Acknowledgements

The major contributions of material by Gordon D. Koshinsky and T.J. Willcocks, Environment Canada, is most gratefully acknowledged. Mr. Koshinsky's continued interest and assistance is also acknowledged.

The generous assistance and advice of G. Halsey, R.C. Thomas, G.D. Taylor, S.J. MacDonald, and A. Tautz of the B.C. Fish and Wildlife Branch, and particularly the help and encouragement of E.H. Vernon is noted with thanks.

J. O'Riordan, Environment Canada was of great assistance and provided considerable stimulus throughout the final phases. A.M. Thomson, Study Director was freely helpful and a pleasure to work with.

T.A.J. Leach and K. Smythe, B.C. Water Investigations Branch, provided much data with regard to tributary and main river flows, on which many aspects of the fisheries analysis are based. These contributions are acknowledged. J.G. Stockner, T.G. Northcote, F. Boyd and R. Hinton contributed information and advice. Frank Metcalf assisted in familiarization with the system.

The helpfulness, friendliness and technical expertise of the Okanagan Basin Study Office personnel is a pleasure to acknowledge.

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APPENDICES

APPENDIX A_1

ELEVATIONS AND SURFACE AREAS AT FULL SUPPLY LEVEL OF 75 "ADDITIONAL" (NON-KEY) OKANAGAN HEADWATER LAKES KNOWN TO HARBOR SPORT-FISHING OPPORTUNITIES LISTING TO ACCOMPANY FIGURE 3.1

NO.	LAKE	ELEVATION, FEET	SURFACE AREA, ACRES	NO.[b]	LAKE	ELEVATION, FEET	SURFACE AREA, ACRES
1	Aeneas	2,400	38	39	Lacoma	3,500	13
2	Baker	4,500	25	40	Lebanon	4,000	3
3	Big Clarke	5,300	13	41	Little Clarke	5,100	11
4	Big Meadow	5,400	56	42	Little Bouleau	4,600	40
5	Blue	2,750	5	43	Loch Drinkie	4,600	45
6	Brent	2,700	58	44	Loch Katrine	6,400	30
7	Bulman	4,400	62	45	Long Meadow	4,300	60
8	Canyon	5,500	40	46	Lower Twin	2,700	82
9	Chapman	5,600	25	47	MacDonald	5,600	12
10	Christie	4,400	7	48	McLean Clan	5,300	25
11	Clarke Meadows	5,000	19	49	Marron	2,000	35
12	Corporation	5,700	12	50	Meadow	4,500	12
13	Crescent	4,500	80	51	Minnow	4,200	35
14	Culper	5,700	8	52	Mission	6,000	133
15	Derenzy	5,300	18	53	Morrison	4,500	5
16	Divide	5,000	14	54	Naramata	4,150	35
17	Dobbin	4,800	20	55	Norman	4,600	3
18	Duo Via	4,400	10	56	Nuttal	5,700	13
19	Eastmere	4,700	30	57	Otter	1,150	120
20	Elinor	4,100	20	58	Paynter	4,500	57
21	Ellis Res. 1	5,050	45	59	Pear	4,200	35
22	Ellis Res. 4	4,400	100	60	Rankin	4,800	10
23	Ellison	1,400	520	61	Ratnip	4,100	5
24	Farleigh	2,500	35	62	Reed	6,000	8
25	Fish	4,300	35	63	Rod	4,600	10
26	Gallagher	1,400	17	64	Round	4,500	30
27	Gemmill	4,700	8	65	Round	1,400	80
28	Glenmore Res.	1,200	18	66	Seaton	4,550	30
29	Goose	1,600	89	67	Shannon	1,700	54
30	Graystoke	6,000	89	68	Shorts	4,600	20
31	Green	1,600	44	69	Tadpole	5,300	17
32	Greyback	5,200	307	70	Thirsk Res.	3,400	148
33	Guest	4,400	28	71	Tugulnuit	1,100	125
34	Hudson Bay	5,200	15	72	Upper Twin	2,700	79
35	Isintok	5,400	97	73	West	4,900	10
36	Islaht	4,800	67	74	Wilson	4,300	12
37	Kathleen	4,500	5	75	Wolf	2,250	3
38	Kilpoola	2,750	42				

APPENDIX A_2

ELEVATION. TOTAL DISSOLVED SOLIDS. AND SURFACE AREAS OF 57 "KEY" HEADWATER LAKES

	ELEVATION FEET	TOTAL DIS-SOLVED SOLIDS	AREA (ACRES) AT FULL SUPPLY LEVEL	AREA (ACRES) AT 50% DRAWDOWN OF LIVE STORAGE VOLUME [b]		
				TOTAL	LIMNETIC	LITTORAL
Agur	3800	232	9	7.5	0.9	6.6
Alex	4800	53	21	20.0	5.3	14.7
Allendale	5000	240	49	42.1	12.5	29.6
Bardolf	3200	100*	27	27.0	14.0	13.0
Bear	4400	50*	20	20.0	0.0	20.0
Becker	4000	120*	25	25.0	8.0	17.0
Bouleau	4600	58	158	158.0	2.0*	156.0*
Browne	4300	80*	61	50.9	0.0*	50.9*
Burnell	2400	210*	41	41.0	20.0*	21.0*
Chute	3800	69	70	67.5	22.5	45.0
Darke	3000	160*	72	53.0	0.0	53.0
Dee Chain [c]	4400	105	485	406.5	94.0	312.5
Deep	1600	85	10	10.0*	7.0*	3.0*
Deer (Tsuh)	4700	82*	28	28.0	0.0	28.0
Echo	4800	70*	35	35.0	0.0*	35.0*
Eneas [d]	4700	82*	49	30.0	10.0	20.0*
Esperon	5400	55*	50	50.0	14.0	36.0
Fish Hawk	6000	48	43	43.0	0.0	43.0
Garnet Valley	2100	160*	87	56.0	17.0	39.0
Geen	5400	60*	40	40.0	5.0*	35.0*
Glen	3800	82*	29	18.0	3.0*	15.0*
Haynes	4200	71*	136	122.0	80.0	42.0
Headwaters #1	4200	88	161	135.0	0.0	135.0
#2	4300	88*	54	38.9	0.0	38.9
#3	4300	88*	54	35.9	0.0	35.9
#4	4300	88*	52	26.0	7.5	18.5
Hereron	5200	60*	25	25.0	15.0*	10.0*
High	4500	50*	30	30.0	24.0*	6.0*
Hydraulic	4000	71	644	316.0	0.0	316.0
Ideal	4400	50*	420	255.0	7.0	248.0
Jackpine	4300	90	106	75.4	0.0	75.4
James	4500	60*	140	108.0	0.0	108.0
Kaiser Bill	4500	50	6	6.0	0.0*	6.0*
King Edward	4500	50*	82	64.3	35.3	29.0
Lady King	3300	190	15	15.0	0.0*	15.0*
Lambly	3800	103	182	126.0	0.0	126.0
Lone Pine	5500	240*	25	25.0	0.0*	25.0*
Lost	4500	55*	45	45.0	18.0*	27.0*
McCall	3300	90*	15	15.0	0.0*	15.0*
Madden	2800	215	17	17.0	6.0	11.0
Munro	5200	82	35	27.6	3.6	24.0
Oyama	4400	54	630 [e]	535.0	248.0	287.0
Peachland	4100	90*	269 [e]	162.0	100.0	62.0
Pinaus	3300	122	407	399.0	347.0	52.0
Pinaus,Little	3100	120*	17	17.0	0.0*	17.0*
Postill	4500	60*	226	118.0	0.0	118.0
Ripley	3100	209	13	13.0	3.0	10.0
Rose Valley	2000	120*	70	50.0	21.0	29.0
Round	4800	50*	35	35.0	0.0*	35.0*
Silver	3400	90*	30	24.2	9.0	15.2
South	4500	60*	60	25.0	13.0*	12.0*
Square	3600	215	25	25.0	20.0	5.0
Streak	4500	50*	50	50.0	5.0	45.0
Swalwell	4500	63	750	548.0	288.0	260.0
Swan	1300	320	973	973.0	0.0	973.0
Whitehead	4700	55*	105	85.0	11.0	74.0
Wilma	4500	90*	25	25.0	5.0	20.0
TOTALS (57)			7338	5808.8		

[a] From Koshinsky and Andres (MS 1972) or MacDonald (personal communication) unless indicated*, in which case estimated by comparison with adjacent lakes .

[b] From B.C. Water Resources Service unless indicated*, in which case estimated by reference to lakes of similar size and location

[c] Includes Dee, Island, Deer and Crooked Lakes.

[d] Includes Big Eneas, Little Eneas and Island Lakes.

[e] Incorporates an upward revision for area of Peachland Reservoir at full supply level from 60 acres (Koshinsky and Andres, MS 1972) to 269 acres (Botham, personal communication).

APPENDIX B

SUMMARY OF TROUT CARRYING CAPACITIES AND ACTUAL TROUT INTRODUCTIONS TO 57 "KEY" OKANAGAN HEADWATER LAKES. 1967-1971[a]

LAKE	BASIC ANNUAL FRY CARRYING CAPACITY NO. AT 2500/lb.	YEARS IN WHICH STOCKING WAS UNDERTAKEN					AVERAGE NO. STOCKED ANNUALLY[b] AT 2500/lb EQUIVALENT
		'67	'68	'69	'70	'71	
Agur	22,200	x	x	x			14,467
Alex	23,300						0
Allendale	104,900	x	x	x		x	38,170
Bardolf	28,800		x	x	x	x	26,978
Bear	30,000						0
Becker	39,400			x			6,259
Bouleau	246,800						0
Browne	81,700	x		x	x		44,674
Burnell	71,300	x	x	x		x	22,767
Chute	79,900						0
Darke	137,800	x	x	x	x	x	39,363
Dee Chain[c]	659,900	x	x		x	x	240,078
Deep	6,800	x	x	x	x	x	13,630
Deer (Tsuh)	53,100						0
Echo	59,500	x	x	x	x	x	32,804
Eneas[d]	38,200						0
Esperon	58,000		x	x	x	x	17,789
Fish Hawk	63,600						0
Garnet Valley	105,800		x[e]	x[e]	x[e]		93,241
Geen	57,000						0
Glen	27,800	x	x	x	x	x	26,252
Haynes	85,800	x	x	x	x	x	17,233
Headwater #1	253,800	x		x	x	x	91,007
#2	73,100			x	x	x	52,970
#3	67,500			x	x	x	18,315
#4	36,200			x	x	x	17,341
Hereron	18,400						0
High	12,600					x	11,111
Hydraulic	540,400	x					18,133
Ideal	373,100		x				7,500
Jackpine	143,300	x	x	x	x	x	48,770
James	172,800						0
Kaiser Bill	9,000						0
King Edward	48,800						0
Lady King	43,500	x	x	x	x	x	14,467
Lambly	255,800	x	x	x	x		78,985
Lone Pine	85,000						0
Lost	44,600		x	x	x	x[e]	14,307
McCall	28,500	x	x	x	x	x[e]	8,952
Madden	36,500	x	x	x	x	x	37,422
Munro	44,300	x	x	x	x	x	23,333
Oyama	481,700		x	x	x	x	51,389
Peachland	136,800				x		6,704
Pinaus	192,500	x	x	x	x	x	182,556
Pinaus (Little)	37,400	x	x	x	x	x	18,230
Postill	188,800						0
Ripley	31,800	x	x	x	x	x	32,430
Rose Valley	68,400	x	x		x	x	46,607
Round	52,500					x	13,926
Silver	30,600	x	x	x	x	x	15,911
South	21,300						0
Square	22,000	x	x	x	x	x	15,974
Streak	68,300						0
Swalwell	470,700	x	x		x	x	243,052
Swan	3,405,500						0
Whitehead	116,400				x		6,704
Wilma	39,000	x	x		x	x	18,604
TOTALS (57)	9,732,500	(40 lakes stocked at least once)					1,728,405

[a] From B.C. Fish and Wildlife Branch Annual Reports.
[b] Based on number of years since trout were first stocked within this particular 5-year period.
[c] Includes Dee, Island, Deer, and Crooked Lakes.
[d] Includes Big Eneas, Little Eneas, and Island Lakes.
[e] Indicates brook trout; remainder are all rainbow trout.

