areas (see Section 2.3.2)

A total of 11,000 ha of wetland are estimated to exist within the entire 1,769,000 ha of the Okanagan TSA (ref OK TSA RMP 1992-96, p.21). 1.5% of this total wetland was designated as riparian zone (OK TSA Timber Supply Analysis, Nov. 1993, p.5). No further breakdown of this information was available which is specific to the Salmon River watershed. The entire Salmon River watershed (1510 km^2) represents approximately 8.5% of the total TSA area (1,769,000 ha).

The total wetland area existing within the Salmon River Watershed is not known. The Recreation, Open Space and Environment Study (ROSE) undertaken by the District of Salmon Arm (District of Salmon Arm,1995) stated that "The exact extent, type and location of the wetlands found within the foreshore areas in the District of Salmon Arm has not been studied in detail". Considering the intense burden of use on wetland and riparian areas and the current lack of detailed information about location, quantity and character of these ecosystem components, an information gap exists which should be addressed under ongoing watershed based planning processes.

As reported by Miles (1995) wetlands in the Salmon River Valley have been reduced due to channelization and drainage activities. "Meander cutoffs and ditches have also been excavated to drain wetlands and reduce the area occupied by the Salmon River....These impacts are significant in terms of channel stability, water storage, bio-diversity and ecological stability for the affected and surrounding areas". A 1982 Salmon Valley OCP Study (CSRD, 1982) states that "in several reaches of the river, there is evidence of channel straightening by bulldozers, apparently carried out as a flood protection measure" .The ROSE study (1995) suggested a need to connect riparian and floodplain habitat reserves to other habitat types, using rivers and creeks to form natural linkages as much as possible. This was cited as an objective of ecosystem based management by T. Antifeau, BCE, (Salmon Arm, pers. comm.). Achieving connectivity between important corridors is especially difficult following development. Attempts are being made to do so in undeveloped areas as part of current land use planning practices.

The width of riparian and wetland area setbacks has a great deal to do with corridor effectiveness. A variety of recommendations regarding setback widths exists. The ROSE study (District of Salmon Arm,1995) recommended a 15 m setback from streams, rivers, creeks and wetlands draining into riparian zones. The study designated wetlands as environmentally sensitive areas of high economic value and are easily impacted by typical rural and suburban development. Miles (1995) recommends a setback for re-establishment of lost riparian cover of about 6 times the channel width (or at least 60 m on average). This goal would likely prove impractical in developed portions of the Salmon River Watershed at the present time. Current restoration projects undertaken are utilizing a 10 m buffer strip under voluntary agreement with co-operative landowners. Future possibilities for enlarging riparian buffers would depend on public acceptance, funding availability and practical use of land convenants.

Interactions Between Land Use Activities and Aquatic Ecosystems

The decline in Salmon River salmon stocks is a result of factors based in the watershed, such as land use practices, as well as factors that are neither locally based nor controlled, such as the Hells Gate slide of 1913 and commercial fishing pressure in coastal waters off British Columbia and Alaska. There seem to be three types of factors affecting the decline in salmon stocks in the Salmon River :

- access denial to spawning and rearing habitat

- commercial fishing
- habitat degradation (including low flow problems)

The Hells Gate slide of 1913, which was caused by blasting operations in the Fraser Canyon during railway construction denied the returning Salmon River sockeye stocks access to their spawning grounds. Historically the large Salmon River sockeye run normally came up the Fraser Canyon in August. “The fish were heavily impacted by the slide due to their upstream migration coinciding with a period when hydraulics at the slide were most impassable” (Burt and Wallis, 1995). This early run is thought to be one of the hardest hit by the 1913 slide. The stronger swimming chinook and later arrival coho also destined for the Salmon River that year and in successive years following the slide, were apparently less affected by the altered hydraulics at the slide because they had greater success in returning to spawn in the Salmon River than did the sockeye. Very few sockeye returned to the Salmon River in 1913 and through successive years returns continued to dwindle until 1925 when the once abundant sockeye run had become virtually extinct (anon DFO).

Whereas the Hells Gate slide took its toll on sockeye runs native to the Salmon River between 1913 and 1925, recently another potential access problem has become evident during low flow periods at the confluence of the Salmon River mouth (at Shuswap Lake). There may be insufficient water coming down the Salmon River to allow fish safe passage from the Shuswap Lake holding area through the shallow delta area of the river to the upstream spawning areas. The frequency and magnitude of this factor has not been adequately documented. Locally initiated attempts in recent years (circa 1992) to assist salmon unable to negotiate the first stretch of river at the delta indicates a need to look more closely at this access denial factor relative to other encumbrances which returning salmon face in the Salmon River today. Factors contributing to this could be excessive soft silt fall-out at the delta, resulting from upstream erosion and low river discharge coinciding with spawner emigration. Miles (1995) indicates that at the delta area a “new distributary channel” has formed with “extensive” sediment loads which “appear to be principally derived from river bank erosion”. The low flow issue has also been fairly well tied to high irrigation demand (Obedkoff, 1976), which is discussed in Section 2.4 . The interrelationship between riparian and upland logging practices on both private and crown lands, and summer low flows exacerbated by irrigation withdrawals, is uncertain. An access denial factor related to shallow water may bear on accessibility of existing spawning habitat to salmon, some years more than others, due to a combination of low flow and a widened, shallow delta morphology.

In addition to the access denial experiences by Salmon River salmon stocks, incremental habitat loss has occurred in the Salmon River watershed. This occurred in relation to European settlement, beginning during the last half of the 1800’s. The watershed was once forested. Large cedar, cottonwood, fir and pine were removed in land clearing and logging operations in the valley bottom. A Department of Fisheries and Oceans report (Anon., DFO, 1954) estimated that 80% of the arable valley bottom land in the Salmon Valley was under cultivation by 1954. Logging also occurred in upper portions of the watershed. Northwest Hydraulic Consultants (1992) indicated that 40.1% of the watershed has been logged at one time or another over the past 100 years and that 5.6% of the watershed land base was classified as improved farmland as of 1990. As logging, ranching and farming practices developed in the Salmon River Watershed salmonid habitat was alienated. A myriad of land use related habitat impacts such as sedimentation, loss of undercut banks, loss of river shading, reduced overstream insect production and low flow reductions have all had an impact on the salmon carrying capacity of the Salmon River. Many of these can be directly related to loss of riparian cover.

The task of managing the multitude of sea run salmon stocks native to B.C. rivers is complicated. International agreements on quotas, balancing harvests between commercial, recreational and native users, uncertainty of offshore mortality rates, ecological shifts occurring in ocean habitats, and difficulty in estimating brood year sizes present complex management issues for those charged with the task of determining amount, location and timing of harvests.

The challenge has become how to protect critical stocks to minimum threshold levels such that upriver productivity is sustained, while harvesting the maximum amount of salmon surplus to these needs. This is particularly complicated by the tendency of small, river-specific return runs, such as the Salmon River runs of today, to be masked by larger runs marked for harvest, due to synchronized returns of different fish stocks through fishing grounds. Since the industry is not capable of distinguishing the destination of individual fish, fishing openings must be timed and located to correspond with expected rendezvous with stocks intended for harvesting. In all of this there is a management need to harvest the maximum number of fish and protect the genetic pool of salmon stocks to achieve sustainability.

There has been a recent realization that the many small stocks returning to spawn in a large number of smaller BC streams represent the genetic backbone to healthy salmon populations. Even with the tremendous effort to date in the area of salmon stock inventory and enhancement, there is still much more that is not known than what is known about B.C. river run salmon populations. Yet, the commercial industry, in Canada and internationally, demands efficiency in salmon fishery management to meet growing consumer demands. Now that it is better understood that enhancing a few key runs to the exclusion and in some cases over-exploitation of other smaller stocks is not sustainable, the issue of developing more specific harvesting strategies is being carefully considered by DFO managers. It is difficult to protect the smaller stocks (and their gene pools) from efficient, indiscriminate fishing techniques used to achieve target harvest quotas in a highly competitive, often very short time window. These external forces are not within the grasp of the SRWR to control, and yet they are a potential issue to consider if maintenance of Salmon River salmon stocks is determined to be a SRWR priority. The solution to this problem will not come easily, however if resolved it will satisfy a need which goes far beyond the Salmon River watershed, to many other salmon bearing streams all over BC and Alaska. There remains a need to implement recommendations made by Obedkoff (1976) for more efficient irrigation practices such as water metering and scheduled watering.

Efforts to strengthen salmon runs to the Salmon River by dealing with local issues such as emigration rates of river reared salmon have included rearing of eggs from the Salmon River at the Eagle River hatchery and return of these Salmon River gene pool fish as fry (satellite rearing). Over an 11 year period an average of 229,240 chinook and 298,547 coho were thus released in an attempt to bolster chinook and coho stocks, with limited success. An assessment by Pitre and Cross (1993) provides interesting insight into this and has been briefly reviewed in Burt and Wallis (1995). Earlier attempts involved a number of attempted transplants of stock reared from the Seymour River genetic stocks (Aquametrix, 1995).

Recently, habitat improvement initiatives have been undertaken by the Salmon River Watershed Roundtable with sponsorship from landowners, First Nations, DFO and MOF. Currently 26 sites have undergone riparian habitat rehabilitation including the following techniques:

- fencing : to limit livestock access to the river banks and channel

- tree planting: to revegetate and stabilize banks
- tree revetment construction: to stabilize eroding banks, provide fish habitat and dissipate hydraulic energy instead of transferring it downstream
- rip-rap installation: to stabilize eroding streambanks where tree revetments are inappropriate

Descriptions of projects undertaken and the strategy behind them are provided by Crowe (1994) and SRWR (1995). Additionally, DFO has undertaken two other projects aimed at enhancing rearing habitat. These are the construction of a groundwater fed rearing channel and installation of a series of low profile, rock weirs. The rearing channel provides a combination of consistently flowing, high quality, low temperature groundwater combined with suitable cover components which can provide rearing potential equivalent to 20 km of river length with every 1 km of channel constructed (M.Sheng, DFO, Pers, comm.). The weir structures provide pool habitat to rearing fish while also dissipating hydraulic energy in stages, as river water moves downstream serving to reduce bank erosion (M. Sheng, DFO, Pers. comm.).

All of these projects are being accomplished as a result of landowner cooperation, often including voluntary restriction of livestock access to river habitats. A strategy to link these restored riparian areas into a riparian corridor has been put forth by M. Crowe, DFO and is currently being pursued by the SRWR with continuing assistance from DFO and MOF. These site locations are illustrated on Figure 12. Additional restoration sites are currently being planned (SRWR).

Various studies have described the need for the re-establishment of riparian vegetation. The question of how wide a riparian corridor is necessary to be effective has not been resolved. Miles (1995) determined that a corridor 6-7 times the current channel width would be necessary to accommodate the tendency for channel course movement. Based on measurements of channel width provided in Burt and Wallis (1995) this would translate to an average corridor width of 10 meters on each river bank, or a total average corridor width of about 60 meters including the existing channel width and a suitable riparian buffer on either bank. The District of Salmon Arm's Recreation, Open Space and Environment Study (ROSE) (District of Salmon Arm, 1995) study proposed a 15 - 60 m setback from wetlands, creeks and rivers be established within the district of Salmon Arm during an assessment of the potential for sustainable development within the District of Salmon Arm.

Approximate location of
Riparian Restoration Projects

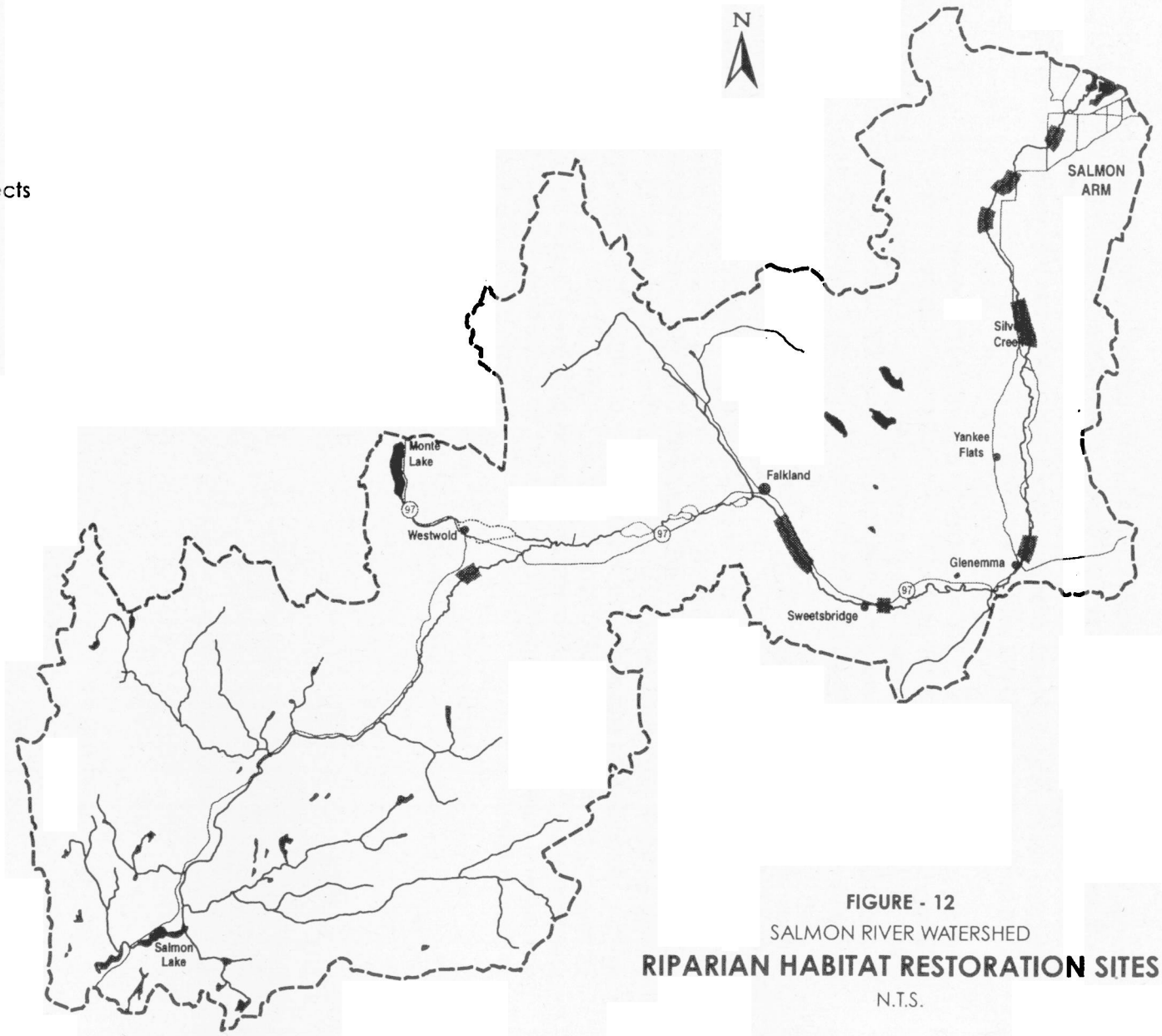


FIGURE - 12

SALMON RIVER WATERSHED

RIPARIAN HABITAT RESTORATION SITES

N.T.S.

The difference between technically based recommendations for riparian buffer width and practicable buffer widths, acceptable to landowners has not been addressed as yet by the stakeholders of the Salmon River Watershed Roundtable. Currently, it is generally viewed amongst members of the Technical committee of the SRWR that a narrower buffer, which has some prospect of becoming contiguous along the length of the Salmon River is a more achievable goal to pursue than a wider zone that is likely to meet with less landowner support. To date, landowners participating in streambank restoration projects have voluntarily agreed to sacrifice a 10m strip of land on each bank by alienating it from agricultural production and unrestricted livestock access (M. Crowe, DFO, Kamloops, pers. comm.). M. Crowe has succeeded in beginning the process of riparian corridor restoration by gaining the cooperation and trust of a growing number of landowners. Through individual, plain language agreements with individual landowners, some continuity in a riparian buffer strip is being achieved along the Salmon River (Figure 12). Significant effort is still required, however, to continue building momentum towards complete riparian corridor restoration.

Also, it should not be overlooked that although a commercial and sport fishing industry continue along the BC and Alaskan coast, there is no commercial, or sports harvest of returning salmon in the Salmon River. Local First Nations have also stated their own no-harvest policy as a show of concern for the state of these dwindling salmon stocks. In this way salmon stocks native to the watershed are being protected at source.

Current Issues/ Anticipated Trends

- rearing and spawning habitat loss have resulted from past land and resource use practices
- summer low flow of river channel waters compounds the effects of water quality and habitat loss factors
- irrigation withdrawals and logging practices impact surface flow at critical times of the year
- the potential for native fisheries resource claims creates concern and uncertainty amongst other stakeholders
- current water demand and budget for the watershed are unknown including groundwater storage and discharge capacities and withdrawals
- lack of knowledge of wetland location, area, ecological and water storage roles in watershed sustainability
- ecosystem linkages e.g., water budget relationship to sustainable fish resources
- re-establishing the riparian corridor
- riparian corridor width
- unknown salmon carrying capacity and inability to model effects of various discharges on carrying capacity
- erosion control
- beaver management

2.3.3 Wildlife Resources, Populations, Distribution and Seasonality

Birds

Abundance and Diversity

A wide diversity of bird species, attracted by habitats ranging from the Salmon River delta to riparian zones in the valley bottoms to high elevation ESSF biogeoclimatic zone habitats, are found within the Salmon River Watershed. A total of 233 species is expected to regularly utilize these habitats. Table 12 lists all bird species expected to regularly occur within the watershed, their seasonal occurrence, status and habitat utilization. Approximately 160 of these species are known to nest. The remaining species utilize habitats within the watershed during migration or during winter. As indicated by Table 12, wetland, riparian and forested habitats (i.e., CF, DF, SH and MA) are particularly important to birds, each supporting a high species richness. Riparian habitats are particularly important to neotropical migrants such as warblers, flycatchers, vireos and thrushes which require a rich food source before continuing their migration to breeding or wintering grounds. The extensive wetland complex at the mouth of the Salmon River watershed and nearby seasonally flooded farmland areas are of important to waterfowl, shorebirds, herons and other bird species.

