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Status of Walleye (*Sander vitreus*) Fishery in Orloff Lake, Alberta, 2004

Alberta Conservation Association

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EXECUTIVE SUMMARY

To aid in the management and recovery of Alberta's walleye stock at Orloff Lake, the Alberta Conservation Association (ACA) conducted a Fall Walleye Index Netting (FWIN) survey on 1 to 4 September 2004. The purpose of this survey was to collect data for the ongoing assessment of the walleye fishery at this lake. Fall Walleye Index Netting provides an estimate of the both fish abundance and population structure and is used to assist Alberta Sustainable Resource Development (ASRD) in the sustainable management of the sport fishery.

Results from the 2004 survey indicate that walleye in Orloff Lake exhibited a bimodal age-class distribution and the fishery was primarily supported by two abundant multi-year classes originating between 1990-1994 and 2000-2004. The presence of the 2000-2004 year-classes suggests that moderate recruitment to the breeding population can be expected in the next 2–4 years. Our data also showed that the walleye fishery was composed of moderately fast growing fish with females maturing two years earlier than males; all females were mature at age 6 compared to age 8 from males. The estimated catch rate of walleye ranged from 18.5 - 28.7 walleye/100 m^2/24 h (95% CI; n = 224) with a maximum likelihood estimate (MLE) of 23.0 walleye/100 m^2/24 h. These catch rates are considered to be moderately high compared to other walleye fisheries in Alberta.

ACKNOWLEDGEMENTS

The Alberta Conservation Association (ACA) funded this work. In addition, The ACA received in-kind support from Alberta Sustainable Resource Development (ASRD), in Edmonton and Athabasca.

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1.0 INTRODUCTION

1.1 General introduction

The Alberta Conservation Association (ACA) conducted a Fall Walleye Index Netting (FWIN) survey at Orloff Lake from 1 to 4 September 2004 to obtain data on the abundance and population structure of walleye (Sander vitreus) in the lake and to assess the status of the walleye fishery eight year after restrictive harvest regulation were imposed under the Walleye Management Recovery Plan (WMRP; Berry 1996). The information collected from a FWIN provides a precise snapshot of the population structure, by completing the survey within a narrow time frame and under moderate water temperatures (i.e., 3 days; water temperature ranging from 10 – 15 degrees °C), thereby minimizing potential the complications associated with growth and age of fish. FWIN catch data were recently validated as an appropriate index of walleye abundance using population density estimates and angler total catch rate data (Sullivan and Park 2004).

1.2 Study rationale

The purpose of this study was to provide Alberta Sustainable Resource Development (ASRD) with data on the current status of the walleye fishery at Orloff Lake, Alberta for use in the ongoing assessment and management of that fishery. The Walleye Management and Recovery Plan was introduced in 1996 and Orloff Lake was subsequently classified as a vulnerable walleye fishery with a minimum size limit of 50 cm (total length) and a daily maximum bag limit of 3 fish (Berry 1995). Since this change in regulations, the walleye fishery in Orloff Lake should have been in a recovery phase. This FWIN survey will provide the data necessary to re-assess the status of the walleye fishery after 8 years of restricted angler harvesting at Orloff Lake, Alberta.

2.0 STUDY AREA

Orloff Lake is located in the Athabasca River drainage, approximately 230 km north of Edmonton, Alberta and 80 kilometres north of Athabasca, Alberta (Figure 1). The lake has a surface area of 1,830 ha (ASRD unpublished data) and can be accessed from

Highway 813 located north of Athabasca and by all-terrain-vehicles (e.g., quad, snowmobile) along cut lines. The major inlet, Drowned Horse Creek flows, into Orloff Lake from the northeast and the lake is drained at the southwest end via Otter Creek, which flows into Otter Lake. There is no development at the lake, except for a few rustic camping areas and a trappers cabin.

3.0 MATERIALS AND METHODS

3.1 Survey method

The FWIN survey methods described by the Ontario Ministry of Natural Resources (Morgan 2000) were followed in this study. Table 1 summarizes the basic sampling methods employed at Orloff Lake in 2004. We used a standard, 1.8 m deep by 61 m long, monofilament gill net, consisting of eight mesh sizes. The following meshes (stretched measurement) are sewn together in ascending order of size: 25 mm, 38 mm, 51 mm, 64 mm, 76 mm, 102 mm, 127 mm and 152 mm.

Table 1. Summary of methods for 2003 Fall Walleye Index Netting survey at Pigeon Lake, Alberta. Modified from Morgan (2000).

Criteria	Target
Season	Fall; when surface temperature is between 15^0 C and 10^0 C
Set duration	24 hours (acceptable range 21-27 hrs)
Gear	Gillnet gang - 8 mesh sizes (25 mm to 152 mm) - Each mesh 1.8 m deep x 7.6 m long
Orientation	Perpendicular to shore contour
Depth	Two strata, 2 m to 5 m and 5 m to15 m
Stratification	Sampling was stratified across shallow (2 – 5 m) and deep (5 – 15 m) quadrants proportional to the area within each stratum across the whole lake.

The surface area of the lake was divided into 0.25 square kilometre (km^2) quadrants using a Universal Transverse Mercator (UTM) grid. We sequentially numbered the quadrants and randomly selected them (without replacement) for sampling in order to minimize bias in locating sites. Net sets were placed in the centre of each quadrant if possible, or within 250 m of the centre where conditions were suitable.

Bathymetry data was used to calculate a ratio of surface area for the depth strata: i) 2 m - 5 m and ii) 5 m - 15 m (Morgan 2000). We stratified the number of nets set in each strata based on this ratio of shallow: deep quadrants throughout the lake. If the desired depth or suitable topography was not found within 250 m of the selected quadrant centre, we replaced that quadrant with the next randomly selected quadrant in the sequence (Morgan 2000; see Figure 1 for a map of the sampled quadrants).

3.2 Biological data

In the field, all fish caught were collected, bagged and recorded separately by species and mesh size (i.e., by panel) for each net. We collected data on fork length (to the nearest mm), total weight (to the nearest 10 g), sex, and state of maturity as well as ageing structures from each fish. Fish were described as sexually mature if they appeared able to spawn during the next spawning season (Duffy et al. 2000). The left operculum and the first three rays of the left pelvic fin were collected to age walleye, the left cleithrum and the first three rays of the left pelvic fin for northern pike (Esox lucius), and scale samples for lake whitefish (Coregonus clupeaformis). Ages were determined according to Mackay et al. (1990).