APPENDIX C

SUMMARY OF TROUT INTRODUCTIONS TO "ADDITIONAL" (NON-KEY) OKANAGAN HEADWATER LAKES, 1967-1971[a]

LAKE	ELEVATION FEET	SURFACE AREA AT FULL SUPPLY LEVEL ACRES	YEARS IN WHICH STOCKING WAS UNDERTAKEN '67	'68	'69	'70	'71	AVERAGE NO. OF FISH STOCKED ANNUALLY[b] AT 2500/lb. EQUIVALENT
Baker	4500	25		x				5,714
Bulman	4400	62					x	39,216
Clarke, Big	5300	13			x	x	x	3,448
Clarke, Little	5100	11			x	x	x	6,990
Corporation	5700	12					x	17,241
Crescent	4500	80				x		6,289
Culper	5700	8					x	10,345
Derenzy	5300	18		x	x	x		8,638
Divide	5000	14		x				5,714
Gallagher	1400	17	x[c]	x[c]	x[c]			31,246
Glenmore	1200	18	x[c]	x[c]	x[c]	x[c]		35,852
Goose	1600	89		x[c]	x[c]	x[c]		23,201
Greyback	5200	307					x	86,207
MacDonald	5600	12					x	8,791
McLean Clan	5300	25				x	x	7,051
Minnow	4200	35		x	x	x	x	11,732
Norman	4600	3		x	x			6,246
Pear	4200	35		x	x	x	x	7,583
Rod	4600	10		x	x	x	x	17,871
TOTALS (19)		794						339,375

[a] From B.C. Fish and Wildlife Branch Annual Reports.

[b] Based on number of years since trout were first stocked within this particular 5-year period.

[c] Indicates brook trout; remainder are all rainbow trout.

APPENDIX D

SIZE DISTRIBUTION OF TROUT STOCKED IN OKANAGAN HEADWATER LAKES, 1967-1971[a]

SIZE CLASS NO./LB.	RAINBOW TROUT ACTUAL NUMBER STOCKED, x 1000	RAINBOW TROUT % DISTRIBUTION ACCORDING TO ACTUAL SIZE	RAINBOW TROUT % DISTRIBUTION ACCORDING TO EQUIVALENT SIZE	BROOK TROUT ACTUAL NUMBER STOCKED, x 1000	BROOK TROUT % DISTRIBUTION ACCORDING TO ACTUAL SIZE	BROOK TROUT % DISTRIBUTION ACCORDING TO EQUIVALENT SIZE	BOTH SPECIES ACTUAL NUMBER STOCKED, x 1000	BOTH SPECIES % DISTRIBUTION ACCORDING TO ACTUAL SIZE	BOTH SPECIES % DISTRIBUTION ACCORDING TO EQUIVALENT SIZE
<50	55.75	3.2	5.9	0.0	0.0	0.0	55.75	3.1	5.6
50-99	191.29	11.1	18.0	0.0	0.0	0.0	191.29	10.6	17.2
100-199	200.45	11.6	16.3	0.0	0.0	0.0	200.45	11.1	15.5
200-299	91.00	5.3	6.0	56.5	69.3	79.1	147.50	8.2	9.3
300-399	172.50	10.0	9.9	0.0	0.0	0.0	172.50	9.6	9.4
400-499	359.50	20.9	18.1	0.0	0.0	0.0	359.50	19.9	17.3
500-599	193.00	11.2	8.5	0.0	0.0	0.0	193.00	10.7	8.2
600-699	351.50	20.4	14.0	25.0	30.7	20.9	376.50	20.9	14.3
700-799	0.00	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0
800-899	37.00	2.2	1.2	0.0	0.0	0.0	37.00	2.0	1.2
900-999	65.00	3.8	2.0	0.0	0.0	0.0	65.00	3.6	1.9
1600-1699	5.00	0.3	0.1	0.0	0.0	0.0	5.00	0.3	0.1
TOTAL, 1967-71	1721.99	100.0	100.0	81.5	100.0	100.0	1803.49	100.0	100.0
Average Annual	344.4			16.3			360.7		

[a] From B.C. Fish and Wildlife Branch Annual Reports.

APPENDIX E

COMPARISON OF RAINBOW TROUT HARVESTS AND VIRTUAL POPULATIONS ESTIMATED FROM "MOST PROBABLE" AVERAGE ANNUAL SURVIVAL RATES, 12 OKANAGAN HEADWATER LAKES, 1971

	AGUR	BROWNE	DARKE	ECHO	JACKPINE	LAMBLY	MADDEN	MUNRO	PINAUS	RIPLEY	SILVER	WILMA
Elevation, feet:	3800	4300	3000	4800	4300	3800	2800	5200	3300	3100	3400	4500
Present (1971) fishery:												
Angling-hours per acre	73	77	73	13	39	48	199	16	197	262	33	19
Number caught per acre	57	47	50	13	8	38	33	14	51	115	22	15
Average weight, lb.	0.40	0.39	0.50	0.59	0.86	0.40	0.73	0.41	0.78	0.45	0.88	0.49
Average age, years	2+	2+	2+	5+	5+	2+	2+	4+	2+	2+	2+	3+
Fry stocked (on basis of 2500/lb) in year which gave rise to trout of average age in catch:												
Number per acre	1804	727	1052	852	276	367	2036	663	478	2644	731	752
Virtual population by age class:												
Number per acre												
1+	361	145	210	170	55	73	407	133	96	529	146	150
2+	180	72	105	85	27	36	203	66	48	264	73	75
3+	108	43	63	51	16	22	122	40	29	158	44	45
4+	81	32	47	38	12	16	91	30	22	118	33	34
5+	61	24	35	28	9	12	69	22	16	88	25	25
6+	30	12	17	14	4	6	34	11	8	44	12	12
At avg. age in catch	162	63	94	24	8	32	183	28	43	238	66	42
Virtual population at average age in catch, less actual angling catch:												
Number per acre	+105	+16	+44	+11	0	- 6	+150	+14	- 8	+123	+44	+27
% "error"	+ 65	+25	+47	+46	0	-19	+ 82	+50	-19	+ 52	+67	+64

MEASURED AVERAGE FORK LENGTHS (CENTIMETERS) - AT-AGE OF RAINBOW TROUT IN 10 OKANAGAN HEADWATER LAKES ACCORDING TO ELEVATION. 1971[a]

LAKE(S)	ELEVATION, FT.	AGE, YEARS				
		1+	2+	3+	4+	5+
Pinaus	< 3501	-	29	40	43	45
Lambly, Agur	3501 - 4000	12	24.5	20	33	36
Headwaters #1, Jackpine, Oyama, Swalwell	4001 - 4500	12.7	20	25.5	30.2	41
Alex	4501 - 5000	-	15	25	30	35
Munro	5001 - 5500	12	22	27	30	-
Fish Hawk	> 5500	8	15	19	22	24

[a] Data from Koshinsky and Andres (MS 1972).

APPENDIX F

ESTIMATED "PRESENT" AVAILABLE AND PRESENT (1971) REALIZED ANNUAL TROUT HARVEST FOR 57 "KEY" OKANAGAN HEADWATER LAKES

	PRESENT ANNUAL AVAILABLE HARVEST[a]		RECORDED HARVEST, 1971	
	NUMBER	POUNDS	NUMBER	POUNDS
Agur	1302	625	427	205
Alex	0	0	179	93
Allendale	1611	838	2838	1476
Bardolph	2428	1578	791	514
Bear	0	0	227	100
Becker	563	270	388	186
Bouleau	0	0	3840	1997
Browne	2511	1104	2570	1131
Burnell	2049	1332	0	0
Chute	0	0	879	422
Darke	3543	2303	2745	1784
Dee Chain	13492	5936	9039	3977
Deep	1227	798	539	350
Deer (Tsuh)	0	0	2106	1095
Echo	1384	720	508	264
Eneas	0	0	542	282
Esperon	751	285	526	200
Fish Hawk	0	0	288	69
Garnet Valley	8392	5455	494	321
Geen	0	0	182	69
Glen	2363	1134	10	5
Haynes	968	425	89	39
Headwaters #1	5115	2251	539	237
#2	2977	1310	209	92
#3	1029	453	450	198
#4	975	429	227	100
Hereron	0	0	111	42
High	624	275	441	194
Hydraulic	1632	784	90	43
Ideal	422	186	1302	573
Jackpine	2741	1206	1698	747
James	0	0	159	70
Kaiser Bill	0	0	227	100
King Edward	0	0	230	101
Lady King	1302	846	488	317
Lambly	7109	3412	5742	2756
Lone Pine	0	0	1603	609
Lost	804	354	186	82
McCall	806	524	138	90
Madden	3368	2189	631	410
Munro	985	374	511	194
Oyama	2888	1271	5014	2206
Peachland	377	166	2225	979
Pinaus	16430	10679	24921	16199
Pinaus, Little	1641	1067	51	33
Postill	0	0	6030	2653
Ripley	2919	1897	1038	675
Rose Valley	4195	2727	837	544
Round	588	306	510	265
Silver	1432	931	878	571
South	0	0	695	306
Square	1438	690	2729	1310
Streak	0	0	439	193
Swalwell	13659	6010	33400	14696
Swan	0	0	135	88
Whitehead	283	147	1963	1021
Wilma	1046	460	411	181
TOTALS (57)	119,369	63,747	125,465	63,454

[a] Based on mean annual stocking 1967-1971.

APPENDIX G

SUGGESTED MINIMUM DISCHARGE REQUIREMENTS, AND PRESENT AVERAGE MOST CRITICAL SEASONAL DISCHARGES AVAILABLE FOR RESIDENT TROUT PRODUCTION IN OKANAGAN TRIBUTARY STREAMS

CREEK AND REACH	GAUGING STATION[b]	MEAN ANNUAL NATURAL DISCHARGE cfs[b,c]	SUGGESTED "MINIMAL OPTIMUM" FISHERY DISCHARGE REQUIREMENT, CFS			PRESENT AVERAGE MOST CRITICAL[d] SEASONAL DISCHARGE AVAILABLE, CFS	
			APRIL-SEPT.	OCT.-MARCH	ABSOLUTE (SHORT-TERM)	SUMMER TO EARLY AUTUMN	WINTER
B-X, Upper	MP-14	7.8	2.3	2.0	1.5	0.1	0.1
B-X, Lower	MP-16	9.5	2.9	2.0	1.5	0.5	0.5
Coldstream	MP-10	16.1	4.8	2.4	1.6	1.0	1.0
Deep	---	11.6[e]	3.5	2.0	1.5	0.8	2.3
Equesis	MP-2	19.6	5.9	2.9	2.0	5.5	3.0
Ellis	---	---	3.5	2.0	1.5	4.0	1.0
Inkaneep	---	---	3.5	2.0	1.5	0.5	0.5
Kelowna	MP-9	22.3[e]	6.7	3.3	2.2	3.6	2.6
Lambly	---	48.9[e]	14.7	7.3	4.9	2.5	5.0
Mission (a)	MP-6	101.3	30.4	15.2	10.1	20	15
(b)	MP-10	145.6	43.7	21.8	14.6	25	15
(c)	MP-16	173.1	51.9	26.0	17.3	25	20
Peachland	MP-7	19.9	6.0	3.0	2.0	3.0	2.0
Penticton	MP-5	37.9	11.4	5.7	3.8	10.0	2.0
Powers	MP-7	18.9	5.7	2.8	1.9	7.0	1.0
Shingle (a)	---	---	3.5	2.0	1.5	0.5	1.1
(b)	---	---	3.5	2.0	1.5	1.2	2.0
Shorts	---	45.0[e]	13.5	6.8	4.5	4.0	4.0
Shuttleworth	---	---	3.5	2.0	1.5	3.0	0.5
Trepanier	---	38.7[e]	11.6	5.8	3.9	4.5	3.0
Trout (a)	CP-1,2	13.8	4.1	2.1	1.5	12.0	1.0
b,c)	MP-9	68.6	20.6	10.3	6.9	17.0	5.7
Vaseux	---	---	3.5	2.0	1.5	4.0	4.0
Vernon (a)	CP-2	26.1	7.8	3.9	2.6	4.0	4.0
(b)	CP-5	101.3[f]	30.4	15.2	10.1	7.0	4.0
Whiteman (a)	---	23.5[f]	7.1	3.5	2.4	5.0	4.0
(b)	---	22.1[f]	6.6	3.3	2.2	5.0	4.0

[b] As given by Smyth (MS 1973) except where otherwise indicated.

[c] As pertaining to a "dry" year (Smyth MS 1973)

[d] Estimated from various sources including Smyth (MS 1973), and personal communications from McNeil, Botham, and B.C. Fish and Wildlife Branch personnel.

[e] Estimated at mouth by McNeil (personal communication).

[f] Estimated by reference to 45.6 cfs mean annual discharge at mouth (McNeil, personal communication).

APPENDIX H
PREDOMINANT CONSTRAINTS TO RESIDENT FISH PRODUCTION AND ANGLING UTILIZATION OF TRIBUTARY STREAMS IN THE OKANAGAN BASIN[a]
(ALSO GIVEN ARE SUGGESTED ACTION PRIORITIES FOR LESSENING CONSTRAINTS)

CREEK AND REACH	CONSTRAINTS
B-X, Upper	Heavy water abstraction
B-X, Lower	Industrial and urban development
Coldstream	--
Deep	Heavy water abstraction for consumptive uses
Equesis	Indian Land
Ellis	Consistently dries up in summer
Inkaneep	Indian land
Kelowna	Industrial and urban development
Lambly	Heavy water abstraction
Mission (a)	Poor access
(b)	Generally poor access
(c)	Some channelization
Peachland	Poor access
Penticton	Generally poor access
Powers	Generally poor access
Shingle (a)	Some Indian Land
(b)	Private and Indian land
Shorts	Some private land
Shuttleworth	Heavy water abstraction
Trepanier	Heavy water abstraction
Trout (a)	Generally poor access
(b)	Sporadic access
(c)	Sporadic access
Vaseux	--
Vernon (a)	Generally poor access
(b)	Excessive development
Whiteman	Sporadic access

[a] Developed from observations of S. MacDonald (personal communication).