Rare, Endangered and Vulnerable Species

Fifty-nine pairs of western grebes with 103 young, were tallied at the mouth of the Salmon River in 1995. An additional survey on 01 August 1995 tallied a total of 296 adults and approximately 100 young indicating that the Bay is also utilized by non-breeding adults arriving from other areas (F. Kime, pers. comm., 1995). The importance of the wetland to the grebes has been identified by Hayes *et al.* (1993), the BC Conservation Data Centre (CDC) (pers. comm., 07 July 1995) and the District of Salmon Arm (1995). The District of Salmon Arm has provided additional protection for the colony by putting restrictions on human activity. No motorized boats are permitted within 100 m and a speed restriction of 15km/hr within 300 m of the colony has been established. Pedestrians are restricted within 50 m of the colony.

Three great blue heron colonies are known to occur at the base of Mount Ida near Salmon Arm Bay. Colony locations are: a) below the north face of Mount Ida and above the Salmon Arm Cemetery; b) below the southeast face of Mount Ida on Grandview Bench and c) possibly only one nest in Mount Ida Park two kilometres west of the Salmon Arm cemetery and north of Foothill Road (F. Kime, pers. comm., 1995). Great blue herons are blue-listed (i.e., sensitive and vulnerable) by BCE and are susceptible to disturbance especially during the breeding season. All human activity in the vicinity of heron nesting areas should be restricted during the breeding season. The District of Salmon Arm has indicated that nesting areas should be left in their natural state with no activity within 100 m during the nesting period. It is unlawful (B.C. Wildlife Act) to remove or disturb heron nests in use or not.

Six active osprey nests have been identified in the vicinity of the Salmon River mouth (F. Kime, pers. comm., 1995). Ospreys are relatively common in British Columbia but are given special protection under the B.C. Wildlife Act. Ospreys require a consistent and available supply of fish and old trees, pilings or platforms for nesting. Installation of artificial nest platforms have been successful in many areas of North America. Two active bald eagle (blue-listed by BCE) nests are also known to occur along the shore of Salmon Arm Bay.

TABLE 12 BIRD SPECIES OCCURRENCE AND HABITAT UTILIZATION IN THE SALMON RIVER WATERSHED, INCLUDING THE SALMON RIVER DELTA

BIRD SPECIES	FREQUENCY OF OCCURRENCE	SEASONAL OCCURRENCE				HABITAT UTILIZATION							
		Sp	Su	Fa	Wi	CF	DF	SH	GR	MA	AQ	UR	RK
LOONS													
Common Loon	UncSuRes;RarWiRes									+	+		
Pacific Loon	RarMig										+		
GREBES													
Pied-billed Grebe	UncSuRes									+	+		
Horned Grebe	ComSuRes;UncWiRes									+	+		
Eared Grebe	UncSumRes;RarWiRes									+	+		
Red-necked Grebe	UncSuRes;RarWiRes									+	+		
**Western Grebe	ComSuRes;OccWiRes									+	+		
PELICANS													
**American White Pelican	RarMig									+	+		
BITTERNS & HERONS													
*American Bittern	RarSuRes									+			
*Great Blue Heron	UncRes					+	+		+	+	+		
SWANS & GEESE													
Tundra Swan	ComWiRes									+	+		
*Trumpeter Swan	UncWiRes									+	+		
Canada Goose	ComRes								+	+	+		
Snow Goose	RarMig								+	+			
SURFACE FEEDING DUCKS													
Wood Duck	UncSuRes						+			+	+		
Mallard	ComRes								+	+	+	+	
Green-winged Teal	ComSuRes;RarWiRes									+	+		
Northern Pintail	UncSuRes									+	+		
Blue-winged Teal	ComSuRes									+	+		
Cinnamon Teal	UncSuRes									+	+		
Northern Shoveler	UncSuRes									+	+		
Gadwall	UncSuRes;OccWiRes									+	+		
American Wigeon	ComSuRes;UncWiRes								+	+	+	+	

BIRD SPECIES	FREQUENCY OF OCCURRENCE	SEASONAL OCCURRENCE				HABITAT UTILIZATION							
		Sp	Su	Fa	Wi	CF	DF	SH	GR	MA	AQ	UR	RK
DIVING DUCKS													
Canvasback	UncMig									+	+		
Redhead	UncMig									+	+		
Ring-necked Duck	UncSuRes									+	+		
Greater Scaup	ComWiRes										+		
Lesser Scaup	ComSuRes;UncWiRes									+	+		
Harlequin Duck	RarSuRes										+		
*Surf Scoter	UncMig										+		
White-winged Scoter	RarSuRes									+	+		
Common Goldeneye	UncWiRes;ComMig					+	+			+	+		
Barrow's Goldeneye	ComRes					+	+			+	+		
Bufflehead	ComMig					+	+			+	+		
Hooded Merganser	UncSuRes					+	+			+	+		
Common Merganser	UncRes					+	+			+	+		
Red-breasted Merganser	RarSpMig									+	+		
Ruddy Duck	UncSuRes									+	+		
VULTURES													
*Turkey Vulture	RarSuRes								+				+
HAWKS & EAGLES													
Osprey	UncSuRes					+	+			+	+		
*Bald Eagle	UncRes					+	+			+	+		
Northern Harrier	UncSuRes;RarWiRes							+	+	+			
Sharp-shinned Hawk	UncSuRes;RarWiRes					+	+	+				+	
Cooper's Hawk	UncSuRes;RarWiRes					+	+	+					
Northern Goshawk	RarRes					+	+	+					
*Swainson's Hawk	UncSuRes							+	+				
Red-tailed Hawk	ComSuRes;UncWiRes					+	+	+	+				
Rough-legged Hawk	RarWiRes							+	+				
Golden Eagle	RarRes							+	+				+
FALCONS													
American Kestrel	ComSuRes;RarWiRes							+	+				
Merlin	RarRes					+	+	+	+	+	+	+	
**Prairie Falcon	RarMig								+	+			+
Gyrfalcon	RarWiRes								+	+			
*Peregrine Falcon	RarMig								+	+			+

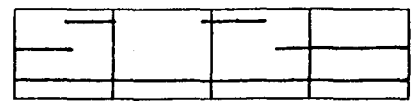
BIRD SPECIES	FREQUENCY OF OCCURRENCE	SEASONAL OCCURRENCE				HABITAT UTILIZATION							
		Sp	Su	Fa	Wi	CF	DF	SH	GR	MA	AQ	UR	RK
GROUSE													
Spruce Grouse	RarRes	—	—	—	—	+	+	+					
Blue Grouse	UncRes	—	—	—	—	+	+	+					
Ruffed Grouse	UncRes	—	—	—	—	+	+	+					
Sharp-tailed Grouse	RarRes	—	—	—	—			+	+				
California Quail	RarRes	—	—	—	—			+	+				
Ring-necked Pheasant	UncRes	—	—	—	—			+	+				
RAILS to CRANES													
Virginia Rail	UncSuRes	—	—	—						+	+		
Sora	UncSuRes	—	—	—						+	+		
American Coot	ComSuRes	—	—	—					+	+	+		
*Sandhill Crane	RarSuRes;UncMig	—	—	—					+	+			
SHOREBIRDS													
Black-bellied Plover	UncMig			—						+			
*American Golden Plover	RarFaMig			—						+			
Semipalmated Plover	UncMig		—	—						+			
Killdeer	ComSuRes;RarWiRes	—	—	—	—				+	+		+	
Greater Yellowlegs	ComMig	—	—	—						+			
Lesser Yellowlegs	ComMig	—	—	—						+			
Solitary Sandpiper	UncMig	—	—	—						+			
Spotted Sandpiper	UncSuRes	—	—	—						+			
*Long-billed Curlew	UncSuRes	—	—						+	+			
Sanderling	RarFaMig			—						+			
Semipalmated Sandpiper	RarSpMig;UncFaMig		—	—						+			
Western Sandpiper	ComFaMig		—	—						+			
Least Sandpiper	UncSpMig;ComFaMig	—	—	—						+			
Baird's Sandpiper	RarSpMig;UncFaMig	—	—	—						+			
Pectoral Sandpiper	RarSpMig;UncFaMig	—	—	—						+			
Dunlin	RarMig	—		—						+			
Stilt Sandpiper	RarFaMig			—						+			
Long-billed Dowitcher	UncSpMig;ComFaMig	—	—	—						+			
Common Snipe	UncSuRes	—	—	—						+			
Wilson's Phalarope	UncSuRes	—	—	—						+	+		
*Red-necked Phalarope	RarSpMig;ComFaMig	—	—	—						+	+		

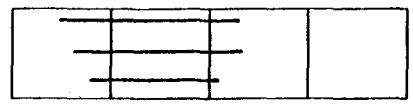
BIRD SPECIES	FREQUENCY OF OCCURRENCE	SEASONAL OCCURRENCE				HABITAT UTILIZATION							
		Sp	Su	Fa	Wi	CF	DF	SH	GR	MA	AQ	UR	RK
GULLS & TERNS													
Franklin's Gull	RarFaMig									+	+		
Bonaparte's Gull	UncMig									+	+		
Mew Gull	RarMig									+	+		
Ring-billed Gull	ComSuRes;RarWiRes								+	+	+	+	
*California Gull	UncSuRes&Mig								+	+	+		
Herring Gull	UncSuRes;ComMig									+	+	+	
Thayer's Gull	RarWiRes									+	+		
Glaucous-winged Gull	RarFaMig									+	+	+	
Glaucous Gull	RarWiRes									+	+		
*Caspian Tern	OccSuVag									+	+		
Common Tern	UncMig										+		
Black Tern	UncSuRes									+			
DOVES													
Rock Dove	ComRes											+	+
Mourning Dove	ComSuRes;UncWiRes						+	+				+	
OWLS													
*Western Screech Owl	RarRes					+	+						
*Flammulated Owl	UncSuRes					+	+						
Great Horned Owl	UncRes					+	+						
Snowy Owl	RarWiRes							+	+	+			
Northern Pygmy Owl	UncRes					+	+						
Barred Owl	UncRes					+	+						
Great Gray Owl	RarRes					+	+						
Northern Hawk-Owl	RarRes					+	+						
Long-eared Owl	RarSuRes					+	+	+					
*Short-eared Owl	RarRes							+	+	+			
Boreal Owl	RarRes					+	+						
Northern Saw-whet Owl	UncRes					+	+						
NIGHTJARS & SWIFTS													
Common Nighthawk	ComSuRes					+	+		+				
Common Poorwill	RarSuRes					+	+		+				
Black Swift	UncSuRes												+
Vaux's Swift	UncSuRes					+	+						
*White-throated Swift	RarSuRes												+

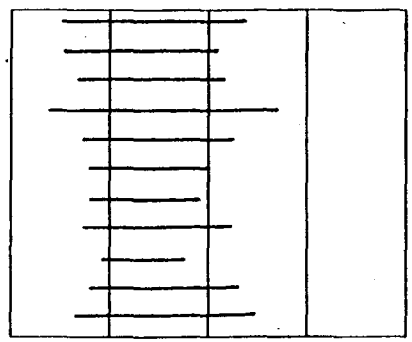
BIRD SPECIES	FREQUENCY OF OCCURRENCE	SEASONAL OCCURRENCE				HABITAT UTILIZATION							
		Sp	Su	Fa	Wi	CF	DF	SH	GR	MA	AQ	UR	RK
HUMMINGBIRDS to KINGFISHERS													
Rufous Hummingbird	ComSuRes					+	+	+					
*Black-chinned Hummingbird	RarSuRes						+	+					
Calliope Hummingbird	UncSuRes						+	+					
Belted Kingfisher	UncSuRes;RarWiRes									+	+		
WOODPECKERS													
*Lewis' Woodpecker	RarSuRes					+	+	+	+			+	
Red-naped Sapsucker	ComSuRes					+	+						
Downy Woodpecker	UncRes					+	+	+				+	
Hairy Woodpecker	UncRes					+	+						
Three-toed Woodpecker	UncRes					+	+						
Black-backed Woodpecker	RarRes					+	+						
Northern Flicker	ComRes					+	+					+	
Pileated Woodpecker	UncRes					+	+						
FLYCATCHERS & LARKS													
Olive-sided Flycatcher	UncSuRes					+	+						
Western Wood-Pewee	ComSuRes					+	+						
Willow Flycatcher	UncSuRes							+					
Least Flycatcher	RarSuRes						+						
Hammond's Flycatcher	UncSuRes					+							
Dusky Flycatcher	ComSuRes						+	+					
Pacific-slope Flycatcher	UncSuRes					+	+						
Say's Phoebe	UncSuRes							+	+				
Western Kingbird	ComSuRes						+	+	+				
Eastern Kingbird	UncSuRes							+		+			
Horned Lark	UncMig								+				
SWALLOWS													
Tree Swallow	ComSuRes					+	+			+		+	
Violet-green Swallow	ComSuRes					+	+			+		+	+
N. Rough-winged Swallow	ComSuRes									+			
Bank Swallow	ComSuRes									+			
Cliff Swallow	ComSuRes									+			+
Barn Swallow	ComSuRes									+		+	

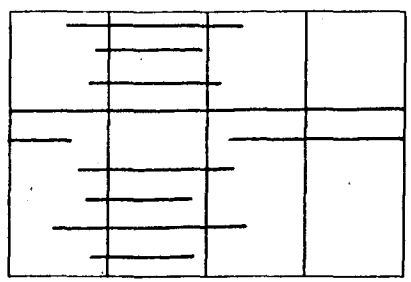
BIRD SPECIES	FREQUENCY OF OCCURRENCE	SEASONAL OCCURRENCE				HABITAT UTILIZATION							
		Sp	Su	Fa	Wi	CF	DF	SH	GR	MA	AQ	UR	RK
JAYS & CROWS													
Gray Jay	UncRes					+	+						
Steller's Jay	UncRes					+	+					+	
Clark's Nutcracker	UncRes					+							
Black-billed Magpie	ComRes							+	+				
American Crow	ComSuRes;UncWiRes					+	+	+	+			+	
Common Raven	ComRes					+	+	+	+				+
CHICKADEES – CREEPERS													
Black-capped Chickadee	ComRes						+	+				+	
Mountain Chickadee	ComRes					+	+						
Boreal Chickadee	UncRes					+	+						
Chestnut-backed Chickadee	RarRes					+	+						
Red-breasted Nuthatch	ComRes					+	+						
White-breasted Nuthatch	UncRes					+							
Pygmy Nuthatch	UncRes					+							
Brown Creeper	UncRes					+	+						
WRENS, DIPPERS													
Rock Wren	RarSuRes												+
House Wren	RarSuRes						+	+				+	
Winter Wren	UncSuRes					+	+						
Marsh Wren	UncSuRes									+			
American Dipper	RarRes										+		
KINGLETS, THRUSHES													
Golden-crowned Kinglet	UncRes					+	+						
Ruby-crowned Kinglet	ComSuRes					+	+						
Mountain Bluebird	ComSuRes							+	+				
Western Bluebird	UncSuRes							+	+				
Townsend's Solitaire	UncRes					+	+	+					
Veery	UncSuRes						+	+					
Swainson's Thrush	ComSuRes					+	+						
Hermit Thrush	ComSuRes					+	+	+					
American Robin	ComSuRes;RarWiRes					+	+						
Varied Thrush	UncSuRes;RarWiRes					+	+						
Gray Catbird	RarSuRes							+					

BIRD SPECIES	FREQUENCY OF OCCURRENCE	SEASONAL OCCURRENCE				HABITAT UTILIZATION							
		Sp	Su	Fa	Wi	CF	DF	SH	GR	MA	AQ	UR	RK
PIPITS, WAXWINGS													
American Pipit	ComMig								+	+			
Bohemian Waxwing	ComWiRes					+	+	+				+	
Cedar Waxwing	ComSuRes;RarWiRes						+	+				+	
SHRIKES, STARLINGS													
Northern Shrike	UncWiRes							+	+				
European Starling	ComRes					+	+	+	+			+	
VIREOS													
Solitary Vireo	UncSuRes					+	+						
Warbling Vireo	ComSuRes						+	+					
Red-eyed Vireo	ComSuRes						+						
WARBLERS													
Orange-crowned Warbler	UncSuRes					+	+	+					
Nashville Warbler	UncSuRes					+	+						
Yellow Warbler	UncSuRes							+	+				
Yellow-rumped Warbler	ComSuRes					+	+						
Townsend's Warbler	UncSuRes					+							
American Redstart	UncSuRes						+	+					
Northern Waterthrush	RarSuRes					+	+			+			
MacGillivray's Warbler	UncSuRes							+					
**Yellow-breasted Chat	Extirpated?							+					
Common Yellowthroat	UncSuRes							+		+			
Wilson's Warbler	UncSuRes						+	+					
SPARROWS, BLACKBIRDS													
Western Tanager	ComSuRes					+	+						
Black-headed Grosbeak	RarSuRes?						+						
Lazuli Bunting	UncSuRes							+					
Rufous-sided Towhee	RarSuRes;OccWiRes							+					
American Tree Sparrow	RarWiRes							+					
Chipping Sparrow	ComSuRes					+	+	+					
Clay-colored Sparrow	RarSuRes							+	+				
Vesper Sparrow	ComSuRes								+				
*Lark Sparrow	RarSuRes							+	+				