3.3 Data analysis

We collected age, fork length frequency distributions and length-at-age from the biological data collected from net catches. Weight-length and length-age graphs were plotted to identify and verify any outliers. Outliers were omitted if a measurement or recording error was suspected.

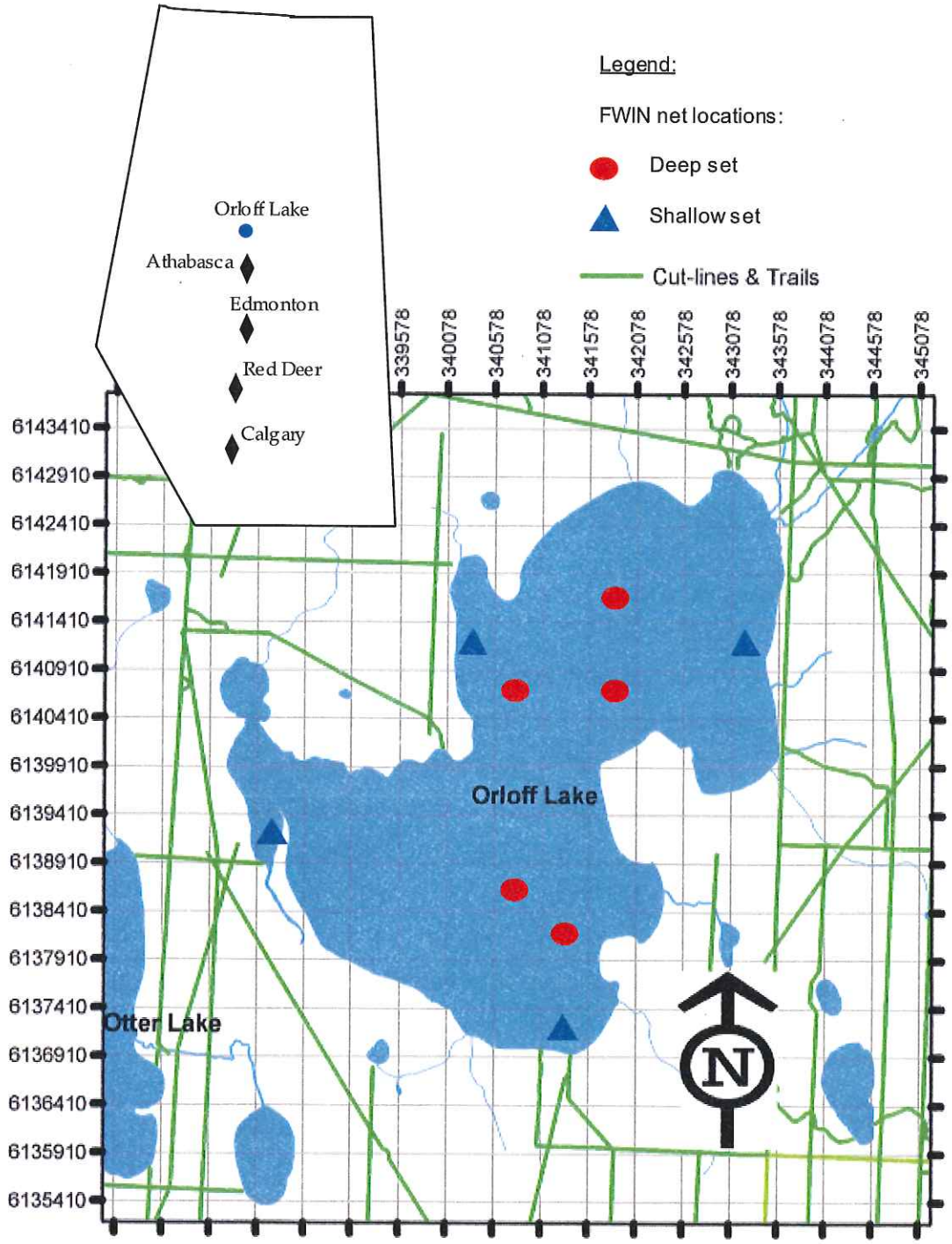

Figure 1. Map of Orloff Lake showing the Fall Walleye Index Netting locations. Red dots and blue triangles indicate deep (5 - 15 m water depth) and shallow (2 - 5 m water depth) net locations, respectively. Grid indicates 0.25 km² quadrants based on a Universal Transverse Mercator (UTM) grid. Insert is map of province of Alberta.

We used a bootstrap technique to estimate catch per unit effort of walleye and 95% confidence intervals for this estimate. Sullivan (2004) summarized bootstrapping as a statistical procedure where an original sample of the population is subsequently re-sampled and a new mean calculated. Bootstrap samples are assumed to approximate the distribution of values that would have arisen from repeatedly sampling the original population (Haddon 2001). Re-sampling thousands of times provides a distribution of possible means describing the likelihood of the true (population) mean being within that distribution (Sullivan 2004). This group of means represents the distribution of possible means from data with the same scale of variation as observed in the original data set. Frequentist parameter estimates (e.g., means) are typically equal to maximum-likelihood estimates (MLE) for the parameters of the specified probability density function (Gotelli and Ellison 2004). Empirical confidence intervals (95% CI) were calculated following Haddon (2001). The final proportions (i.e., probability densities) were standardized to range between 0 and 1 (Paul et al. 2003).

All data including the FWIN data were loaded into the Fisheries Management Information System (FMIS) of Alberta Sustainable Resource Development (ASRD).

4.0 RESULTS

4.1 Walleye abundance and population structure metrics

A total of 9 nets (4 shallow and 5 deep) were set in Orloff Lake between 1 and 4 September 2004. On average nets were deployed for 23.9 hours (range = 21.5 to 28.5). We processed a total of 224 walleye, 75 northern pike, and 62 lake whitefish.

The following subsections are according to biological characteristics used in the assessment of walleye (i.e., stable, vulnerable and collapsed). These categories are described in ASRDs Walleye Management and Recovery Plan (WMRP; Berry 1995).

4.2 Age-class distribution and stability

Walleye in Orloff Lake displayed a wide age-class distribution with 14 age-classes (from age 1 through 14) being represented, with a mean age of 6.5 years (Figure 2). The age-class structure exhibited a bimodal distribution with peaks at ages 1 -4 and 10 - 14. Relatively fewer age 5 to 9 walleye were captured in 2004. The higher densities of ages 1 to 4 individuals suggest that moderate recruitment to the breeding population may be expected in upcoming years.