APPENDIX I_1
SUMMARY OF GILLNET CATCHES FROM WOOD LAKE, 1971 [a,b]

SPECIES	NUMBER CAUGHT		WEIGHT OF CATCH, LB.	
	TOTAL	%	TOTAL	%
Kokanee	33	9.76	5.09	2.80
Rainbow Trout	3	0.89	1.06	0.59
Mountain whitefish	5	1.48	1.65	0.91
Largescale sucker	38	11.24	36.02	19.83
Carp	22	6.51	69.36	38.19
Squawfish	69	20.41	42.59	23.45
Peamouth chub	164	48.52	25.31	13.94
Chiselmouth	4	1.19	0.53	0.29
TOTALS	338	100.00	181.61	100.00

[a] Data of Northcote *et al.* (Ms 1972), as further analysed by Tautz (personal communication).

[b] Based on total effort of 253.16 gang-hours.

APPENDIX I_2

SUMMARY OF GILLNET CATCHES FROM KALAMALKA LAKE, 1971 [a,b]

SPECIES	NUMBER CAUGHT		WEIGHT OF CATCH, LB.	
	TOTAL	%	TOTAL	%
Kokanee	306	31.61	53.97	9.65
Rainbow Trout	67	6.92	48.74	8.72
Lake trout	92	9.50	210.94	37.73
Mountain whitefish	6	0.62	3.84	0.69
Largescale sucker	65	6.72	53.02	9.49
Carp	20	2.07	65.70	11.75
Squawfish	96	9.92	74.07	13.25
Peamouth chub	315	32.54	48.61	8.70
Chiselmouth	1	0.10	0.13	0.02
TOTALS	968	100.00	559.02	100.00

[a] Data of Northcote *et al*. (MS 1972) as further analysed by Tautz (personal communication).

[b] Based on total effort of 517.00 gang-hours.

APPENDIX I_3

SUMMARY OF GILLNET CATCHES FROM OKANAGAN LAKE (ALL REGIONS COMBINED), 1971 [a,b]

SPECIES	NUMBER CAUGHT		WEIGHT OF CATCH, LB.	
	TOTAL	%	TOTAL	%
Kokanee	2179	34.86	741.54	17.71
Rainbow Trout	166	2.66	200.31	4.79
Mountain whitefish	338	5.41	146.26	3.49
Burbot	114	1.82	420.73	10.05
Lake whitefish	634	10.15	625.35	14.94
Largescale sucker	455	7.28	519.47	12.41
Longnose sucker	39	0.62	72.62	1.73
Carp	55	0.88	325.75	7.78
Squawfish	718	11.49	839.18	20.05
Peamouth chub	1449	23.98	286.55	6.84
Chiselmouth	40	0.64	7.94	0.19
Prickly sculpin	13	0.21	0.86	0.02
TOTALS	6250	100.00	4186.56	100.00

[a] Data of Northcote *et al*. (MS 1972), as further analysed by Tautz (personal communication).

[b] Based on total effort of 2260.87 gang-hours.

APPENDIX I_4

SUMMARY OF GILLNET CATCHES FROM SKAHA LAKE, 1971 [a,b]

SPECIES	NUMBER CAUGHT		WEIGHT OF CATCH, LB.	
	TOTAL	%	TOTAL	%
Kokanee	371	13.33	229.01	9.04
Rainbow Trout	23	0.83	17.75	0.70
Mountain whitefish	77	2.77	47.53	1.88
Burbot	4	0.14	11.91	0.47
Pumpkinseed	2	0.07	0.35	0.02
Lake Whitefish	468	16.82	1042.07	41.14
Largescale sucker	307	11.03	345.17	13.63
Longnose sucker	11	0.39	21.83	0.86
Carp	49	1.76	180.40	7.12
Squawfish	377	13.54	324.14	12.80
Peamouth chub	996	35.79	263.49	10.40
Chiselmouth	97	3.49	49.19	1.94
Prickly sculpin	1	0.04	0.07	+
TOTALS	2783	100.00	2532.91	100.00

[a] Data of Northcote *et al.* (MS 1972), as further analysed by Tautz (personal communication).

[b] Based on total effort of 505.00 gang-hours.

APPENDIX I_5

SUMMARY OF GILLNET CATCHES FROM VASEUX LAKE, 1971 [a,b]

SPECIES	NUMBER CAUGHT		WEIGHT OF CATCH, LB.	
	TOTAL	%	TOTAL	%
Kokanee	15	0.66	10.25	1.18
Rainbow Trout	4	0.18	3.00	0.35
Mountain whitefish	22	0.97	9.22	1.06
Yellow perch	47	2.08	11.40	1.32
Black Bullhead	56	2.48	13.58	1.57
Pumpkinseed	7	0.31	1.39	0.16
Lake Whitefish	411	18.21	317.13	36.67
Largescale sucker	102	4.52	94.45	10.92
Carp	13	0.58	38.12	4.41
Squawfish	150	6.65	112.43	13.00
Peamouth chub	1423	63.05	250.97	29.02
Chiselmouth	7	0.31	2.93	0.34
TOTALS	2257	100.00	864.87	100.00

[a] Data of Northcote *et al.* (MS 1972), as further analysed by Tautz (personal communication).

[b] Based on total effort of 249.41 gang-hours.

APPENDIX I_6

SUMMARY OF GILLNET CATCHES FOR OSOYOOS LAKE, 1971 [a,b]

SPECIES	NUMBER CAUGHT		WEIGHT OF CATCH, LB.	
	TOTAL	%	TOTAL	%
Kokanee	307	27.94	54.14	5.82
Rainbow Trout	12	1.09	12.43	1.34
Mountain Whitefish	42	3.82	29.63	3.18
Smallmouth bass	12	1.09	14.55	1.56
Yellow Perch	52	4.73	6.88	0.74
Black Bullhead	3	0.27	0.73	0.08
Pumpkinseed	3	0.27	0.60	0.06
Lake Whitefish	80	7.28	128.75	13.84
Largescale Sucker	37	3.37	64.44	6.93
Longnose Sucker	171	15.56	335.52	36.06
Carp	43	3.91	113.76	12.23
Squawfish	56	5.10	62.96	6.77
Peamouth Chub	104	9.46	48.15	5.18
Chiselmouth	174	15.84	57.54	6.18
Pygmy Whitefish	1	0.09	0.20	0.02
Prickly Sculpin	2	0.18	0.13	0.01
TOTALS	1099	100.00	930.41	100.00

[a] Data of Northcote *et al.* (MS 1972), as further analysed by Tautz (personal communication).

[b] Based on total effort of 341.00 gang-hours.

APPENDIX I_7

SYNOPSIS OF GILLNET CATCHES BY SPECIES, GROUPS[a]

OKANAGAN MAIN VALLEY LAKES, 1971 [b]

	WOOD	KALAMALKA	OKANAGAN	SKAHA	VASEUX	OSOYOOS
Total gillnet effort,gang-hours	253.16	517.00	2260.87	505.00	249.41	341.00
Total gillnet catch,lb/gang-hr.						
Preferred sport fishes	0.031	0.614	0.482	0.583	0.090	0.325
Marginal sport fishes	0.000	0.000	0.186	0.024	0.106	0.024
Preferred commercial fishes	0.000	0.000	0.277	2.064	1.271	0.378
Preferred coarse fishes	0.416	0.230	0.406	1.084	0.532	1.506
Marginal coarse fishes	0.270	0.237	0.501	1.261	1.469	0.495
All species	0.717	1.081	1.852	5.016	3.468	2.728
Percent composition by weight of gillnet catches						
Preferred sport fishes	4.3	56.8	26.0	11.6	2.6	11.9
Marginal sport fishes	0.0	0.0	10.1	0.5	3.0	0.9
Preferred commercial fishes	0.0	0.0	14.9	41.1	36.7	13.8
Preferred coarse fishes	58.0	21.2	21.9	21.6	15.3	55.2
Marginal coarse fishes	37.7	22.0	27.1	25.2	42.4	18.2
All species	100.0	100.0	100.0	100.0	100.0	100.0

[a] For composition of species groups, See Table 5.1

[b] Data of Northcote *et al.* (MS 1972), as further analysed by Tautz (personal communication)

APPENDIX J

DERIVATION OF PRESENT ANNUAL CARRYING CAPACITY ESTIMATES FOR KOKANEE FRY, REFERABLE TO NUMBERS OF KOKANEE SPAWNERS SUPPORTABLE, OKANAGAN MAIN VALLEY LAKES.

	WOOD	KALAMALKA	OKANAGAN	SKAHA	VASEUX	OSOYOOS
Surface area, acres[a]	2298	6,400	85,990	4,967	680	3,719
Average concentration crustacean zooplankton[b], mm^4/cm^2	31.10	10.90	10.55	23.65	23.65[c]	18.40
Zooplankton concentration relative to Okanagan Lake	2.95	1.03	1.00	2.24	2.24[c]	1.74
Estimated plankton abundance index[d]	4.90	1.71	1.66[e]	3.72	3.72	2.89
Effective female sockeye spawners supportable[f], x 100	1,126	1,094	14,275	1,848	253	1,075
Average fork length (mm) of mature kokanee	238	215	259	330	290	249
Average number of eggs per kokanee female	351	240	474	990	654	401
Estimated female kokanee spawners supportable, x 100	4,010	5,698	37,645	2,333	484	3,181[g]
Estimated total kokanee spawners supportable, x 100	8,020	11,396	75,290	4,666	968	6,362

[a] From Stockner, Table 8 (Okanagan Basin Manuscript Report, 1973).

[b] From Patalas and Salki (" " " " , 1973).

[c] Estimated by reference to Skaha Lake.

[d] By reference to relative average Zooplankton concentration in conjunction with specific P.A.I, estimate for Okanagan Lake.

[e] From Halsey (Okanagan Basin Manuscript Report, 1972).

[f] Assuming 3500 successfully-deposited eggs per female

[g] Incorporates an adjustment to accommodate average sockeye escapement.

APPENDIX K
SAMPLE CALCULATION OF PRESENT CARRYING CAPACITY (OF OSOYOOS LAKE) FOR KOKANEE SPAWNERS

A. Basic carrying capacity:

Plankton abundance index for Osoyoos Lake

= P.A.I. for Okanagan x $\frac{\text{(Avg. concentration of Zooplankton in Osoyoos)}}{\text{(Avg. concentration of Zooplankton in Okanagan)}}$

= 1.66 x 18.40/10.55 = 2.89

Area of Osoyoos Lake = 3,719 acres

Therefore, effective female sockeye spawners supportable

= 2.89 x 10 x 3719 = 107,479

Avg. length of mature kokanee in Osoyoos Lake in 1971 = 249 mm. And average number of eggs per female spawners = 401.

Equivalent female kokanee spawners supportable

= (numbers of effective sockeye spawners supportable)

x (Ratio of effective sockeye: kokanee fecundities)

x (Ratio of effective sockeye: kokanee lake residence times)

= 107,479 x (3500/401) x (1.25/3.50) = 335,000

B. Adjustment for sockeye rearing requirement:

Avg. fecundity of Okanagan River sockeye	= 2500 eggs
Avg. fecundity of Osoyoos Lake kokanee	= 401 eggs
Avg. sockeye residence period in Osoyoos Lake	= 1.0 years
Avg. kokanee residence period in Osoyoos Lake	= 3.5 years
Avg. sockeye escapement to Okanagan River	= 19,000 fish

Sockeye rearing requirement is "equivalent" to: (Average sockeye female escapement) x (Ratio of actual sockeye: kokanee fecundities) x (Ratio of actual sockeye: kokanee lake residence times)

= (19,000/2) x (2500/401) x (1.0/3.5) = 16,900 female kokanee

Therefore, carrying capacity of Osoyoos Lake for kokanee spawners

= (Basic carrying capacity) - (Sockeye requirement)

= 335,000 - 16,900 = 318,100 female kokanee

Which, at an assumed sex ratio of 1:1 = 6362 x 10^2 total kokanee

APPENDIX L

DERIVATION OF AVERAGE KOKANEE FECUNDITY, OKANAGAN MAIN VALLEY LAKES, 1971

LAKE	MEAN FORK LENGTH AT AGE 3,[a] mm	MEAN FORK LENGTH AT SPAWNING, mm	AVERAGE FECUNDITY, NUMBER OF EGGS PER FEMALE
Wood	230	238[b]	351[d]
Kalamalka	170	215[c]	240[c]
Okanagan (central)	250	259[c]	474[c]
Skaha	335	330[c]	990[c]
Vaseux	280	290[b]	654[d]
Osoyoos	240	249[b]	401[d]

[a] Interpreted from Northcote *et al.* (MS 1972, Fig. 11).
[b] Derived from length at age 3 on basis of ratio of length at spawning/length at age 3 for Okanagan Lake.
[c] Average of direct determinations (Northcote *et al.* MS 1972, Appendix 4), weighted according to escapement in individual streams.
[d] Derived from mean fork length at spawning according to the fecundity: length regression calculated from Northcote *et al.* (MS 1972, Appendix 4) i.e.: Log fecundity = 1.308 + 0.0052 (fork length in mm).