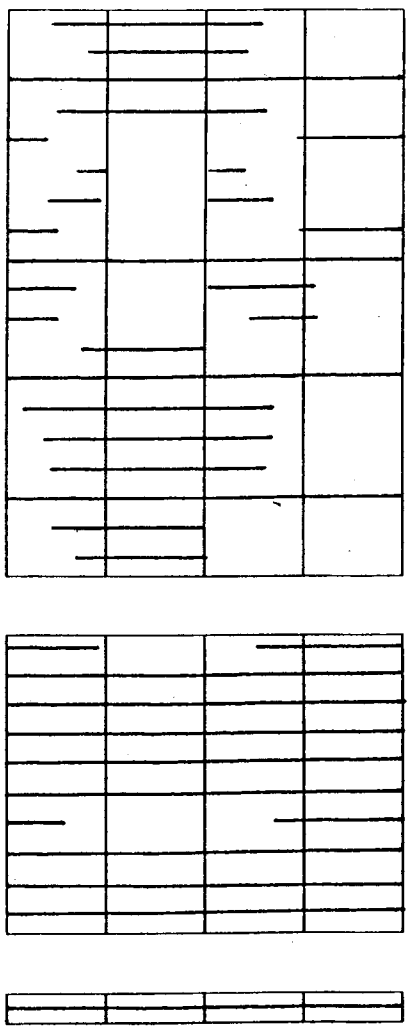








BIRD SPECIES	FREQUENCY OF OCCURRENCE	SEASONAL OCCURRENCE				HABITAT UTILIZATION							
		Sp	Su	Fa	Wi	CF	DF	SH	GR	MA	AQ	UR	RK
SPARROWS, BLACKBIRDS Cont.													
Savannah Sparrow	ComSuRes								+				
Fox Sparrow	RarSuRes;UncMig							+					
Song Sparrow	ComSuRes;UncWiRes							+				+	
Lincoln's Sparrow	UncSuRes							+					
White-throated Sparrow	RarWiRes							+					
Golden-crowned Sparrow	RarMig							+				+	
White-crowned Sparrow	RarWiRes;ComMig							+				+	
Harris' Sparrow	RarWiRes							+				+	
Dark-eyed Junco	ComRes					+	+	+				+	
Lapland Longspur	RarMig								+				
Snow Bunting	RarMig								+				
*Bobolink	RarSuRes								+	+			
Red-winged Blackbird	ComSuRes;UncWiRes							+		+			
Western Meadowlark	ComSuRes								+				
Yellow-headed Blackbird	ComSuRes									+			
Rusty Blackbird	RarSuRes							+		+			
Brewer's Blackbird	ComSuRes;UncWiRes							+	+			+	
Brown-headed Cowbird	ComSuRes					+	+	+	+	+		+	
Northern Oriole	UncSuRes						+						
FINCHES													
Gray-crowned Rosy-Finch	RarWiRes								+				+
Pine Grosbeak	UncRes					+	+	+					
Cassin's Finch	ComSuRes;RarWiRes					+	+						
House Finch	ComRes							+				+	
Red Crossbill	ComRes					+							
White-winged Crossbill	RarRes					+							
Common Redpoll	ComWiRes					+	+	+					
Pine Siskin	ComRes					+	+						
American Goldfinch	UncSuRes;RarWiRes							+					
Evening Grosbeak	UncSuRes;ComWiRes					+	+	+					
OLD WORLD SPARROWS													
House Sparrow	ComRes							+				+	



Note 1: '*' = blue-listed by B.C. Ministry of Environment; '**' = red-listed.
Note 2: References include Campbell et al. 1988, Campbell et al. 1990, Cannings 1989, Howie 1994 and Shuswap Naturalist's Club 1983.

Frequency of Occurrence

Com = Common
Unc = Uncommon
Rar = Rare
Occ = Occasional

Seasonal Occurrence

Res = Resident
Mig = Migrant
Vag = Vagrant
Sp = Spring
Su = Summer
Fa = Fall
Wi = Winter

Habitat Types

CF = Coniferous Forest
DF = Deciduous Forest
SH = Shrubland
GR = Grassland
MA = Marsh, Wet Grass, Mudflat
AQ = Aquatic (lake, creek)
UR = Urban
RK = Rock, talus, cliff

The occurrence of other rare, endangered or vulnerable bird species known to occur within the watershed (see Table 12) are briefly described below. Blue-listed is represented by 'B', red-listed by 'R'.

American White Pelican (R)	- individuals from the Sturn Lake colony in central B.C. occasionally visit Salmon Arm Bay during migration
American Bittern (B)	- a marsh dwelling bird possibly utilizing the Salmon Arm Bay marshes but more commonly found in upland marshes such as at Salmon and Rush Lakes
Trumpeter Swan (B)	- winters in moderate numbers at Salmon Arm Bay
Surf Scoter (B)	- shows up during migration at suitable wetlands such as Salmon Arm Bay and Salmon Lake
Turkey Vulture (B)	- may breed in cliff areas within the watershed but sparsely distributed
Swainson's Hawk (B)	- occurs during summer in open areas on the Douglas Lake Plateau and possibly some areas in the Salmon River valley
Prairie Falcon (R)	- occurs rarely during migration; not known to breed
Peregrine Falcon (B)	- occurs during migration, particularly at Salmon Arm Bay where prey is plentiful
Sandhill Crane (B)	- occurs primarily as a rare summer resident in the Salmon Lake area; seen more regularly during migration
American Golden Plover (B)	- seen rarely during fall migration at Salmon Arm Bay
Long-billed Curlew (B)	- uncommon breeder on grassland areas of the Douglas Lake Plateau
Red-necked Phalarope (B)	- seen during migration in suitable wetlands
California Gull (B)	- seen at Salmon Arm Bay throughout the year; does not breed
Caspian Tern (B)	- shows up as a non-breeding vagrant during the summer
Western Screech-Owl (B)	- breeds uncommonly in mixed species and riparian forests
Flammulated Owl (B)	- known to breed in suitable habitats of Douglas-fir dominated forests within the IDF biogeoclimatic zone
Short-eared Owl (B)	- resides rarely in grass and wet grassland areas within the watershed
White-throated Swift (B)	- breeds locally on cliff faces within the watershed
Black-chinned Hummingbird (B)	- breeds rarely in the Salmon River valley
Lewis' Woodpecker (B)	- occurs rarely in areas in open forested areas with larger trees
Lark Sparrow (B)	- breeds rarely in open habitats within the Salmon River valley
Bobolink (B)	- may breed in overgrown fields and wet grassland areas within the Salmon River valley

Species of Management Concern

Species of management concern are western grebe, great blue heron, bald eagle and osprey as described previously. Other species of management concern are Flammulated owl and ring-billed gull. Campbell *et al.* (1990) describe the breeding habitat of Flammulated owls as consisting of 'well spaced Douglas-fir of varying ages, generally containing thick clumps of young trees with some Ponderosa pine. The general appearance is like parkland, the understorey is very open, consisting largely of pinegrass, bluebunch wheatgrass, birch-leaved spirea, and isolated larger clumps such as saskatoon'. Habitats of this description likely occur throughout the watershed. However, detailed habitat information, which could be provided by biophysical habitat mapping would identify locations and extent of suitable habitat. The impact of logging activity on these habitats is of primary concern. Ring-billed gulls are of management concern because of their tendency to become 'nuisance' birds when populations rise. Ring-billed gulls have recently nested at Christmas Island, an island created artificially from dredge spoils of a federal government boat harbour project. However, annual rises in lake levels during sensitive nesting times appear to be controlling ring-billed gull numbers (F. Kime, pers. comm., 1995).

Mammals

Abundance and Diversity

Numerous mammal species are found within the Salmon River watershed. With the exception of several species of migratory bats, all mammals reside within the watershed year-round. Table 13 lists all species known or expected to occur, their status and habitat utilization within the watershed. Both mule and white-tailed deer are common and are of importance because of their high value to hunters.

Rare, Endangered and Vulnerable Species

None of the mammal species occurring within the Salmon River watershed are classified as red-listed (i.e., threatened or endangered) by BCE (Harcombe *et al.* 1994) or the BC CDC (1995). However, several are considered to be vulnerable or sensitive (Blue-listed - "B)". They include:

Fringed Myotis (B)	- a possible rare breeder in the watershed; little is known of its habitat utilization or requirements within British Columbia
Townsend's Big-eared Bat (B)	- a possible rare breeder; little is known of this bats habitat utilization or requirements within British Columbia
Spotted Bat (B)	- a possible rare breeder; roosts in cracks on cliff faces, and feeds in open forested areas, wetlands and agricultural areas
Common Pika (B)	-a single isolated population of pika exists in a talus slope near Westwold. It is a potentially genetically unique population which is vulnerable to extinction within the watershed
Grizzly Bear (B)	- likely occurs extremely rarely in upland habitats within the watershed. Has been extirpated throughout much of its historical range in southern British Columbia. Absence of fire, increased road access and cattle ranching at higher elevations likely contributes to declines within the watershed
Fisher (B)	- occurs rarely in suitable upland mixed deciduous and coniferous forested habitats
Wolverine (B)	- occurs rarely throughout upland areas of the watershed
Badger (B)	- occurs rarely in lowland areas of the watershed, especially in areas with Columbian ground-squirrel populations

Species of Management Concern - moving towards ecosystem perspectives

Marten is a species of special management concern. To protect marten populations within the watershed and adjacent areas, the BCE, Fish and Wildlife Branch, Thompson Nicola Region and Wildlife Branch, Victoria have produced guidelines for "Maintaining Marten Habitat in Managed Forests" (1994). Preferred marten habitat is dense canopied, multi-storied, multi-species climax coniferous forests containing high numbers of large snags and downed logs. This habitat usually contains riparian corridors used as travel ways and is often interspersed with small openings for foraging. Riparian systems are used by marten and other wildlife species greatly out of proportion to their occurrence in a landscape. Because of this extensive use, maintenance of the integrity of these habitats is critical. BCE (1994b) has recommended that 200 m wide corridors which link special habitats be identified on forest companies five year development plans. The network of upland corridors and riparian management areas should be relatively evenly distributed over the landscape and constitute approximately 10% of the landscape within designated areas of the

TABLE 13: MAMMAL SPECIES OCCURRENCE AND HABITAT UTILIZATION IN THE SALMON RIVER WATERSHED

MAMMAL SPECIES	FREQUENCY OF OCCURRENCE	HABITAT UTILIZATION							
		CF	DF	SH	GR	MA	AQ	UR	RK
SHREWS & MOLES (O. INSECTIVORA)									
Common Shrew	ComRes	+	+	+					
Vagrant Shrew	ComRes		+	+	+	+			
Water Shrew	ComRes					+	+		
Dusky Shrew	ComRes	+	+	+	+				
BATS (O. CHIROPTERA)									
California Myotis	UncRes	+	+	+	+			+	
Western Long-eared Myotis	UncRes	+	+	+	+			+	
Little Brown Myotis	ComRes	+	+	+	+			+	
*Fringed Myotis	RarRes				+				
Long-legged Myotis	RarRes	+	+	+	+			+	
Yuma Myotis	ComRes	+	+	+	+			+	
Hoary Bat	RarSuRes	+	+	+	+				
Silver-haired Bat	RarSuRes	+	+	+	+				
*Spotted Bat	RarSuRes			+	+	+	+		+
Big Brown Bat	UncRes	+	+	+	+			+	
*Townsend's Big-eared Bat	RarRes	+	+	+	+				
HARES & PIKAS (O. LAGOMORPHA)									
Common Pika	UncRes				+				+
Snowshoe Hare	ComRes	+	+	+					
RODENTS (O. RODENTIA)									
Yellow-bellied Marmot	UncRes				+				+
Columbian Ground Squirrel	UncRes	+			+				
Yellow-pine Chipmunk	ComRes	+	+	+	+				
Red Squirrel	ComRes	+	+						
Northern Flying Squirrel	ComRes	+	+						
Northern Pocket Gopher	ComRes	+	+	+	+				
American Beaver	ComRes		+				+		
Deer Mouse	ComRes	+	+	+	+			+	
Bushy-tailed Woodrat	ComRes	+							+
Heather Vole	ComRes	+	+						
Southern Red-backed Vole	ComRes	+	+	+	+				
Water Vole	RarRes	+			+		+		
Meadow Vole	ComRes				+				
Montane Vole	UncRes				+				
Long-tailed Vole	ComRes				+	+			
Muskrat	ComRes					+	+		
House Mouse	ComRes							+	
Meadow Jumping Mouse	ComRes			+	+				
Porcupine	ComRes	+	+						

TABLE 13: Continued.

MAMMAL SPECIES	FREQUENCY OF OCCURRENCE	HABITAT UTILIZATION CF	DF	SH	GR	MA	AQ	UR	RK
CARNIVORES (O. CARNIVORA)									
Coyote	ComRes	+	+	+	+	+		+	
Gray Wolf	RarRes	+	+	+					
Red Fox	UncRes	+	+	+	+				
Black Bear	ComRes	+	+	+	+				
*Grizzly Bear	RarRes	+	+	+	+				
Marten	UncRes	+	+	+					
*Fisher	RarRes	+	+						
Ermine	ComRes	+	+	+	+				+
Long-tailed Weasel	ComRes	+	+	+	+				+
Mink	UncRes	+	+	+	+	+	+		
*Wolverine	RarRes	+	+		+				+
*Badger	RarRes				+				
Striped Skunk	ComRes	+	+	+	+				
River Otter	RarRes					+	+		
Cougar	UncRes	+	+	+	+				+
Bobcat	UncRes	+	+	+	+				
Lynx	UncRes	+	+	+					
UNGULATES (O. ARTIODACTYLA)									
Mule Deer	ComRes	+	+	+	+				
White-tailed Deer	UncRes	+	+	+	+				
Moose	ComRes	+	+	+	+	+	+		+
Mountain Goat	RarRes	+	+		+				

Note 1: '*' = blue-listed by B.C. Ministry of Environment.
Note 2: References include BCE 1995b, Cowan and Guiguet 1975, Nagorsen 1990, Nagorsen and Brigham 1993 and Steven and Lofts 1988.

Frequency of Occurrence

Com = Common
Unc = Uncommon
Rar = Rare

Habitat Types

CF = Coniferous Forest
DF = Deciduous Forest
SH = Shrubland
GR = Grassland
MA = Marsh, Wet Grass
AQ = Aquatic (lake, creek)
UR = Urban
RK = Rock, talus slopes

Seasonal Occurrence

Res = Resident
Su = Summer

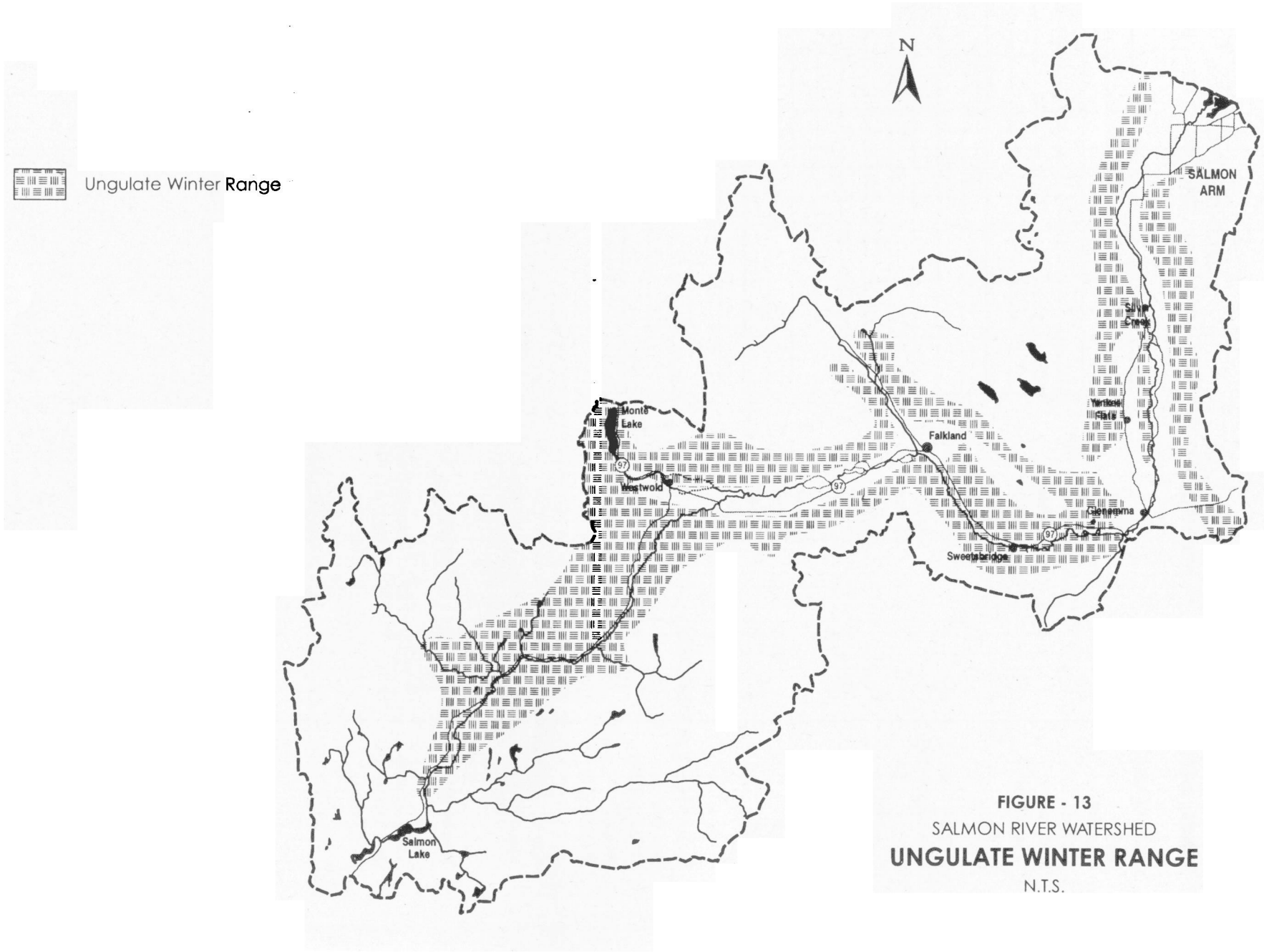


FIGURE - 13

SALMON RIVER WATERSHED

UNGULATE WINTER RANGE

N.T.S.

Salmon River watershed. The primary area of concern for marten is in the Fly Hills Plateau area west of the Salmon River.

Mule and white-tailed deer are also of specific management concern because of their utilization by hunters. One of the critical habitat requirements for deer is the maintenance of winter range. These areas are generally located on east and west slopes at low to mid elevations throughout the watershed (Figure 13). Logging activity, and to a lesser extent residential development, can impact and encroach on these habitats.

