Fish Community Characteristics in Waneta and Lamoka Lakes, October 2003–October 2009, after Herbicide Treatments of Aquatic Macrophytes in April 2003 and June 2008

Final Report

for

The Lamoka-Waneta Lakes Association
P.O. Box 55
Tyrone, NY 14887

by

James M Haynes

Department of Environmental Science and Biology
The College at Brockport
State University of New York
350 New Campus Drive
Brockport, NY 14420-2973

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Introduction

Located southeast of Keuka Lake in west-central New York, Lamoka and Waneta Lakes are shallow, productive and support abundant warmwater fishes (Figure 1). An approximately 0.5-mile channel connects the southern end of Waneta Lake to the northwestern end of Lamoka Lake, and likely accounts for the similarity in the lakes' fish assemblages. An impoundment at the southern end of Lamoka Lake (on Mud Creek) produced the benthic and near-shore topography present in both lakes. Lamoka and Waneta Lakes possess large, shallow water areas providing habitat for extensive aquatic macrophyte growth. Lamoka Lake covers 826 acres (including Mill Pond at its southern end) with 11.3 miles of shoreline (Fagan Engineers 1997). Approximately 55% of the total lake surface area supports rooted aquatic plants, with 96% of this area sustaining dense growth (Madsen et al. 2001). Waneta Lake covers 781 acres with 6.8 miles of shoreline (Fagan Engineers 1997). Of the lake surface area, 34% can support rooted aquatic vegetation, with 89% of this area sustaining dense growth (Madsen et al. 2001).

Before 2003 both lakes had extensive beds of Eurasian watermilfoil (*Myriophyllum spicatum*, EWM), an invasive exotic aquatic macrophyte forming prolific, dense beds that suppress native plant communities and impair recreational use of waterways (Johnson et al. 2000, Madsen et al. 2001). In 1986 an aquatic vegetation control program, chiefly physical harvesting, was implemented to reduce the EWM problem. A combination of questionable control effectiveness (Fagan Engineers 1997) and the end of funding by New York State in 1995 led to cessation of harvesting. By 2000, EWM covered approximately 77% of the littoral area of Lamoka Lake or nearly 43% of the total lake area. Similar trends were observed for Waneta Lake, where EWM occupied 80% of the lake's littoral area or 27% of the total lake area (ENSR International 2001).

In 2002, the NY Department of Environmental Conservation issued a permit for treatment of Waneta Lake in April 2003 with the herbicide fluridone (Sonar®). After isolation with a plastic curtain, Fleet Cove in Lamoka Lake was treated with fluridone in May 2005. Fluridone was used to reduce EWM in hope of encouraging re-establishment of the native plant community from a presumed seed bank on the bottom of Waneta Lake, but by 2007 EWM had fully returned to the littoral zone of Waneta Lake and to Fleet Cove in Lamoka Lake.

In the spring of 2008 and 2009, Schuyler County received permits to spot treat EWM in both lakes with the herbicide triclopyr (Renovate®). The June 2008 the densest growths of EWM were treated: 111.1 acres in Waneta Lake (43.5% of the littoral area) and 152.2 acres in Lamoka Lake (65.5% of the littoral area). In May 2009 less dense EWM growth areas were treated: 104.7 acres in Waneta Lake (41.1% of the littoral area) and 322.2 acres in Lamoka Lake, the Mud Creek Channel between the lakes and Mill pond at the southern end of Lamoka Lake (76.7% of the littoral area).

EWM has been held in check since 2008. In 2010, only three of 138 sampling points on Waneta Lake and four of 180 sampling points on Lamoka Lake had EWM, all at trace levels. Submerged aquatic vegetation (SAV) densities in Lamoka Lake have decreased from their highest levels while densities of native SAV in Waneta Lake, particularly southern naiad (*Najas guadalupensis*) and waterweed (*Elodea* spp.), have increased dramatically (personal communication, D. Fagan, Fagan Engineers, Elmira, NY).

To assess potential changes in the fish community of Waneta and Lamoka Lakes after the herbicide treatments in 2003 and 2008, SUNY Brockport and NYDEC conducted electro-fishing surveys in both lakes from May 2003 through October 2009 (Haynes 2005, 2006, 2008, 2010). This is the final report for the 8-year project.

Objectives

Fish sampled in October from 2003-2009 were analyzed by lake and year for the purpose of evaluating whether biological data (age, length, weight) or fishery statistics (Kr, Wr) changed as a consequence of the herbicide applications in 2003 and 2008. If the fish community was adversely affected by the herbicide applications, it was hypothesized that three changes might be observed.

1. Short-term: older average ages due to less aquatic macrophyte cover to shelter for young-of-the-year (YOY) fish from predators.
2. Long-term: smaller sizes (slower growth) due to less aquatic macrophyte habitat for invertebrate food supplies.
3. Long-term: younger ages and smaller sizes (length and weight) of non-YOY fish due to fewer places to hide from angling pressure.

Methods

Sampling

Using the standard NYDEC protocol for warmwater fisheries (Green et al. 1986), NYDEC and SUNY Brockport electro-fishing boats conducted one night of tandem surveys in each lake during the first or second week of October, 2003-2009. In the field, each fish was measured (TL, mm) and weighed (g). A scale sample for age determination was taken from a subset of the fish captured. Standard fishery statistics (Kr, Wr) were computed (M. J. Sanderson, NYDEC, Avon, NY) according to Willis and Hubert (1996). Fish ages were determined from magnifications of acetate impressions of scales by NYDEC staff.

Fishery statistics

Relative condition (Kr) is a measure of how a fish's actual weight compares to its weight as predicted from its length based on the weight-length relationship computed for a sample of its population ($Kr = W/aL^n$, where W = weight of the fish, L = length of the fish, a = a constant, and n = an exponent ~2-3 relating length to weight). Values of Kr >1 or <1 suggest that a fish is plumper or thinner, respectively, than a typical fish of that length in the sampled population.

Relative weight (Wr) is a measure of how a fish's weight compares to the standard weight (Ws) of fish its age in populations across the species' range ($Wr = W/Ws * 100$, where W = weight of the fish and Ws = weight of the 75^{th} percentile fish of the same age across the species' range). Values of Wr >>100 or <<100 suggest problems with food or feeding relationships or that fish are not making best use of available prey, respectively.

Statistical procedures

Non-parametric Kruskal-Wallis (KW) tests were used to evaluate five variables (length, weight, Kr, Wr, age) by year within each lake because most of the data were not normally distributed or had unequal variances among treatments (e.g., lake, year), or because there were low or no catches of some species in some years (brown bullhead, pumpkinseed) or lakes (chain pickerel, smallmouth bass). General Linear Models (GLM) were run for the

species caught in sufficient numbers in both lakes in all years (bluegill, largemouth bass, yellow perch); lengths and weights were log (N)-transformed before analysis by GLM. All analyses (Statistix 2003) were followed by Tukey's Honest Significant Difference tests to distinguish among treatments (two lakes, seven years) using an experiment-wise error rate ($\alpha = 0.05/5$ statistical tests of the five fishery parameter per species evaluated). Biologically meaningful differences were inferred when the difference between the highest and lowest mean in a treatment group (lake or year) exceeded 50% (Karban and Huntzinger 2006) and a year's 25-75 percentile distribution on a box and whiskers diagram was visibly different from other years.

Results and Discussion

Catch per unit effort (CPUE)

Adjusted for CPUE, 4,375 and 4,665 fish were caught in Waneta (625 $\pm$ 73 fish/h/year) and Lamoka Lakes (666 $\pm$ 83 fish/h/year), respectively (mean $\pm$ SEM), during October 2003-2009 (Table 1, Figure 2). There were no significant differences (GLM) in CPUE between lakes ($P = 0.689$) and years ($P = 0.308$).

Length, weight, Kr, Wr and age

Chain pickerel (*Esox niger*, Lamoka Lake only)—. There were no biologically meaningful or statistically significant differences in age and length of chain pickerel among years (Table 2, Figure 3 a-b). There were statistically significant differences in weight, Kr and Wr among years but these differences were biologically meaningful only for weight (Table 2), which was higher in 2003 and 2005 than in 2007 and 2008 (Table 2, Figure 3c). These data give no indication of an adverse effect of the herbicide treatment in June 2008 on chain pickerel. If Fleet Cove is an important nursery area for chain pickerel, a possible adverse effect after its treatment with fluridone in 2005, as indicated by older and larger fish (Figure 3a-c), cannot be ruled out (see hypotheses 1 and 2 above).

Smallmouth bass (*Micropterus dolomieu*, Waneta Lake only)—. There were statistically significant differences in age, length, weight, Kr and Wr for smallmouth bass but biological differences were meaningful only for age, length and weight (Table 3). The data suggest that age, length and weight were greater in 2003 than in other years (Figure

3 f-h). The data do not indicate an effect of the herbicide treatment in 2008 but smallmouth bass were older and larger in October 2003, after herbicide treatment the previous April, than in other years. Younger and smaller fish, including many YOY suggesting a strong year class, were caught in 2004. Aquatic macrophytes were absent in both years; therefore, this difference cannot be attributed to the fluridone treatment.

Brown bullhead (*Ameiurus nebulosus*)—. Except possibly for weight in Waneta Lake, there were no biologically meaningful or statistically significant differences in length, weight, Kr and Wr of brown bullhead among years in Lamoka and Waneta Lakes (Tables 4a,b; Figure 4). The extreme values of mean weight in Waneta Lake occurred in 2007 and 2008, both with sample sizes of five weighed fish (Table 4b); therefore, these data have questionable biological meaning. Having no scales, brown bullhead were not aged. These data do not suggest an effect of the herbicide treatments in 2003 and 2008.

Pumpkinseed (*Lepomis gibbosus*)—. In Lamoka Lake, only weight and possibly length had biologically meaningful and statistically significant differences (Table 5a). Pumpkinseed were significantly smaller but not younger in 2008 than in 2003 (Figure 5 a-c), potentially consistent with hypotheses 1 and 2 above; however, there were no significant differences in weight among 2004, 2006, 2007, 2008 and 2009.

In Waneta Lake, there were biologically meaningful and statistically significant differences for length, weight, Kr, Wr and age among years (Table 5b); 2007 stood out with much younger and smaller fish than the other years (Figure 5 f-g). Many YOY and no age 4 or older pumpkinseed were caught in 2007. These data do not suggest adverse effects of the herbicide treatments in 2003 and 2008.

Bluegill (*Lepomis macrochirus*)—. In Lamoka Lake, length, weight, Kr and Wr had statistically significant differences but only the differences in Kr and Wr among years were biologically meaningful (Table 6a). Significant differences in Kr and Wr were due to their high variability in 2003 vs. the other years (Figure 6d-e).

In Waneta Lake, length, weight, Kr and Wr also had statistically significant differences but only the differences in weight among years were biologically meaningful (Table 6b). Bluegill in Waneta Lake appeared to be somewhat older and larger in 2004 than in other years (Figure 6f-h), possibly suggesting weak recruitment by 2003 YOY. Also, no YOY

were sampled in 2004. The results for 2003 and 2004 in Waneta Lake are consistent with hypotheses 1 and 2 above.

Because bluegill were abundant in both lakes in all years, a GLM could also be used analyze the data. While several of length, weight, Kr, Wr and age were statistically significant for lakes or years, none of the differences were biologically meaningful (Table 6c). Because the GLM is a more powerful analysis than the Kruskal-Wallis for Waneta Lake only (Table 6b), these data do not suggest adverse effects of the herbicide treatments in 2003 and 2008 (Figure 6a-c, f-h).

Largemouth bass (*Micropterus salmoides*)—. In Lamoka Lake there were statistically significant differences among years for length, weight, Kr, Wr and age but only the differences in length, weight and possibly age were biologically meaningful (Table 7a); values for length and weight in 2005 were higher than in most other years (Figure 7b-c).

In Waneta Lake there were statistically significant differences in length, weight, Kr, Wr and age, and the differences were biologically meaningful for length, weight and age (Table 7b). Captured fish became younger and smaller between 2003-2005 and 2006-2009, especially in 2009 when many YOY and age 1 and few older fish were captured (Figure 7f-h).

Largemouth were abundant in both lakes in all years, so a GLM could also be used analyze the data. Differences between lakes were statistically significant for length, weight and age and biologically meaningful for length and weight. Differences among years were statistically significant for length, weight and age and biologically meaningful for length, weight and perhaps age (Table 7c). In general, largemouth bass were larger and older in Lamoka Lake than in Waneta Lake and they became smaller and younger from 2003-2009. These data do not suggest adverse effects from herbicide treatments in 2003 and 2008 but perhaps a steady increase in fishing pressure on largemouth bass. There is no recreational fishing survey data to document this hypothesis.

Yellow perch (*Perca flavescens*)—. In Lamoka Lake there were statistically significant differences in length, weight, Kr, Wr and age and biologically meaningful differences in weight, age and possibly length and Kr (Table 8a). Age, length and weight declined from 2003-2005 to 2006-2009 (Figure 8a-c), and Kr and Wr have shown downward trends from 2003-2009 (Figure 8d-e).

