

Appendix B. Documentation of Walleye Data

Data in Figure 3

Walleye growth shown in Figure 3 contains mean length at age estimates of female walleye in 425 water bodies. The sources of data are:

- walleye synopses by Carlander (1997) and Colby et al. (1979);
- walleye survey databases maintained by the provinces of Ontario and Québec in Canada.

Zhou et al. (2008) provided a useful compilation of the Carlander data and supplied estimates of degree days for each water body. The data spanned a range in DD5 (Growing degree days above 5 °C) of 1000 – 4633 °C-day. The breakdown of data is as follows:

Source	Number of populations	Range in DD5 (°C-day)
Ontario	345	1097 - 2117
Quebec	49	1000 - 1886
Other	31	1557- 4633
Total	425	1000 - 4633

All data from Ontario and Quebec were obtained using a standard survey method, known as Fall Walleye Index Fishing (FWIN). FWIN is a depth-stratified survey conducted during the fall using a standard multi-mesh gillnet (stretch mesh sizes = 1",

1.5", 2", 2.5", 3", 4", 5" and 6") (Morgan 2002). Fish processing reports sex, maturity, total length and collects otoliths to assign fish age.

Data in Figure 4

Figure 4 includes a subset of growth data shown in Figure 3, as well as estimates of length and age at maturity for female walleye in 92 populations. The maturity data are shown in Table B1. The table includes estimates of age and size at maturity, as well as size at spawning. Populations reported for Ontario and Quebec were surveyed using the FWIN method and female attributes were determined directly using only female data ($n=67$). Data from other locations were extracted from the literature ($n=25$). Methods of calculating statistics shown in Table B1 are described below.

(i) Maturity Estimates

For Ontario and Quebec populations, we estimated length and age at 50% mature by probit analysis of the frequency distribution of immature and mature fish. Estimates are reported for 67 well-sampled populations (i.e., $n > 100$ fish). Because sampling was conducted at the end of the annual growing season and walleye spawn in the spring, the assessed age was rounded up (i.e., minimum age = 1 year) and maturity estimates were treated as estimates of the age and size of spawning (T_{spawn} and L_{spawn}). Age at maturity (i.e., age when egg production begins) was calculated as

$$T = T_{spawn} - 1. \quad (\text{B.1})$$

Size of maturity (i.e., length at start of the year when egg production begins) was estimated as follows:

$$L = \frac{L_{spawn}}{1 + \frac{p}{T}} \quad (B.2)$$

where $p = 0.285 + 0.36e^{-0.23T}$ (B.3)

This formulation accounts for the fact the decline in growth rate after maturation depends on the reproductive investment (i.e., egg production). It was determined empirically by assuming the biphasic growth model and simulating growth for a range of mortality rates ($M = 0.1$ to 0.4).

In addition to the Ontario and Quebec data, we obtained maturity estimates for 25 populations from data reported in the published literature. These reports typically documented age and size of initial spawning (not maturing) and, in most cases, they did not distinguish by sex. To estimate female maturity from the combined-sex estimates, we derived the following conversion formulae using data from populations where sex-specific estimates were available:

$$T_{spawn_female} = 1.175 + 0.98 T_{spawn_combined} \quad (n=53, R^2=0.96, SE = 0.48) \quad (B.4)$$

$$L_{spawn_female} = 20.5 + 1.05 L_{spawn_combined} \quad (n=57, R^2=0.82, SE = 20.7) \quad (B.5)$$

These calculations were performed for 20 populations lacking sex-specific data, after which equations B.1 and B.2 were used to convert estimates of size/age at spawning to size/age at maturity (i.e., one year earlier).

(ii) Mortality Estimates

Natural mortality predictions were calculated from degree days and length at maturity by

applying equation 26: $M = \frac{0.06 DD5}{L_M + 0.03 DD5}$.

For Ontario and Quebec populations, total mortality rate was estimated from age composition using the Robson-Chapman method (Robson and Chapman 1959) and a minimum age of 5 years. For other populations, mortality rate was extracted from the published literature and always based on assessment of age structures.

Literature Cited

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TABLE B1. Walleye maturation and mortality rate for 92 water bodies. Exploitation status identifies sanctuary (S) and remote (R) water bodies (where exploitation is known to be light). Length measurements are total length. Sources are: 1. Fall Walleye Index Netting data from Ontario; 2. Fall Walleye Index Netting data from Quebec; 3. Colby and Nepszy 1981; 4. Gangl and Pereira 2003; 5. Quist et al. 2003, 2004; 6. Kocovsky and Carline 2001.