APPENDIX M

DERIVATION OF PRESENT ANNUAL CARRYING CAPACITY ESTIMATES FOR RAINBOW TROUT FRY (at 2500/lb). OKANAGAN MAIN VALLEY LAKES

	WOOD	KALAMALKA	OKANAGAN	SKAHA	VASEUX	OSOYOOS
Mean depth, feet[a]	72.2	193.6	249.3[b]	85.3	21.3	56.6
Littoral area, acres[a]	208	359	7,636[b]	784	336	863
Limnetic area, acres[a]	2,090	6,041	78,354[b]	4,183	344	2,856
Total dissolved solids, ppm[c]	211	252	164	164	164	168
Estimated basic carrying capacity for rainbow fry, x 1000	1,297	3,390	40,844	3,174	978	3,078
Concentration of total phosphorus relative to Okanagan Lake	7.30	0.47	1.00	2.57	2.57	2.43
Basic adjusted carrying capacity for rainbow fry, x 1000	9,468	1,593	40,844	8,157	2,513	7,480
Total Gillnet catch (lb) of "competitor niche group"	70.61	386.20	1893.03	665.16	401.99	175.93
Total Gillnet catch (lb) of rainbow trout only	1,06	48.74	200.31	17.75	3.00	12.43
Carrying capacity for rainbow fry adjusted for competition, x 1000	142	201	4,322	218	19	528
Total Gillnet catch (lb) of "predator complex"	43.65	333.75	1460.22	354.14	141.80	98.15
Total Gillnet catch (No.) of all species	338	968	6,250	2,783	2,257	1,102
Total Gillnet catch (No.) of rainbow trout only	3	67	166	23	4	12
Estimated rainbow (relative lb) lost annually to predation	1.16	69.30	116.35	8.78	0.75	3.21
Additional "capacity" for rainbow fry due to predation, x 1000	74	118	1,588	72	4	108
Secondary (fully adjusted) carrying capacity for rainbow fry, x 1000	216	319	5,910	290	23	636

[a] From Stockner (MS 1973), except where otherwise indicated.
[b] Halsey, personal communication.
[c] From Patatas and Salki (1973).

APPENDIX N

SAMPLE CALCULATION OF BASIC, BASIC ADJUSTED, SECONDARY, AND MOST PROBABLE ESTIMATES OF PRESENT CARRYING CAPACITY (OF OKANAGAN LAKE) FOR RAINBOW TROUT FRY

A. Estimate of basic carrying capacity:

Assumption: That the basic capacity of a lake to accept trout fry is given by the stocking formula, i.e. Basic carrying capacity = K(limnetic area) + 10K (Littoral area).

For Okanagan Lake:

K (based on TDS 164 ppm) = 264
Limnetic area = 78,354 acres
Littoral area = 7,636 acres

Therefore basic carrying capacity = (20,685,456) + (20,159,040) = 40,844.000 fry at 2500/lb.

B. Estimate of basic adjusted carrying capacity:

Assumption: That the capacity of a lake to accept trout fry is proportional to the total phosphorus concentration of the water, relative to the undisturbed state.

For Okanagan Lake:

No adjustment is made, since Okanagan Lake was adopted as representative of undisturbed conditions as regards phosphorus.

Therefore basic adjusted carrying capacity = basic carrying capacity

= 40,844,000 fry at 2500/lb.

C. Estimate of secondary carrying capacity:

Assumptions: (1) That competitor species reduce carrying capacity in proportion to their weight in the population relative to rainbow trout.

(2) That predator species increase the apparent carrying capacity in proportion to the weight of trout they consume relative to the trout available. The corollary assumption is made that the impact of predation on rainbow trout is proportional to the numerical contribution by trout to the total fish population.

For Okanagan Lake:

(1) Species in the "rainbow trout competitor niche", with their relative weight from gillnet catches given in brackets, were assumed to be as follows: Rainbow trout (200.31), mountain whitefish (146.26), burbot (420.73), squawfish (839.18), and peamouth chub (286.55); total (1893.03).

Therefore carrying capacity adjusted for competition = 4,322,000 x (200.31/1893.03) = 4,322,000 fry at 2500/lb.

(2a) The number of rainbow trout as a proportion of the total fish population is presumed to be indicated by the gillnet catch (Appendix N) as follows:

Numercial proportion of rainbow trout = 166/6,250
= 0.02656.

(2b) The relative weight of consumption of rainbow trout annually by predators is presumed to reflect 3x the predator biomass multiplied by the numerical proportion of trout. Species in the "predator complex", with their relative weight from gillnet catches given in brackets, were assumed to be as follows: Rainbow trout (200.31), burbot (420.73), and squawfish (839.18); total (1460.22).

Therefore relative weight of rainbow trout lost annually to predation =(3)

(1460.22) (0.02656) = 116.35 lb.

And additional "capacity" for rainbow fry due to predation

=(Carrying capacity adjusted for competition) (proportion of rainbow trout lost annually to predation)

=(4,322,000 (116.35)7(116.35 + 200.31) = 1,588,000 fry at 2500/lb.

(3) Secondary estimate of carrying capacity for rainbow trout = Capacity

for competition + additional capacity due to predation

= 4,322,000 + 1,588,000 = 5,910,000 fry at 2500/lb.

D. Estimate of "most probable" carrying capacity:

Assumption: That most probable carrying capacity is the average of the two lowest of the three carrying capacity estimates above.

For Okanagan Lake:

Most probable carrying capacity = (40,844,000 + 5,910,000)/2

= 23,377,000 fry at 2500/lb.

APPENDIX 0
DERIVATION OF PERTINENT RAINBOW TROUT POPULATION PARAMETERS AT MEAN AGE-AT-CATCHING. OKANAGAN MAIN VALLEY LAKES. 1971

	WOOD	KALAMALKA	OKANAGAN	SKAHA	VASEUX	OSOYOOS
Mean size (lb) of trout in angling catch	1.380[a]	1.380	1.248	0.696	0.696[b]	1.616
Estimated mean age- (years) at-catching	5[a]	5	5	3	3[b]	5
Mean age of effective spawners[e]	4	4	4	3	3	4
Estimated number at mean effective spawning age[e]	119	10,558	32,864	1,551	49	299
Survival, mean effective spawning age to mean age-at-catching	0.75	0.75	0.75	1.00	1.00	0.75
Estimated number at mean age-at-catching	89	7,918	24,648	1,551	49	224

[a] Estimated by reference to Kalamalka Lake.

[b] Estimated by reference to Skaha Lake.

[c] From mean size in catch, in conjunction with size: age characteristics (Northcote *et al*. MS 1972)

[e] From Koshinsky & Willcocks, MS 1973.

APPENDIX P_4

SPORT FISHING EFFORT STATISTICS BY BOAT-FISHERMEN, 1971-72

WOOD LAKE	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov-Mar.	Season
Interviews: Angling-days	1	80	k4	6	18	8	2	0	119
Anglers per boat	1.00	1.86	1.27	2.00	1.80	1.60	2.00	-	
Hours per angling-day	1.00	3.40	3.28	4.00	1.75	4.50	4.50	-	2.92
Estimated total angling-days[a]	10	352	466	412	893	174	10	0	2317
Estimated angling-hours	10	1197	1528	1648	1563	783	45	-	6774

APPENDIX P_2

KALAMALKA LAKE	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov-Mar.	Season
Interviews: Angling-days	24	49	18	44	36	6	5	0	182
Anglers per boat	1.85	1.82	1.20	1.22	1.64	2.00	1.67	-	
Hours per angling-day	3.21	3.17	3.06	2.67	2.32	4.00	4.08	-	2.98
Estimated total angling-days[a]	50	63	734	691	298	212	85	15	2148
Estimated angling-hours	161	200	2246	1845	691	848	347	69	6407

APPENDIX P_3

NORTH OKANAGAN LAKE	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov-Mar.	Season
Interviews: Angling-days	11	107	99	139	99	36	27	140	658
Anglers per boat	1.83	1.91	2.19	1.70	1.45	2.00	1.80	2.00	
Hours per angling-day	2.25	3.34	3.40	3.43	2.97	4.06	4.29	4.60	3.47
Estimated total angling-days[a]	79	455	6442	6770	6056	3626	577	1082	25087
Estimated angling-hours	178	1520	21903	23221	17986	14722	2475	4977	86982

APPENDIX P_4

SOUTH OKANAGAN LAKE	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov-Mar.	Season
Interviews: Angling-days	33	88	55	47	133	74	37	109	576
Anglers per boat	1.74	2.00	2.12	1.47	1.93	1.72	2.06	1.70	
Hours per angling-day	3.42	3.58	3.00	2.81	2.90	3.19	3.47	4.73	3.02
Estimated total angling-days[a]	183	1579	12262	8035	7107	2205	1518	475	33364
Estimated angling-hours	626	5653	36786	22578	20610	7034	5267	2247	100801

[a] From MacDonald *et al.* MS 1972.

APPENDIX P_5
SPORT FISHING EFFORT STATISTICS BY BOAT-FISHERMEN, 1971-72
(continued)

SKAHA LAKE	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov-Mar.	Season
Interviews: Angling-days	12	135	109	51	76	27	3	0	401
Anglers per boat	1.50	1.99	2.22	1.96	1.81	1.69	1.50	-	
Hours per angling-day	2.00	3.57	3.06	3.69	3.05	4.71	3.75	-	3.44
Estimated total angling-days[a]	25	466	1068	1597	1683	451	181	0	5471
Estimated angling-hours	50	1664	3268	5893	5133	2124	679	0	18811

APPENDIX P_6

VASEUX LAKE	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov-Mar.	Season
Interviews: Angling-days	0	0	4	6	0	2	0	0	12
Anglers per boat	-	-	2.00	1.50	-	1.00	-	-	
Hours per angling-day	-	-	1.25	2.00	-	1.50	-	-	1.43
Estimated total angling-days[a]	0	14	262	56	0	126	0	0	458
Estimated angling-hours	0	28	328	112	0	189	0	0	657

APPENDIX P_7

OSOYOOS LAKE	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov-Mar.	Season
Interviews: Angling-days	83	72	16	14	3	40	26	3	257
Anglers per boat	1.43	1.47	1.23	1.27	1.00	1.74	1.73	1.50	
Hours per angling-day	3.61	4.13	3.45	2.91	2.67	2.78	3.33	2.75	3.20
Estimated total angling-days[a]	100	116	300	333	28	294	150	10	1331
Estimated angling-hours	361	479	1035	969	75	817	500	28	4264

[a] From MacDonald *et al.* MS 1972.

APPENDIX Q_1

AVERAGE SIZE OF FISHES TAKEN BY ANGLING. OKANAGAN MAIN VALLEY LAKES AND OKANAGAN RIVER, 1971-72

WOOD LAKE	NUMBER OF SIZE DETERMINATIONS	AVERAGE FORK LENGTH (mm) OF MEASURED FISH	AVERAGE WEIGHT (grams)	AVERAGE WEIGHT (pounds)
Kokanee	43	190.2	72	0.159
Mtn. Whitefish	4	253.8	160	0.353
Squawfish	11	358.2	-	-
Carp	1	516.0	-	-

KALAMALKA LAKE

APPENDIX Q_2

Kokanee	6	200.0	85	0.187
Lake trout	8	506.4	1673	3.689
Squawfish	3	401.7	-	-
Carp	2	400.0	-	-

NORTH OKANAGAN LAKE

APPENDIX Q_3

Kokanee	873	228.4	124	0.273
Rainbow trout, summer	38	368.6	626	1.380
Rainbow trout, winter	38	435.6	2094	4.616
Mtn. Whitefish	23	248.0	170	0.375
Burbot	1	790.0	4300	9.482
Squawfish	1	270.0	-	-

SOUTH OKANAGAN LAKE

APPENDIX Q_4

Kokanee	218	223.4	131	0.289
Rainbow trout, summer	57	344.7	434	0.957
Rainbow trout, winter	27	505.0	2700	5.953
Mtn. Whitefish	392	221.6	118	0.260
Burbot	1	-	3175	7.000
Squawfish	2	375.0	-	-
Carp	2	330.0	-	-

SKAHA LAKE

APPENDIX Q_5

Kokanee	153	275.1	238	0.525
Rainbow trout	59	312.0	316	0.697
Mtn. Whitefish	76	299.1	309	0.681
Squawfish	4	257.5	-	-
Carp	2	355.0	-	-

APPENDIX Q_6

AVERAGE SIZE OF FISHES TAKEN BY ANGLING, OKANAGAN MAIN VALLEY LAKES AND OKANAGAN RIVER, 1971-72 (continued)

VASEUX LAKE	NUMBER OF SIZE DETERMINATIONS	AVERAGE FORK LENGTH (mm) OF MEASURED FISH	AVERAGE WEIGHT (grams)	AVERAGE WEIGHT (pounds)
Bass[a]	2	-	313	0.691
Yellow perch	7	150.0	200	0.442
Squawfish	1	260.0	-	-

OSOYOOS LAKE

APPENDIX Q_7

Kokanee	277	216.4	119	0.262
Rainbow trout	67	331.4	733	1.616
Largemouth bass	62	354.6	831	1.831
Smallmouth bass	49	196.1	300	0.661
Crappie	25	257.7	264	0.582
Yellow perch	27	114.1	19	0.041
Pumpkinseed	1	100.0	-	-
Squawfish	1	406.4	-	-
Carp	4	450.0	-	-

OKANAGAN RIVER

APPENDIX Q_8

Kokanee	4	257.5	202	0.445
Rainbow trout	14	320.4	350	0.772
Mtn. Whitefish	9	296.1	307	0.677
Bass	4	203.0	130	0.287
Yellow perch	1	8.0	-	-
Squawfish	21	300.5	-	-

[a] Includes both largemouth and smallmouth bass.