In Waneta Lake there were statistically significant differences in length, weight, Kr, Wr and age and biologically meaningful differences in weight, age and possibly length (Table 8b). Length, weight and age declined from 2003-2005 then rose from 2006-2009 (Figure 8f-h). Kr and Wr remained stable from 2003-2008 then rose in 2009 (Figure 8i-j).

Because yellow perch were common in both lakes in most years, a GLM could also be used analyze the data. Differences between lakes were statistically significant for length and weight and biologically meaningful for weight (Table 8c). Differences among years were statistically significant for length, weight and age and biologically meaningful for length, weight and perhaps age (Table 8c). Yellow perch were longer and heavier but not older in Waneta Lake than in Lamoka Lake (Table 8c), perhaps due to better conditions for growth in Lamoka Lake or poor conditions for recruitment in Waneta Lake. Because the patterns of age, length and weight in each lake were similar from 2003-2004 (Figure 8a-c, f-h), it is not clear that the herbicide treatment of only Waneta Lake in 2003 had an effect; however, no YOY were captured in Waneta Lake in 2003, consistent with hypotheses 1 and 2 above and, perhaps, a hypothesis of poor spawning substrate (aquatic macrophytes) after the treatment with fluridone.

General discussion

These data provide no evidence to support the hypothesis that the triclopyr treatment in June 2008 and little evidence to support the hypothesis that the fluridone treatment in 2003 had adverse effects on the seven abundant fish species examined. Depending on the species, few YOY or high values for age, length or weight in October 2003 (or October 2005 in the case of chain pickerel in Lamoka Lake) compared to the other years could be attributed either to the effects of fluridone or to natural factors on fluctuations in year class strength.

Unlike the other years, YOY chain pickerel were not sampled in Lamoka Lake in 2005, suggesting that the fluridone treatment of Fleet Cove could have had an effect in 2005 if it is an important spawning or nursery area for chain pickerel. Smallmouth bass were older and larger in Waneta Lake in October 2003 (no YOY) than in other years; however, smallmouth bass were younger and smaller in 2004 (many YOY) than in all years but 2007. There were no aquatic macrophytes in either 2003 or 2004, so the difference in YOY smallmouth bass abundance cannot be attributed to the fluridone treatment.

No changes in age, length and weight associated with the treatment of Waneta Lake with fluridone in 2003 were apparent for brown bullhead, pumpkinseed, bluegill and largemouth bass. However, there was a pronounced trend toward younger and smaller largemouth bass in Lamoka Lake, and to a lesser extent in Waneta Lake, from 2003-2009. These data suggest potentially heavy recreational angler exploitation of larger fish, not herbicide treatments as a cause.

Yellow perch had opposite trends in the two lakes. In Lamoka Lake ages, lengths and weights trended down from 2003-2005 to 2006-2009, while in Waneta Lake, with small sample sizes, they trended down from 2003-2006 and back up from 2007-2009. Neither trend can be associated with the herbicide treatments in 2003 and 2008.

Conclusions

1. These data provide no evidence that the treatment of Waneta and Lamoka Lakes with triclopyr in June 2008 had adverse effects on seven common fish species.
2. These data may provide weak evidence for an adverse effect of the fluridone treatment on chain pickerel in Lamoka Lake (Fleet Cove, 2005) and yellow perch in Waneta Lake (2003); however, the absence of similar effects on other species and no treatment of Lamoka Lake in 2003 for comparison leave open the possibility of natural causes for few YOY caught.
3. There were no significant differences in total fish CPUE between lakes and among years during the study.
4. Because sample sizes were large (mostly >20 fish per species per lake and year), the statistical reliability of the results presented here is high. The analyses were extremely sensitive to Type II errors (finding no significant differences among treatments when there were) and magnified the potential for Type I errors (mistakenly finding significant differences among treatments).
5. Taken together with the previous reports arising from this project (Haynes 2005, 2006, 2008, 2010), there is little evidence to suggest biologically meaningful short-term impacts and no evidence to suggest any long-term impacts of the herbicide treatments of Waneta and Lamoka Lakes on the seven most abundant species of fish.

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Tables 1-8

Significance levels

Bold = $P < 0.05$

Italics = $0.01 < P < 0.05$ (suggestion of statistical significance)

NS = no statistically significantly difference

Table 1. Electrofishing catches in Waneta and Lamoka Lakes, October 2003-2009 (CPUE = N/hours fished).

Waneta Lake		DEC	2003		2004		2005		2006[1]		2007[2]		2008		2009	
Common Name	**Scientific Name**	**Code**	**N**	**CPUE**	**N**	**CPUE**	**N**	**CPUE**	**N**	**CPUE**	**N**	**CPUE**	**N**	**CPUE**	**N**	**CPUE**
Alewife	*Alosa pseudoharengus*	289	36	36.0	20	20.0	230	230.0	224	224.0	44	44.0	56	56.0	5	10.0
Muskellunge[3]	*Esox masquinongy*	348	5	2.5	16	7.1	12	5.2	2	0.8	9	3.6	1	0.4	6	12.0
Chain pickerel	*Esox niger*	349	9	4.5	5	2.2	6	2.6	2	0.8	3	1.2	6	2.7	2	4.0
Common carp[4]	*Cyprinus carpio*	365	2	2.0	0	0.0	1	1.0	0	0.0	0	0.0	2	2.0	0	0.0
Golden shiner	*Notemigonus crysoleucas*	377	9	9.0	10	10.0	13	13.0	14	14.0	9	9.0	63	63.0	3	6.0
Bluntnose minnow	*Pimephales notatus*	400	11	11.0	32	32.0	190	190.0	39	39.0	58	58.0	94	94.0	0	0.0
Common shiner	*Notropis cornutus*	385	0	0.0	5	5.0	0	0.0	24	24.0	0	0.0	0	0.0	0	0.0
Spottail shiner	*Notropis hudsonius*	390	10	10.0	12	12.0	73	73.0	9	9.0	20	20.0	16	16.0	16	32.0
Mimic shiner	*Notropis volucellus*	397	10	10.0	0	0.0	0	0.0	10	10.0	0	0.0	0	0.0	6	12.0
White sucker	*Catostomus commersoni*	419	2	4.0	1	1.0	1	1.0	0	0.0	5	5	6	6	1	2
Brown bullhead	*Ameirus nebulosus*	444	37	37.0	2	2.0	0	0.0	12	12.0	7	7.0	34	34.0	15	30.0
Rock bass	*Ambloplites rupestris*	591	17	17.0	2	2.0	13	13.0	3	3.0	15	15.0	43	43.0	41	82.0
Pumpkinseed	*Lepomis gibbosus*	596	105	105.0	79	79.0	56	56.0	16	16.0	26	26.0	25	25.0	50	100.0
Bluegill	*Lepomis macrochirus*	598	229	229.0	194	194.0	237	237.0	100	100.0	129	129.0	160	160.0	216	434.0
Smallmouth bass	*Micropterus dolomieu*	600	25	12.5	27	12.0	35	15.0	46	18.4	27	10.8	48	21.3	75	47.2
Largemouth bass	*Micropterus salmoides*	601	55	27.5	70	31.1	102	43.8	74	29.6	331	132.4	480	213.3	179	112.6
Black crappie	*Pomoxis nigromaculatus*	603	5	5.0	2	2.0	12	12.0	9	9.0	4	4.0	1	1.0	2	4.0
Tesselated darter	*Etheostoma olmstedi*	614	0	0.0	1	1.0	86	86.0	29	29.0	35	35.0	29	29.0	4	8.0
Yellow perch	*Perca flavescens*	617	9	4.5	5	2.2	12	5.2	7	2.8	32	12.8	16	7.1	10	6.3
Other species			5	2.5	3	0.0	4	0.0	2	0.0	3	1.2	1	0.4	3	6.0
	Total Captured		581	529.0	486	414.7	1083	983.7	622	541.4	757	514.0	1081	774.3	634	908.0

[1]Of the muskellunge caught, all but one was a fingerling stocked the previous week.

[2]Includes three redbreast sunfish, *Lepomis auritus* (only year captured during the study).

[3]In Waneta Lake, several more large muskellunge were observed avoiding the electrical field out of netting range in most years.

[4]More carp than reported here were observed, but to save live well space they were not netted and recorded.

Table 1 continued.

Lamoka Lake			2003[5]		2004		2005		2006		2007[6]		2008		2009	
Common Name	**Scientific Name**	**DEC Code**	**N**	**CPUE**	**N**	**CPUE**	**N**	**CPUE**	**N**	**CPUE**	**N**	**CPUE**	**N**	**CPUE**	**N**	**CPUE**
Alewife	*Alosa pseudoharengus*	289	40	40.0	1	1.0	6	12.0	16	16.0	11	8.8	18	18.0	0	0.0
Muskellunge	*Esox masquinongy*	348	0	0.0	0	0.0	0	0.0	1	0.4	0	0.0	0	0.0	0	0.0
Chain pickerel	*Esox niger*	349	60	30.0	81	36.0	14	11.2	84	33.6	64	23.3	80	29.1	28	17.7
Common carp[4]	*Cyprinus carpio*	365	2	1.0	1	1.0	0	0.0	0	0.0	0	0.0	2	2.0	0	0.0
Golden shiner	*Notemigonus crysoleucas*	377	28	28.0	9	9.0	42	84.0	22	22.0	10	8.0	7	7.0	14	18.7
Bluntnose minnow	*Pimephales notatus*	400	2	2.0	16	16.0	0	0.0	5	5.0	20	16.0	1	1.0	7	9.3
Common shiner	*Notropis cornutus*	385	0	0.0	13	13.0	0	0.0	6	6.0	0	0.0	0	0.0	0	0.0
Spottail shiner	*Notropis hudsonius*	390	0	0.0	0	0.0	3	6.0	0	0.0	79	63.2	0	0.0	0	0.0
Mimic shiner	*Notropis volucellus*	397	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
White sucker	*Catostomus commersoni*	419	0	0.0	2	2.0	1	1.0	0	0.0	1	0.8	1	1	1	1.3
Brown bullhead	*Ameirus nebulosus*	444	20	20.0	9	9.0	7	14.0	3	3.0	19	15.2	4	4.0	14	18.7
Rock bass	*Ambloplites rupestris*	591	9	9.0	9	9.0	7	14.0	2	2.0	3	2.4	5	5.0	8	10.7
Pumpkinseed	*Lepomis gibbosus*	596	43	43.0	39	39.0	2	4.0	54	54.0	70	56.0	39	39.0	55	73.3
Bluegill	*Lepomis macrochirus*	598	374	374.0	319	319.0	123	246.0	332	332.0	250	200.0	290	290.0	575	766.7
Smallmouth bass	*Micropterus dolomieu*	600	0	0.0	1	0.4	4	3.2	1	0.4	4	1.5	9	3.3	4	2.5
Largemouth bass	*Micropterus salmoides*	601	91	45.5	140	62.2	79	63.2	176	70.4	295	107.3	97	35.3	115	72.8
Black crappie	*Pomoxis nigromaculatus*	603	6	6.0	8	8.0	2	4.0	9	9.0	5	4.0	1	1.0	10	13.3
Tesselated darter	*Etheostoma olmstedi*	614	1	1.0	0	0.0	0	0.0	2	2.0	3	2.4	1	1.0	3	4.0
Yellow perch	*Perca flavescens*	617	27	27.0	108	48.0	9	7.2	143	57.2	158	57.5	73	26.6	44	27.9
Other species			14	14.0	5	5.0	0	3.0	6	0.0	4	0.8	1	1.0	2	2.6
	Total Captured		717	640.5	761	577.7	299	472.8	862	613.0	996	567.0	629	464.2	880	1039.5

[5]Includes one creek chubsucker, *Erimyzon oblongatus* (only year captured during the study)
[6]Includes 15 highfin carpsuckers, *Carpiodes velifer* (only year captured during the study); identification uncertain: could be quillback carpsuckers, *Carpiodes cyprinus*

Table 2. Chain Pickerel: Lamoka Lake (length, weight, Kr, Wr and age)
(too few were caught in Waneta Lake for analysis).

Length						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	43	356.3	19.0	*0.015*	*NS*	35%
2004	72	295.7	12.0			
2005	14	385.4	17.2			
2006	62	306.3	14.9			
2007	64	291.5	16.1			
2008	80	298.6	14.3			
2009	28	284.8	21.3			

Weight						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	43	350.8	48.6	**0.0008**	**2005=2003=2006=2004=2009;**	**94%**
2004	72	194.3	21.5		**2006=2004=2009=2008=2007;**	
2005	14	356.5	50.5		**2005=2003>2007=2008**	
2006	62	229.3	26.6			
2007	64	183.5	23.4			
2008	74	188.5	22.6			
2009	24	197.3	40.0			

Kr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	38	0.577	0.011	**<0.0001**	**2007<rest**	21%
2004	72	0.540	0.001			
2005	14	0.574	0.012			
2006	62	0.543	0.001			
2007	64	0.476	0.001			
2008	74	0.513	0.012			
2009	23	0.547	0.020			

Wr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	38	94.0	2.2	**0.0037**	**Relationships cannot be interpreted**	14%
2004	72	91.9	1.6			
2005	14	90.5	2.0			
2006	62	92.1	1.2			
2007	64	82.2	1.9			
2008	74	88.9	2.3			
2009	23	93.0	3.3			

Table 2 continued

Age						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	51	2.5	0.2	0.0667	NS	44%
2004	66	1.8	0.2			
2005	15	2.6	0.2			
2006	68	2.2	0.2			
2007	57	1.8	0.2			
2008	26	2.1	0.2			
2009	26	2.0	0.2			

Table 3. Smallmouth bass: Waneta only (length, weight, Kr, Wr and age) (too few were caught in Lamoka Lake for analysis).