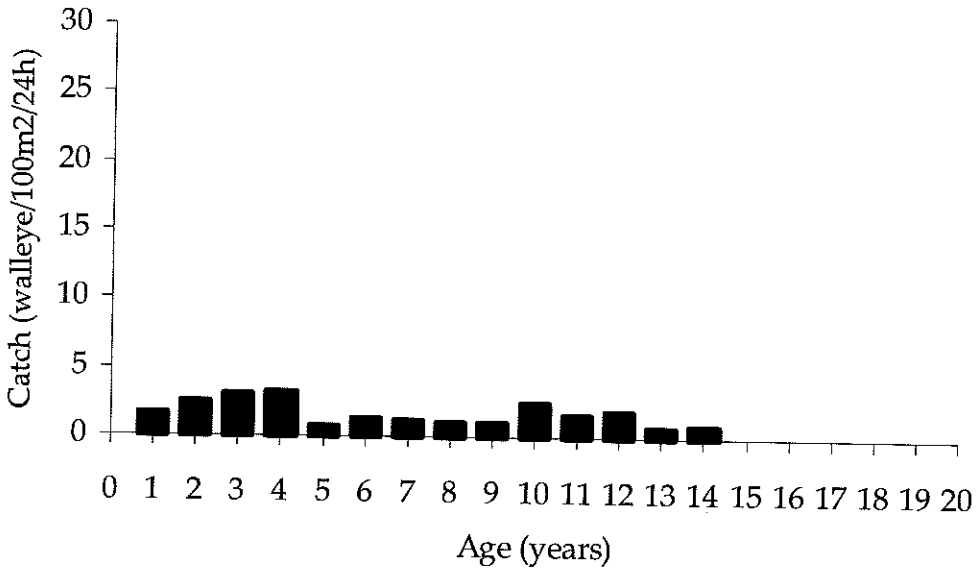

Figure 2. Age-class distribution of walleye caught in gill nets at Orloff Lake, 2004. The mean age was 6.5, n= 200.

4.3 Length-at-age

Walleye in Orloff Lake reach 500 mm FL at about age 7, indicating a moderate length-at-age classification according to the WMRP (Figure 3).

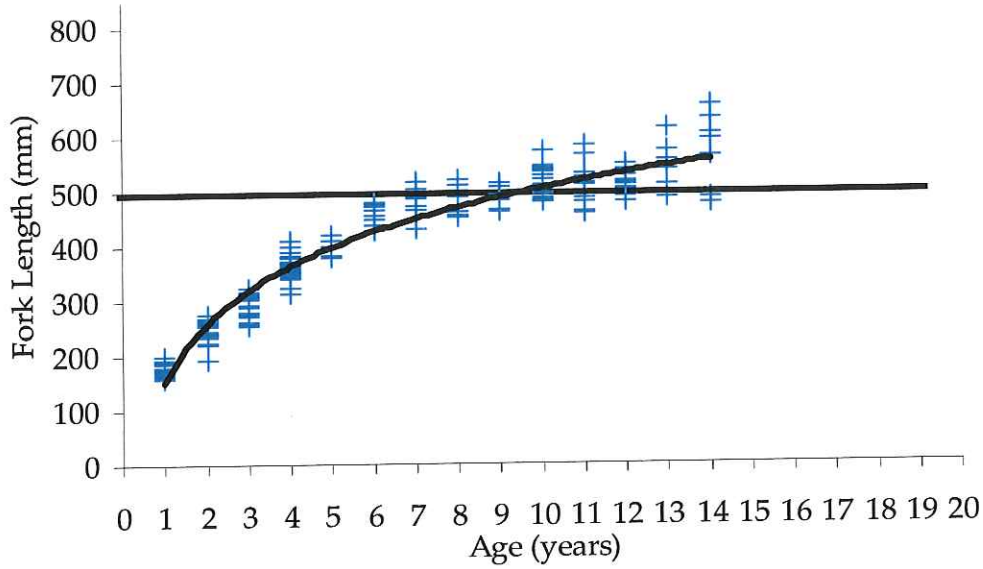

Figure 3. Length-at-age of walleye from the 2004 Fall Walleye Index Netting survey at Orloff Lake. The black line represents the logarithmic line-of-best fit (r^2=0.93; n = 200).

4.4 Catch rate

Catch-per-unit-effort of walleye at Orloff Lake in 2004 ranged from 18.5 - 28.7 walleye/100 m^2/24 h (95% CI, n=224, Figure 4). The maximum likelihood estimate of catch was 23.0 walleye/100 m^2/24 h. This catch rate is indicative of a moderate density of walleye according to ASRD management set points (Watters 2005).

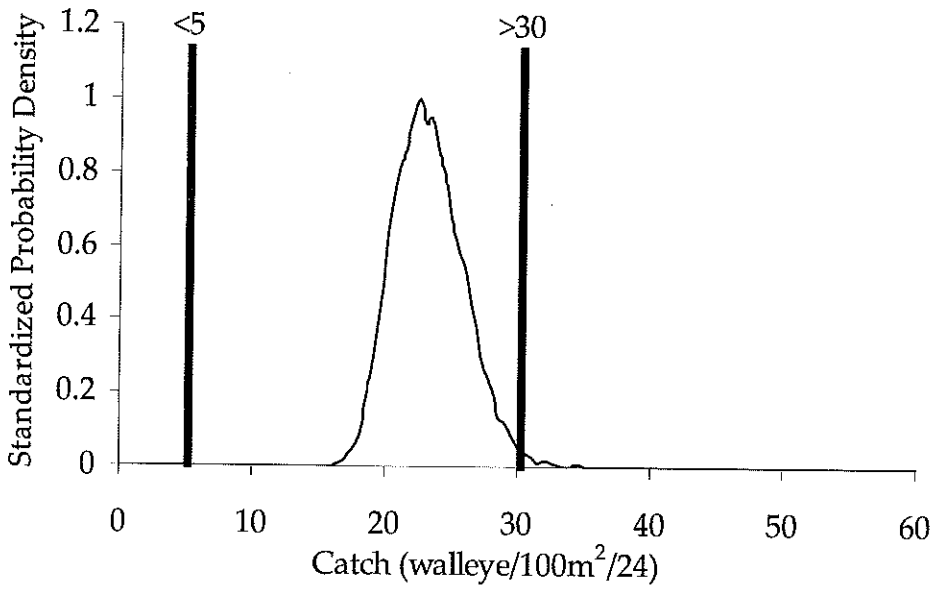

Figure 4. Standardized probability density function of the Fall Walleye Index Netting catch rate of walleye at Orloff Lake in 2004. The catch rates (i.e., < 5, 5 - 30 and > 30 walleye/100 m^2/24 h) indicated by the vertical bars specify the set points of the management categories (i.e., collapsed, vulnerable, stable).