Beavers are of specific management concern because of their tree falling and dam building activities long the Salmon River. Dams constructed by beavers flood agricultural and riparian areas and may be barriers to fish passage, especially during the fall salmon runs. Aquametrix (1995) identified 13 beaver dams in the lower reaches of the Salmon River. Because of salmonid spawning concerns, some beaver dams may have to be breached and resident beavers trapped and relocated.

Steps to maintaining biodiversity, rather than continuing to emphasize species specific management policies need to be addressed. By broadening our perspective of ecosystem health to include a larger number of indicator species, a more realistic view of ecosystem health should result. Forest Ecosystem Networks (FENS) are being incorporated into forest harvest plans with the purpose of protecting ecologically important and sensitive vegetation communities and wildlife habitats with the overall goal to protect B.C.'s biodiversity. FENS involves creating linkages (e.g., generally river and creeks) between important wildlife habitats.

Amphibians

Abundance and Diversity

Table 14 lists the eight amphibian species expected to occur within the Salmon River watershed, their frequency of occurrence and habitat utilization.

Rare, Endangered and Vulnerable Species

The blue-listed Great Basin spadefoot toad appears to occur within the watershed. Tadpoles were collected by fisheries crews from Wallensteen and Kernaghan Lakes on the Fly Hills Plateau, west of the Salmon River (Leupin *et al.* 1995). These records have been recorded as rare element occurrences by BC Conservation Data Centre (CDC, 1995). Generally, Great Basin spadefoot toad populations within the watershed are expected to be low because of the lack of low elevation pond and lake habitats that they prefer.

The occurrence of other rare, endangered or vulnerable amphibian species known to occur within the watershed (see Table 14) are briefly described below. Blue listed is represented by ‘B’, red listed by ‘R’

Tailed Frog (B)	-known to occur rarely in clear cool mountain streams within the watershed
Leopard Frog ®	-a four year old sighting exists for the east side of the Salmon River watershed

Critical Habitat Requirements

Riparian zones and wetland complexes at the Salmon River mouth, along the Salmon River and upland wetland areas are of particular importance to amphibian populations within the watershed.

Reptiles

Abundance and Diversity

Table 14 lists the nine reptile species expected to occur within the Salmon River watershed, their frequency of occurrence and assumed habitat utilization. Little is known of population sizes and actual habitat utilization within the watershed.

Rare, Endangered and Vulnerable Species

Five blue-listed (i.e., vulnerable and sensitive) species are expected to occur at relatively low populations within the watershed:

Painted Turtle (B)	- occurs in riparian areas, lakes and streams
Rubber Boa (B)	- occurs in variety of habitats, often in the vicinity of lakes and streams
Western Yellow-bellied Racer (B)	- occurs in sagebrush steppe and open ponderosa pine forests within the watershed
Great Basin Gopher Snake (B)	- occurs in sagebrush steppe and open ponderosa pine forests within the watershed
Western Rattlesnake (B)	- occurs in rocky terrain within sagebrush steppe and open ponderosa pine forests

TABLE 14: AMPHIBIAN AND REPTILE SPECIES OCCURRENCE AND HABITAT UTILIZATION IN THE SALMON RIVER WATERSHED

HERPTILE SPECIES	FREQUENCY OF OCCURRENCE	HABITAT UTILIZATION							
		CF	DF	SH	GR	MA	AQ	UR	RK
AMPHIBIANS									
*Tailed Frog	RarRes	+	+				+		
**Leopard Frog	RarRes	+	+				+		
Long-toed Salamander	ComRes	+	+			+	+		
*Great Basin Spadefoot Toad	UncRes		+	+	+	+	+		
Western Toad	ComRes	+	+	+	+	+	+		
Pacific Treefrog	ComRes	+	+	+	+	+	+	+	
Spotted Frog	ComRes		+	+	+	+	+		
Wood Frog	RarRes	+	+	+	+	+	+		
REPTILES									
*Painted Turtle	UncRes					+	+		
Western Skink	RarRes	+	+	+	+	+			
Northern Alligator Lizard	UncRes	+	+	+					+
*Rubber Boa	RarRes	+	+	+	+				
*Western Yellow-bellied Racer	UncRes	+	+	+	+				
*Great Basin Gopher Snake	RarRes	+	+	+	+				
Common Garter Snake	ComRes	+	+	+	+	+		+	+
West. Terrestrial Garter Snake	ComRes			+	+	+	+		
*Western Rattlesnake	RarRes	+		+	+				+

Note 1: '*' = blue-listed '**' = red-listed by B.C. Ministry of Environment.
Note 2: References include Gregory and Campbell 1984, Green and Campbell 1984, BCE 1993, Orchard 1988a and Orchard 1988b.

Frequency of Occurrence

Com = Common
Unc = Uncommon
Rar = Rare

Habitat Types

CF = Coniferous Forest
DF = Deciduous Forest
SH = Shrubland
GR = Grassland
MA = Marsh, Wet Grass
AQ = Aquatic (lake, creek)
UR = Urban
RK = Rock, talus slopes

Seasonal Occurrence

Res = Resident

Environmentally Sensitive Habitats

Several of the habitats within the Salmon River watershed are particularly sensitive to naturally or human induced disturbance. Sensitive habitats are those utilized by rare or endangered plants and animals, are required for the survival of a diversity of wildlife species, and are generally sparsely distributed within the watershed. Most of these habitats are waterbodies (e.g., Salmon River), wetland areas and/or nearby forests. Because of their linear nature, they act as important linkages between habitats (Figure 14).

Riparian Habitats/ Wetland Complexes

The mouth of the Salmon River in Salmon Arm Bay (Shuswap Lake) has been identified as an important wetland for wildlife species, particularly waterfowl (Hayes *et al.* 1993) (Figure 14). The breeding colony of red-listed (i.e., threatened and endangered) western grebes is of provincial importance and nesting bald eagles and great blue herons are blue-listed (i.e., sensitive and vulnerable) by BCE (Harcombe *et al*. (1994). Some restoration and enhancement of these riparian and marsh habitats has been conducted through funding provided by the Fraser River Action Plan by Environment Canada, and in partnership with Ducks Unlimited Canada, Adams Lake and Neskonlith Indian Bands, SRWSR, SABNES, BCE and B.C. Ministry of Agriculture, Fisheries and Food. The management plan included fencing off key habitats from cattle grazing, and monitoring wildlife habitat and diversity. Placement of nest boxes for wood ducks has also been recommended.

Additional wetlands important for waterfowl and other wildlife species are Rush and Salmon Lake at the extreme southern end of the watershed. Rush Lake was identified by Hayes *et al.* (1993) as critical waterfowl habitat. These lakes are not only important as breeding areas for wetland bird species but are stopovers for numerous migrant waterfowl, particularly diving ducks such as scaup and bufflehead (F. Kime, President, SABNES, pers. comm., 1995). The Twig Creek, Drum Lake, Blackwell Lake and Sawmill Lake wetland complexes, lakes on the Fly Hills Plateau west of the Salmon River (i.e., Blair, Spa, Bolean, Kernaghan and Wallensteen Lakes) and Monte Lake are also of significance to wildlife (Figure 14). A proposal is currently underway to preserve land at and in the vicinity of Blackwell Lake. Several rare and endangered plants have been identified from the Drum Lake area (see 'Rare and Endangered Plants' below).

The Salmon River, its tributaries (e.g., Bolean Creek) and associated riparian zones are also of critical importance to wildlife. Many wildlife such as passerine birds, especially wood warblers, utilize these riparian areas for breeding and many mammal species utilize them as movement corridors (Figure 14). The District of Salmon Arm has implemented streamside protection zones of 30 m along the Salmon River (i.e., minimum corridor width of 60 m) and an 80 m 'Pesticide Free Zone'. A 15 m protection zone (i.e., minimum corridor width of 30 m) has been recommended for all other streams within their jurisdiction (District of Salmon Arm 1995).

Key Riparian Corridors & Wetlands

1. Blackwell Lake Area
2. Twig Creek Wetland Area
3. Sawmill Lake Wetland Complex
4. Drum Lake Wetlands
5. Monte Lake
6. Rush & Salmon Lakes
7. Salmon River mouth and delta
8. Bolean, Spa & Arthur (Blair) Lakes
9. Kernaghan & Wallensteen Lakes
10. Salmon River & tributaries

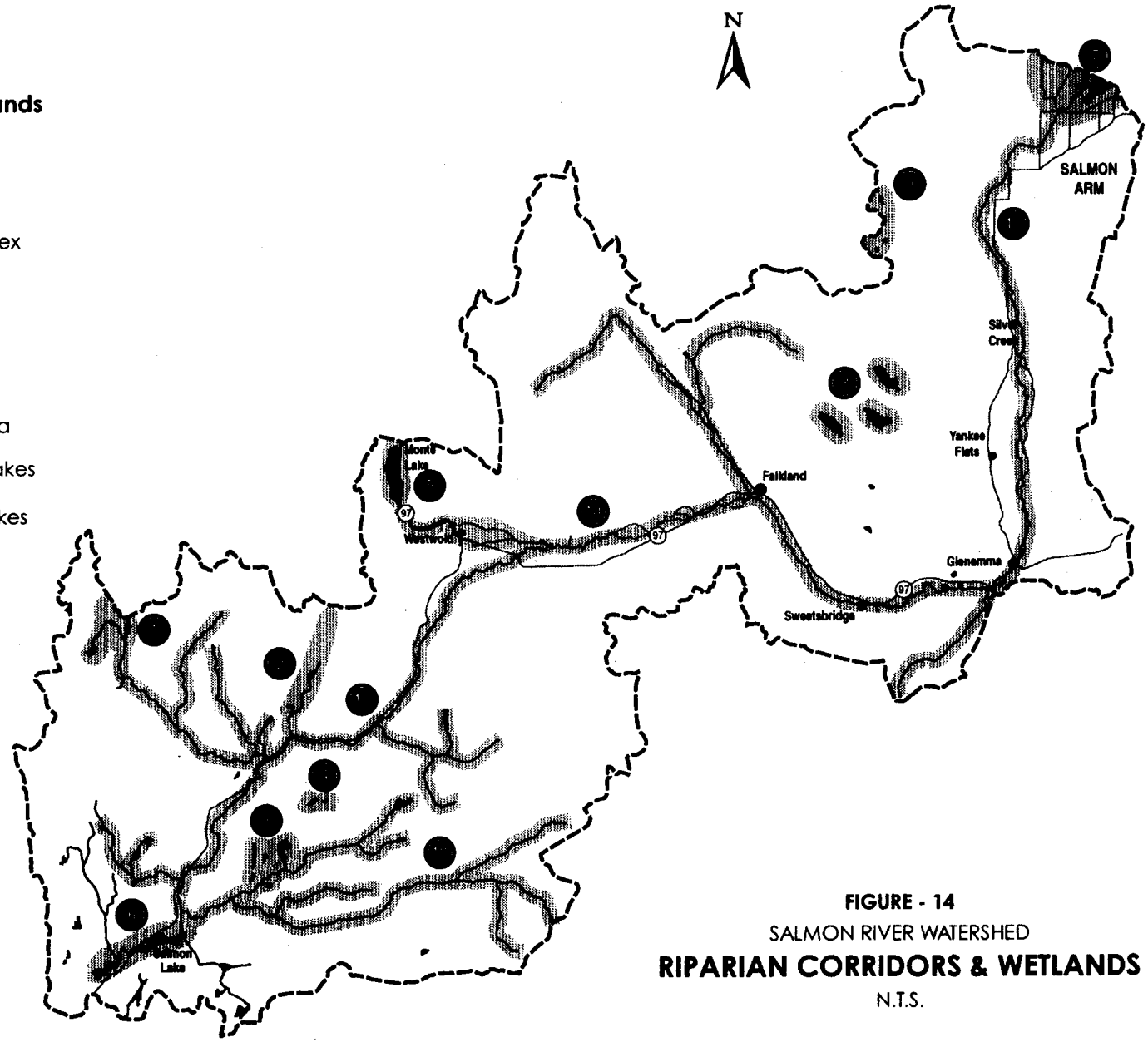


FIGURE - 14

SALMON RIVER WATERSHED

RIPARIAN CORRIDORS & WETLANDS

N.T.S.

Old-Growth Forests

Although lodgepole pine is a common seral species throughout the watershed, old-growth forests exist to a lesser or greater extent within each of the biogeoclimatic zones. Old-growth forests are important to a host of wildlife species such as woodpeckers (e.g., pileated and three-toed woodpecker), brown creeper, owls and marten. Representative old-growth forests within each of the biogeoclimatic zones of the watershed should be identified and considered for protection. Detailed forest cover maps of the watershed (generated by Ministry of Forests and Riverside Forest Products) delineate old-growth forested areas.

Rare and Endangered Plants

Rare and endangered plants identified by the British Columbia Conservation Data Centre (BC CDC 1995) along with collection location and status are listed below. Red-listed species are those whose populations are considered to be threatened or endangered within British Columbia whereas blue-listed species are those considered to be vulnerable or sensitive.

- American Sweetflag (*Acorus americanus*) - Salmon Arm - blue-listed
- Mosquito Fern (*Azolla mexicana*) - 2 km W of Salmon Arm - red-listed
- Rocky Mountain Sedge (*Carex saximontana*) - Salmon River/Weyman Creek -blue-listed
- Obscure Cryptantha (*Cryptantha ambigua*) - Drum Lake - red-listed
- Hairy Water-Clover (*Marsilea vestita*) - mouth of Salmon River - red-listed
- Kellogg's Knotweed (*Polygonum polygaloides ssp kelloggii*) - northeast of Drum Lake - blue-listed
- Tweedy's Willow (*Salix tweedyi*) - Bolean Lake - blue-listed.

Plants of Value to Indigenous People

A variety of plant species are used both as food and for ceremonial purposes by local Indian Bands such as the Upper Nicola and Neskonlith Bands. Current forestry practices such as spacing remove saskatoons, soopolallie and highbush cranberry (*Viburnum edule*) which are food items utilized by local Indian Bands (Bell 1994).

Interactions Between Land Use Activities and Terrestrial Ecosystems

Agriculture

Land clearing practices which do not retain a buffer strip between agricultural areas and wetland areas, unrestrained cattle grazing and channelization of the river have reduced the overall amount of riparian habitat available. Riparian habitat is particularly important to numerous wildlife species (e.g., wood warblers, other passerines, amphibians etc.) and act as movement corridors for mammals. Efforts are currently underway to re-establish riparian zones in impacted areas along the lower reaches of the Salmon River.

The Douglas Lake Ranch has channelized the upper reaches of the Salmon River (i.e., McInnis Creek), near the outlet of Salmon Lake. The change in water levels has reduced the productivity and extent of the wetland area and has resulted in more extensive grassland areas (i.e., for the purpose of cattle grazing and forage production). Erosion of steep, unstable stream banks and resulting sedimentation are of concern in this area.

Forestry
Five year plans by Riverside Forest Products, the primary operator in the watershed, call for clearcut logging within TFL 49 near to some wetland areas. One example is in the vicinity of Drum Lake where two clearcuts proposed for 1999 and 2000 are adjacent to wetland areas with red and blue-listed plant species. Old-growth habitats and the wildlife that utilize them, such as marten, may also be affected, although specific management guidelines such as a Forest Ecosystem Network System must be incorporated into forest companies five year development plans. Harvesting plans are also reviewed by environmental agencies. In areas inhabited by marten, large woody debris can be left on cutblocks, enhancing marten use in these areas in winter.

Other wildlife such as flammulated owl may also be impacted by forestry activity although the magnitude of the potential impact is not clear. Further work on habitat utilization and location of this species needs to be conducted. Ungulate winter range may also potentially impacted, although forest companies are required to follow specific guidelines to reduce long-term impacts. Generally, because of limited knowledge on wildlife species range and habitat requirements within the watershed, impacts from forest practices are difficult to determine. With the implementation of the Forest Practices Code, this situation may be rectified.

Increased access resulting from new logging roads is an issue within the watershed. These roads open up and can fragment previously isolated areas. They can also lead to increased hunting pressure and recreational activity such as snowmobiling which may disturb wildlife populations. The new Forest Practices Code reduces this problem by requiring forest companies to deactivate abandoned or currently unused roads. Some private landowners are locking gates to further restrict access.

Hunting
Government agencies responsible for implementing hunting regulations are to ensure that game populations are managed on a sustainable basis. However, the extent and impact of illegal hunting activity (i.e., poaching) is not known within the watershed.

Recreation/Tourism
Boating activity on Salmon Arm Bay and in upland wetlands such as Salmon Lake result in disturbance to nesting wildlife species. Restrictions on boat speeds and buffers between boating activity and nesting areas as has been implemented on Salmon Arm Bay, can reduce disturbance to sensitive populations.

Increased access and resulting increase in the use of all terrain vehicles for hunting or recreation increase disturbance to wildlife populations.

Sports Fishing
Sports fishing likely is not resulting in significant disturbances to wildlife populations, although over-fishing may threaten wild populations of rainbow trout, bull trout and other resident freshwater fish. Sports fishing activity on lakes such as Salmon Lake, may disturb nesting wetland birds.

Urban Development
Urban development is slowly encroaching on wildlife habitats in the vicinity of town centres. Bird species such as great blue heron, which nest near the town of Salmon Arm are particularly sensitive to residential development and increased human disturbance. Alienation of important wildlife habitats within urban areas is of concern. Urban planners should ensure that appropriate linkages are provided between sensitive habitats. Increased development in

rural areas encroach on wildlife such as deer and flammulated owls which utilize lower elevation habitats within the IDF biogeoclimatic zone.

Transportation
Highway corridors can act as barriers to wildlife movements. Deer/vehicle collisions resulting in damage to vehicles and possible injury to occupants occurs each year within the watershed. Deer often cross these roadways during seasonal migration to wintering areas or daily movements to water sources. Better identification and appropriate highway signs for wildlife crossings would help reduce this problem.

Current Issues and Anticipated Trends

Loss of Wetland Habitat
Destruction of riparian zones and wetland complexes is one of the primary concerns in the Salmon River watershed. These habitats are particularly important to numerous wildlife species. Continued development and land-clearing activity in the watershed continues to impact these habitats although progress has been made in addressing riparian vegetation loss in some areas.