Length

Year	N	Mean	SE	P	Result	Maximum Difference
2003	17	280.9	26.8	**<0.0001**	**2003=2009=2008=2006=2005; 2006=2005=2004=2007; 2003=2009=2008>2004=2007**	**84%**
2004	26	160.8	21.3			
2005	35	220.8	13.5			
2006	45	224.6	10.2			
2007	27	152.7	18.9			
2008	48	237.0	11.9			
2009	75	256.7	9.5			

Weight

Year	N	Mean	SE	P	Result	Maximum Difference
2003	17	384.2	86.7	**<0.0001**	**2003=2009=2008=2006=2005; 2008=2006=2005=2004; 2006=2005=2004=2007 2003=2009>2004=2007; 2008>2007**	**196%**
2004	21	172.0	60.8			
2005	33	199.2	50.4			
2006	43	195.1	24.3			
2007	26	130.0	44.5			
2008	47	239.3	30.1			
2009	74	313.5	32.5			

Kr

Year	N	Mean	SE	P	Result	Maximum Difference
2003	15	1.282	0.023	*0.0262*	*Relationships cannot be interpreted*	15%
2004	21	1.243	0.032			
2005	33	1.315	0.024			
2006	43	1.299	0.050			
2007	26	1.279	0.050			
2008	47	1.264	0.022			
2009	74	1.426	0.042			

Wr

Year	N	Mean	SE	P	Result	Maximum Difference
2003	15	91.5	3.3	**0.0085**	**Relationships cannot be interpreted**	13%
2004	21	98.5	2.7			
2005	33	97.0	2.2			
2006	43	94.6	1.9			
2007	26	102.5	2.4			
2008	47	91.1	1.8			
2009	74	101.8	3.2			

Table 3 continued.

Age						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	24	3.6	0.4	**0.0006**	**Relationships cannot be interpreted**	**125%**
2004	18	1.6	0.5			
2005	34	2.2	0.3			
2006	46	2.1	0.2			
2007	19	1.6	0.5			
2008	46	2.5	0.3			
2009	3	3.3	0.9			

Table 4a. Brown bullhead: Lamoka Lake (length, weight, Kr and Wr) (insufficient sample size in 2006; no age data).

Length						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	20	267.6	7.5	0.718	NS	11%
2004	9	266.8	38.1			
2005	7	274.3	3.6			
2007	19	247.3	14.4			
2008	5	254.2	21.8			
2009	14	266.4	14.4			
Weight						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	20	251.4	18.3	0.683	NS	13%
2004	8	240.4	117.1			
2005	7	271.1	12.2			
2007	21	245.5	22.1			
2008	3	261.7	7.7			
2009	12	271.9	32.2			
Kr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	19	1.288	0.030	0.163	NS	30%
2004	8	1.157	0.085			
2005	7	1.311	0.038			
2006	nc					
2007	21	1.229	0.051			
2008	3	1.030	0.110			
2009	12	1.336	0.061			
Wr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	19	244.8	5.2	0.181	NS	39%
2004	8	219.3	15.7			
2005	7	246.2	7.4			
2006	nc					
2007	21	232.5	8.6			
2008	3	189.4	21.6			
2009	12	262.7	18.6			

Table 4b. Brown bullhead: Waneta Lake (length, weight, Kr and Wr) (insufficient sample size in 2004; no age data).

Length						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	26	257.9	6.5	0.146	NS	14%
2005	22	293.9	9.5			
2006	12	272.8	8.7			
2007	7	267.0	34.4			
2008	34	263.8	14.0			
2009	15	258.1	17.2			
Weight						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	26	236.4	16.5	*0.012*	*NS*	**133%**
2005	22	373.3	38.4			
2006	12	271.4	23.6			
2007	5	379.0	84.4			
2008	5	162.8	79.5			
2009	15	262.0	46.8			
Kr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	26	1.321	0.025	0.643	NS	5%
2004	nc					
2005	22	1.347	0.034			
2006	12	1.311	0.042			
2007	5	1.356	0.050			
2008	5	1.286	0.039			
2009	14	1.391	0.054			
Wr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	26	254.1	5.6	0.673	NS	7%
2004	nc					
2005	22	247.6	5.0			
2006	12	247.5	9.1			
2007	5	248.6	6.8			
2008	5	264.2	11.4			
2009	14	272.2	13.1			

Table 5a. Pumpkinseed: Lamoka Lake (length, weight, Kr, Wr and age).

Length						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	33	125.2	4.8	**<0.0001**	**Relationships cannot be interpreted**	*53%*
2004	31	131.2	6.1			
2006	30	130.6	4.9			
2007	57	132.6	3.2			
2008	39	109.4	5.2			
2009	52	141.5	4.1			

Weight						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	33	64.5	4.8	**0.005**	**2003=2009=2004=2006=2007;**	**76%**
2004	30	55.6	6.7		**2009=2004=2006=2007=2008;**	
2006	30	50.3	5.4		**2003>2008**	
2007	56	48.2	3.2			
2008	31	36.7	6.3			
2009	37	55.3	4.9			

Kr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	17	2.168	0.120	0.101	NS	19%
2004	30	2.005	0.038			
2005	nc					
2006	30	1.984	0.044			
2007	56	1.904	0.050			
2008	31	1.973	0.090			
2009	38	2.256	0.412			

Wr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	17	101.8	5.1	*0.026*	*2004=2003=2006=2008=2007;*	16%
2004	30	96.1	1.9		*2003=2006=2008=2007=2009;*	
2005	nc				*2004>2009*	
2006	30	94.8	2.0			
2007	56	90.7	2.4			
2008	31	98.6	4.9			
2009	38	105.6	18.9			

Age						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	23	3.1	0.3	0.289	NS	35%
2004	27	3.3	0.3			
2006	34	3.2	0.2			
2007	33	3.3	0.2			
2008	24	2.6	0.3			
2009	32	3.5	0.3			

Table 5b. Pumpkinseed: Waneta Lake (length, weight, Kr, Wr and age).

Length						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	54	141.3	3.4	**<0.0001**	**2004=2005=2003=2006;**	**106%**
2004	43	153.7	2.1		**2005=2003=2006=2008;**	
2005	39	143.0	3.9		**2006=2008=2009=2005; 2009=2007**	
2006	16	131.8	8.8		**2007<2008=2006=2003=2005=2004;**	
2007	26	74.5	6.9		**2004>2008=2009=2007**	
2008	25	119.1	6.5			
2009	50	116.9	2.9			

Weight						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	54	61.8	3.1	**<0.0001**	**2004=2005=2003=2006;**	**133%**
2004	42	77.8	2.8		**2005=2003=2006=2008=2009;**	
2005	33	67.1	4.0		**2006=2008=2009=2007**	
2006	15	54.3	8.5		**2007<2003=2005=2004;**	
2007	11	28.8	11.7		**2007<2003=2005=2004**	
2008	21	55.1	7.1			
2009	50	53.9	3.6			

Kr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	52	2.034	0.021	**<0.0001**	**2009=2008; 2008=2004=2005=2003;**	**101%**
2004	42	2.078	0.026		**2004=2005=2003=2006=2007;**	
2005	33	2.094	0.046		**2009>2004=2005=2003>2006=2007;**	
2006	15	1.947	0.051		**2008>2006=2007**	
2007	11	1.639	0.140			
2008	21	2.368	0.103			
2009	50	3.296	0.103			

Wr

Year	N	Mean	SE	P	Result	Maximum Difference
2003	52	95.7	1.1	**<0.0001**	**Relationships cannot be interpreted**	**93%**
2004	42	95.2	1.3			
2005	33	97.9	2.2			
2006	15	93.4	2.2			
2007	11	84.3	6.3			
2008	21	113.8	5.4			
2009	50	162.4	8.3			

Age

Year	N	Mean	SE	P	Result	Maximum Difference
2003	28	3.1	0.3	**<0.0001**	**2004=2006=2005=2003=2008=2009;**	**333%**
2004	20	3.9	0.3		**2008=2009=2007;**	
2005	29	3.3	0.2		**2004=2006=2005=2003>2007**	
2006	17	3.5	0.4			
2007	12	0.9	0.4			
2008	19	2.8	0.3			
2009	18	2.7	0.3			

Table 6a. Bluegill: Lamoka Lake (length, weight, Kr, Wr and age).

Length						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	166	116.7	2.5	**<0.0001**	**Relationships cannot be interpreted**	23%
2004	130	105.1	3.7			
2005	117	128.0	2.9			
2006	153	129.0	2.6			
2007	182	127.5	2.5			
2008	289	120.6	2.3			
2009	576	115.7	1.6			

Weight						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	166	48.6	2.7	**<0.0001**	**2004<rest**	38%
2004	108	38.7	3.9			
2005	107	53.3	3.4			
2006	139	49.3	2.7			
2007	180	45.8	2.5			
2008	245	48.8	2.8			
2009	261	52.6	2.0			

Kr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	167	2.761	0.146	**<0.0001**	**2005=2006=2003>**	**59%**
2004	108	1.771	0.030		**2008=2007=2004=2009**	
2005	107	2.032	0.029			
2006	139	1.920	0.019			
2007	180	1.761	0.023			
2008	244	1.830	0.022			
2009	260	1.733	0.019			

Wr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	167	149.5	8.5	**<0.0001**	**2005=2003=2006; 2003=2006=2004:**	**71%**
2004	108	97.3	1.7		**2006=2004=2008; 2004=2008=2007;**	
2005	107	103.9	1.6		**2007=2009;**	
2006	139	98.6	1.1		**2005>2004=2008>2007=2009**	
2007	180	90.7	1.2			
2008	244	95.7	1.3			
2009	260	87.5	1.0			

Table 6a continued.

Age						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	37	3.1	0.2	0.584	NS	30%
2004	57	3.2	0.3			
2005	25	3.5	0.4			
2006	51	3.3	0.3			
2007	45	3.1	0.2			
2008	54	3.0	0.2			
2009	63	2.7	0.2			

Table 6b. Bluegill: Waneta Lake (length, weight, Kr, Wr and age).

Length						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	143	125.0	3.2	**<0.0001**	**2004>rest;**	42%
2004	111	153.8	2.9		**2005=2007=2003=2008=2006;**	
2005	123	125.1	4.6		**2008=2006=2009;**	
2006	80	109.0	4.5		**2005=2007=2003>2009**	
2007	129	124.2	4.4			
2008	145	118.6	4.4			
2009	216	108.3	2.0			
Weight						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	143	46.5	3.0	**<0.0001**	**2004=2008=2007; 2008=2007=2005;**	**99%**
2004	93	77.6	2.9		**2007=2005=2003;**	
2005	92	56.3	4.0		**2005=2003=2009=2006**	
2006	69	39.0	4.6			
2007	107	64.0	4.0			
2008	113	66.4	4.8			
2009	203	39.5	2.4			
Kr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	138	1.838	0.015	**0.001**	**2008=2009=2004=2007=2006;**	35%
2004	93	1.906	0.015		**2004=2007=2006=2003=2005;**	
2005	92	1.839	0.023		**2008=2009>2003=2005**	
2006	69	1.875	0.030			
2007	107	1.826	0.034			
2008	113	2.000	0.037			
2009	203	2.463	0.091			

Table 6b continued

Wr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	138	96.7	1.0	**<0.0001**	**2009>2003=2005=2007=2004;**	45%
2004	93	91.9	1.1		**2009=2006=2008;**	
2005	92	96.6	1.5		**2006=2008=2003=2005;**	
2006	69	101.0	1.4		**2003=2005=2007=2004;**	
2007	107	95.5	1.5		**2006=2008>2007=2004**	
2008	113	102.3	2.1			
2009	203	133.1	5.1			

Age						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	50	2.3	0.2	0.666	NS	17%
2004	45	2.7	0.2			
2005	50	2.6	0.2			
2006	37	2.5	0.3			
2007	56	2.3	0.3			
2008	60	2.7	0.3			
2009	26	2.7	0.3			

Table 6c. Bluegill GLM results for length, weight, Kr, Wr and age.