4.5 Age-at-Maturity

Overall, 62% of the male walleye caught in 2004 were mature compared to 46% for females (Figure 6). In general, females matured earlier than males; females matured at age 6 while males matured at age 8. . However, given the small sample sizes, caution should be used in interpreting these results.

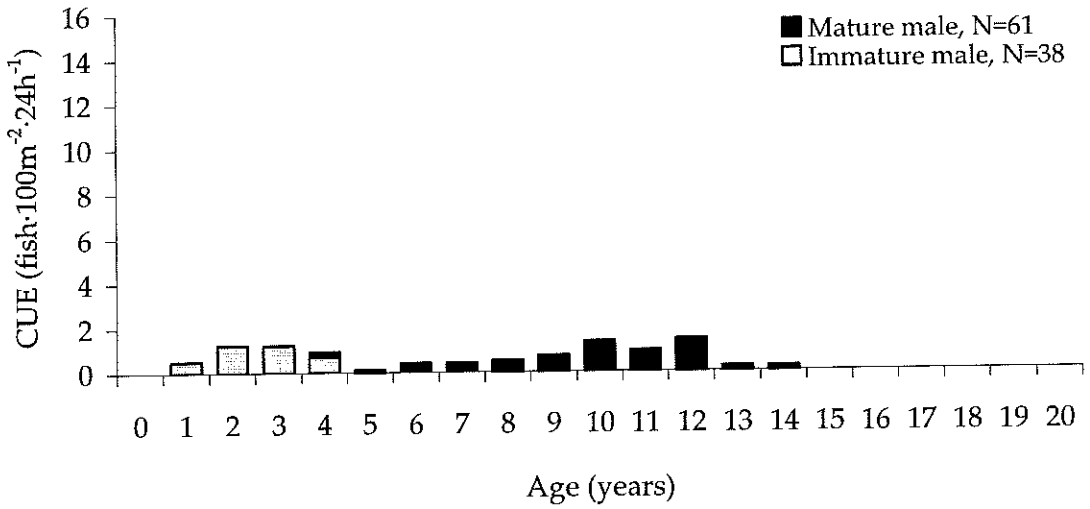

Figure 5. Age-at-maturity of male walleye from the Fall Walleye Index Netting survey at Orloff Lake in 2004.

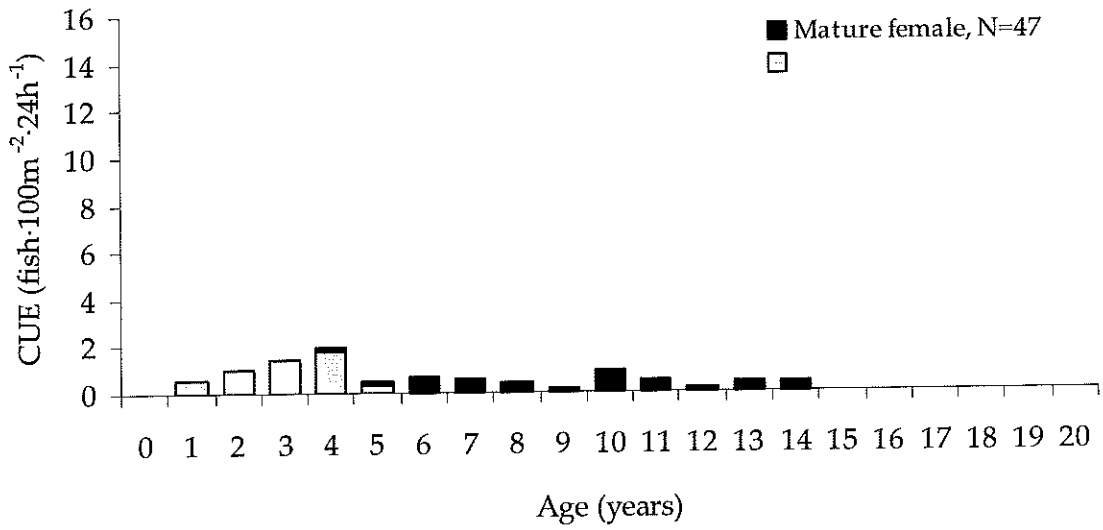

Figure 6. Age-at-maturity of female walleye from the Fall Walleye Index Netting survey at Orloff Lake in 2004.

4.6 Stock assessment summary

Data collected at Orloff Lake in 2004 suggests that the walleye fishery is still in the process of recovery, with some population metrics characteristic of both a stable and a vulnerable fishery (Berry 1995). The extent of the 2000 to 2004 year-classes (ages 4 to young-of-year) indicates moderate recruitment to the breeding population should be expected in upcoming years. The walleye fishery was composed of moderately fast growing fish with a growth rate that was relatively high in comparison with Alberta walleye fisheries in the 1980s and 1990s (Sullivan 1994). Small sample sizes in many age-classes suggest that these results should be interpreted with caution. The estimated catch rate of walleye in Orloff Lake was 23.0 walleye/100 m^2/24 h (95% CI = 18.5 - 28.7 walleye/100 m^2/24 h), a moderate density of walleye compared to other Alberta lakes (Watters 2005; Sullivan 1994).

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6.0 APPENDICES

6.1 Appendix 1. Catch of walleye from Fall Walleye Index Netting surveys at Orloff Lake, 2004.

Set number	Depth strata	Walleye catch	Northern pike catch	Lake whitefish catch	Net set date	Net pull date	Net soak (hours)
7B	Deep	29	6	10	01-Sept	02-Sept	25.0
11C	Deep	21	10	16	01-Sept	02-Sept	26.0
10B	Deep	24	6	8	01-Sept	02-Sept	28.5
29A	Shallow	43	8	4	01-Sept	02-Sept	22.0
8D	Shallow	23	18	8	03-Sept	04-Sept	21.5
23D	Deep	28	6	7	03-Sept	04-Sept	23.3
5D	Shallow	13	8	5	04-Sept	05-Sept	22.8
20A	Shallow	21	9	2	04-Sept	05-Sept	22.8
22B	Deep	22	4	2	04-Sept	05-Sept	23.3