Existing wetland complexes in the Twig Creek, Blackwell Lake, Salmon and Rush Lake and Drum Lake areas may represent regionally important habitats. Further work should be conducted to determine the value of these wetland systems to wildlife and plants. Ministry of Forests (1992) in their timber harvesting guidelines for the Okanagan TSA require maintenance of a 200 m Lakeshore Zone surrounding upland lakes. Harvesting within the Lakeshore Zone is permitted, however, the extent of logging at each lake is dependent on factors such as degree of use, angler effort, productivity, recreational value, aesthetic value and hydrological importance. Consideration of these factors is important, however, other factors such as use of a lake by wildlife (e.g., loons, goldeneyes etc.) also need to be considered in determining forest management within the zone. Under the new Forest Practices Code, all lakes greater than five hectares will be classified in order to protect the unique combination of fish, wildlife, water and recreation values. No harvesting will be permitted within the lakeshore management area of a lake classified as being of very high value (Class A).

Retention of Old-Growth Forests
Retention of old-growth habitats is an important step in maintaining biodiversity and sustainability within the watershed. Through mechanisms such as the Forest Ecosystem Network System and the Provincial Old Growth Strategy, important old-growth areas will hopefully be set aside for the benefit of wildlife. Old growth forests which may provide important wildlife habitat should be identified.

The current position of the Ministry of Forests (1992) is to ensure that sufficient and suitable old-growth units will be available to effectively apply the Provincial Old Growth Strategy, once it has been determined. After implementation, any surplus old-growth units identified by this process will be available for harvesting. A concern with this approach is what the quality, nature and wildlife use of these 'retained' old growth areas actually is when few studies have been conducted.

Impacts of Past Forestry Practices
Past forestry practices within some areas of the watershed have resulted in erosion and degradation of riparian, creek and other habitats. However, the extent of these impacts are unknown. More comprehensive guidelines for forestry practices, as legislated under the Forest Practices Code, should reduce large-scale and long-term impacts to key habitats. There are concerns, however, over the applicability of the Code on private land.

Potential impacts of forestry activities on rare and endangered species is not clearly understood because of the lack of information on species occurrence, habitat utilization and range. Biophysical habitat mapping information would provide a clearer understanding of sensitive habitats and allow for consideration of these habitats during development or land-use planning. Limitations on clearcut size will also reduce the potential for large-scale impacts to isolated populations of threatened or endangered wildlife species.

Rare, Endangered and Vulnerable Species

Attention should be given to protecting rare and endangered species residing within the watershed. Adequate protection and enhancement of habitats utilized by western grebes appears to be in place. Further investigation into the extent of habitat utilization by species such flammulated owl and Great Basin spadefoot toad are required prior to protecting key habitats. Common Pika habitat is threatened as well (D. Lowe, BCE, pers. comm.)

A concern raised by several land managers was the lack of detailed information of habitats occurring within the watershed. Bioterrain and ecosystem mapping of the watershed would delineate all habitats and allow determination of suitability and capability indices for key wildlife species. Habitat mapping information is important when developing land-use plans for the watershed. Forests should be managed on an ecological basis to ensure adequate retention of old-growth and sufficient representation of key ecosystems.

Management of Large-Game Populations

Management of large-game populations within the watershed is important from both a nature viewing and hunting perspective. Deer populations, especially, require maintenance of forested wintering areas at lower levels when snow conditions limit distribution at higher elevations.

The forest industry is well aware of the importance of maintaining winter range for ungulates. Timber harvesting guidelines for the Okanagan Timber Supply Area (Ministry of Forests 1992) emphasize the importance of maintaining the winter range resource, including cover and forage for ungulates. 'The intent is to maintain or enhance forage production by dispersing the harvest throughout the winter range and by spreading it out evenly over the rotation in as may passes as possible'. Winter range should be identified as habitat inventory is upgraded and field inspections undertaken.

2.4 Water Quantity

2.4.1 Overview of Watershed Hydrology

The hydrology of the Salmon River watershed has been affected by the geology of the area (Fulton, 1976; LeBreton, 1975 ; Obedkoff, 1976). The present day Salmon River is a remnant stream which follows a river course formed some 10-20,000 years ago. The Salmon River Valley was formed by glacial meltwater which flowed into Shuswap Lake, which at the time extended further south than it does today.

Present day discharges from the river are substantially lower than the flows which formed the valley. A description by Fulton (1975), re-iterated in Miles (1995) is useful to this discussion of hydrological character. It divides the Salmon River Watershed into several physiographic subdivisions, four of which are used as landmarks here as follows (locations illustrated in Figure 15):

1. Salmon Arm Valley
2. Salmon Valley
3. Chapperon Valley
4. Tahaetkun Upland

During glacial melt the Salmon River Valley eroded headward, cutting into the adjacent Nicola River drainage to include the *Chapperon Valley* and *Tahaetkun Upland* physiographic subdivisions. As a result, part of what might otherwise have remained the Nicola drainage was diverted to the glacial melt channel which became the Salmon River. Glacial-fluvial deposits at the south end of the *Salmon Arm Valley* physiographical subdivision are thought to have diverted the river from its original Okanagan drainage northward into glacial Shuswap Lake which at the time extended along the Salmon Arm Valley physiographic subdivision. Large quantities of gravel, which in recent history has become high quality salmon spawning substrate, was deposited in the river bed during this period. Large quantities of this substrate remain in the system, located particularly between Falkland and Silver Creek providing potential spawning area although it has become impacted significantly with fine sediments resulting from human induced erosion during the last 100 years (Burt and Wallis, 1995).

Present day water flow patterns and river character reflect the watershed's geological history. For example, as a portion of the river near Westwold (in the *Salmon Valley* physiographic subdivision) passes below surface most of the year, entering a large groundwater storage area resulting from expansive deposits of porous gravel and sand (Obedkoff, 1976). The "dry" reach of the river is approximately 13 km in length extending 8 km upstream and 5 km downstream of Westwold (Miles, 1995). Obedkoff (1976) reported that surface flows generally occur from mid-April to early July (2.5 - 3.0 months) but in a very high flow year with heavy precipitation, this section could potentially flow above ground for the full year. Anecdotal information from long time residents corroborates this, with few recollections of the "dry" reach running above ground for a full twelve month period (SRWR).

Physiographic Subdivisions along the Salmon River

1. Salmon Arm Valley
2. Salmon Valley
3. Chapperon Valley
4. Tahaetkun Upland

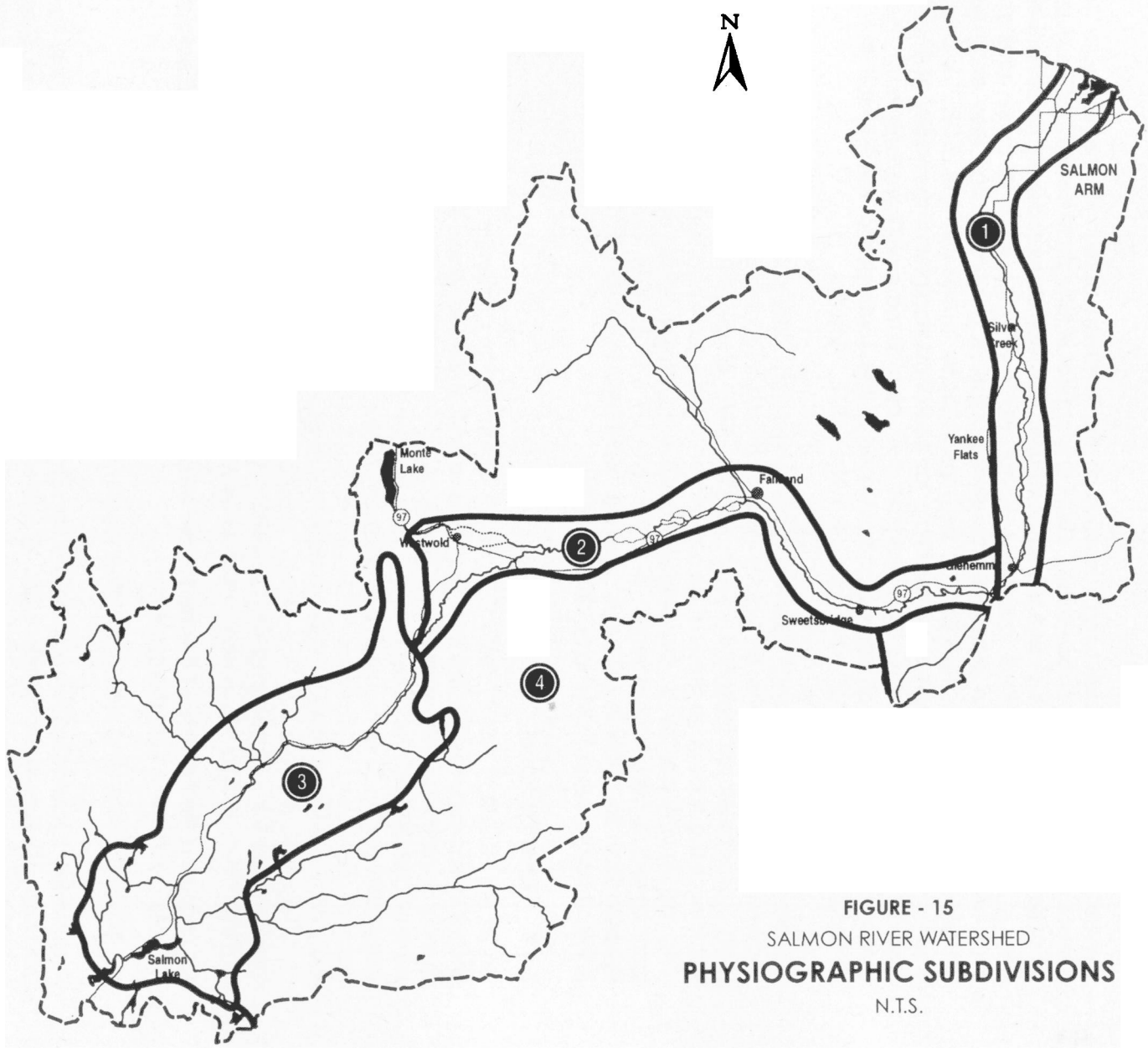


FIGURE - 15

SALMON RIVER WATERSHED

PHYSIOGRAPHIC SUBDIVISIONS

N.T.S.

Two isolated aquifers have been identified in the northern portion of the valley, a smaller surface and a larger deeper one below. The lower aquifer is thought to be isolated by geological formation from the upper one and the upper aquifer may exchange relatively freely with surface flows in the river above (Pers. comm., A. Kohut, BCE, Victoria). Maps of these aquifers have been developed based on available groundwater records (well logs) and may soon become available to the SRWR in hard copy or perhaps in digital format (M. Wei, BCE, Victoria, pers. comm.). Similar information is not available for headward portions of the valley at the present time. Information collected by BCE indicates that there is no significant long term decline in groundwater flow based on sample sites located at the south end of the Salmon Arm Valley physiographic subdivision (Pers. comm., A. Kohut, BCE, Victoria).

Surface flow varies along the river in relation to geology, inflow sources and outflow sources. Important outflow components include natural losses and human use withdrawals. Obedkoff (1976) presented an insightful assessment in 1976 of the streamflow regime of the river including perspectives on the relative bearing of groundwater and surface water inputs, losses and withdrawal demands on fisheries resource requirements at low flow. This study documented significant interaction between ground and surface water indicating a need to consider both as a single resource. This was reiterated by A. Kohut, BCE at a public meeting presentation given at Falkland in 1995 (SRWR).

2.4.2 Water Demand

Under the Obedkoff (1976) study (Figure 16) high irrigation demand periods (July-August) were shown to correspond with low flow periods and critical time windows for salmon migration and spawning activities. Aquametrix (1995) noted that 30-50% of the in-stream flow reduction experienced during low flow periods in the Salmon River which are critical to spawning and rearing life stages of salmon can be accounted for by surface water withdrawal for irrigation and domestic purposes. Further to a 1954 (anon, DFO, 1954) realization that low flow period water availability conflicts existed between irrigation demand and minimum fisheries requirements, Obedkoff (1976) reiterated a need to manage water extraction to maintain minimum flow requirements for sustaining salmon reproduction requirements. Two key recommendations of Obedkoff et al. (1976) which remain unresolved are to:

- *conduct a field survey of licensed water withdrawals to determine or estimate the quantity of water withdrawn from the system*
- *establish a licensing system for groundwater, similar to surface water licensing*

Present day hydrologic flow regimes are thought to have been affected by several key land and resource use practices which have occurred in the watershed as a result of European settlement. These especially include forest harvesting methods and agricultural practices of the past 100-150 years (Fraser River Environmentally Sustainable Task Force, 1991; NW Hydraulics, 1992; Aquametrix, 1995; Burt and Wallis, 1995; Miles 1995; Vadas, in prep). Mean monthly discharge data collected by Water Surveys Canada for the period of record are provided in Figure 17. Breakdowns of this data by Miles (1995) for three segments of the river length from the uppermost station (Salmon River above Salmon Lake) to monitoring stations further downstream (at Falkland and near Salmon Arm*)* show an increase in mean annual discharge (MAD) in a pattern from upper to lower watershed. A corresponding comparison shows lower mean annual discharge per unit of drainage area in lower versus upper watershed. A combination of natural and human related factors including elevation, snowpack,

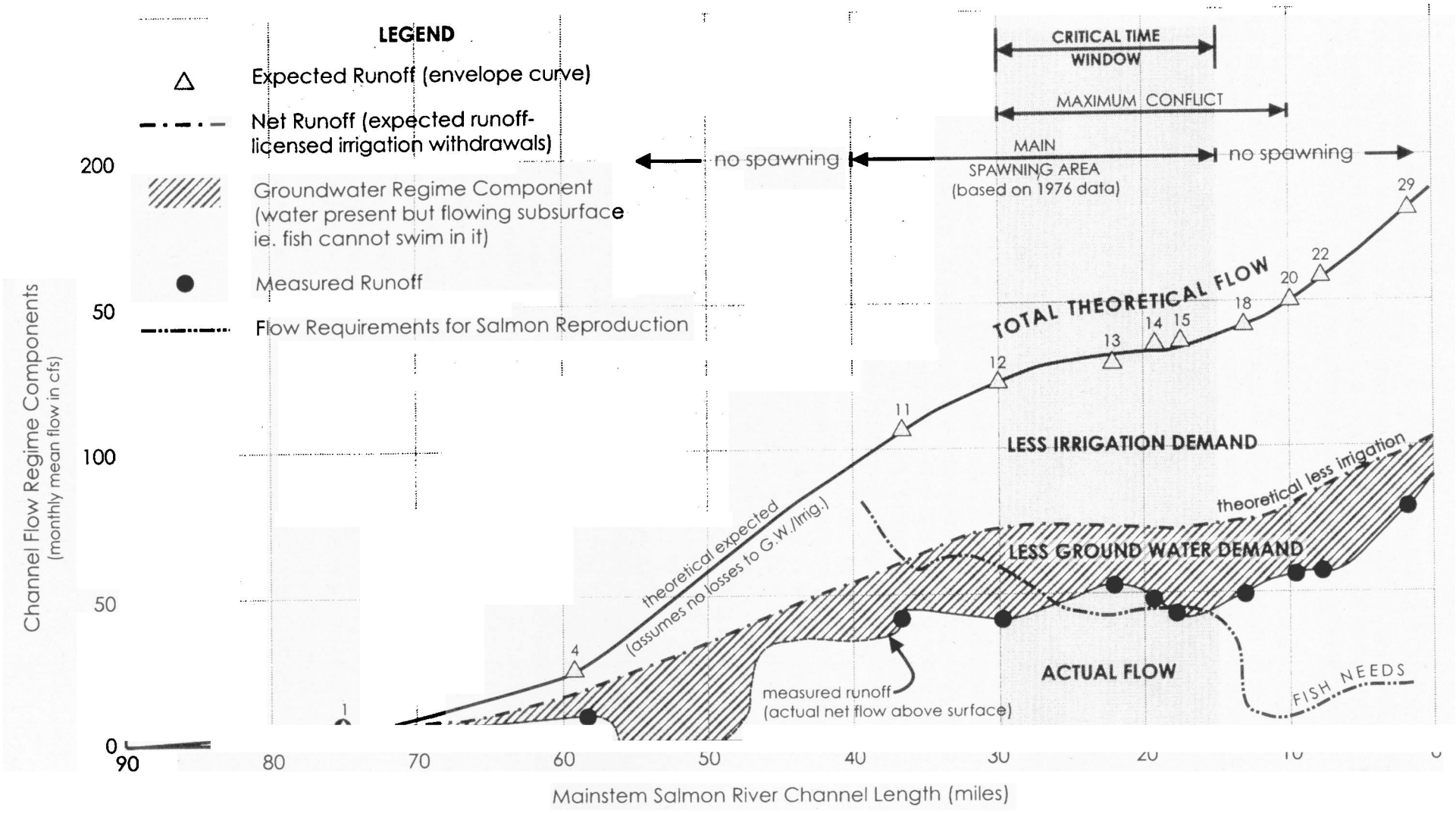
geology and water extraction create this difference between discharge and drainage area patterns. From an

FIGURE - 16

SALMON RIVER FLOW REGIME PROFILE

August, 1975

Source: Obedkoff et al, 1976



analysis of annual minimum flow records, LeBreton (1976) concluded that a noted increase in "frequency of late-summer minimum flows in the lower river appear to result from water withdrawals for irrigation, groundwater infiltration and possibly a diversion of some groundwater flow down the O'Keefe Valley to Okanagan Lake."

Figure 18 illustrates a decreasing trend in surface flow down the river at Salmon Arm since 1952, while no such decrease occurred at a measurement site upstream of Falkland. This indicates an impact due to increasing water demand, perhaps for irrigation purposes, between Falkland and Salmon Arm since 1952. BC Environment has been requested, on several occasions, to issue water withdrawal shutdown orders by the Department of Fisheries and Oceans due to fish habitat concerns during periods of low summer flow. An attempt to correlate these events with a specific critical low flow were made by BC Environment but proved inconclusive due to other contributing factors such as precipitation and groundwater flow (R. Reid, pers. comm.).