Length						Maximum
	N	Mean	SE	P	Result	Difference
Lake				0.853	NS	30%
Waneta	949	123.3	1.3			
Lamoka	1614	120.1	1.0			
Year				**<0.0001**	**2004=2005=2007=2003=2006;**	16%
2003	312	119.4	1.2		**2005=2007=2003=2006=2008;**	
2004	241	129.4	2.5		**2006=2008=2009; 2004>2008=2009**	
2005	240	126.7	2.5		**2005=2007=2003>2009**	
2006	233	119.0	2.5		**W04>rest; L06=L05=L07=W03=L08=W05=L03=W07;**	
2007	311	125.9	2.2		**W03=L08=W05=L03=W07=L09=W08=W09=W06;**	
2008	434	119.7	1.9		**W05=L03=W07=L09=W08=W09=W06=L04**	
2009	792	111.9	1.4		**L06=L05=L07>L09=W08=W09=W06=L04;**	
LxY interaction				**<0.0001**	**L09=W08=W09=W06>L04**	n/a

Table 6c continued.

Weight						Maximum
	N	Mean	SE	P	Result	Difference
Lake				0.250	NS	17%
Waneta	822	55.5	1.3			
Lamoka	1205	47.5	1.1			
Year				0.077	NS	28%
2003	312	46.5	2.1			
2004	201	56.6	2.6			
2005	199	55.0	2.6			
2006	208	44.2	2.5			
2007	287	55.1	2.2			
2008	357	57.0	1.9			
2009	463	46.2	1.7			
LxY interaction				**<0.0001**	**Interactions cannot be interpreted**	n/a

Kr						Maximum
	N	Mean	SE	P	Result	Difference
Lake				0.807	NS	25%
Waneta	815	2.300	0.026			
Lamoka	1205	1.838	0.021			
Year				**<0.0001**	**2003>rest; 2009=2005**	28%
2003	305	2.300	0.042		**2005=2008=2006=2004=2007;**	
2004	201	1.936	0.051		**2009>2008=2006=2004=2007**	
2005	199	1.898	0.052			
2006	208	1.898	0.051		**L03>W09>rest; W05>L09;**	
2007	287	1.793	0.043		**L05=W08=L06=W04=W06=**	
2008	357	1.915	0.039		**W05=W03=L08=W07=L04=L07;**	
2009	463	2.098	0.034		**W08=L06=W04=W06=W05=**	
LxY interaction				**0.0006**	**W03=L08=W07=L04=L07=L09**	n/a

Table 6c continued.

Wr						Maximum
	N	Mean	SE	P	Result	Difference
Lake				0.517	NS	1%
Waneta	815	102.0	1.5			
Lamoka	1205	103.3	1.2			
Year				**<0.0001**	**2003>rest; 2009>2006=2008=2004=2007**	34%
2003	305	123.1	2.4		**2009=2005; 2005>2006=2008=2004=2007**	
2004	201	94.6	2.9			
2005	199	100.3	3.0			
2006	208	99.8	2.9		**L03>W09>rest; L05>L09**	
2007	287	91.6	2.5		**L05=W08=W06=L06=L04=**	
2008	357	99.0	2.2		**W03=W05=L08=W07=W04=L07;**	
2009	463	111.0	1.9		**W08=W06=L06=L04=W03=**	
LxY interaction				**0.0006**	**W05=L08=W07=W04=L07=L09**	n/a

Age						Maximum
	N	Mean	SE	P	Result	Difference
Lake				**<0.0001**	**Lamoka>Waneta**	24%
Waneta	324	2.5	0.1			
Lamoka	332	3.1	0.1			
Year				0.753	NS	15%
2003	87	2.6	0.2			
2004	102	3.0	0.2			
2005	75	2.9	0.2			
2006	88	3.0	0.2			
2007	101	2.6	0.2			
2008	114	2.8	0.2			
2009	89	2.7	0.2			
LxY interaction				0.644	NS	n/a

Table 7a. Largemouth bass: Lamoka Lake (length, weight, Kr, Wr and age).

Length						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	63	254.1	13.8	**<0.0001**	**2005=2004=2003;**	**98%**
2004	121	264.6	7.9		**2004=2003=2009=2008;**	
2005	78	285.1	12.7		**2009=2008=2006; 2007<rest**	
2006	104	191.7	11.4			
2007	151	143.8	9.1			
2008	96	216.7	12.5			
2009	115	228.5	9.5			

Weight						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	58	403.2	69.8	**<0.0001**	**2005=2003;**	**285%**
2004	113	310.7	21.9		**2003=2004=2009=2008=2006;**	
2005	66	506.3	36.9		**2005>2004=2009=2008=2006=2007**	
2006	83	235.2	27.0		**2007<rest**	
2007	146	131.6	20.4			
2008	94	291.8	41.9			
2009	82	311.9	41.9			

Kr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	58	1.490	0.055	**0.0007**	**2003=2009=2008;**	16%
2004	113	1.300	0.010		**2009=2008=2004=2006=2005=2007;**	
2005	66	1.295	0.014		**2003>2004=2006=2005=2007**	
2006	83	1.282	0.019			
2007	146	1.320	0.039			
2008	94	1.335	0.028			
2009	82	1.334	0.030			

Wr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	58	113.9	5.5	**<0.0001**	**2007>2004=2005;**	37%
2004	113	97.6	1.1		**2007=2003=2006=2008=2009;**	
2005	66	91.1	1.1		**2003=2006=2008=2009=2004**	
2006	83	105.0	1.9			
2007	146	125.3	4.7			
2008	94	110.1	3.3			
2009	82	102.7	2.7			

Age						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	68	3.5	0.3	**0.0031**	**2005=2003=2006;**	*54%*
2004	89	3.1	0.2		**2005>2004=2009=2007=2008**	
2005	38	4.3	0.3		**2003=2006=2004=2009=2007=2008**	
2006	75	3.2	0.2			
2007	66	2.9	0.3			
2008	62	2.8	0.3			
2009	83	3.0	0.2			

Table 7b. Largemouth bass: Waneta Lake (length, weight, Kr, Wr and age).

Length						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	40	252.9	16.3	**0.0006**	**2003=2005=2004; 2004=2009=2006;**	**136%**
2004	69	219.4	15.8		**2006=2008=2007;**	
2005	85	248.2	12.1		**2003=2005>2009=2006=2008=2007;**	
2006	74	142.7	12.2		**2008=2007<2003=2005=2004=2009**	
2007	330	107.0	4.2			
2008	348	114.5	4.6			
2009	179	133.2	4.6			

Weight						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	40	310.0	51.3	**<0.0001**	**2005=2003>2009=2008=2006=2007;**	**465%**
2004	60	326.5	60.2		**2005>2004=2009=2008=2006=2007**	
2005	75	343.1	39.1		**2007<rest**	
2006	58	161.6	39.1			
2007	170	105.5	19.1			
2008	191	117.2	20.3			
2009	168	60.7	8.6			

Kr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	37	1.278	0.030	**0.0004**	**2005>2007**	31%
2004	60	1.272	0.028		**2003=2004=2006=2009=2008**	
2005	75	1.323	0.018			
2006	58	1.246	0.023			
2007	169	1.611	0.023			
2008	191	1.227	0.023			
2009	168	1.293	0.034			

Wr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	37	97.3	2.2	**0.0003**	**2006=2008=2009>2003;**	20%
2004	60	105.0	2.8		**2007=2004=2005=2003**	
2005	75	101.9	1.9			
2006	58	111.1	2.2			
2007	169	107.5	2.2			
2008	191	112.9	2.4			
2009	168	116.5	3.3			

Age						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	52	3.2	0.3	**<0.0001**	**2003=2005=2004;**	**256%**
2004	55	3.1	0.3		**2004=2007=2008=2006;**	
2005	83	3.2	0.3		**2007=2008=2006=2009;**	
2006	45	1.8	0.3		**2003=2005>2007=2008=2006=2009;**	
2007	72	2.1	0.3		**2003=2005=2004>2009**	
2008	77	2.0	0.3			
2009	20	0.9	0.2			

Table 7c. Largemouth bass GLM results for length, weight, Kr, Wr and age.

Length						Maximum
	N	Mean	SE	P	Result	Difference
Lake				**<0.0001**	**Lamoka>Waneta**	**58%**
Waneta	1125	138.6	3			
Lamoka	728	218.4	4.4			
Year						
2003	103	253.6	10.5			
2004	190	248.2	7.8	**0.0013**	**2005=2003=2004>2009>2006=2008>2007**	**124%**
2005	163	265.9	8.9			
2006	178	171.3	8.5			
2007	481	118.6	4.1		**L05=L04=W03=L03=W05=L09;**	
2008	444	136.6	4.1		**W03=L03=W05=L09=L08=W04;**	
2009	294	170.4	5.4		**L08=W04=L06; L06=W09=W06;**	
LxY interaction				**<0.0001**	**W09=W06=L07; W06=L07=W08=W07**	n/a

Table 7c continued.

Weight						Maximum
	N	Mean	SE	P	Result	Difference
Lake				**<0.0001**	**Lamoka>Waneta**	**91%**
Waneta	767	153.5	10.6			
Lamoka	642	292.6	13.6			
Year				**0.0006**	**2005=2003; 2003=2004;**	**256%**
2003	98	365.2	46.4		**2005>2004>2009=2006=2008>2007**	
2004	173	316.2	25.2			
2005	141	419.5	27.8			
2006	141	205.0	22.7			
2007	316	118.0	13.9			
2008	288	174.3	19.9		**L05=L03=L04=W05=W03; L03=L04=W05=W03=L09;**	
2009	254	141.3	16.4		**W05=W03=L09=L08=L06=W04; W04=W06;**	
LxY interaction				**<0.0001**	**W06=W09=W08=L07=W07**	n/a

Kr						Maximum
	N	Mean	SE	P	Result	Difference
Lake				0.130	NS	3%
Waneta	765	1.288	0.024			
Lamoka	646	1.320	0.013			
Year				0.142	NS	14%
2003	95	1.408	0.037			
2004	173	1.290	0.012			
2005	141	1.310	0.012			
2006	141	1.267	0.015			
2007	321	1.239	0.027			
2008	286	1.308	0.048			
2009	254	1.363	0.040			
LxY interaction				0.550	NS	n/a

Table 7c continued.

Wr						Maximum
	N	Mean	SE	P	Result	Difference
Lake				0.202	NS	7%
Waneta	765	114.6	2.5			
Lamoka	646	107.5	1.5			
Year				**0.0024**	**2007=2008=2009=2006=2003=2004;**	22%
2003	95	107.5	3.5		**2006=2003=2004=2005; 2007=2008=2008>2005**	
2004	173	100.2	1.2			
2005	141	96.9	1.2			
2006	141	107.5	1.4			
2007	321	116.4	3.0			
2008	286	116.8	5.2			
2009	254	118.0	4.1			
LxY interaction				*0.0149*	*Not interpretable*	n/a

Age						Maximum
	N	Mean	SE	P	Result	Difference
Lake				**<0.0001**	**Lamoka>Waneta**	28%
Waneta	404	2.5	0.1			
Lamoka	481	3.2	0.1			
Year				**<0.0001**	**2004>2009; 2005=2004; 2004=2006=2007=2008;**	50%
2003	120	3.4	0.2		**2005=2003=2004; 2004=2006=2007=2008;**	
2004	144	3.1	0.2		**2006=2007=2008=2009**	
2005	121	3.6	0.2			
2006	120	2.5	0.2			
2007	138	2.5	0.2			
2008	139	2.4	0.2			
2009	103	2.6	0.2			
LxY interaction				*0.022*	*Interactions cannot be interpreted*	n/a

Table 8a. Yellow perch: Lamoka Lake (length, weight, Kr, Wr and age).

Length						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	22	180.9	9.7	**<0.0001**	**Relationships cannot be interpreted**	*54%*
2004	51	117.3	8.0			
2005	9	147.9	22.5			
2006	88	127.5	2.8			
2007	71	121.6	4.2			
2008	73	139.2	4.8			
2009	44	149.7	5.7			

Weight						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	22	98.0	8.5	**<0.0001**	**2003=2009=2005;**	**324%**
2004	34	40.0	10.8		**2005=2008=2006=2007=2004**	
2005	8	68.0	29.3		**2003=2009>2008=2006=2007=2004**	
2006	62	27.5	3.4			
2007	71	23.1	2.5			
2008	73	36.2	4.3			
2009	32	48.0	5.0			

Kr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	17	1.449	0.058	**<0.0001**	**Relationships cannot be interpreted**	*52%*
2004	34	1.069	0.022			
2005	8	1.114	0.072			
2006	62	1.098	1.388			
2007	71	0.955	1.517			
2008	73	1.104	3.021			
2009	32	1.000	0.023			

Wr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	17	105.0	4.3	**<0.0001**	**2003=2004=2006=2005;**	40%
2004	34	88.5	1.9		**2004=2006=2005=2008;**	
2005	8	86.7	4.6		**2005=2008=2007=2009;**	
2006	62	87.9	1.4		**2003>2008=2007=2009;**	
2007	71	77.4	1.5		**2004=2006>2007=2009**	
2008	73	87.8	3.0			
2009	32	75.2	1.7			

Table 8a continued.