6.2 Appendix 2. Biological data collected from the Fall Walleye Index Netting activity at Orloff Lake, 2004.

Species code: WALL = walleye, NRPK = northern pike; Sex code: M = male, F = female.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
1	WALL	116	120		U	Immature	
2	WALL	114	117		U	Immature	
3	WALL	117	124		U	Immature	
4	WALL	114	122		U	Immature	
5	WALL	124	127		U	Immature	
6	NRPK	563	599	1320	F	Mature	4
7	YLPR	96	102				
9	YLPR	101	106				
11	YLPR	98	102				
13	YLPR	100	104				
15	YLPR	92	98				
17	YLPR	97	102				
19	YLPR	92	97				
21	YLPR	102	104				
23	YLPR	115	121				
25	WALL	193	207		M	Immature	2
26	WALL	315	333	360	M	Immature	4
27	WALL	223	235		F	Immature	2
28	NRPK	473	504	760	M	Mature	2
29	YLPR	159	169				
30	YLPR	134	141				
31	YLPR	163	168				
32	YLPR	163	171				
33	YLPR	136	145				
34	YLPR	155	163				
35	YLPR	151	160				
36	YLPR	141	151				
37	YLPR	149	159				
38	YLPR	177	187				
39	YLPR	156	166				
40	YLPR	139	145				

6.2 Appendix 2. Continued.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
41	YLPR	160	169				
42	YLPR	161	171				
43	YLPR	181	191				
44	YLPR	145	150				
45	YLPR	146	154				
46	YLPR	147	155				
47	YLPR	162	172				
48	YLPR	142	151				
49	YLPR	153	161				
50	YLPR	151	157				
51	YLPR	154	163				
52	YLPR	145	151				
53	WALL	325	345	400	M	Immature	4
54	WALL	235	247	140	F	Immature	2
55	NRPK	710	749	2800	F	Mature	6
56	NRPK	635	675	2100	M	Mature	4
57	YLPR	182	192				
58	YLPR	191	197				
59	YLPR	226	232				
60	YLPR	197	207				
61	YLPR	210	220				
62	YLPR	209	219				
63	YLPR	194	201				
64	YLPR	201	211				
65	WALL	345	363	440	M	Immature	4
66	WALL	293	314	280	M	Immature	3
67	WALL	497	530	1380	M	Mature	10
68	WALL	593	624	2200	F	Mature	14
69	WALL	311	331	300	M	Immature	3
70	WALL	472	510	1240	F	Mature	8
71	WALL	315	336	340	F	Immature	4
72	NRPK	667	712	2200	F	Mature	4
73	LKWH	308	352	420	M	Mature	

6.2 Appendix 2. Continued.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
74	WALL	540	576	1800	F	Mature	10
75	WALL	315	336	340	F	Immature	3
76	WALL	558	593	2200	F	Mature	13
77	WALL	496	525	1420	F	Mature	7
78	WALL	370	394	520	F	Immature	4
79	WALL	500	532	1420	M	Mature	8
80	NRPK	597	635	1580	M	Mature	4
81	WALL	530	565	1900	F	Mature	10
82	WALL	432	459	920	M	Mature	7
83	WALL	614	645	2400	F	Mature	13
84	WALL	534	568	2000	F	Mature	10
85	LKWH	461	520	1400	M	Mature	
86	LKWH	456	510	1380	M	Mature	
87	LKWH	467	519	1420	M	Mature	
88	LKWH	465	514	1320	M	Mature	
89	WALL	511	545	1700	M	Mature	11
90	WALL	584	619	2100	F	Mature	11
91	LKWH	490	545	1700	M	Mature	
92	LKWH	496	550	2000	F	Mature	
93	LKWH	524	579	2300	F	Mature	
94	LKWH	500	554	2100	M	Mature	
95	LKWH	508	561	1900	F	Mature	
96	WALL	511	536	1540	M	Mature	13
97	YLPR	117	124				
98	YLPR	106	112				
99	WALL	165	179		U	Immature	1
100	WALL	516	550	1700	F	Mature	11
101	WALL	496	529	1500	M	Mature	12
102	NRPK	558	599	1280	M	Mature	5
103	NRPK	571	602	1200	M	Mature	4
104	NRPK	588	617	1320	M	Mature	5
105	YLPR	159	164				
106	YLPR	144	148				

6.2 Appendix 2. Continued.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
107	YLPR	155	167				
108	YLPR	157	164				
109	YLPR	154	161				
110	WALL	360	382	520	F	Immature	4
111	WALL	428	458	860	M	Immature	6
112	WALL	257	278	180	F	Immature	3
113	WALL	342	364	460	M	Immature	4
114	WALL	309	333	300	F	Immature	3
115	NRPK	568	601	1320	M	Mature	5
116	NRPK	600	637	1340	M	Mature	4
117	YLPR	177	187				
118	YLPR	174	184				
119	WALL	527	555	1700	M	Mature	12
120	WALL	314	336	340	F	Immature	3
121	WALL	319	338	360	F	Immature	3
122	WALL	487	517	1320	F	Mature	7
123	NRPK	695	734	2200	F	Mature	6
124	NRPK	653	694	1600	M	Mature	4
125	LKWH	500	550	2100	F	Mature	
126	WALL	480	512	1280	M	Mature	11
127	WALL	380	403	580	F	Mature	4
128	WALL	380	403	700	F	Mature	4
129	NRPK	593	630	1200	M	Mature	5
130	NRPK	617	652	1680	M	Mature	6
131	LKWH	530	585	2100	F	Mature	
132	WALL	481	510	1260	F	Mature	6
133	WALL	499	526	1440	M	Mature	10
134	WALL	539	563	1700	F	Mature	13
135	WALL	499	534	1420	M	Mature	10
136	LKWH	415	462	1200	M	Mature	
137	LKWH	388	434	800	F	Mature	
138	LKWH	479	533	1520	F	Mature	
139	LKWH	445	498	1200	F	Mature	
140	LKWH	431	484	1200	F	Mature	

6.2 Appendix 2. Continued.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
141	WALL	499	535	1500	M	Mature	12
142	NRPK	776	817	3700	F	Mature	6
143	LKWH	455	500	1340	M	Mature	
144	LKWH	550	601	2200	M	Mature	
145	LKWH	528	580	2200	M	Mature	
146	LKWH	412	455	960	F	Mature	
147	LKWH	533	590	2200	M	Mature	
148	LKWH	535	586	2400	F	Mature	
149	LKWH	509	554	1900	F	Mature	
150	LKWH	470	522	1520	M	Mature	
151	LKWH	490	533	1700	M	Mature	
152	WALL	116	122		U	Immature	
153	WALL	487	519	1600	M	Mature	14
154	YLPR	115	121		F	Immature	
155	NRPK	691	731	2700	M	Mature	4
156	NRPK	580	617	1580	M	Mature	4
157	YLPR	141	147		F	Mature	
158	YLPR	171	179		F	Mature	
159	YLPR	140	146		F	Mature	
160	YLPR	152	159		F	Mature	
161	YLPR	156	165		F	Mature	
162	YLPR	175	181		F	Mature	
163	YLPR	151	161		F	Mature	
164	YLPR	141	147		F	Mature	
165	YLPR	166	175		F	Mature	
166	YLPR	165	178		F	Mature	
167	YLPR	132	140		M	Mature	
168	YLPR	145	153		F	Mature	
169	YLPR	153	161		F	Mature	
170	YLPR	155	168		F	Mature	
171	WALL	222	236	120	F	Immature	2
172	WALL	262	281	220	M	Immature	2
173	WALL	273	289	220	F	Immature	3