The water budget of the watershed including the exchange regimes between groundwater and surface flow are not well understood. At the south end of the Salmon Arm Valley physiographic subdivision some groundwater is thought to still pass southward, toward the Okanagan while most groundwater and all surface flow continues north past Silver Creek to the Shuswap Lake at Salmon Arm. This phenomenon is a result of ancient geomorphologic formations including deposition patterns during the post glacial period. A more complete understanding of ebb and flow patterns of groundwater leaving the watershed via this underground route is relevant to the determination of a watershed wide water resource budget.

A water quality assessment undertaken by Aquametrix (1995) on behalf of BCE has provided a useful summary of currently available information regarding water resources in the Salmon River Watershed (SRW). It includes a summary of known water use in the watershed reporting 2,913 logged wells, many of which are currently of "unknown use". The locations of only 22% of these wells is known.[25] Maximum estimated well yields, based on drilling records, totalled 98,316 litters per minute for all wells on record combined (Aquametrix, 1995). This may not be representative of actual use from this set of wells, nor does it account for other wells for which no records have been obtained. Because there is no requirement to license or report groundwater withdrawal this is understood to be an incomplete representation of groundwater withdrawal in the watershed.

Surface water withdrawal records summarized by Aquametrix (1995) indicate domestic withdrawal licenses for 1,223 cubic meters per day, with over half of the licensees being located in the portion of the watershed downstream of Fowler Creek. Licensed irrigation withdrawals are a much more significant component of surface water demand than domestic licensees. Irrigation licensees hold rights to 26,000,000 cubic meters of water per year under a total of 425 licenses. Aquametrix (1995) also reported that more than half of the total volume of surface water licensed for irrigation use is withdrawn at diversion points located downstream of the confluence of Fowler Creek. As described in Obedkoff (1976), the majority of irrigation water use (based on water licenses at the time) occurs concurrently with seasonal low flow and critical migration and spawning life stages of returning salmon stocks (Figure 16). Obedkoff showed that during critical low flow periods, some stretches of river accrue a net loss in discharge over their length in terms of inflow versus outflow (Obedkoff, 1976, p. 48).

[25] This situation may be improved by work currently underway by BC Environment, Vernon

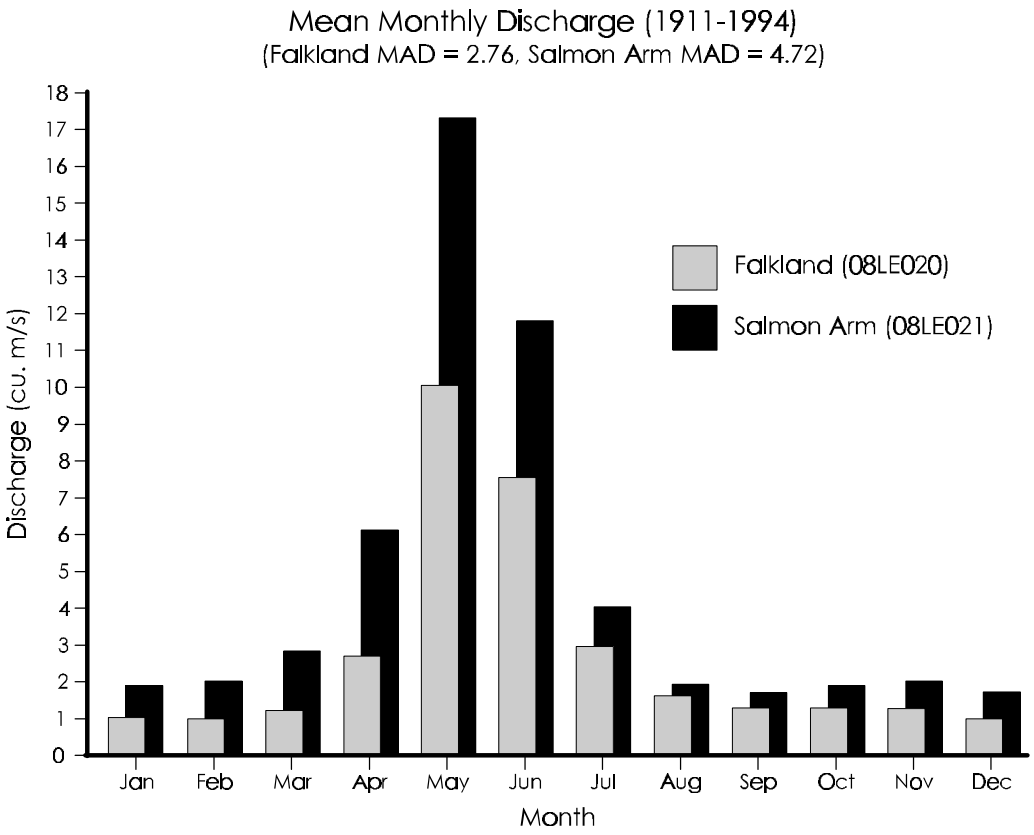


FIGURE 17: Mean monthly discharge for the Salmon River at Water Survey Canada stations near Falkland (08LE020) and Salmon Arm (08LE021). Mean annual discharge (MAD) is 2.77 m³/s for the Falkland station, and 4.75 m³/s for the Salmon Arm station.

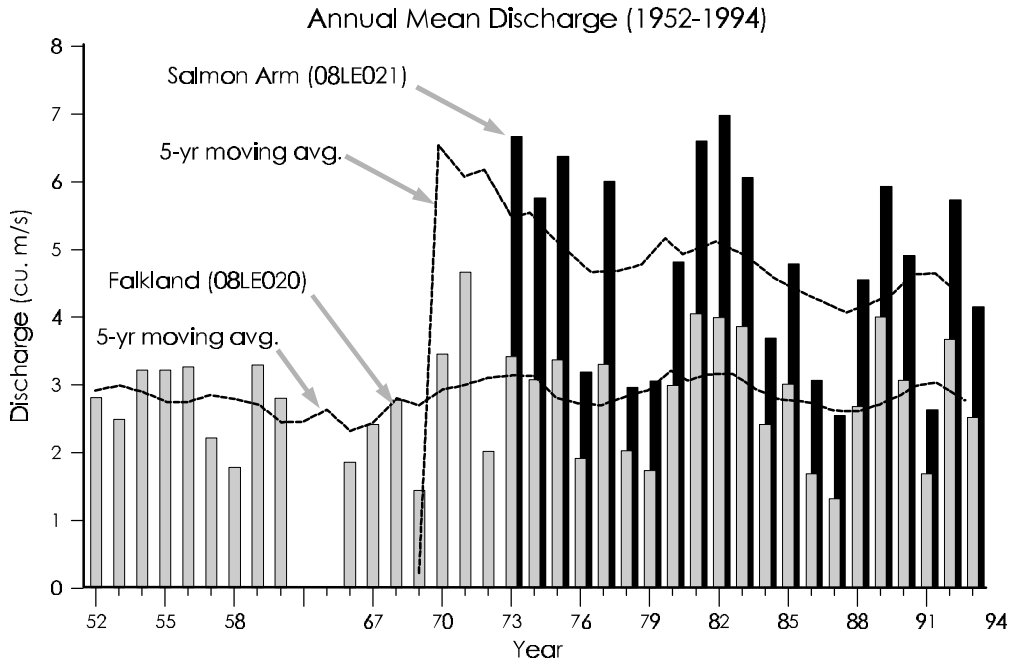


FIGURE 18: Annual mean discharge for the Salmon River at Falkland, and near Salmon Arm for the period of record (from Water Survey Canada records).

This information, like the groundwater withdrawal data is also known to be an incomplete estimate of surface water withdrawal. Although there is a licensing requirement for surface water withdrawals in B.C. under the Water Act, the amount of surface water allocated through water withdrawal licenses versus actual use represents another important information gap. Factors such as unlicensed withdrawals and the fact that most licensed users do not measure the water they withdraw, translate to a large unknown component in any assessment using currently available government records to determine surface water withdrawal. The situation is further complicated by the fact that from a watershed wide (ecosystem based) perspective groundwater and surface water are in fact part of the same resource and in some locations exchange freely.[26] Land and resource utilization (including logging and agriculture) which affect ground and surface water storage or consumptive use in one part of the watershed can have a direct effect on the availability of water resources in other parts of the watershed.

An assessment undertaken by BCE to help determine current water demand in the watershed has been underway for some time, but has not been completed. This study addresses licensed diversion points and well log information, and when complete, would provide a better understanding of the water balance of the Salmon River watershed. As part of this undertaking, a questionnaire is being used to fill information gaps known to exist between recorded and unrecorded water use in the watershed. Issues have been identified by BCE staff pointing out a disparity under current provincial policy and regulation between the treatment of licensed users of surface water compared with groundwater users, who are drawing from the same resource but are regulated differently. While conditional surface water license holders may be denied access to water in critical low flow periods, groundwater users remain unrestricted in their withdrawal of water from the same water table (Dovetail, 1995). Unauthorized water use in the form of unlicensed surface water withdrawals and also groundwater are likely to account for a significant proportion of the total water demand from human related uses in the watershed. A water budget for the watershed, including a thorough determination of irrigation and domestic use of water from both surface and groundwater sources will be a critical element in understanding the long term sustainability of water resources. The involvement of water users in developing a water budget might increase awareness and cooperation in implementing a shared resource agreement.

The impact of historical land use practices on water quantity in the Salmon River has been addressed in various studies including lost riparian cover, channelization, cattle grazing, crop irrigation, logging patterns and cycles (Anon DFO, 1954; Obedkoff, 1976; Ralph, 1976, Neskonlith Fisheries Crew, 1993; Crowe, 1994; Fraser River Environmentally Sustainable Task Force, 1991; Northwest Hydraulics Ltd. 1992; Aquametrix, 1995; Burt and Wallis, 1995 and Miles, 1995). Major factors felt to be impacting water quantity include:

- irrigation demand can exceed water availability at low flow periods
- seasonal runoff pattern alteration due to the effects of logging at higher elevations may alter groundwater storage capacity of the system and modify critical low flow patterns
- wetland drainage and infilling can alter the groundwater and surface water storage capacity of the system
- loss of shade and wind buffering from streamside vegetation and widened, shallower channels increases exposure of surface water to evaporation losses (along with serious increases in water temperature)

[26] For example the area near Westwold where surface flow contributes to groundwater storage, resulting in a dry riverbed for an average of 9 or 10 months of the year, followed 13 km downstream with the reappearance of surface flow contributed from groundwater storage 12 months of the year.

- channel destabilization including loss of stable streambanks banks decreases the groundwater storage capacity of the riparian area during high runoff

Undertaking water budget analyses of watersheds can be complicated. Even with state of the art technology it is still difficult to accurately determine how much water is lost through irrigation (based on evaporation, evapo-transpiration crop retention and return flow rates) than would have been donated to the atmosphere by a mature riparian zone occupying a similar area comprised of natural vegetation (Hudson, DOE, Winnipeg, pers. comm.). Nevertheless, a reasonably accurate estimate of water supply versus water demand would be a very useful watershed planning tool, given the importance of water resources to ecosystem health in the Salmon River watershed. This would also serve as a tool to highlight the need to consider how such resources could be shared within the watershed ecosystem. By utilizing available information, if seems feasible to concentrate efforts along critical reaches of the river as previously identified by Obedkoff (1976). Discharge curves for these areas could be developed relatively easily.

2.5 Water Quality

BCE have set ambient criteria for water quality for certain parameters as indicated in Table 15.

TABLE 15: WATER QUALITY CRITERIA FOR SALMON RIVER
(From Aquametrix, 1995)

CONSTITUENT	WATER QUALITY CRITERIA	SOURCE	COMMENTS
Oil and grease	0 mg.L	1	Surface water should be free from floating non-petroleum or petroleum oils
pH	6.5 - 9.0	1	6.5 - 8.5 for drinking
Residue: Non-filterable	10 mg/L - background ≤ 100 10% - background > 100	1,2	
Turbidity	5 NTU - background ≤ 50 10% - background >50	1,2	
Alkalinity, Total	> 20 mg/L as $CaCO_3$	1	Provides low sensitivity to aquatic life
Chloride, Dissolved	< 4 mg/L as $CaCO_3$	1	Highly sensitive to acid inputs
Cyanide	≤ 5 μg/L (as CN) 30d avg. 10 μg/L (as CN) Max.	1	CCREM (2) gives 5 μg/L (as CN) as maximum
Hardness, Total Dissolved	≤ 200 mg/L $CaCO_3$	1	drinking water
Ammonia, Total	< 0.25 mg/L Total NH_3	1,2	pH and Temperature dependent
Nitrite, Total	0.06 mg/L max. ≤ 0.02 mg/L avg.	1,2	
Nitrate, Total	200 mg/L max. ≤ 40 mg/L average	1	
Phenols, Total	1 μg/L max.	1	To prevent fish tainting
Phosphorus, Total		1	None proposed for streams 5-15 μg/L for Lakes only
Surfactant, Total	0.2 mg/L	1	
Tannin and Lignin		1	None for Aquatic life; 0.4 mg/L for drinking
Chlorophyll a	1 - 3.5 μg/L 100 mg/m2	1 1	Lakes, summer average Flowing water, maximum
Fecal Coliforms	≤ 200 / 100 mL geometric mean	1	For crop irrigation and contact recreation None for aquatic life
Sulphate, Dissolved	100 mg/L SO4	1	Tentative, effects on some aquatic species/life stages
Aluminium	0.1 mg/L Dissolved	1,2	Maximum (pH must also be considered)
Arsenic	0.05 mg.L	1.2	
Boron, Total		1	none given, 5 mg/L for marine life (SW contains 4.5 mg/L
Barium, Total	1 mg/L Ba, 30-d avg. 5 mg/L Ba, max	1	
Calcium, Dissolved	<4 mg/L Ca	1	Highly sensitive to acid inputs
Cadmium, Total	0.2 μg/L max.	1	Hardness 0-50 mg/L $CaCO_3$
Cobalt, Total	50 μg/L	1	Lowest level reported to cause effects
Chromium, Total	0.02 mg/L to protect fish 0.002 mg/L to protect phyto- & zooplankton	1,2	
Copper, Total		1	[0.094 (hardness) +2] where hardness is

			reported as mg/L $CaCO_3$
Iron, Total	0.3 mg/L	1,2	

TABLE 15 (cont'd)			
CONSTITUENT	**WATER QUALITY CRITERIA**	**SOURCE**	**COMMENTS**
Mercury, Total	0.1 μg/L max. 0.02 μg/L 30d. avg.	1,2	
Potassium, Dissolved		1	None except for livestock 20 mg/L for dairy sanitation
Manganese, Total		1	None except for drinking 100 mg/L
Molybdenum	≤ 1 mg/L, 30 d. avg. 2 mg/L, max.	1	
Sodium, Dissolved		1	For Drinking (health) 20 mg/L for very restricted sodium diet
Nickel, Total	25 - 150 μg/L max.	1	Depends upon Hardness
Lead	1 - 7 μg/L max. dependant on pH	1,2	see ref 2 values for various pH
Vanadium, Total	10 mg/L	1	For some marine fish, based on 96 in LC50
Zinc, Total	0.03 mg/L max	1,2	Tentative, Phytoplankton affected at 0.014 mg/L

Sources:

1. MOE. 1991. Approved and Working Criteria for Water Quality
2. CCREM. 1987. Canadian Water Quality Guidelines
   (Reproduced from Aquametrix, 1995.)

2.5.1 Water Quality Conditions

Water quality monitoring within the Salmon River watershed has been conducted since 1970 by BCE at over 50 different sites for various durations ranging from single sample events conducted at some sites to consistent sampling for periods as long as 12 years. The parameters most regularly monitored included: phosphorus, nitrogen, coliforms, temperature, dissolved oxygen, pH, hardness, turbidity and (15) metals. The most complete data set available on the Salmon River is from a sample station located at the TransCanada highway bridge crossing on the outskirts of Salmon Arm, monitored jointly by BCE and Environment Canada. Available water quality data from this site were summarized by Aquametrix (1995) provisionally and is reproduced below as Table 16.[27] From a comparison of provincial water quality and available water quality monitoring data for key parameters Aquametrix (1995) drew the following conclusions:

Phosphorus concentrations

- there are currently no provincial phosphorus concentration objectives set that are applicable to the Salmon River, but from available data the phosphorus concentrations at the mouth of the river averaged .096 mg/L and maximum value was .523 mg/L (n=81). Shuswap Lake water quality standards have been set at 5-15 μg/L
- phosphorus concentration spikes have been noted in connection with early season snowmelt at low elevations in the vicinity of cattle feed lot operations reaching a maximum of 1.06 mg/l total phosphate
- phosphorus concentration varies over the length of the river with higher concentrations in headwater tributaries such as Nash and McInnis Creek than expected relative to the

[27] This table is modified from the Aquametrix (1995) report which was still under review at the time the current paper was prepared. As such, it should be noted that the data may contain some errors.

undeveloped nature of the surrounding landscape, indicating natural phosphorus sources such as geologic contributions from apatite[28]

- Bolean Creek water carries relatively low phosphorus concentrations diluting concentrations of phosphorus at its confluence with Salmon River (like most other tributaries downstream of Weyman Creek)
- contributions of phosphorus from Salmon River to Tappen Bay of Shuswap Lake are significant, particularly during spring freshet
- phosphorus from the Salmon River contributes significantly to eutrophication of Tappen Bay in conjunction with inputs from Salmon Arm's sewage treatment plant

TABLE 16: SUMMARY OF SELECTED PARAMETERS FOR SALMON RIVER WATER QUALITY DATA NAQUADAT STATION BC08LE004

	Air Temp. DEG. C	Water Temp. DEG. C	Specific Conductivity uSIE/CM	Turbidity FTU	Alkalinity Total MG/L	Hardness MG/L	Phosphorus Total MG/L	Iron Extractable Total MG/L	Lead Extractable Total MG/L	Nitrogen Nitrate, Nitrate MG/L	Nitrogen Total Dissolved MG/L
n	79	78	81	81	81	81	81	81	81	81	81
MIN	0	0	2	0.1	1	0.4	0	0	0	0.002	0.010
MAX	29.5	24.0	481	45	199	225	0.523	10.5	0.0048	0.851	1.400
AVG	11.0	7.8	371	3	154	169	0.096	0.8	0.0005	0.133	0.278

Note: Data not fully reviewed. Sample frequency approximately every 2 weeks. Period of record April 1988 - April 1992
(Reproduced from Aquametrix, 1995.)