Age						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	21	4.3	0.5	**0.0088**	**2003=2005=2009;**	**115%**
2004	28	2.3	0.5		**2003>2008=2007=2006=2004;**	
2005	7	3.7	1.3		**2005=2009=2008=2007=2006=2004**	
2006	44	2.0	0.2			
2007	32	2.0	0.2			
2008	46	2.4	0.3			
2009	37	2.4	0.3			

Table 8b. Yellow perch: Waneta Lake (length, weight, Kr, Wr and age).

Length						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	7	223.6	3.5	*0.0204*	*2009=2003=2008=2004=2007=2006;*	*58%*
2004	5	203.6	12.4		*2003=2008=2004=2007=2006=2005;*	
2005	12	148.7	17.3		*2009>2005*	
2006	7	176.3	16.0			
2007	32	183.0	11.4			
2008	16	197.0	16.1			
2009	10	234.6	9.6			
Weight						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	7	123.1	6.2	**0.0018**	**Relationships cannot be interpreted**	**340%**
2004	5	102.2	19.2			
2005	9	40.7	15.3			
2006	7	74.9	24.0			
2007	32	94.1	14.5			
2008	16	103.6	18.1			
2009	10	179.2	20.4			
Kr						Maximum
Year	N	Mean	SE	P	Result	Difference
2003	7	1.211	0.091	**0.0007**	**2009>2008=2007**	27%
2004	5	1.149	0.031		**2006=2004=2003=2005**	
2005	9	1.146	0.046			
2006	7	1.173	0.022			
2007	32	1.064	0.038			
2008	16	1.081	0.044			
2009	10	1.350	0.032			

Table 8b continued.

Wr						Maximum
	Year	N	Mean	SE	P	Result	Difference
	2003	7	85.1	6.6	*0.0110*	*2009>2007*	19%
	2004	5	82.4	1.9		*2005=2006=2004=2008=2003*	
	2005	9	91.9	4.6			
	2006	7	87.4	2.5			
	2007	32	79.0	2.8			
	2008	16	79.7	4.1			
	2009	10	93.9	2.9			

Age						Maximum
	Year	N	Mean	SE	P	Result	Difference
	2003	9	3.7	0.3	*0.0110*	*Relationships cannot be interpreted*	**192%**
	2004	5	3.2	1.0			
	2005	10	1.3	0.6			
	2006	7	2.4	1.0			
	2007	30	2.0	0.3			
	2008	16	2.3	0.4			
	2009	4	3.8	0.5			

Table 8c. Yellow perch GLM results for length, weight, Kr, Wr and age.

Length						Maximum
	N	Mean	SE	P	Result	Difference
Lake				**<0.0001**	**Waneta>Lamoka**	42%
Waneta	89	190.5	6.2			
Lamoka	358	133.8	2.3			
Year				**<0.0001**	**2003=2009; 2009=2008;**	**53%**
2003	29	191.2	8.2		**2008=2006=2004=2007=2005**	
2004	56	125.0	8.1			
2005	21	148.3	13.5			
2006	95	131.1	3.1			
2007	103	140.7	5.3			
2008	89	149.6	5.4			
2009	54	165.4	6.7			
LxY interaction				0.058	NS	n/a

Table 8c continued.

Weight						Maximum
	N	Mean	SE	P	Result	Difference
Lake				**<0.0001**	**Waneta>Lamoka**	**163%**
Waneta	86	101.4	8.1			
Lamoka	302	38.6	2.4			
Year				**<0.0001**	**Relationships cannot be interpreted**	**222%**
2003	29	104.1	6.9			
2004	39	48.0	10.2			
2005	17	53.5	15.8			
2006	69	32.3	4.2			
2007	103	45.2	5.8			
2008	89	51.7	5.5			
2009	42	68.0	10.5			
LxY interaction				**0.0096**	**Interactions cannot be interpreted**	n/a

Kr						Maximum
	N	Mean	SE	P	Result	Difference
Lake				0.051	NS	6%
Waneta	86	1.135	1.605			
Lamoka	296	1.071	1.045			
Year				**<0.0001**	**Relationships cannot be interpreted**	40%
2003	24	1.380	0.053			
2004	39	1.080	0.020			
2005	17	1.131	0.040			
2006	69	1.106	0.015			
2007	103	0.989	0.019			
2008	89	1.100	0.028			
2009	41	1.081	0.031			
LxY interaction				**<0.0001**	**Interactions cannot be interpreted**	n/a

Table 8c continued.

Wr						Maximum
	N	Mean	SE	P	Result	Difference
Lake						2%
Waneta	86	83.6	1.6	0.605	NS	
Lamoka	296	85.0	1.0			
Year				**0.0007**	**Relationships cannot be interpreted**	27%
2003	24	99.2	4.0			
2004	39	87.7	1.7			
2005	17	89.4	3.2			
2006	69	87.9	1.3			
2007	103	77.9	1.4			
2008	89	86.3	2.6			
2009	41	79.5	1.9			
LxY interaction				**0.0012**	**Interactions cannot be interpreted**	n/a

Age						Maximum
	N	Mean	SE	P	Result	Difference
Lake				0.772	NS	9%
Waneta	81	2.3	0.2			
Lamoka	215	2.5	0.1			
Year				**0.0016**	**2003=2009=2004=2005;**	**105%**
2003	30	4.1	0.4		**2009=2004=2005=2008=2006=2007;**	
2004	33	2.5	0.5		**2003>2008=2006=2007**	
2005	17	2.3	0.7			
2006	51	2.1	0.2			
2007	62	2.0	0.2			
2008	62	2.3	0.3			
2009	41	2.6	0.2			
LxY interaction				0.132	NS	n/a

Figure 1. Google Earth image of Waneta (upper middle) and Lamoka (lower middle) Lakes. The east branch of Keuka Lake is at the upper left.

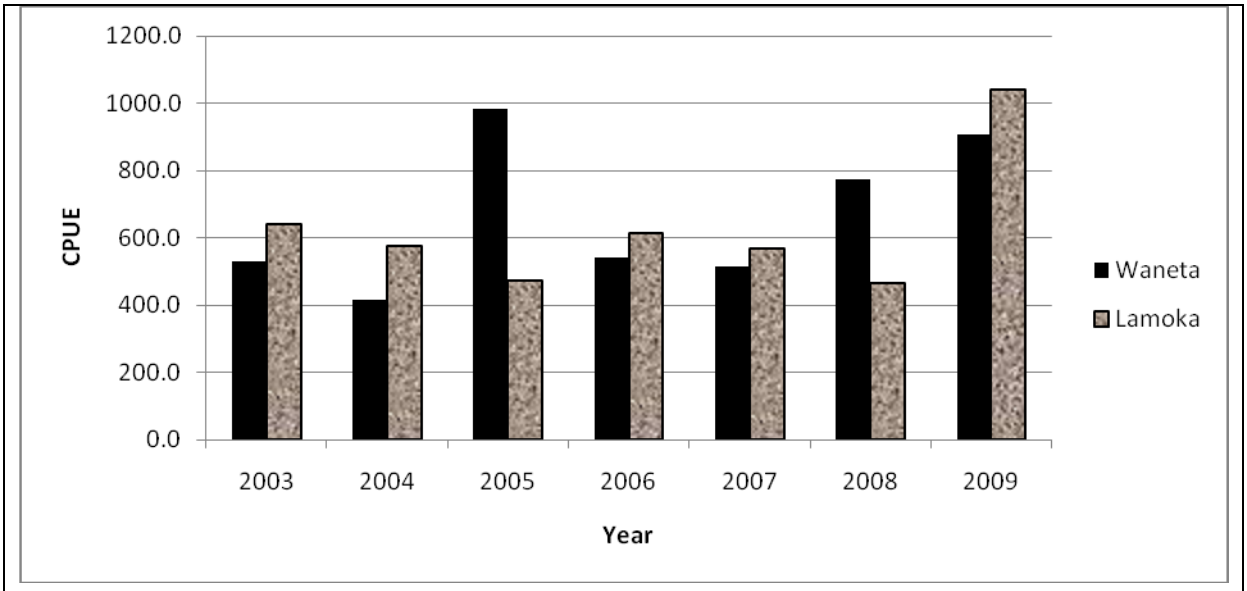


Figure 2. Catch per hour by electrofishing in Waneta and Lamoka Lakes, October 2003-2009.

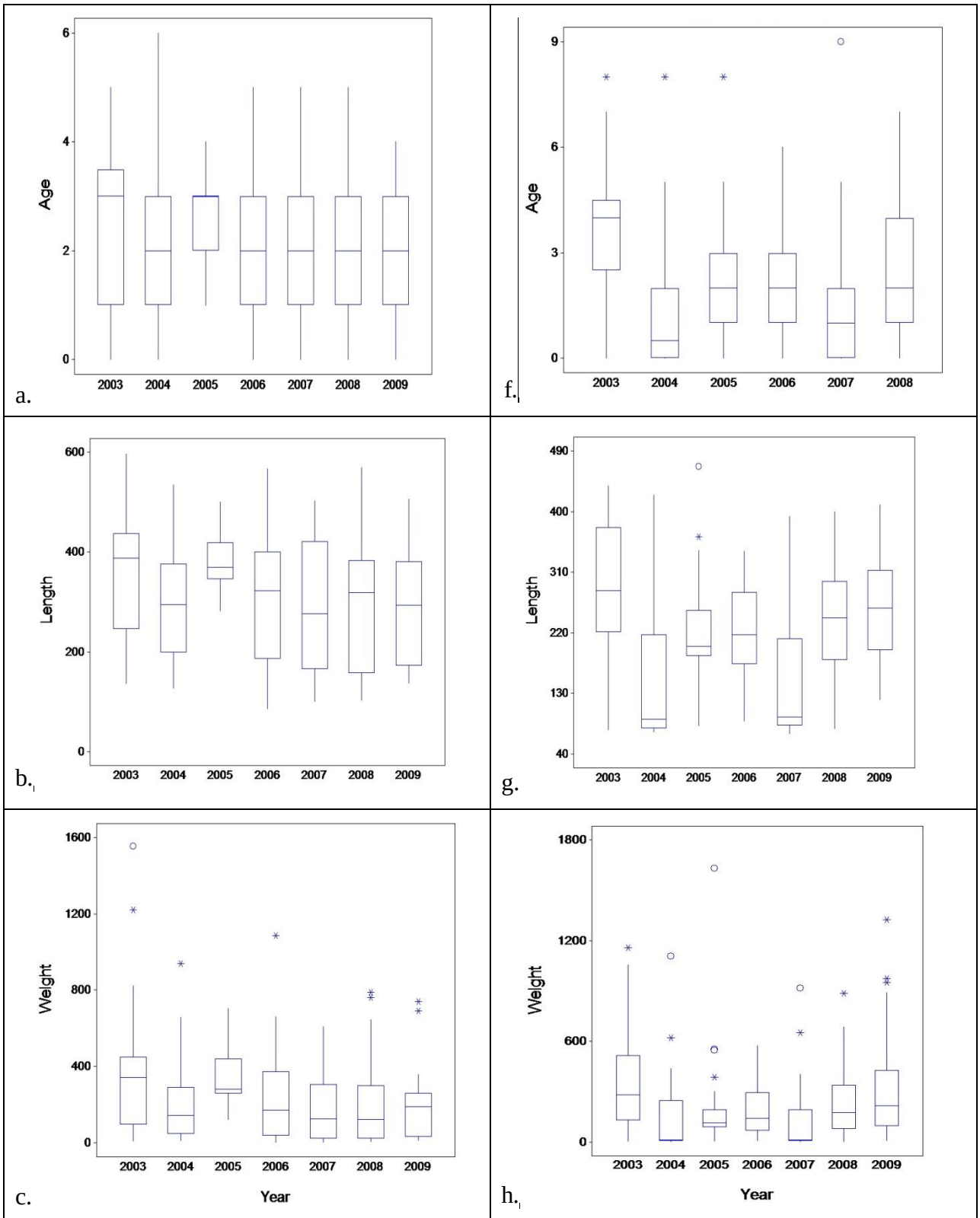
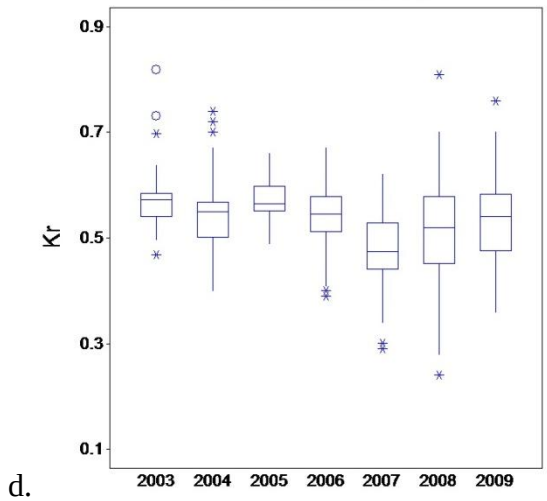


Figure 3. Age, length, weight, Kr and Wr of chain pickerel in Lamoka Lake (a-e) and smallmouth bass in Waneta Lake (f-j), 2003-2009 (box and whiskers plot). Continued on next page.