6.2 Appendix 2. Continued.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
174	WALL	263	283	200	M	Immature	3
175	NRPK	610	650	1460	F	Mature	4
176	NRPK	640	680	1740	M	Mature	6
177	YLPR	195	205	100	F	Mature	
178	YLPR	192	202		F	Mature	
179	YLPR	201	211	120	F	Mature	
180	YLPR	185	199		F	Mature	
181	WALL	400	423	640	F	Immature	4
182	WALL	304	326	300	M	Immature	3
183	WALL	295	324	300	F	Immature	3
184	WALL	291	319	300	F	Immature	3
185	WALL	448	477	1060	M	Mature	6
186	WALL	491	522	1500	M	Mature	12
187	NRPK	909	955	3900	F	Mature	9
188	NRPK	548	575	1100	M	Mature	3
189	LKWH	323	360	480	F	Mature	
190	WALL	509	536	1580	F	Mature	9
191	WALL	351	371	480	M	Immature	4
192	WALL	354	374	520	M	Mature	4
193	WALL	373	394	560	F	Immature	4
194	WALL	457	483	1020	F	Mature	6
195	WALL	357	381	480	F	Immature	4
196	NRPK	585	621	1600	M	Mature	4
197	LKWH	463	513	1400	M	Mature	
198	LKWH	351	392	600	M	Mature	
199	WALL	464	495	1180	M	Mature	9
200	WALL	562	595	2100	F	Mature	14
201	WALL	540	576	1780	F	Mature	10
202	WALL	463	492	1160	M	Mature	11
203	LKWH	490	545	1800	F	Mature	
204	LKWH	519	565	1900	M	Mature	
205	LKWH	466	515	1460	M	Mature	
206	WALL	541	580	1940	F	Mature	10

6.2 Appendix 2. Continued.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
207	WALL	512	545	1580	F	Mature	8
208	LKWH	500	549	1500	M	Mature	
209	LKWH	494	544	1700	M	Mature	
210	WALL	116	124		U	Immature	
211	WALL	115	122		U	Immature	
212	WALL	105	113		U	Immature	
213	WALL	116	125		U	Immature	
214	WALL	485	515	1300	M	Mature	10
215	YLPR	112	118				
216	YLPR	110	117				
217	YLPR	91	96				
218	YLPR	109	112				
219	YLPR	111	117				
220	YLPR	93	98				
221	YLPR	92	95				
222	YLPR	119	123				
223	YLPR	105	110				
224	YLPR	100	105				
225	YLPR	104	118				
226	YLPR	111	119				
227	WALL	189	202		U	Immature	1
228	WALL	162	176		U	Immature	1
229	WALL	485	518	1400	M	Mature	9
230	YLPR	165	179				
231	YLPR	145	154				
232	YLPR	142	151				
233	YLPR	141	150				
234	YLPR	147	156				
235	YLPR	139	147				
236	YLPR	139	148				
237	YLPR	152	160				
238	YLPR	155	162				
239	YLPR	135	143				

6.2 Appendix 2. Continued.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
240	YLPR	149	156				
241	YLPR	140	146				
242	YLPR	161	168				
243	YLPR	140	145				
244	YLPR	145	155				
245	YLPR	152	162				
246	YLPR	148	155				
247	YLPR	155	165				
248	YLPR	146	153				
249	YLPR	156	162				
250	YLPR	155	163				
251	YLPR	145	152				
252	YLPR	151	161				
253	YLPR	142	151				
254	YLPR	140	146				
255	YLPR	175	184				
256	YLPR	155	160				
257	LKWH	346	388	560	F	Mature	
258	WALL	366	389	560	F	Immature	4
259	WALL	260	274	180	F	Immature	2
260	WALL	520	546	1520	F	Mature	7
261	WALL	293	311	260	M	Immature	3
262	WALL	263	281	200	M	Immature	2
263	WALL	265	282	200	F	Immature	2
264	WALL	574	604	2100	F	Mature	10
265	WALL	280	300	220	F	Immature	3
266	NRPK	390	414	500	M	Mature	1
267	NRPK	639	680	1980	F	Mature	4
268	YLPR	195	208				
269	YLPR	205	214				
270	YLPR	203	212				
271	WALL	305	325	300	M	Immature	3
272	WALL	279	298	220	M	Immature	3

6.2 Appendix 2. Continued.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
273	WALL	256	268	200	F	Immature	3
274	WALL	472	499	1220	M	Mature	7
275	WALL	346	366	480	M	Immature	4
276	WALL	439	465	1000	M	Mature	6
277	WALL	315	335	320	M	Immature	3
278	WALL	466	495	1120	M	Mature	7
279	WALL	360	380	500	F	Immature	4
280	WALL	525	563	1600	M	Mature	11
281	WALL	270	282	200	M	Immature	2
282	NRPK	587	625	1480	F	Mature	4
283	WALL	540	570	1800	M	Mature	12
284	WALL	488	516	1280	M	Mature	11
285	WALL	379	402	540	F	Immature	5
286	WALL	493	525	1640	F	Mature	12
287	WALL	521	554	1600	M	Mature	10
288	WALL	245	261	160	M	Immature	2
289	WALL	472	502	1300	M	Mature	8
290	NRPK	664	702	2200	F	Mature	4
291	NRPK	440	465	640	M	Mature	
292	LKWH	379	425	720	F	Mature	
293	WALL	502	531	1500	M	Mature	12
294	WALL	515	543	1600	M	Mature	12
295	WALL	477	508	1300	F	Mature	6
296	WALL	472	503	1180	M	Immature	7
297	WALL	488	518	1320	M	Mature	10
298	WALL	550	583	2000	M	Mature	12
299	NRPK	585	625	1380	M	Mature	4
300	NRPK	626	665	2000	M	Mature	5
301	WALL	632	663	2700			14
302	WALL	496	529	1500	M	Mature	10
303	NRPK	720	755	3500	F	Mature	6
304	LKWH	503	561	1980	M	Mature	
305	LKWH	482	531	1640	M	Mature	