APPENDIX R

INVENTORY OF PRESENT ANGLING OPPORTUNITIES AND ANGLING UTILIZATION OF TRIBUTARY STREAMS IN THE OKANAGAN BASIN[a]

CREEK	LOCATION OF ANGLING REACH	APPROXIMATE LENGTH OF REACH, MILES	ACCESS	PRESENT UTILIZATION, ESTIMATED ANGLING-DAYS PER YEAR
			VEHICLE,+HIKE(MINS.)	
B-X, Upper	Above Swan Lake	4	Car, + 5-10	25
B-X, Lower	Swan Lake to Vernon Creek	3	Car	few[b]
Coldstream	Above Kalamalka Lake	4	Car	300
Deep	Above Armstrong	2	Car, + 5-10	25[b]
Equesis	Below Square Lake	8	Car, + 5	50
Ellis	Below Ellis Reservoir, to irrigation diversion	8.5	Car, + 10	250[b]
Inkaneep	Above elevation 1500 feet	2	Car, + 10	few
Kelowna	Near Kelowna airport	2	Car, + 10	few
Lambly	Below Lambly Lake, to 1.5 miles above mouth	11	Car, + 15	100
Mission a)	Above confluences Belgo and Joe Rich Creeks	4	Pick-up‡ 15	
b)	Below a), to impassible falls (Mile 11.8)	9	Car, + 15	500
c)	Below b), to 4.8 miles above mouth	7	Car, + 20	
Peachland	Above mouth	10	- , + long	0
Penticton	Below Greyback Reservoir, to irrigation diversion	10	Car, + 30	75[b]
Powers	Above highway	2	Car, + 15	100
		8	- , + long	0
Shingle a)	Above confluence Shatford Creek	7	Car, + 10	0
b)	Shatford Creek	6	Car, + 10	0
Shorts	Above point 1.5 miles above mouth	12	Jeep, + 15	25
Shuttleworth	Above Kilmer Creek, to elevation 4500 feet	3	Car, + 15	few
Trepanier	Below Lacoma Lake, to 2 miles above mouth	9	Car, + 10	300
Trout a)	Below Headwater Lakes, to Thirsk Reservoir	11	Variable	
b)	Below Thirsk Reservoir, to Mile 17	9	Car, + 10	500
c)	Below c)- to Summerland irrigation diversion	10	Car, + 15	
Vaseux	Below McIntyre Creek, to Highway 97	12	Car, + 15	25
Vernon a)	Below Swalwell Lake, to Ellison Lake[c]	6	Car, + 20	50
b)	Below Kalamalka Lake, to Okanagan Lake	5	Car	few
Whiteman a)	Upper Sections	6	Car, + 10	few
b)	Bouleau Creek	7	Car, + 10	few
TOTALS 21		193.5		2325

[a] Developed from observations and estimates by S. MacDonald (personal communication) and other local B. C. Fish and Wildlife Branch personnel.

APPENDIX S

SPORT-FISHING EFFORT, CATCH, AND HARVEST STATISTICS

	Okanagan River upper improved section[a], 1971-72					Okanagan River unimproved section, 1971-72					Okanagan River lower improved section, 1971-72				
	April -June	July-Aug.	Sept-Oct.	Nov.-March	Season	April -June	July-Aug.	Sept-Oct.	Nov.-March	Season	April -June	July-Aug.	Sept-Oct.	Nov.-March	Season
Angling-Hours sampled	122	6	35	30	193	4	5	19	3	31	54	0	42	15	111
Hours per angling-day	1.76	1.68	1.43	1.48	1.68	2.00	1.80	2.17	1.00	1.99	1.83	-	2.42	2.63	2.35
Estimated total angling effort															
Angling-days	1806	630	276	439	3151	151+	+	275	48	474+	220+	+	625	270	1115+
Angling-hours	3179	1058	395	650	5282	302+	+	597	48	947+	403+	+	1512	710	2625+
Fish Kept per angling-hour															
Rainbow trout	0.082	0.000	0.057	0.033		0.000	0.000	0.211	0.000						
Mountain Whitefish	0.000	0.000	0.000	0.033							0.019	-	0.168	0.200	
Sockeye salmon						0.000	0.000	0.053	0.000						
Kokanee											0.000	-	0.096	0.000	
Bass						0.000	0.800	0.000	0.000						
Yellow perch											0.000	-	0.024	0.000	
Bullheads											0.148	-	0.000	0.000	
Squawfish	0.099	0.000	0.000	0.000		0.000	0.000	0.053	0.000		0.019	-	0.215	0.000	
Peamouth chub	0.189	0.000	0.000	0.000		0.000	0.000	0.105	0.000						
Carp	0.008	0.000	0.000	0.000							0.019	-	0.000	0.000	
Suckers	0.017	0.000	0.000	0.000							0.055	-	0.000	0.000	
TOTAL	0.395	0.000	0.057	0.066		0.000	0.800	0.422	0.000		0.260	-	0.503	0.200	
Estimated total harvest, numbers															
Rainbow trout	261	0	23	22	306	0	0	126	0	126					
Mountain Whitefish	0	0	0	22	22						8	-	254	142	404
Sockeye salmon						0	0	32	0	32					
Kokanee											0	-	145	0	145
Bass						0	+	0	0	+					
Other	995	0	0	0	995	0	0	94	0	94	97	-	325	0	422
Estimated total harvest, pounds															
Rainbow trout	201	0	18	17	236	0	0	97	0	97					
Mountain Whitefish	0	0	0	15	15						5	-	172	96	273
Sockeye Salmon						0	0	+	0	+					
Kokanee											0	-	65	0	65
Bass						0	+	0	0	+					
Yellow Perch											0	-	+	0	+
Other	+	0	+	+	+	0	0	+	0	+	+	-	+	0	+

[a] Only that portion between Skaha and Vaseux Lakes

APPENDIX T

INTERVIEW FORM FOR OKANAGAN VALLEY FISHERMEN

Date: _____

Area of Interview _____ (name of lake, etc.)

1. Where is your present home?

_____ _____
(Town) (Province/State)

If an Okanagan resident, how long have you lived in the Okanagan?
_____ years

2. Are you alone _____ or with a party _____ on this trip?
If with a party, please indicate the following:

(i) Composition of party _____ (family group, etc.)

Sex	Age	Relationship
_____	___	_____
_____	___	_____
_____	___	_____

(ii) Number of unlicensed fishermen (i.e. under age) _____

(iii) Number of non-fishermen _____

(iv) Activities of non-fishermen _____

3. If the interviewee is a resident of the Okanagan Basin:

(i) How many times each year do you go fishing in the Okanagan Valley (on average) _____ times. Are these usually one day trips _____ or longer _____? If usually longer, how long on average? _____ days. How many days do you spend fishing in the Okanagan in an average year? _____ days.

(ii) How many times a year, on average, do you go fishing to places outside the Okanagan? _____ times. How many days do you spend fishing outside the Okanagan? _____ days.

4. If the interviewee is not a resident of the Okanagan:

(i) Is fishing the main reason for your trip to the Okanagan Basin?
_____ Yes _____ No _____ Undecided

(ii) How long will you be staying in the Okanagan on this trip? _____ days.
During how many of these days do you expect to be fishing? _____ days.

(iii) How many trips do you make to the Okanagan Valley each year, on average _____ trips. How many of these are fishing trips? How long, on average, do you stay in the Okanagan on these trips? Fishing trips _____ days Other trips _____ days.

(iv) Why did you choose the Okanagan Valley for this trip? _____
_____

5. Can you tell me why you chose this particular site for this fishing trip? (close to home, easy access, good fishing, etc.) (Why this site rather than some other?)
_____

6: How did you travel to the fishing site?

Car _____
Truck _____
4-wheel drive _____
Camper or trailer _____
How long did it take you to get here from place of residence in Okanagan?
_____ hours.

7. Cost of Trip:

For non-residents whose primary purpose of trip is fishing -

Total Costs _____

For non-residents for whom fishing is not primary reason for trip, what are your additional costs incurred by going fishing?

Additional costs _____

For residents - how much do you expect this trip will cost you?

$_____

How much do you spend on equipment, mooring fees, etc. on fishing here in the average year? _____

For all categories, use following cost break-down:

Gas and Oil _____
Accommodation _____
Food _____
Beverage _____
Boat & equipment rental _____
Equipment purchases _____

8. In which areas do you usually fish, both in and out of the Okanagan Valley?

_____

In the Okanagan? (Be specific here getting name of site and usual number of days fished there)

Days	Trips	Site	Time of Year	Type of Fishing (fly fishing, etc. probe)
____	_____	____	_____	_____
____	_____	____	_____	_____

9. Is this the type of fishing you prefer, or if it was possible, would you like to see more opportunities for certain kinds of fishing in the Okanagan Basin, such as in streams and rivers or high altitude lakes?

Satisfied at present _____

Would prefer more: (rank preference)
High altitude lakes and reservoirs _____
Stream and River Fishing _____
Valley bottom lake fishing _____
Fly fishing only _____
Lakes with no motor boats _____
Other (specify) _____

10. (a) When fishing in the Okanagan, what species of fish are you mainly interested in catching?

1. _____ 2. _____ 3. _____

Would you like to see other species available in the Okanagan?

Yes _____ No _____

If yes, which species, and why:

Species	Reason
_____	_____
_____	_____

Have you fished for these species elsewhere? ____ Yes _____ No

(b) Are there any species of fish you don't want introduced into the Basin?
Yes _____ No _____
If yes, which species and why?

Species	Reason
_____	_____
_____	_____

(c) What is your opinion on the introduction of a commercial white-fish fishery into the Okanagan? _____

_____

(d) For how many years have you been fishing? (a) in the Okanagan _____
(b) in all areas _____

11. What is your opinion on the quality and availability of boat launching and other facilities at lakes in the Okanagan?

_____

_____

12. Have you any comments on fishing, especially with regards to the Okanagan area, you'd like to make? _____

_____

Personal Information:

13. a) Sex _____M _____F
    b) Which age group do you fall in?

_____under 20 _____40-49 _____70 or older

_____20-29 _____50-59

_____30-39 _____60-69

c) What is your approximate household income?

_____ under $2999 _____ $7,000-$9,999
_____ $3,000-$4,999 _____ $10,000-$14,999
_____ $5,000-$6,999 _____ $15,000 and over

d) What level of education did you complete?

_____ Grade 1-8 _____ some college or university
_____ Grade 9 - 12 _____ college or university grad.
_____ technical training - Explain

_____

e) What is your present occupation? _____

_____

Economic Evaluation

14. For Residents of Okanagan Valley only

We would like to know how much a day's fishing on this _____ is worth to you. One way of estimating this is for you to indicate how much money you would have to be paid to give up happily your day of fishing here. I am going to read a series of hypothetical payments and I want you to tell me to stop when I reach the minimum amount that would give you the same satisfaction you get from a day's fishing:

$1.00 _____	$5.00 _____	$14.00 _____
$1.50 _____	$6.00 _____	$16.00 _____
$2.00 _____	$8.00 _____	$18.00 _____
$3.00 _____	$10.00 _____	$20.00 _____
$4.00 _____	$12.00 _____	$22.00 _____

etc. in $2.00 increments

$_____ fee indicated.

15. ALTERNATIVE

We would like to know how much a day's fishing on this _____ is worth to you. How much do you think a day's fishing here is worth to you, not counting your expenses $ _____

16. For non-residents of Okanagan Valley only

We would like to know how much a day's fishing on this _____ is worth to you. One way of estimating this is for you to indicate how much money you would pay for a day of fishing here if daily charges were in effect. Of course, charges would never be levied, but it is important for us to know how much fishermen would be willing to pay. I am going to read you a series of hypothetical daily fees and I want you to tell me to stop when I reach the maximum fee you would pay for each day of fishing here.