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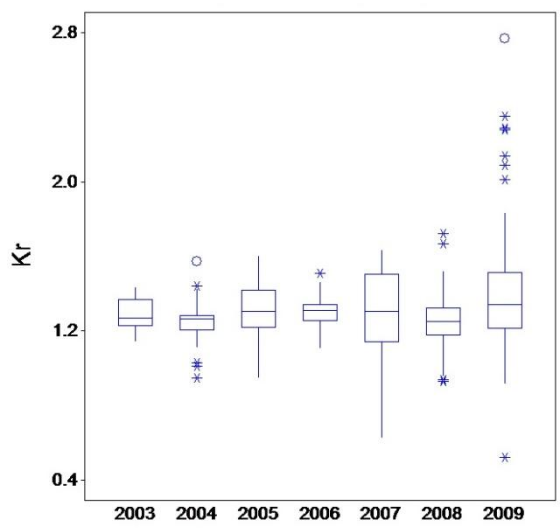

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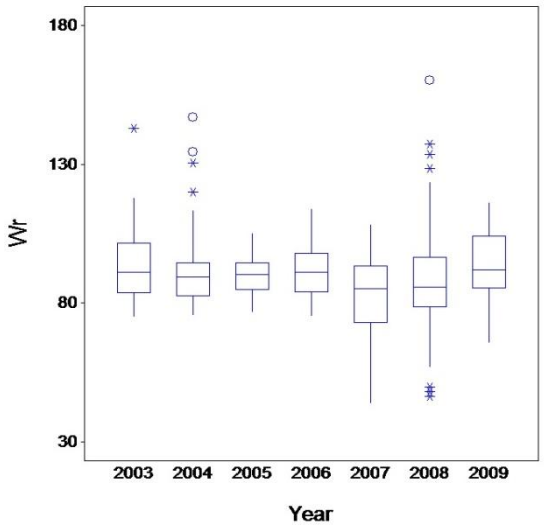


e.

j.

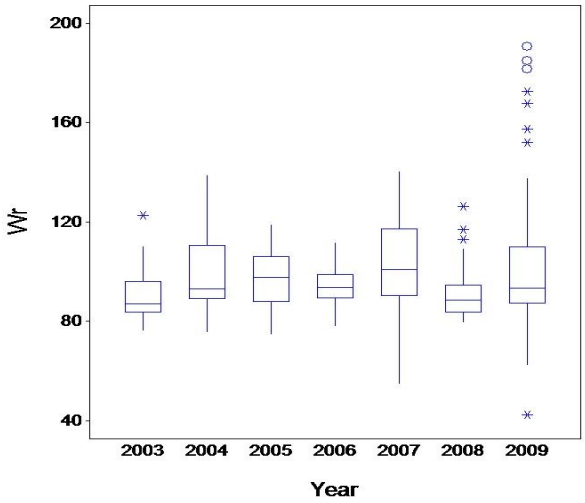


Figure 3 continued. * = +/- 2 SD beyond the mean. o = +/- 3 SD beyond the mean.

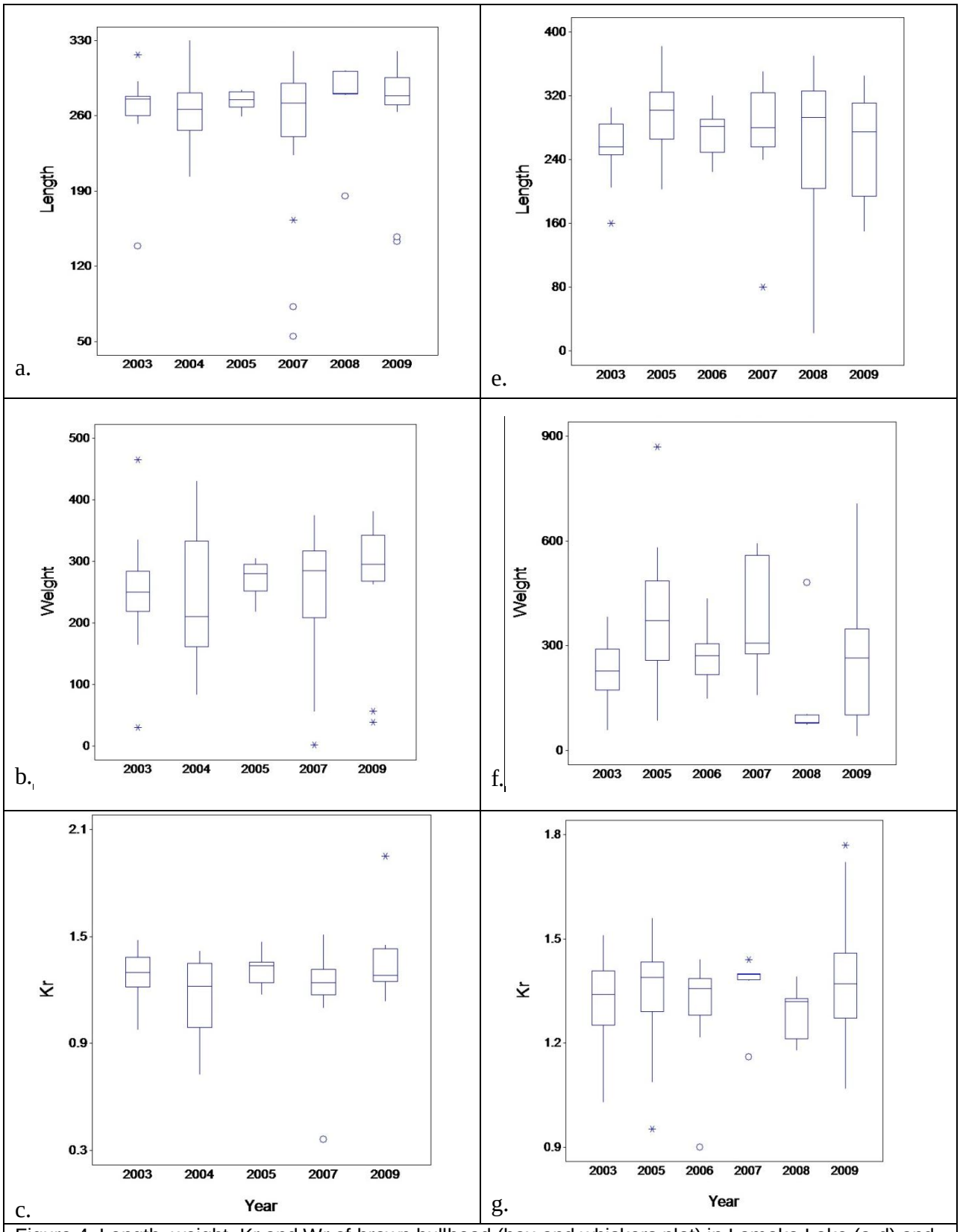
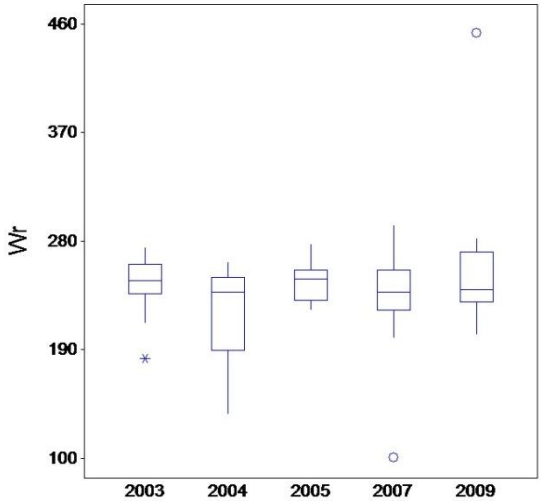


Figure 4. Length, weight, Kr and Wr of brown bullhead (box and whiskers plot) in Lamoka Lake (a-d) and Waneta Lake (e-h), 2003-2009. Continued on next page.



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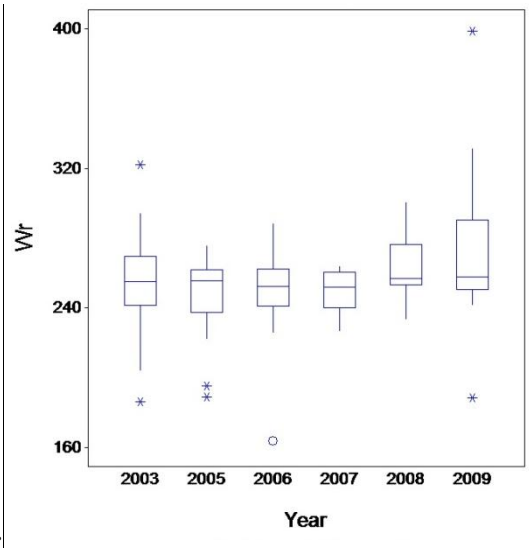


h.

Figure 4 continued. * = +/- 2 SD beyond the mean. o = +/- 3 SD beyond the mean.

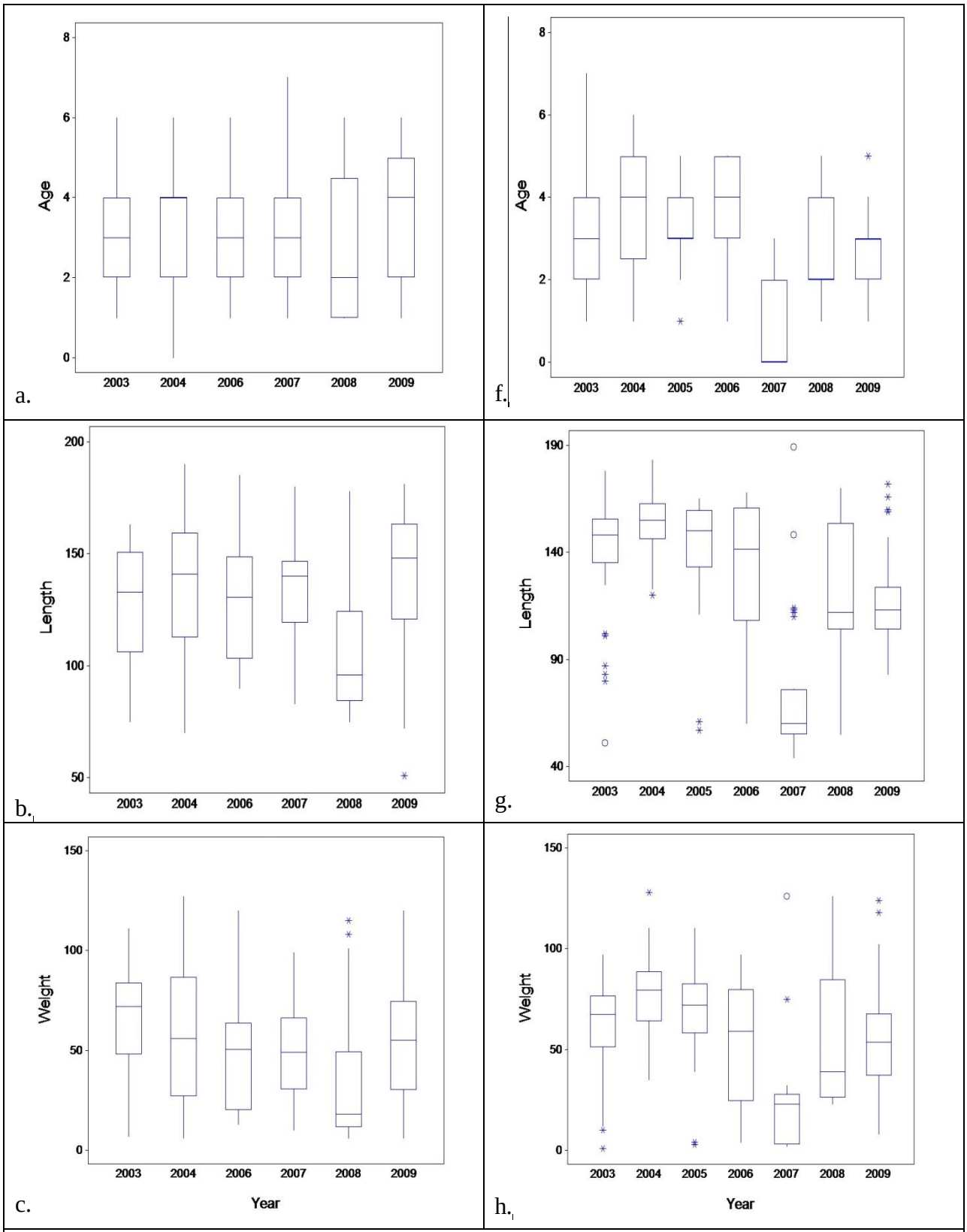
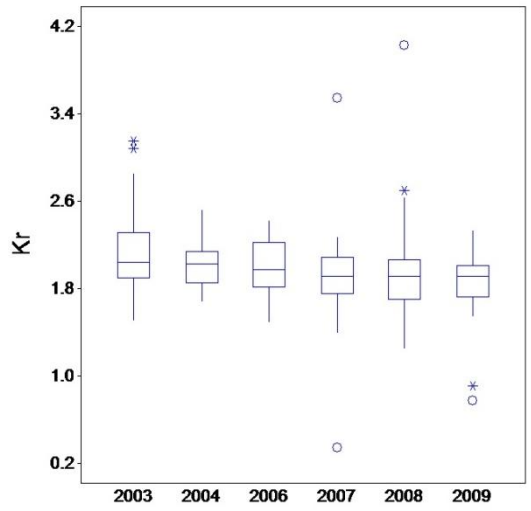


Figure 5. Age, length, weight, Kr and Wr of pumpkinseed (box and whiskers plot) in Lamoka Lake (a-e) and Waneta Lake (f-j), 2003-2009. Continued on next page.