Nitrogen concentrations

- the historical data base describing nitrogen concentrations in the Salmon River is not extensive
- available data includes no cases where nitrogen concentrations have exceeded drinking water quality criteria (10 mg/L) but many cases where concentrations are high enough to have potential negative impacts on aquatic life (>.5-1.0 mg/L)
- average nitrate-N values obtained to date are .132 mg/L and the maximum value measured was .851 mg/L
- higher concentrations were noted during winter months
- substantial additional data has been recently collected by BCE and is currently being assessed (B. Grace, BCE, pers. comm.)

Bacteriology

- maximum values for fecal coliforms exceeded recommended drinking water, crop irrigation and recreational contact standards at least once at every sample location over the duration of the sampling period to date, indicating an area of concern for further investigation

Temperature

- maximum temperatures of 24°C measured exceed the criteria set to protect salmon stocks returning to the river for spawning and rearing

pH and hardness

- criteria were not exceeded within the data base collected to date

[28] First suggested by LeBreton, 1972 , and as yet unconfirmed by field assessment

- Salmon River water is “hard” with calcium carbonate concentrations measurements ranging from 121 to 180 mg/L
- drinking water quality is considered to be poor when calcium carbonate concentration exceeds 200 mg/L

Metals

- of 15 metal concentrations monitored, only iron and lead have exceeded criterion levels
- detection of these metals in concentrations above criterion levels was correlated with spring freshet and is felt to be a result of natural sources via resuspension of fine sediments

Turbidity

- limited data is available to describe turbidity in the Salmon River
- provincial criterion were exceeded during spring freshet but the duration and magnitude of exceedance are not known

2.5.2 Water Quality Concerns

An understanding of the impact of increased erosion on water quality in the Salmon River can be obtained from various studies as follows. Low flow was also shown to exacerbate water quality difficulties in terms of temperature (Ralph, 1976) and nutrient loading (B. Grace, Aquametrix, 1995) (see Section 2.5). Miles (1995) determined that with regard to the stretch of river between Westwold and Salmon Arm, the majority of the fines being contributed to the system are derived from erosion points along the mainstem river, rather than its 16 tributaries. No sewage discharge permits are in place on the river, however septic seepage is likely, and is of unknown impact. There are four tile field waste discharge permits reported by Aquametrix (1995), none of which drain directly into the river. A community water service is located on Fly Hills serving a small subdivision, and a few small storage licenses are held in the watershed.

Other projects currently ongoing which will contribute to an understanding of water quality in the Salmon River are the base line data collection being conducted as a pre-cursor for development of a citizens monitoring program by Environment Canada staff from the National Institute of Freshwater research, Saskatoon and the SRWR. The product of this undertaking will be a low tech, ecosystem health monitoring program, customized to the character of the Salmon River, but fashioned in a format similar to the Streamkeepers Program. The method will use a combination of bio-indicators and physical parameters to act as ecosystem health indicators to track watershed condition from an ecological assessment perspective. Also, a study being undertaken by B.Vadas, SFU/CWS researcher, will provide information regarding the ecological structure in terms of species assemblages and abundance at forested versus unforested sites within the Salmon River (and Nicola) watersheds.

The main points of concern regarding water quality include:

- high temperatures (largely due to loss of riparian cover and low flows)
- erosion of streambank and upland areas contributing large silt loads to the system (increasing turbidity, impacting spawning gravel) increased iron and lead concentrations in river water, potential for increased algal production from nutrient loading (and slower, warmer waters), nutrient input from sediments, animal waste, fertilizer infiltration, septic field seepage and natural sources
- large organic debris (LOD), and stream complexity, reduced streambank and channel stability, reduced insect production (overhead and aquatic),

- high coliform and E. Coli counts
- potential development
- pesticide sources
- downstream impacts (Shuswap Lk, human use and wildlife habitat impacts)
- need to work towards sustainability guidelines which are related to ecosystem health, holistic rather than using isolated parameter sets
- a need to broaden the perspective beyond the river and its immediate banks to include a larger view of the watershed's water resource and the factors which impact it such as water demand

3.0 SUMMARY OF MAJOR TRENDS

The Salmon River Watershed has been affected by many changes over the past 100 years. Many of these changes are internal to the watershed, while others are from outside. This section summarizes major trends that were described in previous sections of the report.

3.1 Social and Economic Trends

Many of the social and economic trends occurring in the Salmon River Watershed are also found throughout the province. These include, for example, increasing population, less reliance on traditional primary industries for employment (e.g., forestry), greater cultural diversity, and more dependency on government income support.

Population Growth

- The Salmon Arm area will continue to grow most quickly compared to other areas within the watershed. This is faster than the provincial growth rate.
- In-migration has, and will, bring new cultural influences, skills, investment capital and incomes. *However, the sense of community will also be challenged by greater cultural diversity, and by higher crime rates, which appear to be related to larger centres of population.*
- Population growth will continue to drive up property values and the demand for rental housing. This will increase wealth and/or rental incomes of property owners. *However, this could reduce the availability of affordable housing for renters and first time home buyers.*

Employment

- Total income and employment in the watershed will continue to grow as population increases, despite declines in the importance of resource sectors. Retiree incomes, tourism and service industries will be the strongest growth areas. *However, per capita incomes may decline as the proportion of the labour force in lower wage service sector jobs increases.*
- Government income assistance and other programs will have a steadying influence on the economy and help displaced workers find other jobs. Education levels are much higher, helping people to adjust to a changing economy. *However, there is a possibility that government will cut back income support, education, health and other social services, and that a permanent "underclass" is developing, with little or no stake in the economy or community.*
- Greater participation of women in the economy will continue, thereby adding to, and diversifying family incomes. *However, there may be increased stress on two worker or single parent families with children that are having difficulties finding work and adequate child care.*

Economic Opportunities

- Goods and services that were once bought outside the watershed will be provided by local businesses (e.g., retailing). Improved communications will create growing opportunities in home businesses.
- Settling Native land claims will generate economic benefits to all watershed residents in the long term, because of First Nations business ventures and greater investment certainty.

- Government will manage Crown-owned resources more intensively and is likely to expect a higher economic return from them. Forest Renewal BC represents an example of this trend. *There is a possibility that public resources, such as water, Crown timber and range lands may be underpriced, discouraging more efficient uses and providing insufficient resources for properly managing and sustaining them.*

3.2 Land Use Trends

Settlement

- The majority of the new settlement in the watershed will continue to be in the District of Salmon Arm. In recent years, housing construction in the District of Salmon Arm has increased at a more rapid rate than population growth.
- While local and regional governments have policies to discourage sprawl, there will be increasing demand for rural residential development. This is due primarily to the proximity of the area to employment centres in Vernon and Kamloops and the attraction of the climate and character of the area to retired and semi-retired people. *There could be some diminishing of the rural character of the watershed.*
- Increasing residential growth will result in pressure to remove land from the agricultural resource base, including lands within the Agricultural Land Reserve (ALR). *However, the current policies of local and regional governments within the watershed have been to firmly maintain the ALR.*
- Impacts from land development on water quality and streamside vegetation are likely to occur in some rural areas where there is no requirement for building inspections to ensure stream protection policies or regulations are being met.

Agriculture

- There has been minimal exclusion of land from the Agricultural Land Reserve within the watershed since its designation in 1974. *Some limited subdivision of larger parcels has been allowed within the ALR by the Agricultural Land Commission mostly on low capability agricultural lands.*
- It is anticipated that the current distribution, mix and range of agricultural uses within the watershed will remain relatively stable for the foreseeable future with some increased emphasis on speciality crops or commodities.

  A comparison of the 1981 and 1991 Census of Agriculture suggests:

  livestock enterprises were the dominant agricultural use with 58% of farms in 1991, although this is a significant reduction from 74.5% of farms in 1981.

  speciality agricultural operations have increased from 9.8 % to 26.5% between 1981 and 1991.

  land use for dairying has increased since 1981 while the land area used for beef production has declined significantly. Hog and poultry farms have also declined in numbers. Field crop, tree fruit, vegetable and livestock combination uses remained relatively consistent in the ten year period.
- There will likely be a trend to higher value agricultural products with more intensive management. Historically beef/forage production has been the dominant type of agricultural use within the watershed. This has gradually changed to the current situation

where there are over 30 different agricultural uses and commodities. *However, the diversity of agricultural uses will vary with market demand and production economics.*

- Although there is some opportunity for expansion of existing farm and ranch production units within the watershed, opportunities are constrained by a limit of available high capability agricultural land (Crown or private). *Competition for alternative uses and competition for water required for irrigation purposes will affect agricultural opportunities.*
- Implementation of province-wide environmental management practices within the agricultural industry should contribute towards sustainability in the watershed. Codes of practice and environmental guidelines for particular agricultural commodity groups are part of provincial waste management laws (e.g., Environmental Guidelines for Dairy Producers).
- The recently adopted Farm Practices Protection Act should assist with urban-rural land and water use conflict resolution.

Forestry

- In the Okanagan Timber Supply Area, which covers the majority of the watershed, the current level of harvesting can be maintained for 15 years. After that, it must be reduced by 10% per decade, until the long-term harvest level is reached in 40 years. In the Merritt Timber Supply Area, which covers a much smaller percentage of the watershed, the current level of harvesting can be maintained for 110 years.
- Implementation of the Forest Practices Code should result in better harvesting methods and protection of fish and wildlife resources. *In the past, harvesting methods have not always respected other values and have led to increased runoff, soil erosion and removal of streamside vegetation. Fish and wildlife habitat has been negatively affected. There is some concern that the Forest Practices Code does not apply to private lands that are subject to logging activities.*

3.3 Fish and Wildlife Trends

Salmon Abundance

- Salmon populations that depend on the Salmon River as their home waters remain in jeopardy. Salmon returns to the Salmon River have declined by about 100 times (from over 200,000 to 2,000-3,000). *Agriculture, logging and commercial fishing practices, acceptable in their day, have contributed to this decline.*

Wetland and Riparian Habitat

- Important fish and wildlife habitat has been lost due to impacts of development on wetlands and riparian zones in the Salmon River Watershed. *The majority of the losses have occurred as a result of past land use practices, including river channelization, draining and filling.*

Old Growth Forest

- Due to natural and man-made fires and logging over the past several decades, old growth forest components of the Salmon River Watershed ecosystem have been significantly reduced. *The old growth forest component of the ecosystem cannot be rapidly replaced, and is a key part of maintaining biodiversity and ecosystem health.*

Limited Knowledge

- Our perspective of ecosystem health is based on limited knowledge of only a few species and their habitats. *Assessments of habitat impact have traditionally emphasized a select few species which are of particular economic or cultural importance such as salmon or deer. These species are often used as biological indicators of ecosystem health. Biodiversity and ecological health will remain difficult to protect unless ecological linkages between species and their physical environment in the watershed are better understood.*

3.4 Water Quantity Trends

Low River Flow and Water Demand

- Summer low flows continue to be a critical problem in the Salmon River. Water temperature in the Salmon River during summer low flow periods are a major threat to fish survival. Lack of water exerts tremendous pressure on salmon populations attempting to spawn and rear in the Salmon River watershed. The peak irrigation season coincides with critical low flow periods.

Conservation and Regulation

- Water resources, generally, have been treated as a free, unrestricted resource (first come, first serve). There are very few economic incentives to conserve water in our current regulatory system. *Surface water use is controlled through regulation and licensing, but there is no regulation of groundwater use.*

3.5 Water Quality Trends

Streambank Erosion and Nutrient Loading

- Water quality in the Salmon River is being seriously impacted due to streambank erosion and nutrient inputs. Erosion of streambanks and upland areas are increasing the fine sediments in the river and impacting on fish spawning gravels. Nutrients are entering the Salmon River and Shuswap Lake from animal wastes, fertilizers, human sewage and natural sources. *Bacteria concentrations are known to have sometimes exceeded health standards for human use in the Salmon River.*

Initiatives to Improve Water Quality

- Recent initiatives in the watershed should contribute to improved water quality. These include: public education and streambank restoration projects along the Salmon River, improved forest practices through the Forest Practices Code, implementation of streamside setbacks by local and regional governments and control of nutrients through application of agricultural environmental guidelines and codes of practice. *However, despite these initiatives, water quality will also be affected by low flows.*

4.0 KEY PROBLEMS IN THE WATERSHED

The issues and trends identified in this report and by workshops and interviews undertaken by the Salmon River Watershed Roundtable suggest a number of key problems or challenges facing the Salmon River watershed (Christiansen and Romaine, 1995). These include water, ecosystem health, sense of community and rural lifestyle and livelihood. The problems outlined below are not meant to include all the issues facing the watershed. It is important to recognize that there are many linkages and overlaps between issues of sustainability in the watershed. This section is intended to help in the understanding of the linkages so that options and management strategies can be developed which have a good chance of being implemented successfully.

4.1 Water

Water is the lifeblood of the watershed. It sustains trees, crops, fish and wildlife, and humans. Water provides recreational and tourism opportunities. It carries and dilutes wastes. Virtually all activities in the watershed involve water in one way or another. There are very real concerns that water is less available when needed in the watershed and is in danger of becoming more polluted.

Rapid snow melt and reduced storage of ground and surface water from activities such as logging, land clearing, drainage of wetlands, straightening of river channels and removing streamside vegetation contribute to rapid runoff, erosion, loss of productive soils, and loss of fish and wildlife habitat.

Low flows in the Salmon River are of particular concern in the late summer when high water temperatures can be lethal to fish and create shortages for irrigation and spawning salmon. Pollutants from urban and rural runoff, faulty septic systems, fertilizers and pesticides are more concentrated during low flows.

There are growing concerns over inefficient uses of water in the watershed. Surface water rights are allocated through licences and no new licences are being issued, however there is no regulation of groundwater, and no incentive to conserve it. It is believed that there is a strong relationship between surface water and groundwater in the watershed. Wells close to the Salmon River may be drawing river water.

With growing population and settlement in the watershed there will be increasing demands on water resources. Water will be a key factor in the long term sustainability of the watershed. Steps have been taken by the Roundtable and other partners in educating people about the linkages between land use activities and water quantity and quality. Projects to re-establish streamside vegetation and keep livestock away from the river, in cooperation with landowners, are positive initiatives.

Opportunities also exist to store water in upland areas and to restore wetlands in some areas (e.g., vicinity of Salmon Lake) which can have positive benefits for wildlife habitat and possibly create recreational opportunities (e.g., hunting and fishing). Partnerships between watershed interests and other organizations can be pursued. An example of such a partnership is the

Interior Wetlands Program involving federal and provincial agencies, Ducks Unlimited Canada, ranchers, naturalist and native organizations.

4.2 Ecosystem Health

There is a growing recognition that we cannot treat the environment as a separate entity. We are all part of it and we affect it as much as we are affected by it. *The system of which we are a part also has a limited capacity to support us. There are thresholds at which point certain parts may not function properly or may be destroyed completely.*

We might ask why the residents of the watershed should value and take steps to protect the quality of environmental resources?

One reason is the respect for other life forms. From this perspective, fish, mammals, birds and other species are accorded an inherent survival value, independent of whether or not they have any particular "use" to humans.

A second reason is that protecting natural areas and a diversity of plants and animals is an important indicator of the health of human communities.

A third reason is that natural areas have both an economic and social value. The watershed contains significant forest resources that have the ability to sustain economic, social and environmental values in perpetuity. The same is true of productive soils, waterbodies and wetlands of the watershed. Many of these areas of the watershed also provide recreational and tourism opportunities.

Ecosystem health in the Salmon River watershed has been compromised in the past. Land use decisions, settlement patterns and human activities have not always considered effects on fish and wildlife resources or habitats.

When habitats are altered, there can be serious implications on the food chain and interrelationships between life forms. Some wildlife are forced to leave when their shelter becomes too exposed or as certain plant species are destroyed. In some cases, alternative habitat areas do not exist either locally or regionally.

When a species is removed from the food chain of a habitat, a break occurs which has ramifications throughout the biological community. Some species may be driven out, others may overpopulate, and others may develop a dependency on humans. There is also the potential for habitat fragmentation where habitat is isolated into small units, unable to support viable populations of fish and wildlife.

The most common forms of habitat alteration occur through land clearing, draining and filling of wetlands, road building, removal of streamside vegetation and alteration and obstruction of watercourses (damming, culverting, straightening, water withdrawal). Habitat impacts which are not always as visible, but can be just as damaging include water pollution from siltation, sewage, toxic chemicals, fertilizers, pesticides and stormwater runoff.

Linking important habitats through corridors is also a critical element in protecting and maintaining a healthy ecosystem. Riparian corridors are especially important for a wide variety of wildlife and in connecting upland and lowland habitats. This is why ecosystem management cannot just stop at an administrative or property boundary. An integrated approach is essential.

Identifying and protecting important ecosystems is a first step towards an integrated approach. While there has been progress in this regard through the Forest Practices Code, old growth strategy and other initiatives, there are relatively few protected areas within the watershed.

4.3 Sense of Community

The rapid population growth in the watershed, and the increased cultural mix of new residents to the area have put strains on the sense of community. Higher rates of crime are often associated with increasing population growth. With the majority of the population growth occurring in the Salmon Arm area, there is a concern that the rural-urban split in the watershed will heighten. Should sprawl tend to occur, there is likely to be increasing friction between suburban and rural lifestyles.

The sense of community in the watershed is also linked to resource sustainability. With decreasing dependency on primary resources over time in the watershed, a greater proportion of residents may have to find other sources of livelihood or commute to jobs outside the watershed.

There is also a concern that as more people become dependent upon government income support, that a permanent "underclass" may develop, with little or no stake in the economy or community. A strong, sustainable economy will help to counteract this tendency and lead to more citizen interest and involvement in the community.