Degree-Days > 5°C	Water body name	Prov. or State	Exploitation Status	Female Age at 50% maturity (years)	Female length at 50% maturity (mm)	Female length at 50% spawning (mm)	Natural mortality (M, /yr)	Total mortality (Z, /yr)	Number of fish sampled	Female maximum length (mm)	Maximum age (y)	Source
1052	Lac Le Cordier	QC	R	12.4	446	457	0.13	0.17	690	598	30	2
1054	Lac Weakwaten	QC	R	12.7	462	473	0.13	0.15	544	693	31	2
1057	Lac Sans Nom (Stvi-03)	QC	R	11.5	443	455	0.13	0.15	253	570	28	2
1065	Lac Regnault	QC	R	12.0	491	503	0.12	0.15	922	613	31	2
1187	Lac Chibougamau	QC		9.0	543	562	0.12	0.30	734	740	29	2
1217	Lac Duparquet	QC		6.0	345	366	0.19	0.26	986	686	23	2
1217	Lac Preissac	QC		6.0	376	399	0.18	0.37	2097	715	24	2
1253	Lac Malartic	QC		5.6	311	332	0.22	0.27	759	455	19	2
1299	West Kabenung Lake	ON		4.6	399	434	0.18	0.53	252	716	24	1
1299	Lac Dasserat	QC		5.2	416	448	0.17	0.29	578	745	26	2
1303	Makokibatan Lake	ON		7.2	483	507	0.15	0.31	198	740	26	1
1335	Miminiska Lake	ON	R	7.7	412	431	0.18	0.15	188	568	25	1
1364	Wabatongushi Lake	ON		6.9	446	469	0.17	0.38	495	732	20	1
1367	Dog Lake	ON		4.8	459	497	0.16	0.22	221	777	24	1
1375	Nagagami Lake	ON		7.4	516	541	0.15	0.41	294	771	22	1
1375	Lac Des Quinze	QC		5.1	325	350	0.23	0.37	1575	676	22	2
1383	Garnham Lake	ON		5.3	405	435	0.19	0.45	274	775	19	1
1385	Lac Temiscamingue	QC		5.4	357	383	0.21	0.44	582	700	27	2

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1387	Fushimi Lake	ON		6.4	392	415	0.19	0.50	370	717	20	1
1392	Lac Opasatica	QC		4.7	344	374	0.22	0.36	625	715	28	2
1412	Missinaibi Lake	ON		7.8	463	484	0.17	0.36	194	711	19	1
1421	Kapkichi Lake	ON		7.2	414	435	0.19	0.34	239	633	20	1
1431	Whitewater Lake	ON		8.5	404	420	0.19	0.19	299	688	25	1
1445	Lac Kipawa	QC		4.4	422	462	0.19	0.46	2145	730	19	2
1445	Lac Mitchinamecus	QC		7.6	448	469	0.18	0.50	1145	775	21	2
1448	Smoothrock Lake	ON		7.2	425	445	0.19	0.30	332	736	19	1
1464	Ivanhoe Lake	ON		6.1	482	512	0.17	0.43	228	790	20	1
1469	Savanne Lake	ON	S	6.9	396	417	0.20	0.22	718	517	17	1
1473	Lake St. Joseph	ON	R	7.2	425	446	0.19	0.19	1019	614	27	1
1483	Henderson Lake	ON	S	4.1	379	419	0.21	0.19	118	662	22	1
1487	Lac Cabonga	QC	R	4.1	415	458	0.19	0.25	979	758	22	2
1494	Red Lake	ON		5.3	342	367	0.23	0.23	848	726	28	1
1503	Wakami Lake	ON		3.6	396	445	0.20	0.31	681	741	20	1
1507	Wenebegon Lake	ON		5.1	362	390	0.22	0.35	265	750	20	1
1511	Lac Des Mille Lacs	ON		7.4	478	500	0.17	0.35	1592	712	26	1
1525	Kebskwasheshi Lake	ON		3.9	385	427	0.21	0.19	218	714	22	1
1533	Trout Lake	ON	R	6.6	455	480	0.18	0.17	298	647	24	1
1544	Lake Abitibi	ON		7.7	441	461	0.19	0.39	588	805	23	1
1545	Little Trout Lake	ON	R	7.1	456	479	0.18	0.23	234	666	24	1
1557	Longlegged Lake	ON		5.1	401	432	0.21	0.23	251	624	23	1
1557	Churchill Lake	ON	R	6.5	408	431	0.21	0.23	341	550	20	1
1582	Lac Nominingué	QC		3.2	335	383	0.25	0.31	508	681	20	2
1589	Round Lake	ON		7.5	519	544	0.17	0.43	806	759	22	1
1613	Pelican Lake	ON		6.0	447	475	0.20	0.50	286	612	15	1
1613	Abram Lake	ON		5.8	437	466	0.20	0.41	179	612	15	1
1614	Botsford Lake	ON		5.5	410	439	0.21	0.44	256	622	25	1
1617	Minnitaki Lake	ON		6.1	458	486	0.19	0.32	620	689	21	1
1621	Lac Seul	ON		5.3	405	435	0.21	0.24	2199	720	28	1
1636	Sandford Lake	ON		5.2	435	468	0.20	0.57	210	720	25	1
1638	Wabigoon Lake	ON		5.1	412	444	0.21	0.37	259	742	26	1
1641	Lac Desjardins	QC		6.0	504	535	0.18	0.77	915	820	19	2