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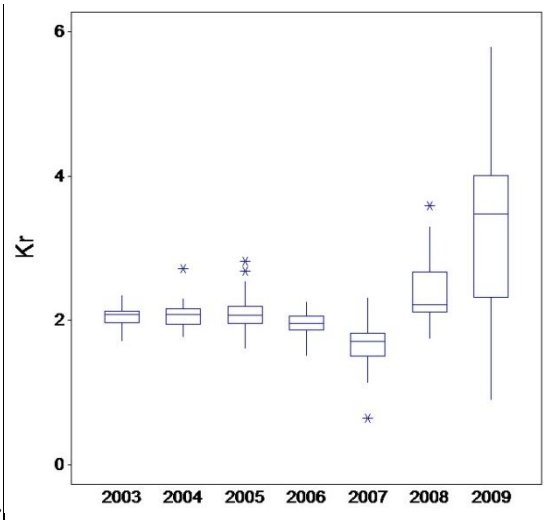

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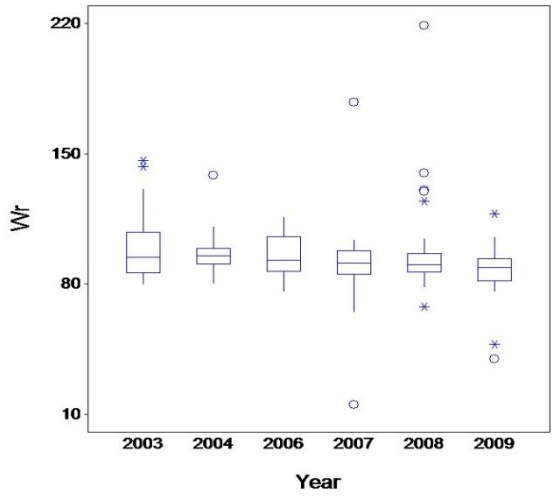

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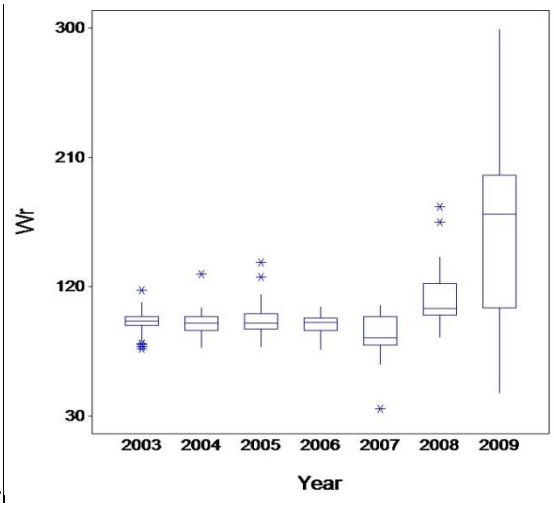


j.

Figure 5 continued. * = +/- 2 SD beyond the mean. o = +/- 3 SD beyond the mean.

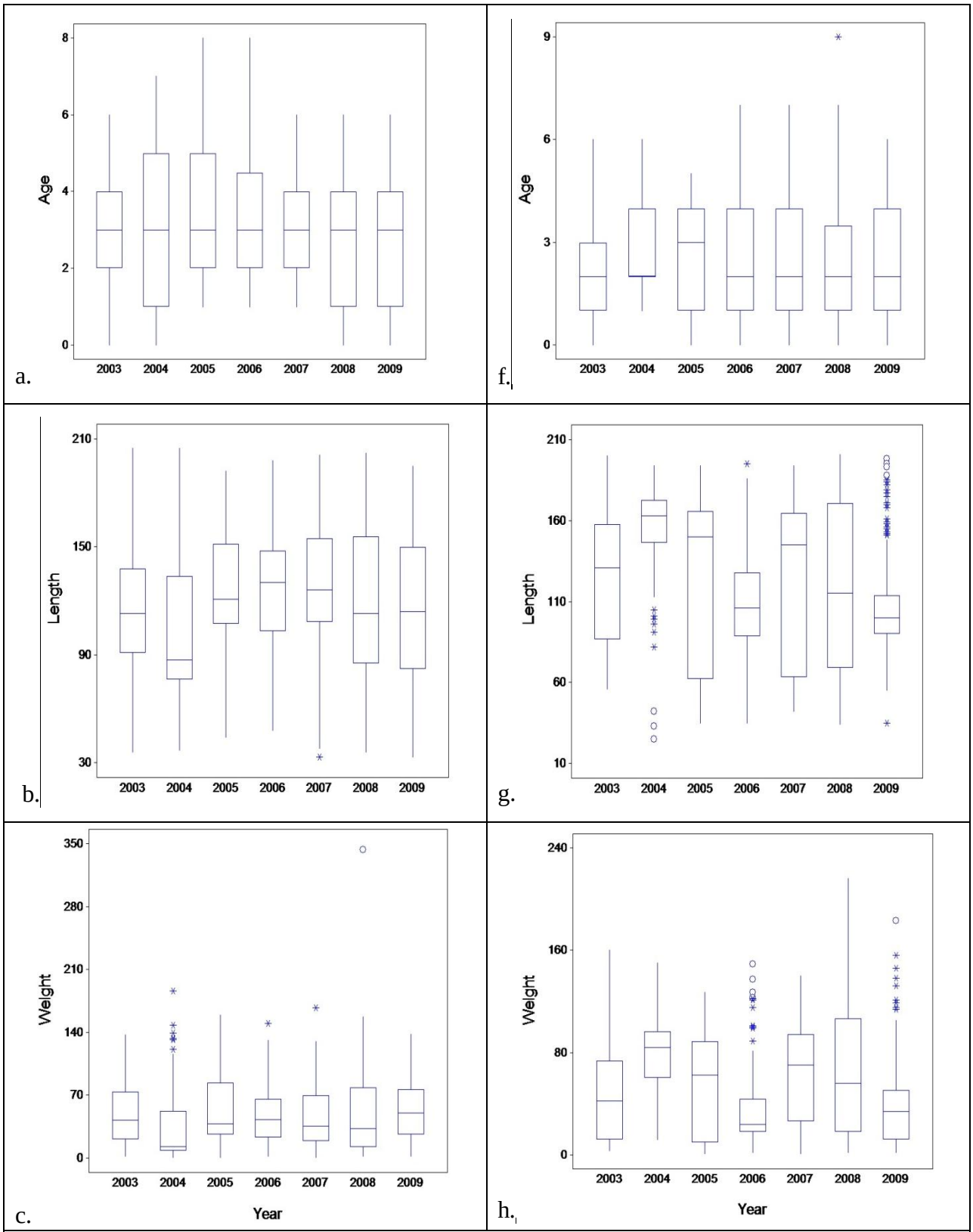
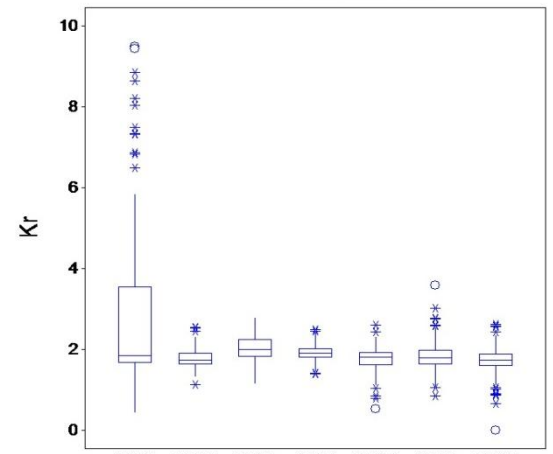


Figure 6. Age, length, weight, Kr and Wr of bluegill (box and whiskers plot) in Lamoka Lake (a-e) and Waneta Lake (f-j), 2003-2009. Continued on next page.



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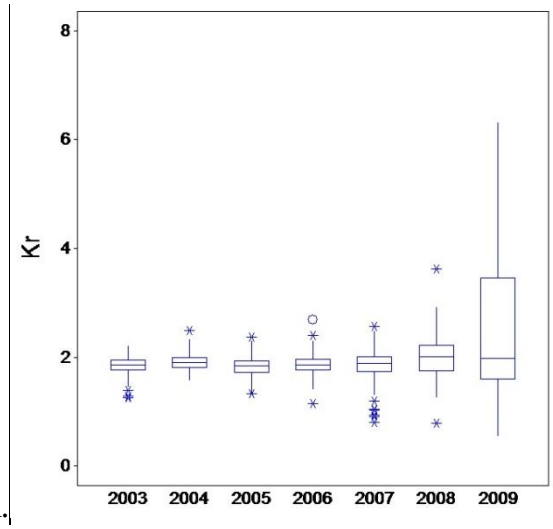

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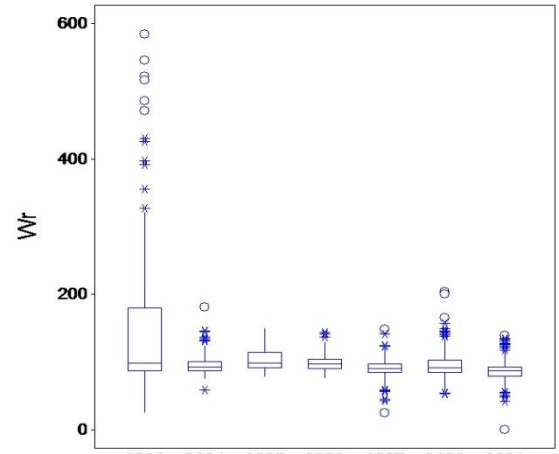

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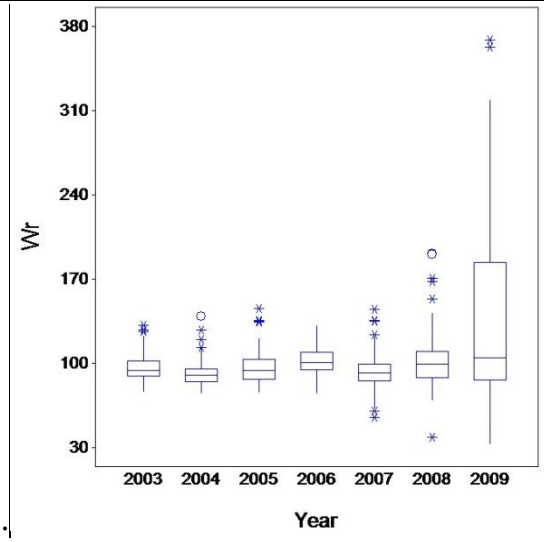


j.

Figure 6 continued. * = +/- 2 SD beyond the mean. o = +/- 3 SD beyond the mean.