$0.50 _____	$1.00 _____	$1.50 _____
$2.00 _____	$2.50 _____	$3.00 _____
$5.00 _____	$5.50 _____	$6.00 _____

Continue upwards in increments of $1.00

$_____ fee indicated.

APPENDIX U

RELATIVE CONTRIBUTION OF TRIBUTARY AND SHORE SPAWNING KOKANEE TO INCREASE HARVEST AVAILABILITY IN OKANAGAN AND SKAHA LAKES, WITH 1970 WATER QUALITY CONDITIONS, MODIFIED DISCHARGE REGIMES, AND REPRODUCTIVE HABITAT ENHANCED TO ITS REALISTIC POTENTIAL

	OKANAGAN		SKAHA	
	KOKANEE	RAINBOW TROUT	KOKANEE	RAINBOW TROUT
Total Spawners in 1970, number x 1000	8817	32.86	401	1.55
Shore Spawners (historic discharges) number x 1000	5180	0	0	0
Total Annual Harvest in 1970, number x 1000	1128.7	17.86	95.78	1.45
Ratio of Total Escapement to Total Harvest, 1970	7.81:1.00	1.84:1.00	4.19:1.00	1.07:1.00
Harvest Derived from Shore Spawners (Okan.), or River Spawners (Skaha) under Historic Discharges, number x 1000	663.3	0	95.78	1.45
Improvement Factor for Mainstem Alternative #36	1.07	---	1.29	---
Harvest Derived from Shore Spawners (Okan.), or River Spawners (Skaha) under Modified Discharges, number x 1000	710.0	---	123.56	1.45
Increase of Harvest Due to Modified Mainstem Discharge, number x 1000	46.7	0	27.78	0
Total Increase of Harvest Due to Modified Discharges and Enhanced Spawning Habitat, number x 1000 1970	1219.0	179.14	113.98	0.90
1980	2030.7	161.15	79.07	1.23
2020	1126.5	177.57	98.19	1.07
Harvest Increase Due to Enhanced Spawning Habitat and Modified Discharges in Tributaries Only (Okanagan), or Okanagan River (Skaha). 1970	1172.3	179.14	86.20	0.90
1980	1918.4	161.15	51.29	1.23
2020	1014.2	177.57	70.41	1.07

APPENDIX V

ANNUAL AND MAXIMUM MONTHLY DISCHARGE DEFICIENCIES IN AN AVERAGE YEAR FOR THE ACCOMMODATION OF FULL FISHERY REQUIREMENTS IN SIX TRIBUTARIES TO OKANAGAN LAKE, 1970, 1980, and 2020 FOR HISTORIC AND MODIFIED DISCHARGE MANAGEMENT

STREAM		DEFICIENCY, ACRE-FEET					
		1970		1980		2020*	
		HISTORIC	MODIFIED	HISTORIC	MODIFIED	HISTORIC	MODIFIED
Trout Cr.	Annual deficiency	777	0	937	0	4,683	1,648
	Max. monthly deficiency	596	0	596	0	899	899
Peachland Cr.	Annual deficiency	377	0	566	0	860	156
	Max. monthly deficiency	197	0	263	0	268	0
Powers Cr.	Annual deficiency	383	0	582	0	1,546	590
	Max. monthly deficiency	237	0	237	0	300	235
Equesis Cr.	Annual deficiency	340	0	502	0	1,378	617
	Max. monthly deficiency	157	0	160	0	357	357
Vernon Cr., lower	Annual deficiency	96	0	0	0	0	0
	Max. monthly deficiency	96	0	0	0	0	0
Mission Cr.	Annual deficiency	7,695	4,410	6,082	2,160	12,323	8,324
	Max. monthly deficiency	2,008	2,304	1,651	792	2,223	2,376
					TOTAL	20,790	11,335

* High Growth - Average of Dry and Average Year

APPENDIX W

DERIVATION OF NATURAL AND ARTIFICIAL PRODUCTIVITY FACTORS FOR OKANAGAN AND SKAHA LAKES, 1970-2020, INDICATING THE INCREMENTAL HARVESTS OF KOKANEE AND RAINBOW TROUT MADE AVAILABLE PER UNIT AREA OF REPRODUCTIVE HABITAT

KOKANEE	YEAR	OKANAGAN	SKAHA
Best estimate of spawning escapement, number x 1000	1970	8817	401
"Most probable" estimate of annual sustainable harvest, number x 100	1970	1128.7	95.78
Ratio of escapement to harvest	1970	7.81:1.00	4.19:1.00
Additional kokanee harvest with modified discharges and enhanced habitat (excluding shore-spawners) number x 1000	1970 1980 2020	1172.3 1918.4 1014.0	113.98 79.07 98.19
Sum of (Area x Improvement Factor), sq. yards x 1000	1970 1980 2020	1211.5 1768.9 1041.0	28.31 30.02 22.04
Natural productivity factor, harvest number per sq. yard	1970 1980 2020	0.968 1.085 0.974	4.026 2.634 4.455
Spawning channel productivity factor, harvest number per sq. yard	1970 1980 2020	4.84 5.43 4.87	20.13 13.170 22.275
Incubation channel productivity factor, harvest number per sq. yard	1970 1980 2020	33.90 37.98 34.10	140.91 92.19 155.93
RAINBOW TROUT			
Best estimate of spawning escapement, number x 1000	1970	32.86	1.55
"Most probable" estimate of annual sustainable harvest, number x 1000	1970	17.86	1.45
Ratio of escapement to harvest	1970	1.84:1.00	1.07:1.00
Additional rainbow trout harvest with modified discharges and enhanced habitat, number x 1000	1970 1980 2020	179.14 161.15 177.57	0.90 1.23 1.07
Sum of (area x Improvement Factor), sq. yards x 1000	1970 1980 2020	1995.5 1731.8 1753.0	44.27 45.79 42.94
Natural productivity factor, harvest number per sq. yard	1970 1980 2020	0.090 0.093 0.101	0.020 0.027 0.025
Spawning channel productivity factor, harvest number per sq. yard	1970 1980 2020	0.90 0.93 1.01	0.20 0.27 0.25
Incubation channel productivity factor, harvest number per sq. yard	1970 1980 2020	6.30 6.51 7.07	1.40 1.89 1.75

CANADA-BRITISH COLUMBIA OKANAGAN BASIN AGREEMENT

TECHNICAL SUPPLEMENT IX(B)

TO THE
FINAL REPORT

WATER DEPENDENT WILDLIFE ASSOCIATED WITH WATER MANAGEMENT OF OKANAGAN LAKE AND THE OKANAGAN RIVER

PUBLISHED BY
OFFICE OF THE STUDY DIRECTOR
Box 458, PENTICTON, B.C.
MARCH, 1974

THE CONSULTATIVE BOARD WISH TO ACKNOWLEDGE THE CONTRIBUTION OF THE FOLLOWING PEOPLE IN THE PREPARATION OF THIS TECHNICAL SUPPLEMENT

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

SUMMARY

1. Okanagan Lake, its shoreline, the Okanagan River and its immediate surroundings support a diverse water-based wildlife fauna. The number of species found in these areas are comparable to, if not greater than the number found in similar ecological settings in British Columbia.
2. Okanagan Lake has a low wildlife production capacity. Water dependent birds and mammals have decreased in abundance since the turn of the century in spite of a slight trend to increased eutrophication in the lake. The decrease is thought to be due to shoreline alteration, the introduction of carp, and water level manipulation.
3. Substantial wildlife production in Okanagan Lake is limited to the north arm of the lake and a limited number of small, shallow protected bays and creek mouths.
4. Within the Okanagan River complex, only Vaseux Lake and the marshes at the north end of Osoyoos Lake are noteworthy water dependent wildlife producers. The river system and its associated oxbows are unproductive under present water flow regimes,
5. Alteration of Okanagan Lake water levels below the present minimum level would have a severe effect on water dependent wildlife. This effect would be temporary provided normal water levels were resumed.
6. Wildlife production in the oxbows of the Okanagan River could be greatly increased if three of the oxbows were "charged" permanently and if flows in excess of 250 cfs were maintained. Flows below 250 cfs cause a drying of several potentially productive oxbows and a deterioration of wildlife habitat.
7. Since water dependent wildlife tends to thrive in eutrophic situations, any enrichment of the shoreline areas of Okanagan Lake would probably be of some benefit to these wildlife species.
8. Vaseux Lake, which produces from 150 to 200 Canada geese annually, is a key nesting site in the Okanagan Basin. To avoid nest flooding and loss of young, the mid-March water level of Vaseux Lake should not be exceeded by more than two feet during the incubation and nesting stages.

CHAPTER 1

Introduction

1.1 GENERAL OUTLINE, SCOPE OF STUDY

Wildlife, as fisheries, has some real value as an attraction for tourists, but it is perhaps most valuable to the Okanagan as an active (hunting) and passive (non-consumptive bird watching, etc.) recreational resource for Okanagan Basin residents. The public has come to regard wildlife as an indication of the ecological well being of a particular area. Its role as such an indicator is also of concern to Okanagan residents.

While all wildlife requires some water to a greater or lesser degree, many species require it directly for consumption and indirectly for the growth of plants upon which they depend for food or shelter. Shore birds, waterfowl and aquatic mammals, however, live in an intimate association with water bodies. It was determined that these water dependent wildlife species would be most markedly affected by water management plans for the Okanagan Basin, thus they were the wildlife groups examined,

The headwater lakes and tributary streams in the Okanagan Basin support only very limited numbers of water dependent wildlife. Okanagan Lake and the Okanagan River are the only areas of the basin with any notable water dependent wildlife potential, thus study was concentrated in these areas. Water quality, lake level controls, river flow, adjacent land use were all examined with a view to effect on wildlife populations, once a subjective overview of water dependent wildlife populations was completed. The objectives were:

1. to determine the effects of short and long-term fluctuations of Okanagan

   Lake levels upon resident and migrant bird and mammal populations found along

   the lake shoreline.

2. to determine the effects of specified minimum flows in the Okanagan River

   south of Okanagan Falls, upon resident and migrant bird and mammal populations.

3. to determine the impacts of specified minimum flows in Okanagan River upon bird and mammal populations dependent upon the oxbows between Oliver and Osoyoos Lake.

1.2 DATA BASE AND APPROACH

Only a very limited and subjective survey of water dependent wildlife was attempted. Lack of time. funds and personnel were main limitations. A.C. Brooks was commissioned briefly, as consultant to the Study, to investigate wildlife problems associated with water management of the Okanagan Lake and River. He further evaluated the mainstem water quantity alternatives and their effect on wildlife. His reports are the primary data base for the following comments on water dependent wildlife.

Wildlife and recreation in the Trout Creek basin were examined. This study did not however, provide a sufficiently adequate analysis of wildlife values to warrant extrapolation to other tributaries. The essential gleaning from these data was that water dependent wildlife do not make a significant contribution to recreation in the headwater areas of the Basin.

Two distinct areas were examined during the Study:

1. Okanagan Lake
2. Okanagan River

Wildlife populations are not necessarily distinct within the two areas and it is suspected that in particular, migrant waterfowl make well integrated use of Okanagan Lake, the oxbows of the river and the north end of Osoyoos Lake. For purposes of discussion however, the areas are dealt with separately. The marshes of the north end of Osoyoos Lake, and all of Vaseux Lake are discussed within the framework of the Okanagan River. Vaseux Lake is in effect a widening and shallowing of the river, while the marshes at the north end of Osoyoos Lake are essentially a part of the mouth of the river exhibiting almost delta-like characteristics.

CHAPTER 2

Water Dependent Wildlife Potentials of Okanagan Lake

2.1 PRESENT WATER DEPENDENT WILDLIFE

Due to its oligotrophic character and rocky littoral shelf, Okanagan Lake generally has a poor potential for wildlife production. The number of birds using the lake as a whole is low, particularly during the nesting season. Areas of the lake which have a sloping clay or organic mud bottom which would be expected to be good waterfowl habitat, are often limited by lack of shelter, a requirement for most waterfowl nesting.

The Canada Land Inventory waterfowl evaluation, classifies the deeper parts of the lake (most of its surface area) as having severe limitations for waterfowl production. It also indicates the margins and north arm of the lake as areas with little or no breeding potential, but with a high value for wintering and migrating waterfowl. Presently, the north arm of Okanagan Lake, the mouth of Deep Creek and a few limited areas of shoreline are the principal areas of waterfowl concern.

Okanagan Lake in its entirety, but particularly the shallower waters near the shore, is an important stop for migrating waterfowl, a number of species of which winter here as well. Of these, Canada geese, coots, loons, grebes, golden-eyes and other ducks are important. Lass frequent numerically, but of high aesthetic and biological importance are bald eagles and the occasional osprey. Limited numbers of beaver and muskrat use the softer banks of the creek mouths and the north arm area as homesites.

2.2 WATERFOWL NESTING

Naturalist records from about the turn of the century to 1945 indicate that the north arm of Okanagan Lake, which is the best waterfowl habitat in the lake, supported only a very limited number of nesting birds. Gadwall, Barrow's golden-eye, mallard, redhead, coots and loons were the principal nesting waterfowl in 1909. Canada geese first nested in 1926 in the north arm. Records indicated a steady decline in nesting waterfowl in the north arm to 1945, with the exception of Canada geese, numbers of which increased slightly.