6.2 Appendix 2. Continued.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
306	WALL	122	130		U	Immature	
307	WALL	159	171		F	Immature	1
308	NRPK	563	601	1380	M	Mature	5
309	YLPR	114	121		M	Mature	
310	YLPR	107	112		M	Mature	
311	YLPR	99	104		M	Mature	
312	WALL	172	186		M	Immature	1
313	NRPK	577	616	1500	M	Mature	4
314	YLPR	151	156		F	Mature	
315	YLPR	163	171		F	Mature	
316	YLPR	138	144		M	Mature	
317	YLPR	148	157		M	Mature	
318	YLPR	137	146		M	Mature	
319	YLPR	155	168		F	Mature	
320	LKWH	193	217		F	Immature	
321	WALL	410	437	820	F	Immature	5
322	NRPK	630	642	1600	M	Mature	5
323	NRPK	367	389	380	F	Immature	1
324	NRPK	382	407	500	F	Mature	1
325	NRPK	566	598	1320	M	Mature	4
326	WALL	464	496	1160	M	Mature	11
327	WALL	545	577	1740	F	Mature	10
328	WALL	391	413	660	F	Immature	4
329	NRPK	371	396	380	M	Mature	1
330	NRPK	543	587	1400	M	Mature	3
331	NRPK	364	390	380	M	Mature	1
332	NRPK	420	451	580	M	Mature	2
333	NRPK	397	423	520	F	Immature	1
334	NRPK	660	703	2200	M	Mature	5
335	NRPK	610	645	1720	M	Mature	4
336	LKWH	289	323	320	F	Immature	
337	WALL	487	516	1280	M	Mature	13
338	WALL	468	495	1280	F	Mature	6
339	WALL	545	580	2100	F	Mature	10

6.2 **Appendix 2. Continued.**

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
340	WALL	473	501	1280	F	Mature	7
341	WALL	465	496	1160	M	Mature	9
342	NRPK	436	472	640	M	Mature	2
343	NRPK	531	570	1120	F	Mature	3
344	NRPK	599	646	1540	M	Mature	5
345	NRPK	543	575	1100	M	Mature	3
346	LKWH	277	314	280	F	Immature	
347	LKWH	286	322	320	F	Immature	
348	WALL	468	498	1140	F	Mature	6
349	WALL	490	520	1320	F	Mature	7
350	WALL	567	598	2200	F	Mature	11
351	WALL	537	567	1800	F	Mature	10
352	WALL	523	550	1700	F	Mature	8
353	WALL	494	523	1360	M	Mature	9
354	NRPK	585	622	1400	M	Mature	4
355	LKWH	455	503	1440	F	Mature	
356	LKWH	538	586	2000	F	Mature	
357	WALL	514	543	1440	F	Mature	9
358	WALL	461	494	1360	M	Mature	11
359	WALL	519	548	1680	M	Mature	12
360	WALL	510	543	1520	M	Mature	10
361	WALL	603	638	2500	F	Mature	14
362	LKWH	449	502	1420	F	Mature	
363	LKWH	504	555	1700	M	Mature	
364	WALL	117	126		U	Immature	
365	WALL	106	114		U	Immature	
366	WALL	478	507	1240	M	Mature	14
367	WALL	163	172		M	Immature	1
368	NRPK	587	622	1400	F	Mature	4
369	YLPR	159	167		F	Mature	
370	YLPR	131	138		M	Mature	
371	YLPR	157	166		F	Mature	
372	YLPR	160	169		F	Mature	
373	YLPR	148	152		M	Mature	

6.2 Appendix 2. Continued.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
374	YLPR	161	169		F	Mature	
375	YLPR	142	150		M	Mature	
376	YLPR	155	164		M	Mature	
377	YLPR	144	151		U	Immature	
378	YLPR	142	148		F	Mature	
379	YLPR	241	252	180	F	Mature	
380	YLPR	149	156		F	Mature	
381	WALL	317	340	320	F	Immature	3
382	WALL	247	263		M	Immature	2
383	WALL	351	375	460	F	Immature	4
384	WALL	186	202		M	Immature	1
385	WALL	277	295	200	M	Immature	2
386	WALL	267	287	200	M	Immature	2
387	WALL	257	267		F	Immature	2
388	NRPK	601	641	1420	F	Mature	4
389	LKWH	248	280	1200	F	Immature	
390	WALL	366	389	480	F	Immature	4
391	WALL	265	273	200	M	Immature	2
392	WALL	346	369	460	F	Immature	4
393	NRPK	355	376	360	M	Mature	1
394	LKWH	470	520	1500	M	Mature	
395	WALL	503	533	1340	F	Mature	7
396	WALL	503	531	1500	M	Mature	12
397	WALL	360	382	480	F	Immature	4
398	WALL	383	407	580	F	Mature	5
399	NRPK	598	636	1540	M	Mature	5
400	NRPK	522	553	1020	M	Mature	3
401	NRPK	565	602	1320	M	Mature	3
402	WALL	533	557	1640	M	Mature	11
403	WALL	573	601	2200	F	Mature	13
404	WALL	490	521	1320	F	Mature	8
405	WALL	438	464	940	M	Mature	6
406	WALL	453	485	1160	M	Mature	8
407	WALL	464	494	1100	M	Mature	8

6.2 Appendix 2. Continued.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
408	LKWH	505	551	1680	M	Mature	
409	WALL	656	686	3200	F	Mature	14
410	WALL	486	515	1320	M	Mature	10
411	WALL	510	539	1600	M	Mature	12
412	LKWH	484	537	1560	M	Mature	
413	LKWH	495	554	1840	F	Mature	
414	LKWH	543	597	2400	M	Mature	
415	LKWH	502	553	1900	M	Mature	
416	WALL	106	112		U	Immature	
417	YLPR	100	106				
418	YLPR	95	100				
419	YLPR	95	100				
420	YLPR	98	103				
421	YLPR	101	108				
422	YLPR	98	103				
423	YLPR	97	103				
424	YLPR	91	96				
425	YLPR	95	101				
426	YLPR	97	102				
427	YLPR	111	117				
428	YLPR	95	99				
429	YLPR	102	108				
430	YLPR	100	104				
431	WALL	176	190		M	Immature	1
432	WALL	168	181		F	Immature	1
433	WALL	494	522	1440	M	Mature	9
434	YLPR	145	153				
435	YLPR	159	169				
436	YLPR	159	168				
437	YLPR	175	185				
438	YLPR	146	152				
439	WALL	223	239		M	Immature	2
440	WALL	363	388	500	F	Immature	4
441	WALL	479	506	1420	M	Mature	12