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1644	Pekagoning Lake	ON		4.4	420	460	0.21	0.46	566	736	22	1
1646	Eagle Lake	ON		3.9	396	440	0.22	0.28	694	740	26	1
1648	Finlayson Lake	ON		6.3	450	476	0.20	0.31	208	700	20	1
1664	Lac La Garde	QC		6.2	494	523	0.18	0.67	932	830	22	2
1666	Otukamamoan Lake	ON		5.5	439	470	0.20	0.47	394	683	19	1
1671	Winnipeg River	ON		7.1	450	472	0.20	0.32	996	729	25	1
1672	East Vermillion Lake	MN		4.9	421	456	0.21				4	
1672	West Vermillion Lake	MN		4.6	463	504	0.20				4	
1691	Lake of the Woods	ON		5.9	447	475	0.20	0.49		760	19	1
1701	Lake Timiskaming	ON		5.3	359	386	0.25	0.42	232	677	24	1
1719	Kanetogama Lake	MN		4.1	410	453	0.22				4	
1719	Rainy Lake	MN		4.1	400	442	0.23				4	
1736	Lake Nipissing	ON		4.3	385	423	0.24	0.66	2497	694	17	1
1744	Upper Red Lake (1990s)	MN		3.5	420	473	0.22				4	
1751	French River	ON		4.5	429	468	0.22	0.39	2191	725	21	1
1757	Pickerel River	ON		4.0	423	468	0.22	0.29	248	721	16	1
1765	Lake of the Woods	MN		4.8	471	511	0.20				4	
1770	Mindemoya Lake	ON		3.8	341	380	0.27	0.29	524	640	19	1
1801	Upper Red Lake (1980s)	MN		3.8	409	456	0.23				4	
1804	Ottawa-Holden Lake	ON		4.3	413	452	0.23	0.39		739	18	1
1828	Lac Aux Sangsues	QC		4.9	408	441	0.24	0.49	1216	770	22	2
1870	Mille Lacs	MN		3.9	443	492	0.22				4	
1900	Escanaba Lake	WI		4.4	419	459	0.24	0.63		488	7	3
1918	Winnibigoshish Lake	MN		3.6	428	481	0.24				4	
1924	Leech Lake	MN		4.3	446	489	0.23	0.46			4	
1955	Ottawa-Allumette Lake	ON		4.7	387	420	0.26	0.47		606	16	1
2036	Rice Lake	ON		3.9	428	476	0.25	0.47	618	689	13	1
2123	Lake Winnebago	WI		3.7	391	438	0.28			536	8	3
2327	Pymatuning Reservoir	PA	S	2.0	334	420	0.35	0.45		625	10	6
2400	Pool 2	MN		4.7	516	561	0.24				4	
2857	Kirwin Reservoir	KA		2.0	407	512	0.35	0.90	202	601	5	5
2862	Lovewell Reservoir	KA		2.0	415	521	0.34	0.72	770	642	8	5
2973	Webster Reservoir	KA		2.0	448	563	0.33	0.52	155	666	7	5

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3046	Cedar Bluff Reservoir	KA	2.0	412	518	0.36	0.78	354	673	7	5
3061	Glen Elder Reservoir	KA	2.0	417	523	0.36	0.88	1882	702	8	5
3194	Wilson Reservoir	KA	2.0	435	547	0.36	0.76	309	652	8	5
3358	Marion Reservoir	KA	2.0	414	520	0.39	0.54	747	624	8	5
3378	Cheney Reservoir	KA	2.0	385	484	0.42	0.61	307	617	8	5
3502	Center Hill Reservoir	TN	2.2	419	513	0.40			715	8	3
3600	Current River	MO	2.4	364	438	0.46			704	9	3
3690	Lake Meredith	TX	2.3	423	513	0.42			563	7	3