Present data indicate that the situation with regard to nesting waterfowl is much as it was in the 1940's. Canada goose numbers however, have increased about sixteen-fold (seven to 130) since 1942. A check list of waterfowl species observed in the north arm is presented in Appendix A.

2.3 WINTERING AND MIGRATING WATERFOWL

The principal value of Okanagan Lake to water-dependent wildlife, is as a site for migrating and wintering waterfowl. The north end of Okanagan Lake plays host to practically every species of migrant waterfowl in western Canada. Thousands of ducks annually spend time in the fall and winter on Okanagan Lake.

Some waterfowl may stay on the lake for a considerable time during fall and spring. Some species, coot in particular, winter on the lake while others, such as pintail and snow geese are transients.

Indications are that the number of semi-resident diving ducks which may spend several weeks on the lake in the fall and spring have decreased in the last sixty years. Observations in 1971 indicate still fewer waterfowl are spending time on the lake. The birds tend to use very limited areas such as the dense pond weed growth areas near the mouth of Deep Creek, the outlet of Vernon Creek, the growths of pond weed near Kelowna and the Gartrell Point area near Summerland.

Canada geese are the obvious exception to decreasing waterfowl numbers on Okanagan Lake. They are first recorded as nesting on the lake in 1926. It is suggested that up to 40 pairs are presently nesting on the lake and about 200 use the lake for some period during spring and fall migrations. The development of lawns and the growing of grass and alfalfa in the orchards has increased the attractiveness of the area for geese.

2.4 AQUATIC MAMMALS

Muskrats are the only aquatic mammals of any significance in Okanagan Lake. Their numbers appear to have decreased in recent years, mainly as a result of habitat alteration due to shoreline development. The only concentration of muskrats noted in 1971 was in the marshy areas near the mouth of Deep Creek.

2.5 FACTORS AFFECTING WILDLIFE POTENTIAL OF OKANAGAN LAKE

2.5.1 Lake Level Fluctuations

Outlined below are some of the effects that varying lake levels may have on wildlife and wildlife habitat. Short term conditions are considered to be a period of less than one year. Long term conditions are deemed to be for one year or more.

(a) Short Duration - Low Water

1. Low, low water: less than 1117.8'

from December through February - during a severe winter, the exposed shoreline would be frozen. Ice and the action of thaws would result in much of the emergent vegetation along the shore being damaged, resulting in a sparse growth of bulrushes during the following season. An exposed shoreline would leave, in a mild winter, little cover for waterfowl and muskrat.

2. From May through July: less than 1117.8'

water's edge would be below the zone of bulrushes in many places. This would mean limited shore cover for waterbirds and limited nesting habitat for birds such as grebe and loon that have floating nests. Broods of young ducks, owing to lack of cover, would be exposed to a higher predation risk.

3. From August to November: low water less than 1117.8'

exposed shoreline - an absence of cover; natural weed beds would be exposed, become dried up and would therefore result in limited food supplies for waterfowl. Lake shore marshes would dry up and birds and mammals dependent upon these, affected.

4. From May through February; moderately low water

between 1117.8' and 1119.8' - similar conditions would result as noted above in 1, but the affects would not be as drastic.

5. From May through July; moderately low high water

between 1118.8' and 1121.8'would still leave much lakeshore marsh lands in which cattails and bulrushes predominate, high and dry and thus habitat requirements for a number of species of birds and for muskrat would be affected.

6. During March and April; low, low water, less than 1117.8'

similar effects on wildlife and vegetation as expressed in 1 and 3 above, but not as severe.

It is pointed out that low water levels between 1118.8' and 1121.8' have no appreciable effect on migrating waterfowl. Diving ducks are bottom feeders and will range into deeper waters down to 5 meters in depth if food sources are available at these depths. Surface feeding ducks are able to procure their food from emergent aquatic vegetation and in shallows; geese which principally feed on grass, and fish-eating species (grebes, loons, mergansers) would not be markedly affected.

(b) Short Duration - High Water

High water levels in the lake are generally beneficial to wildlife. Marshes are flooded and flooding of fields provide ample cover and food for wildlife. Water levels exceeding 1123.9' for more than two consecutive years would kill much of the brush and young tree growth that have become established on the shores since the inception of the flood control scheme in 1955.

A rapidly rising lake level during the spring and early summer months can flood the nests of some waterfowl close to the water's edge and the nests of loons and grebes which float. Canada geese, which may nest below mean high water mark however, are not usually hatched by the second or third week in May, well before the period of rapid rise in take level.

(c) Long Duration - Low Water

Winter and spring lows of less than 1117.8' for three or more years would bring about considerable changes in the shoreline of the lake, particularly in those localities where there is a gently sloping shoreline. Bulrushes would diminish in extent and much of the nesting habitat of the bird life dependent upon this would be lost. If normal winter and spring low water levels were to return after three years, the shoreline would resume its previous character. With this recovery would come the return of the wildlife dependent upon it.

2.6 HUMAN AGENCIES AND EXPLOITATION

Alteration of the shoreline of Okanagan Lake by various forms of development, coupled with flood control programs are affecting the potential of the lake for water dependent wildlife.

The advent of water level control, immediate shoreline alteration, undergrowth removal, emergent aquatic plant removal, construction of docks and boathouses, and alteration for extensive recreational use has resulted in the removal of wildlife habitat. The disappearance of water dependent wildlife has followed.

In the area adjacent to the north arm, clearing for agriculture has resulted in the removal of clumps of brush which provided nesting cover for ducks and perching birds.

If shoreline alteration and development continue, or is intensified in the future, it is predicted that water dependent wildlife on Okanagan Lake will continue to decline due to this generally negative influence on wildlife potential.

2.7 CARP

Carp became established in Okanagan Lake about 1917. By 1929, this fish was deemed responsible for the eradication of duckweed in Okanagan Landing Arm. The lake bottom in an area where *potamogeton* was abundant was observed by the lake Allan Brooks as "quite clean, and covered with round holes where carp have gobbled up the roots". McCrimmon (1968) notes that removal of carp from confined areas brought about a replenishment of aquatic growth, and at the same time a marked clearing of water thus further stimulating photosynthetic activity.

It is suggested that carp populations are presently exhibiting a negative influence on waterfowl populations in Okanagan Lake. An increase in carp numbers will certainly cause a further decline in waterfowl numbers in the future. Management activities and shoreline alteration activities should be carried out with a view to at least limiting carp habitat.

CHAPTER 3
Water Dependent Wildlife Potentials of the Okanagan River

As pointed out earlier, the Okanagan River was taken to include Vaseux Lake and the marshes at the north end of Osoyoos Lake where the river enters. The river was subdivided into two sections, the portion from Okanagan Falls to Oliver (including Vaseux Lake) and the portion from Oliver to Osoyoos Lake (including the marshes at the north end of Osoyoos Lake and the oxbows adjadent to the river).

3.1 OKANAGAN FALLS TO OLIVER

This section of the Okanagan River proper is of very little value to water dependent wildlife. The oxbows in this portion of the river have been subjected to landfills and other landuse activities which make them of little or no use to waterfowl. The river banks between station 600 and the McIntyre dam harbor a variety of bird and mammal species which are not affected by river f1uctuations.

Tugulnuit Lake is used to a limited extent by migrating waterfowl, and a few pairs of geese breed there each year.

Vaseux Lake is the key area for water dependent wildlife in this portion of the river system. It is essentially a wide, shallow portion of the Okanagan River, since a complete water exchange takes only a few days (see Technical Supplement V).

3.1.1 Vaseux Lake Wildlife

In 1923, Vaseux Lake and its shore were made a Federal Migratory Bird Sanctuary, primarily to protect a wintering flock of rare trumpeter swans. While a few swans and other waterfowl still winter there, it is noted as a nesting and rearing area for large numbers of Canada geese (Harris, 1964). Each year from 150 to 200 Canada geese are raised on the lake.

In addition to its principal use as a Canada goose rearing area, many other water dependent wildlife species use the Vaseux Lake area. Table 3.1 is a checklist of such species inhabiting Vaseux Lake.

While Vaseux Lake is very shallow and quite productive, its productive capacity due to rapid water exchange, is in large part a function of the water quality of the Okanagan River. Since water dependent wildlife prefer eutrophic conditions, the artificial enrichment of Okanagan River waters would be of benefit to Vaseux Lake wildlife.

TABLE 3.1

A CHECKLIST OF WATER DEPENDENT WILDLIFE IN THE VASEUX LAKE AREA

Blue winged teal	*Anas discors*
Bufflehead	*Bucephula albeola*
Canada goose	*Branta canadensis*
Canvasback	*Aythya valisineria*
Goldeneye	*Bucephala clangula*
Coot	*Fulica americana*
Dipper	*Cinclus mexicanus*
Green winged teal	*Anas carolinensis*
Harlequin	*Histronicus histronicus*
Lesser scaup	*Aythya affinis*
Long-billed curlew	*Numenius americanus*
Mallard	*Anas platyrhynchos*
Merganser	*Mergus spp.*
Pintail	*Anas acuta*
Redhead	*Aythya americana*
Trumpeter swan	*Olor buccinator*
Whistling swan	*Olor columbianus*
Widgeon	*Mareca americana*
Painted turtle	*Chrysemys bellii*
Muskrat	*Ondatra zibethica*
Beaver	*Castor canadensis*

About 25% of the geese nesting at Vaseux Lake build nests in elevated sites (i.e. old eagle and osprey nests, on top of pilings, etc). Water level alterations will have little effect on nesting success of this group. The remaining 75% nest on Hatfield Island in Vaseux Lake in March. A water level increase of greater than 2 feet during the incubation period and prior to the young leaving the nest would cause extended gosling mortality.

Changing water levels will have an effect on growth of aquatic plants, however. Prolonged dry periods will cause exposure of roots and dessication with an overall loss of productive capacity. A more detailed examination of effect of lake level changes is presented in Section 2.2.1. These statements are roughly comparable to effects to be expected in Okanagan Lake.

3.2 OLIVER TO OSOYOOS LAKE

The principal areas of wildlife concern in the Oliver to Osoyoos section of the river are some of the oxbows and the marsh areas at the north end of Osoyoos Lake (Figure 3.1). The meanders or "oxbows" on either side of the