Another issue affecting the sense of community is the outstanding settlement of native land claims. The uncertainty regarding the settlement of claims is of concern to many. However, tensions may increase during negotiations if natives are dissatisfied with slow progress and if non-natives believe their economic opportunities are being diminished.

There is also a general level of frustration among many residents that most decisions affecting sustainability are being made outside the watershed, with little effective local input or control.

There are also positive signs of community involvement as more residents take an interest in sustainability of the watershed and participate in forums and programs such as those sponsored by the Salmon River Watershed Roundtable and its members.

4.4 Rural Lifestyle and Livelihood

Rapid population growth and fewer jobs in forestry and agriculture are viewed by many people as an erosion of the traditional rural lifestyle in the watershed. A perceived decline in the sense of community is directly related to this view.

While more traditional resource dependent jobs are expected to decline in some areas of the watershed over the years, there will be an increase in employment in tourism and service industries. More money will come into the watershed economy through retiree incomes. Job opportunities for young people in the more traditional resource sectors, however, may be limited.

There are more part-time farmers in the watershed, living on smaller farms who supplement their incomes with other jobs. Because of the existence of the Agricultural Land Reserve and the policies of local and regional governments, residential development opportunities in the rural areas of the watershed are limited. However, this could increase property values and may mean that traditional livelihoods are less viable, particularly for younger people or first-time home buyers.

While overall, there has been a reduction of farms in the watershed, there has been an increase in the number of speciality and higher value commodities. It must be recognized that farming, like many other economic enterprises, is market driven. These types of farms may use land more intensively and be more efficient in their operations. It is difficult to estimate at this time whether this could lead to greater demands on water or greater use of fertilizers and pesticides. One effect may be that such agricultural operations will be able to afford more modern technology (e.g., automated irrigation systems) that would make more efficient use of water.

Preserving rural lifestyles and traditional livelihoods will require that sustainable approaches to resource management are followed. Not only will productive agricultural land need to be protected, but soil productivity must also be maintained through good farming practices. The same is true of forest lands and forestry practices. Both sectors must be managed on an ecosystem basis to ensure that ecological, social and economic values are integrated. This also applies to land use and community planning.

Population growth and economic change will continue in the watershed. The challenge will be to manage the growth in a sustainable way and to ensure the benefits of growth are distributed more broadly among those vulnerable to economic change. This will help to maintain a sense of community and interest in the affairs of the watershed.

5.0 MOVING TOWARDS SUSTAINABILITY

Barriers and Constraints

This section examines a number of ways in which the problems and challenges identified in Section 4 can be addressed and assist the Roundtable in working with others towards sustainability. It starts with a recognition of some of the key barriers or constraints that characterize each problem including:

- legislative/administrative
- information needs
- cooperation
- resources

Legislative/administrative constraints generally relate to institutional issues - how we govern and manage. To overcome these constraints will often require changes to these systems, through legislative changes and reorganization of management approaches.

Information needs are concerned with overcoming critical gaps in our knowledge that are required to understand and effectively deal with an issue.

Because of the degree of complexity and multi-jurisdictional nature of most problems in the watershed, solutions will require *cooperation* among users, governments, organizations, businesses and individuals.

Resources will be required, both in terms of people and money to implement actions. This is closely related to cooperation, because very few individuals, government agencies or businesses alone, have the necessary resources to tackle a problem. In many cases, it may be necessary to more efficiently and effectively utilize and allocate existing resources.

Actions For Change

Proposed actions are presented along with potential advantages and disadvantages. This list is not meant to be exhaustive, but is presented to assist the Salmon River Watershed Roundtable and others to begin thinking and examining some of the opportunities for addressing sustainability issues in the watershed.

5.1 Water

Barriers

<u>Legislative/administrative</u>

- very little incentive for users to conserve water
- surface water users are licensed while groundwater is virtually a "free resource" with no licensing or regulation
- water use is an "underpriced resource" either for supply or as a system of disposing of wastes as it does not always reflect the full environmental costs or value to future generations

- possible oversubscription of water licences has resulted in not enough water for salmon
- lack of local control over water allocation
- in some jurisdictions there are no bylaws or building inspections to protect natural drainage systems and to control erosion
- no bylaws to regulate land clearing activities and protect trees on private land

Information Needs

- measurement of water use and supply (water budget)
- stream flows at different times of year
- assessment of non-point discharges to Salmon River (amount and type)
- lack of awareness and understanding among water users and property owners about the need for water conservation and retention of streamside vegetation
- assessment of creating wetlands at Salmon Lake and other areas to increase water storage, fish and wildlife benefits and tourism opportunities
- identification of potential areas and methods of water storage
- evaluation of forest harvesting practices on runoff rates
- widely publicized water health indicators

Cooperation

- property owners concerns over loss of water rights and potential user fees
- property owner concerns over greater regulation re: land clearing, tree removal and fencing of livestock
- farm operators cooperation required in implementing environmental guidelines and codes of practice
- government-community cooperation to ensure integrated water management

Resources

- funding/resources required to undertake water budget studies, study alternative water storage options and assess non-point pollution sources
- funding/resources required to fill information gaps and other barriers

Actions: Water

POSSIBLE ACTIONS	ADVANTAGES	DISADVANTAGES
Undertake a water budget of supply and demand for both surface and groundwater (domestic and irrigation)	• necessary information base for effective management • opportunity to work jointly with property owners	• time-consuming/costly • difficulties in obtaining data
Create a local water authority to regulate water use	• provides for local responsibility and decision making on water issues • rents/fees collected would stay in region	• may be seen as another layer of government/bureaucracy • costs of establishing and running
Introduce user fees for water use and waste discharges	• recognizes true value/cost of resources • more efficient use of water and waste treatment systems • fees collected could be targeted to specific needs in the watershed (e.g., water storage, waste treatment)	• additional fees may place a burden on some users • an administrative system will be required to set, collect and distribute fees
Licence groundwater use	• recognizes inequities between surface and groundwater use allocation • creates ability to take a more holistic approach to water use management	• more resources required to administer • concern over more regulation
Work with local and regional governments to develop and implement policies and bylaws to protect watercourses and natural drainages (e.g., wetlands)	• protection of natural drainage systems to recharge groundwater • protection of fish and wildlife habitat • opportunities to work cooperatively with all levels of government and landowners	• requires resources to implement (i.e., building inspections) • resistance to greater control over private land development
Work with government agencies and landowners to identify and create water storage opportunities, e.g., snow wells and strips in forests, impoundments, wetlands	• create opportunities for more water storage, particularly during melting and freshet periods for later release during low flows • provision of wetlands for fish and wildlife and recreation/tourism • cooperation opportunities between residents and others • individuals take more responsibility in water management	• resources required to undertake studies and to implement storage measures
Develop, educate and demonstrate: water conservation methods, streamside vegetation retention, codes of environmental practice in agricultural operations	• more efficient use of water • protection of water quality • builds on initiatives, partnerships and cooperation now underway	• resources required to develop and implement
Undertake an assessment of non-point pollution sources	• increased understanding of significant sources of water quality	• resources required to implement study and organize community

POSSIBLE ACTIONS	ADVANTAGES	DISADVANTAGES
	degradation • opportunities for community involvement in collecting data and monitoring	involvement

5.2 Ecosystem Health

Barriers

Legislative/Administrative

- current fragmentation of administrative boundaries of government agencies in the watershed are not conducive to an ecosystem approach
- use of water, wetlands and old growth forests does not always reflect the full environmental costs or their value to future generations
- benefits of protecting a resource may not go directly to watershed residents (e.g., salmon produced in the watershed are caught elsewhere)
- lack of growth management strategies in the watershed
- lack of formal provincial wetland restoration and protection policy
- minimal control of environmentally harmful activities on private land
- ineffective management of population growth

Information Needs

- biophysical inventories to identify important wildlife habitats, especially for rare, endangered and threatened species
- identification of key wetlands in the watershed and their significance as fish and wildlife habitat and opportunities for recreation and tourism
- identification of important wildlife corridors
- establishment of ecosystem objectives and indicators as a basis for future monitoring of ecosystem health

Cooperation

- fragmented jurisdictions has been a barrier to ecosystem management
- some private property owners have resisted participation in cooperative programs to address ecosystem health issues
- different views and opinions on the seriousness of ecosystem issues

Resources

- funding/resources required to fill information gaps and address other barriers

Actions: Ecosystem Health

POSSIBLE ACTIONS	ADVANTAGES	DISADVANTAGES
Develop ecosystem objectives and indicators as a basis for monitoring ecosystem health	• provides a basis for evaluation of sustainability of the watershed	• some costs associated with identifying suitable objectives and indicators and monitoring and reporting
Examine ways of pricing resources that lead to more efficient use and reflect environmental values	• takes a more holistic view of management of resources and environmental costs	• may result in higher fees for some resource uses
Municipalities and regional districts to work together on a growth management strategy (Note: Thompson-Nicola Reg. District has begun this for the upper portion of the watershed)	• identifies and protects important ecosystem values • identifies where and how future growth will be accommodated in the watershed • provides opportunities for resident and senior government involvement and cooperation • covers private land	• resources required to undertake planning process and to implement policies
Undertake biophysical inventories to identify important fish and wildlife habitat and corridors	• could be part of LRMP and growth management initiatives • increased understanding of habitat requirements • opportunities to involve community and naturalists in inventory work	• additional costs of inventory
Participate in and support government initiatives such as forest ecosystem planning and land and resource management plans (LRMP)	• takes an ecosystem and integrated approach to management of provincial forest and crown land • builds on existing initiatives such as the Forest Practices Code • offers a mechanism for involving government agencies, residents and others in resource management planning	• does not apply to private land • requires government resources/funding
Examine opportunities for re-establishing wetland habitat	• opportunity to integrate wetland restoration with recreation and tourism activities • opportunity to undertake cooperative initiatives between private landowners, non-profit orgs. and First Nations	• possible loss of agricultural production
Examine feasibility of establishing a watershed management authority to overcome jurisdictional and administrative barriers to ecosystem management	• opportunity for a more holistic approach to management of the watershed • more local authority and accountability	• might be perceived as another layer of bureaucracy
Investigate whether important wetland complexes and other significant habitats meet criteria for protection as Wildlife Management Areas	• provides protection for significant ecosystem components	• funding/resources required to investigate • potential acquisition and management costs

5.3 Sense of Community

Barriers

Legislative/Administrative

- fragmented jurisdictions and decision making authority
- perceived lack of growth management in some areas of watershed
- perceived lack of local control and involvement in decisions affecting the watershed
- lack of resolution of native land claims

Information Needs

- articulation of residents' vision of community - this may vary across communities within the watershed
- identification of groups or people at risk of becoming part of a permanent "underclass"
- status of native land claims

Cooperation

- need for coordinating mechanisms to ensure growth, social and sustainability issues are addressed in the watershed
- residents feel their input is not being listened to by government

Resources

- concern that income support, education, health and other social services may be reduced
- lack of available opportunities for job retraining and employment
- costs of native land claims

Actions: Sense of Community

POSSIBLE ACTIONS	ADVANTAGES	DISADVANTAGES
Examine feasibility of a local watershed management authority	• more local authority and accountability	• might be perceived as another layer of bureaucracy
Build on initiatives like Forest Renewal BC to provide community involvement projects	• opportunities for cooperation with agencies and community groups • job training and experience	• dependence on government programs
Implement outreach program for street kids	• provides a supportive environment for kids at risk • opportunity for govern-ment/community partnerships	• resources to implement
Encourage affordable housing initiatives (e.g., creating extra densities in villages for rental housing or for a community land bank for co-op housing)	• provides housing for those who need it • contributes to a sense of community if a number of groups can become involved	• some concern over subsidies
Provide opportunities for community forums to discuss growth management issues, land claims and other issues	• provides much needed communication and awareness • can be done in cooperation with Roundtable and other partners (e.g., community colleges, agencies, First Nations)	• requires coordination and logistics
Encourage local and regional governments to undertake coordinated growth management strategies	• provides a means for addressing community concerns over population growth and sprawl • should incorporate social, economic and environmental objectives	• requires resources for planning and implementation

5.4 Rural Lifestyle and Livelihood

Barriers

<u>Legislative/Administrative</u>

- need for growth management strategy in watershed
- need for land and resource management plan in watershed that covers crown land and links with growth management strategies and local plans for private land

<u>Information Needs</u>

- need to understand the impacts of reduced timber harvests on jobs and the economy within the watershed so that strategies can be developed to offset these impacts
- obtain information on the viability of other business opportunities and employment generators (e.g., eco-tourism, farm experience holidays, etc.)

Cooperation

- concern over lack of integration of social, economic and environmental agencies of government to deal with issues of sustainability
- perceived lack of local input and control over decisions affecting rural lifestyle and livelihood
- lack of communication and awareness in order to build a common understanding of issues
- difference of opinion over what the problems are and how to deal with them

Resources

- until recently, with introduction of Forest Renewal BC, there has been concern over lack of resources for those displaced from forest related jobs; there is scepticism that such programs will be effective

Actions: Rural Lifestyle and Livelihood

POSSIBLE ACTIONS	ADVANTAGES	DISADVANTAGES
Encourage retention of productive farm land in the ALR	• to maintain a viable agricultural industry in the watershed • helps to maintain a rural character • discourages urban sprawl	• restricts ability of private property owners to develop land • may drive up the price of developable land in the watershed (reduced supply) and the cost of housing
Encourage local and regional governments to avoid sprawl through infill, higher density neighbourhoods, cluster housing, etc.	• helps maintain the rural character of the watershed • protects important green space and open areas • protects productive agricultural land • lower servicing costs	• as land becomes scarcer, property values will rise making it more difficult to obtain affordable housing
Participate in programs like Forest Renewal BC	• will help some re-adjust to job losses • provides for joint government-community projects	• requires resources to implement
New economic projects to enhance agricultural opportunities (e.g., farm folk/city folk concept (pre-sell system), cooperative marketing to promote more local buying, food processing and agro-tourism)	• helps to diversify the local economy • encourages money to be spent in local community • contributes to sense of community and rural character	• requires coordination and resources to implement
Encourage profitable enterprises on smaller farms which are underutilized	• greater diversity • better utilization of farm land	• potential resistance from landowners who believe their land is unproductive
Put more emphasis on co-op education programs which combine education and work experience	• allows more community involvement in education • positive work/training experience • greater local investment	• requires coordination
Through provincial land and resource management planning (LRMP), ensure that sustainable	• provides an opportunity for residents to be involved in decisions about the watershed	• covers crown land only and needs to be integrated with growth management planning on

harvesting practices are implemented and integrated with ecosystem objectives		private lands

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Burn, Pat. Forest Health Specialist, Ministry of Forests, Merritt.

Carr, Steve. Ministry of Forests, Vernon.

Casavant, Eugene. Hospital Administrator, Shuswap Lake Hospital.

Coombs, Wayne. Ministry of Forests, Kamloops.

Crouch, Ted. Regional Economic Development Officer, Ministry of Small Business, Tourism and Culture.

Dawson, Julie, Area Manager, Ministry of Social Services.

Delay, John. Recreation Officer, Ministry of Forests, Salmon Arm.

den Hertog, Johanna. Special Advisor, International Relations, Forestry and Environment, Ministry of Forests, Vancouver.

Drury, Wayne. Federated Cooperatives Ltd., Canoe.

Enemark, Gordon. Senior Economist, Ministry of Employment and Investment.

Federal Treaty Negation Office, Vancouver.

Finley, Bob, Planner, Thompson Nicola Regional District, Kamloops.

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Gaines, Tom. B.C. Ministry of Environment, Kamloops.

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Grace, Bob, BC Environment, Vernon

Hampton, Bruce. Ardew Wood Products, Merritt.

Hanry, Mike, Planner, BC Parks, Ministry of Environment, Lands and Parks, Kamloops.

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Lowe, Dave, Wildlife Branch, BC Environment, Kamloops

Mah, Fred, Environment Canada.

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McIntosh, Dave. Recreation Officer, Ministry of Forests, Vernon.

McRae, Ted. Ministry of Forests, Vernon.

Nash, Charles, Planning Director, District of Salmon Arm.

Obedkoff, Bill, Water Management, BC Environment, Victoria

Olding, Nancy, BC Treaty Commission, Vancouver.

Ortner, Chris. Forest Renewal BC representative, Kamloops Region.

Pearson, Anita. Planning Department, North Okanagan Regional District.

Pearson, Ken. Staff Sargeant, RCMP, Salmon Arm.

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Power, Geoff, Planning Director, Columbia Shuswap Regional District.

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Seefeldt, Graham. Recreation Officer, Ministry of Forests, Merritt.

Shimmin, Laing. B.C. Ministry of Environment, Kamloops.

Smith, Rick, Operations Manager, Ministry of Forests, Vernon

Smith, Ron, Water Management, BC Environment, Kamloops

Strachan, Graham, B.C. Ministry of Agriculture, Fisheries and Food, Kamloops

Vadas, Bob, Jr. Canadian Wildlife Service/University of British Columbia, Vancouver.

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Walker, Art. Forest Renewal BC, Victoria.

Wardley, Ian, Ministry of Energy, Mines and Petroleum Resources, Victoria

Watson, Barry, Environment Canada.

Wearing, Jerry. Silviculture Officer, Ministry of Forests, Vernon.

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APPENDIX A:

Enumeration Areas Chosen As Representative of the Salmon Valley Watershed for Census Data Collection

Year	Federal Electoral District	Enumeration Areas	Description
1991	9	001	Westwold
		004	Rural Watershed
		003	Monte Lake
	18	306-307, 311	Rural Watershed
		308	Some Falkland, Glenemma
		309	Silver Creek
		310	Falkland
		312	Salmon River IR #1
		314-315, 356, 358-360	Salmon Arm (portion within watershed)
		365-366	Switsemalph IR #'s 3 & 7
1986	10	059-066, 073-074	Rural Watershed, incl. IR #1
		008-009, 052-055	Salmon Arm (within watershed)
		056-057	Switsemalph IR #'s 3 & 7
1981	10	059-066	Rural Watershed
		008-009, 052-055	Salmon Arm (within watershed)
		056-057	Switsemalph IR #'s 3 & 7