6.2 Appendix 2. Continued.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
442	WALL	325	345	380	M	Immature	3
443	WALL	311	331	340	M	Immature	3
444	WALL	411	434	780	F	Immature	5
445	NRPK	735	783	3300	F	Mature	6
446	NRPK	376	400	380	F	Immature	1
447	WALL	525	560	1700	F	Mature	11
448	NRPK	600	641	1520	F	Mature	4
449	NRPK	802	846	4000	F	Immature	8
450	NRPK	704	745	2600	F	Mature	6
451	NRPK	703	743	2500	F	Mature	5
452	LKWH	522	567	2100	F	Mature	
453	LKWH	510	560	2100	F	Mature	
454	WALL	584	615	2100	F	Mature	11
455	NRPK	890	933	6100	F	Mature	10
456	NRPK	743	776	3400	F	Mature	7
457	LKWH	495	543	2000	F	Mature	
458	WALL	350	371	500	M	Immature	4
459	LKWH	558	610	2900	F	Mature	
460	LKWH	523	570	2200	M	Mature	
461	WALL	118	126		U	Immature	
462	WALL	116	125		U	Immature	
463	WALL	114	128		U	Immature	
464	YLPR	97	102		M	Mature	
465	YLPR	106	110		F	Immature	
466	YLPR	94	100		M	Mature	
467	WALL	162	174		F	Immature	1
468	YLPR	141	147		M	Mature	
469	YLPR	139	146		M	Mature	
470	YLPR	179	188		F	Mature	
471	WALL	260	277	200	F	Immature	3
472	WALL	374	395	540	F	Immature	4
473	WALL	325	346	380	F	Immature	3
474	WALL	316	339	340	F	Immature	3
475	WALL	540	572	1740	M	Mature	10

6.2 Appendix 2. Continued.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
476	WALL	269	288	200	F	Immature	2
477	NRPK	591	628	1520	M	Mature	4
478	NRPK	546	580	1200	M	Mature	3
479	NRPK	550	586	1320	M	Mature	4
480	WALL	463	486	1180	M	Mature	11
481	WALL	468	493	1200	M	Mature	9
482	WALL	360	385	480	M	Mature	4
483	WALL	319	340	380	M	Immature	3
484	WALL	480	504	1220	M	Mature	12
485	NRPK	534	565	1180	F	Mature	3
486	NRPK	545	578	1280	M	Mature	3
487	NRPK	632	676	1780	F	Mature	4
488	NRPK	420	448	540	F	Immature	2
489	WALL	411	433	740	F	Immature	4
490	WALL	472	501	1280	F	Mature	6
491	WALL	529	562	1800	M	Mature	12
492	NRPK	632	668	2100	M	Mature	4
493	LKWH	288	325	300	F	Immature	
494	WALL	463	494	1180	M	Mature	9
495	WALL	479	505	1260	M	Mature	10
496	NRPK	685	728	2100	F	Mature	6
497	LKWH	444	496	1200	F	Mature	
498	WALL	106	128		U	Immature	
499	WALL	117	121		U	Immature	
500	WALL	129	132		U	Immature	
501	WALL	103	122		U	Immature	
502	YLPR	105	110		M	Mature	
503	YLPR	96	101		M	Immature	
504	YLPR	111	117		M	Mature	
505	YLPR	115	121		F	Immature	
506	YLPR	103	108		M	Mature	
507	YLPR	117	129		M	Mature	
508	YLPR	107	119		M	Mature	
509	YLPR	204	215		F	Mature	

6.2 Appendix 2. Continued.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
510	WALL	173	186		F	Immature	
511	WALL	178	192		F	Immature	1
512	WALL	168	181		F	Immature	1
513	WALL	201	216		F	Immature	1
514	WALL	193	201		M	Immature	1
515	NRPK	761	808	3600	F	Mature	8
516	YLPR	166	175		F	Mature	
517	YLPR	174	183		F	Mature	
518	YLPR	142	151		M	Mature	
519	YLPR	143	150		F	Mature	
520	YLPR	147	152		F	Mature	
521	YLPR	164	173		F	Mature	
522	YLPR	148	156		F	Mature	
523	YLPR	142	150		F	Mature	
524	YLPR	148	156		F	Mature	
525	YLPR	146	153		F	Mature	
526	YLPR	103	107		M	Mature	
527	YLPR	151	160		F	Mature	
528	YLPR	150	156		F	Mature	
529	YLPR	142	150		F	Mature	
530	YLPR	154	161		F	Mature	
531	YLPR	161	164		F	Mature	
532	YLPR	143	152		F	Mature	
533	YLPR	156	168		F	Mature	
534	YLPR	167	179		F	Mature	
535	YLPR	150	168		F	Mature	
536	YLPR	154	160		M	Mature	
537	YLPR	158	166		F	Mature	
538	YLPR	157	161		F	Mature	
539	YLPR	146	157		F	Mature	
540	YLPR	161	168		F	Mature	
541	WALL	271	283		M	Immature	2
542	WALL	243	264		M	Immature	2
543	WALL	238	255		F	Immature	2

6.2 Appendix 2. Continued.

Sample number	Species	Fork length (mm)	Total length (mm)	Weight (g)	Sex	Maturity	Age (yrs)
544	WALL	481	508	1300	F	Mature	6
545	YLPR	209	217		F	Mature	
546	YLPR	198	207		F	Mature	
547	YLPR	200	207		F	Mature	
548	YLPR	187	195		F	Mature	
549	YLPR	187	197		F	Mature	
550	YLPR	186	195		F	Mature	
551	YLPR	206	215		F	Mature	
552	YLPR	205	217		F	Mature	
553	WALL	268	287	200	F	Immature	2
554	WALL	277	296	220	M	Immature	3
555	WALL	270	288	200	F	Immature	2
556	WALL	456	486	980	M	Mature	8
557	WALL	493	526	1240	M	Mature	10
558	WALL	420	446	800	F	Mature	5
559	WALL	385	410	620	F	Immature	4
560	LKWH	532	590	2100	M	Mature	
561	NRPK	642	673	1700	M	Mature	5
562	NRPK	647	676	2000	M	Mature	4
563	NRPK	750	788	3600	F	Mature	5
564	LKWH	535	589	2200	M	Mature	
565	WALL	496	523	1520	M	Mature	10
566	WALL	550	580	2200	F	Mature	12
567	WALL	402	429	820	M	Mature	5

The Alberta Conservation Association acknowledges the following partner for their generous support of this project

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