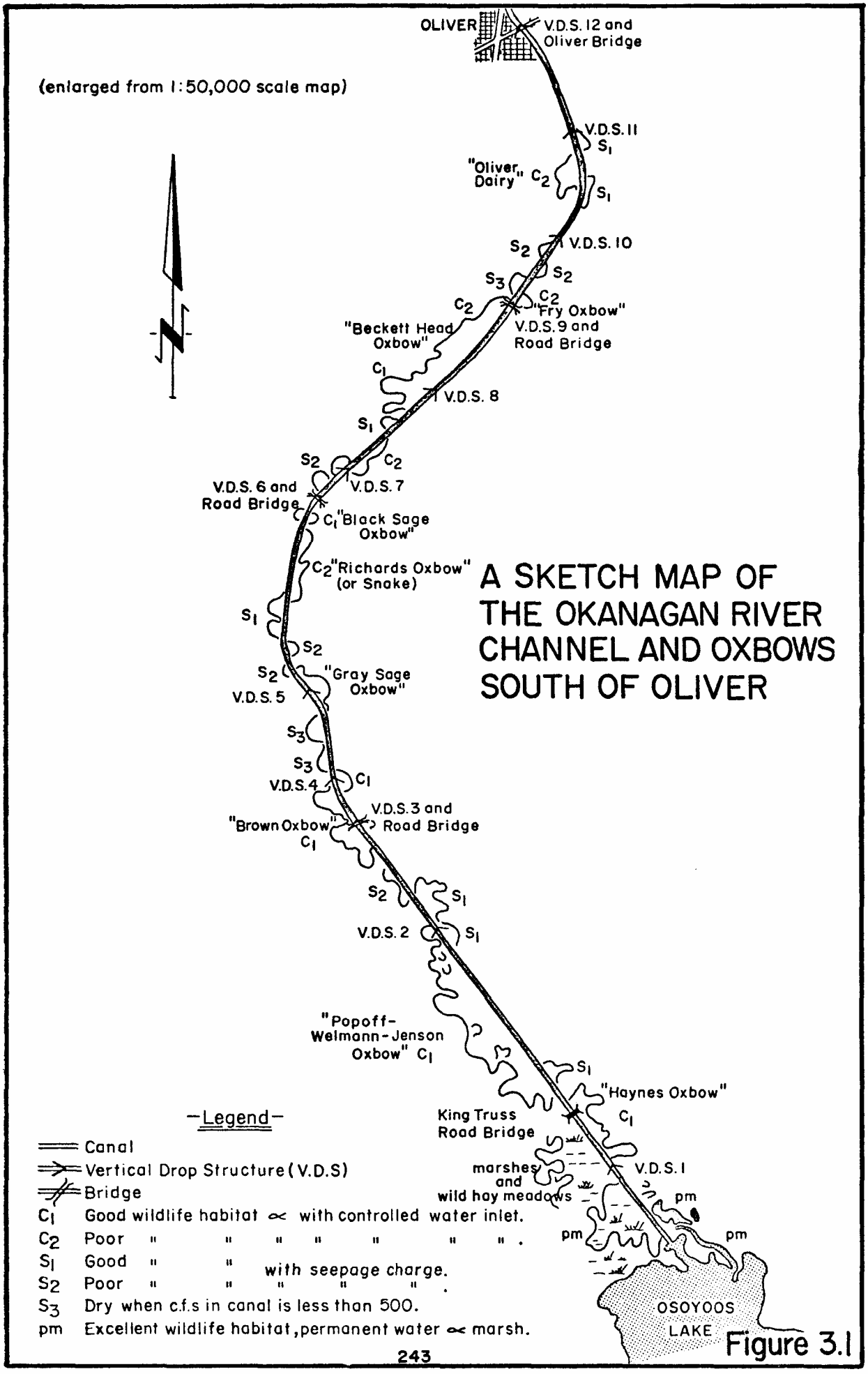
OLIVER
V.D.S. 12 and Oliver Bridge
(enlarged from 1:50,000 scale map)
V.D.S. 11
S1
"Oliver" Dairy
C2
S1
S2
V.D.S. 10
S3
S2
C2
"Fry Oxbow"
V.D.S. 9 and Road Bridge
C2
"Beckett Head Oxbow"
C1
V.D.S. 8
S1
S2
C2
V.D.S. 6 and Road Bridge
V.D.S. 7
C1 "Black Sage Oxbow"
C2 "Richards Oxbow" (or Snake)
S1
S2
S2
"Gray Sage Oxbow"
V.D.S. 5
S3
S3
V.D.S. 4
C1
V.D.S. 3 and Road Bridge
"Brown Oxbow"
C1
S2
S1
V.D.S. 2
S1
"Popoff-Welmann-Jenson Oxbow" C1
S1
"Haynes Oxbow"
King Truss Road Bridge
C1
marshes and wild hay meadows
V.D.S. 1
pm
pm
pm
OSOYOOS LAKE
A SKETCH MAP OF THE OKANAGAN RIVER CHANNEL AND OXBOWS SOUTH OF OLIVER
—Legend—
Canal
Vertical Drop Structure (V.D.S)
Bridge
C1 Good wildlife habitat ∝ with controlled water inlet.
C2 Poor " " " " " " " .
S1 Good " " with seepage charge.
S2 Poor " " " " " .
S3 Dry when c.f.s in canal is less than 500.
pm Excellent wildlife habitat, permanent water ∝ marsh.

Figure 3.1

present river are the original course of the river prior to its channelization as part of the Okanagan Flood Control program. They could be classified as ponds, marshes, slow running streams, etc., as well as oxbows but for simplicity are all referred to as oxbows in the following discussion.

The oxbows south of Oliver have been categorized according to their potential as water dependent wildlife habitat, (Figure 3.1).

3.2.1 Classification of Okanagan River Oxbows South of Oliver

Oxbows with water levels which are controlled for purposes of irrigation are referred to as "charged" oxbows. These are divided into "C_1" and "C_2" oxbows. The latter are favorable habitat for wildlife, the former due to a lack of brush and reed cover and their generally rocky bottoms, present poor habitat for water dependent wildlife.

It is noted that all the "C" oxbows north of Vertical Drop Structure No. 6 (VDS6) with the exception of the lower portion of the Beckett Head oxbow, (Figure 3.1), are classified as "C?", while those south of VDS6 are "C_1". (These mostly have sand or silt substrates).

"S" are seepage oxbows with water levels dependent upon seepage from the river channel. As in the case of the charged oxbows, these are classified on the basis of plant cover around them, their substrate, and aquatic growth in them. Beside "S_1", and "S_2", there is a third category, "S_3" which represents seepage oxbows which become dry when the flow in the river channel drops below 500 cfs. S_1 oxbows retain water when river flows drop as low as 250 cfs.

"PM" are permanent ponds and marshes at the extreme north end of Osoyoos Lake, north to the Kingtruss Bridge.

3.2.2 Present Water Dependent Wildlife

Present (1971) species of water dependent wildlife and approximate abundance and location are summarized in Table 3.2. As is indicated, wildlife is generally limited in the area with the exception of the marsh area between Kingtruss Bridge and Osoyoos Lake. The permanent marshes provide some degree of stable habitat and are thus likely to be more suitable habitat for semi-aquatic wildlife.

From field observation it is suggested that the lack of waterfowl on the oxbows is probably attributable to a number of factors including:

1. The oxbows north of VDS 6 are vestiges of a fast flowing river, thus they have a gravel or sandy substrate which is unsuitable for aquatic vegetation
2. Growth of aquatic vegetation in oxbows with suitable substrate is checked by fluctuating water levels which often fail to follow a seasonal pattern and are more dependent on irrigation demands.

3. Habitat destruction and alteration along banks of oxbows.

4. Using oxbows as dumps and landfill areas.

3.2.3 Effects of Flow on Water Dependent Wildlife in the Okanagan River

Maximum high water levels in the Okanagan River usually occur in May or June, but occasionally as early as March. Maximum flows from 1959 to 1969 varied from 350 to 1970 cfs. It is estimated a flow in excess of 1500 cfs would fill essentially all oxbows, even those labelled S_2 (Figure 3.1). Low maximum, i.e. 350 cfs. would severely limit waterfowl breeding in the oxbows. It was observed that flows of 250 cfs maintained water levels in S_1 oxbows. This is estimated to be about a minimum level for maintaining adequate wildlife production in S_1 oxbows. Flows between 500 and 600 cfs. also maintain adequate levels in S_2 oxbows.

Charged oxbows present quite a different situation from seepage oxbows since water levels are maintained for the exclusive benefit of persons having irrigation intakes within the oxbow. Water levels which are generally beneficial to wildlife occur during the irrigation season. In the fall these oxbows cease to be charged and water levels almost immediately drop 18-24 inches, resulting in many of the charged oxbows becoming a series of shallow puddles. submerged and emergent aquatic plants dessicate, openings to muskrat dens are exposed and the oxbows cease to be suitable wildlife habitat. As each charged oxbow is managed on quite an individual basis, being only generally full during the irrigation season, no general conclusions could be reached correlating their suitability to wildlife with river flows.

TABLE 3.2

SPECIES LIST, LOCATION AND GENERAL ABUNDANCE OF WATER DEPENDENT WILDLIFE IN OKANAGAN RIVER BETWEEN OLIVER AND OSOYOOS LAKE, 1971-72*

SPECIES		GENERAL ABUNDANCE AND LOCATION			
Common Name	Scientific Name	Rare	Limited	Common	Comments
Canada geese	*Branta canadensis*		●		Marshes, north Osoyoos Lake
Red necked grebe	*Podiceps grisegene*		●		" " "
Horned grebe	*Podiceps auritus*		●		" " "
Western grebe	*Aechmorphus occidentalis*		●		" " "
Mallard	*Anas platyrynchos*			●	Marshes, north Osoyoos Lake and north of Kingtruss Bridge
Redhead	*Aythya americana*		●		Marshes, north Osoyoos Lake
Wood duck	*Aix spansa*	●			" " "
Hooded merganser	*Lophodytes cucullatus*	●			North of Kingtruss Bridge
Bluewinged teal	*Anas discors*	●			" "
Greenwinged teal	*Anas carolinasis*	●			" "
Muskrat	*Ondatra zibethica*			●	Popoff-Jenson oxbow, No. Osoyoos Lake
Beaver	*Castor canadensis*		●		Gray Sage, Brown and Beckett-Head oxbows

*Data from A.C. Brooks. MS 1973

CHAPTER 4

Discussion and Conclusions

In terms of wildlife productivity, Okanagan Lake is low. However, the lake is an important stop for many migrating and wintering waterfowl. It has a very limited potential for waterfowl breeding, due primarily to its lack of sheltered, eutrophic, gently sloping bays and coves.

Numbers of water dependent wildlife have decreased during the past sixty years due to a number of factors including human intrusions and shoreline development, introduction of carp and the inception of flood control measures. The exception to this general decline are Canada geese, whose numbers have increased over the past half century. Land use adjacent to Okanagan Lake has exerted considerable influence over water dependent wildlife abundance.

Since water dependent wildlife species thrive in sheltered eutrophic conditions, any advancement, induced or natural, of eutrophication would certainly benefit wildlife. The more recent growths of aquatic plants adjacent to the City of Kelowna and the use of that area by migrating waterfowl illustrates the point.

Land use adjacent to Okanagan Lake will intensify in the future, likely to the detriment of wildlife. Intensive farming practices, development of private recreational properties and public recreation facilities often remove wildlife habitat.

Alteration of water levels, if of short duration, will have little effect on wildlife. Low water conditions for extended periods of time cause dessication of the roots of emergent and semi-emergent aquatic plants contributing to their demise. This effectively removes the area from wildlife use.

The Okanagan River itself has little potential for water dependent wildlife. Some of the larger oxbows, Vaseux Lake and the permanent marshes between Kingtruss Bridge and Osoyoos Lake, all of which depend on the River for maintenance of water level, do support very considerable wildlife populations.

The Gray Sage, Brown and Popoff-Welmann-Jensen oxbows (Figure 3.1), are potentially rich wildlife producers. These are all "charged" oxbows, in that their water levels are maintained during the irrigation season since irrigation intakes are within the oxbows. A relatively stable water level is essential for good wildlife production. The "charged" oxbows have water levels maintained only during the irrigation season. During the non-irrigating months, water levels drop too far to maintain good wildlife production. It is proposed that water levels in

these three oxbows be maintained permanently to conserve and enhance wildlife habitat. With this stability, further habitat improvement measures should be considered.

The permanent marshes between Kingtruss Bridge and the north end of Osoyoos Lake present essentially delta conditions which tend to be highly productive wildlife areas. The marshes are maintained by Okanagan River flows and Osoyoos Lake levels. A prolonged lowering of water levels would hasten development of brush, trees and riparian habitat in the marshes which would be detrimental to particularly waterfowl and muskrats. It is suggested that present minimum Osoyoos Lake levels and minimum Okanagan River flows be retained to ensure the wildlife productivity of this area.

Vaseux Lake, which can be considered functionally as a widening and shallowing of the Okanagan River, is the major nesting and rearing area for Canada geese in the Okanagan Basin. Any enrichment of Okanagan River waters will have a favorable effect on the waterfowl production of the lake. Alteration of lake levels within a normal range is not expected to have a marked effect on nesting success of Canada geese, if levels in mid-March are not exceeded by two feet during the incubation and nesting period.

In conclusion, Okanagan Lake and River have a limited number of areas of wildlife potential, notably the north arm, Vaseux Lake, some oxbows and the permanent marshes north of Osoyoos Lake. The system is used by waterfowl primarily for wintering and migrating. Canada geese nest in Vaseux Lake and the north arm of Okanagan Lake in increasing numbers, a trend that will likely continue. Land use adjacent to the lake and river, extended low lake levels and flows below 250 cfs., will place further limitations on the generally low water dependent wildlife productivity of the area.

REFERENCES

Manuscript reports resulting from Canada-British Columbia Okanagan Basin Agreement studies which have been used extensively in the compilation of Technical Supplement IX, Part B

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2. Brooks, A.C. 1971. Task 102 (i) The Trout Creek Basin Study; Wildlife and Recreation
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Harris, R.D. 1964. Natural History Notes, Vaseux Lake Region, Queen's Printer, Ottawa, 7 pp.

McCrimmon, H.R. 1968. Carp in Canada. Fisheries Research Board Bulletin 165, Ottawa, 93 pp.

APPENDIX A

WATERFOWL SPECIES OBSERVED IN THE NORTH ARM AREA OF OKANAGAN LAKE FROM RECORDS OF THE LAKE ALLAN BROOKS AND A.C. BROOKS, 1907-1971.

SPECIES	SCIENTIFIC NAME	NESTING	WINTERING AND/OR MIGRATING
Gadwall	*Anas strepera*		
Barrow's goldeneye	*Bucephala islandica*		
Mallard	*Anas platyrhynchos*		
Coot	*Fulica americana*		
Loon	*Gavia immer*		
Redhead	*Aythya americana*		
Canada goose	*Branta canadensis*	(Increasing)	(Increasing)
Rednecked grebe	*Podiceps grisegena*		
Western grebe	*Aechmorphus occidentalis*		
Hooded merganser	*Lophodytes cucullatus*		
American merganser	*Mergus merganser*		
Shoveller	*Spatula clypeata*		
Curlew	*Numenius sp.*		
American widgeon	*Mareca americana*		
Wood duck	*Aix sponsa*		
Canvasback	*Aythya valisineria*		
Buffleheads	*Bucephala albeala*		
Pintail	*Anas acuta*		
Teal	*Anas carolinensis*		

- Abundant - Common - Limited - Rare