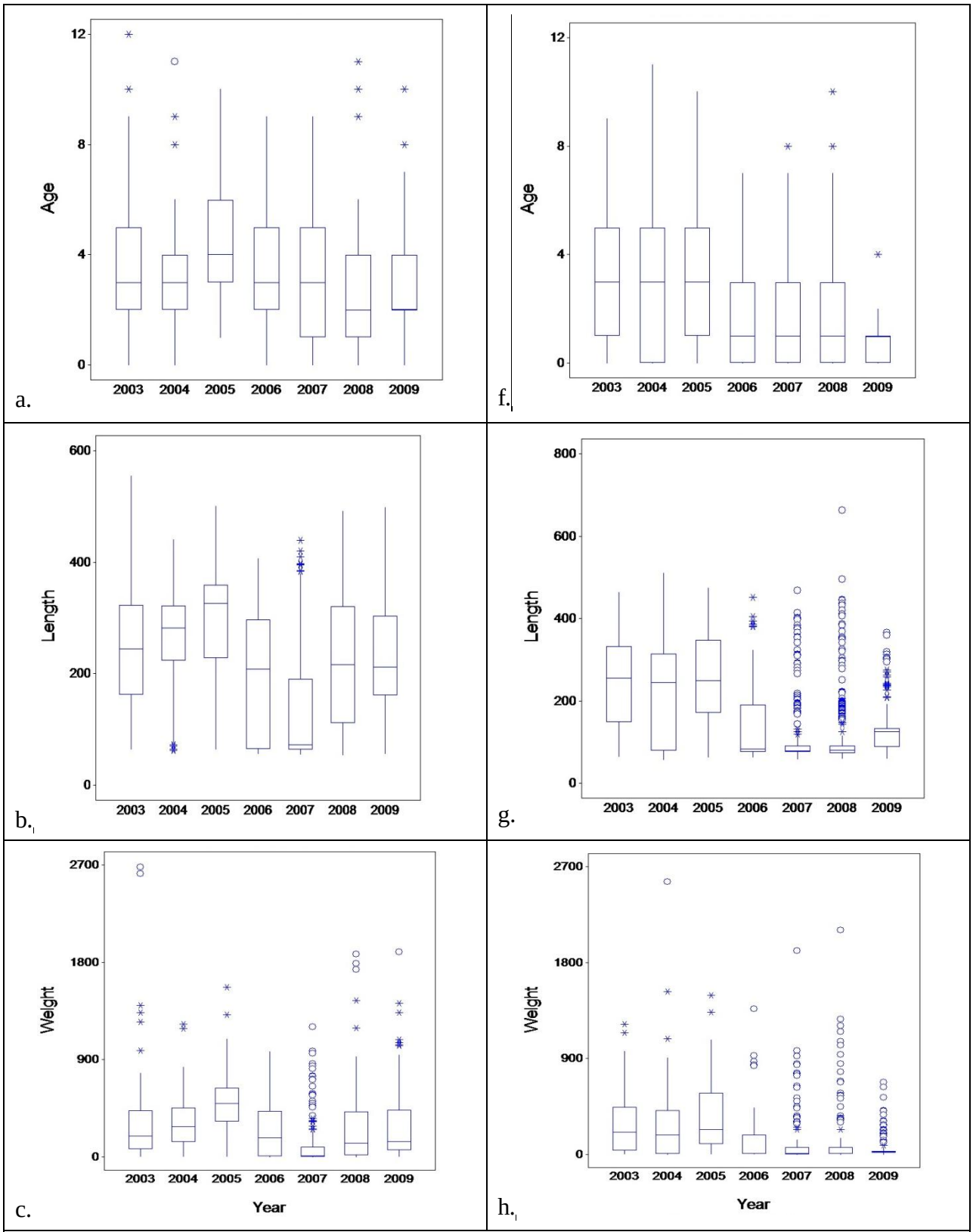
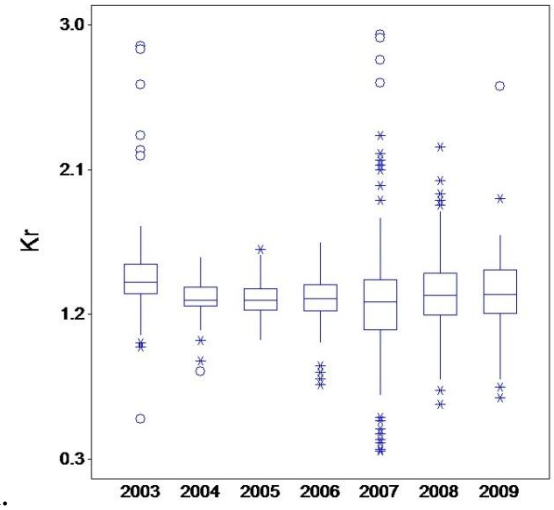
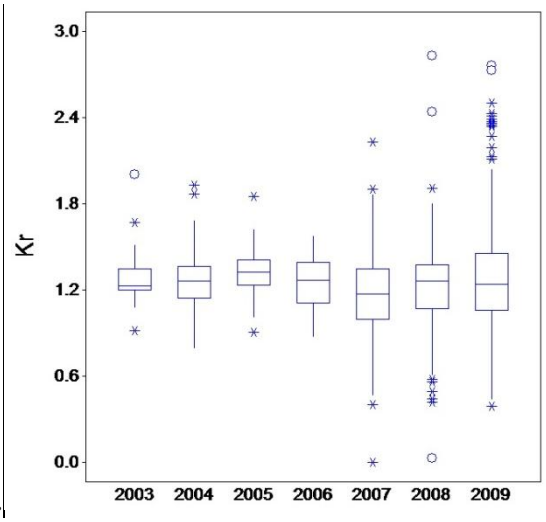


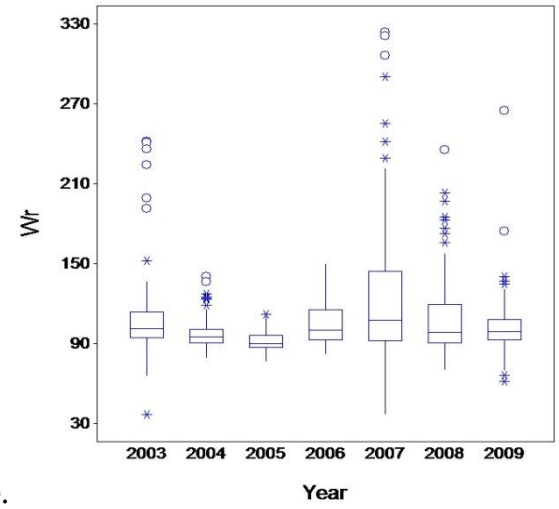
Figure 7. Age, length, weight, Kr and Wr of largemouth bass (box and whiskers plot) in Lamoka Lake (a-e) and Waneta Lake (f-j), 2003-2009. Continued on next page.



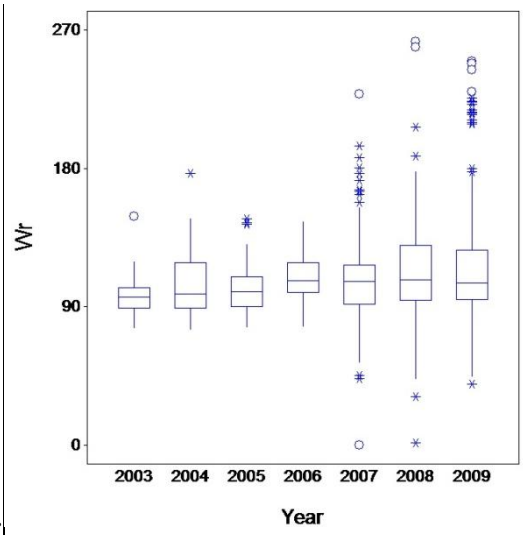
d.



i.



e.



j.

Figure 7 continued. * = +/- 2 SD beyond the mean. o = +/- 3 SD beyond the mean.

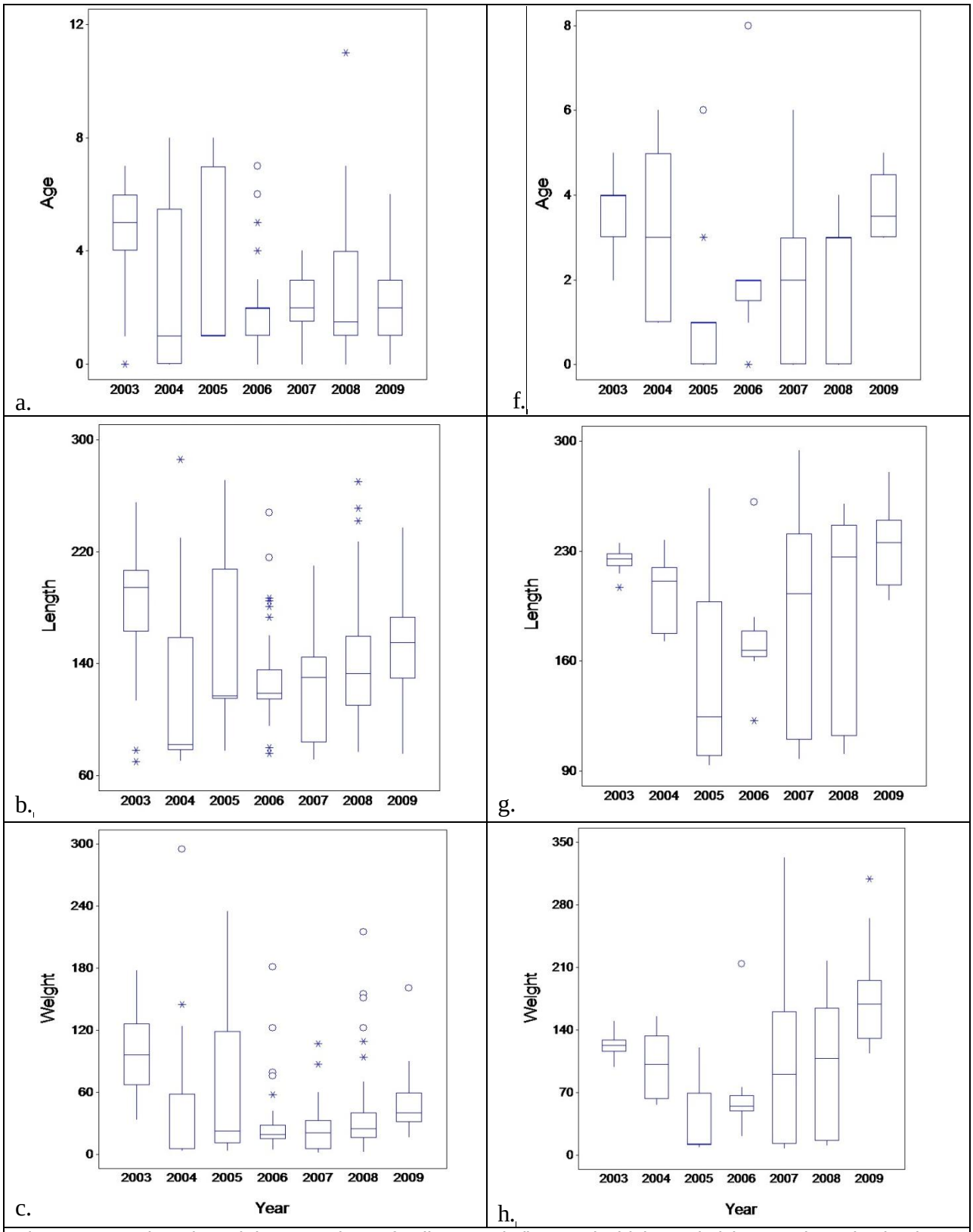
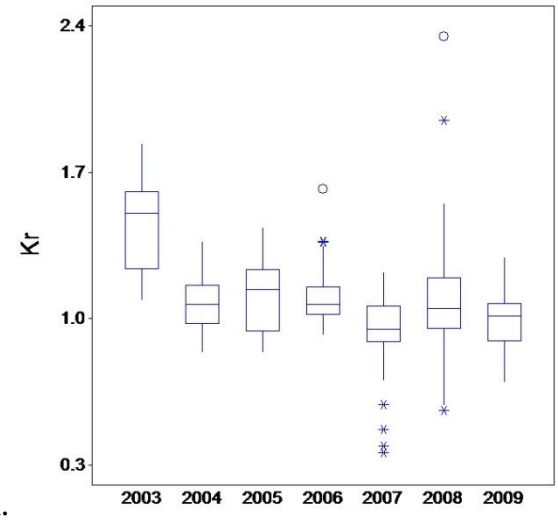


Figure 8. Age, length, weight, Kr and Wr of yellow perch (box and whiskers plot) in Lamoka Lake (a-e) and Waneta Lake (f-j), 2003-2009. Continued on next page.



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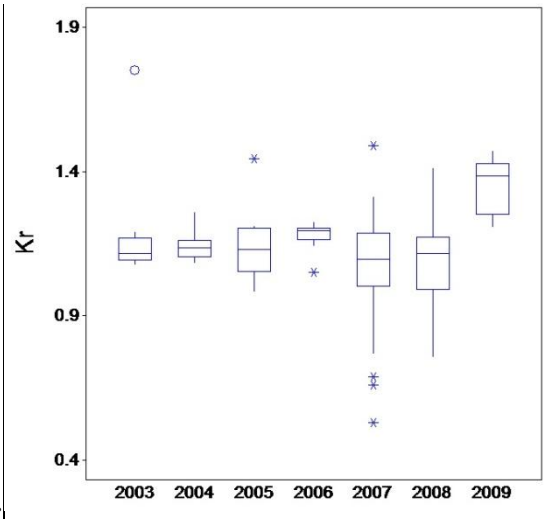
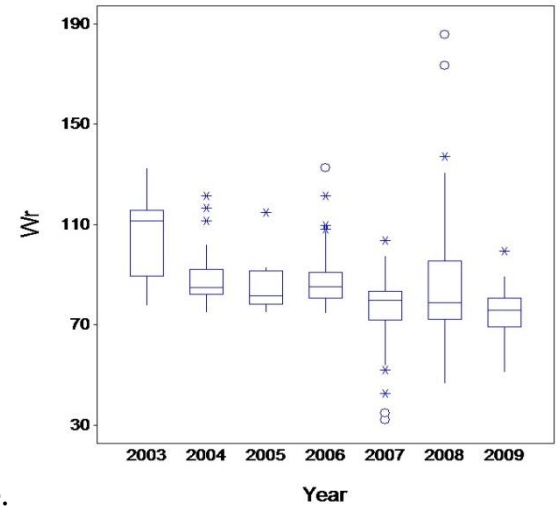
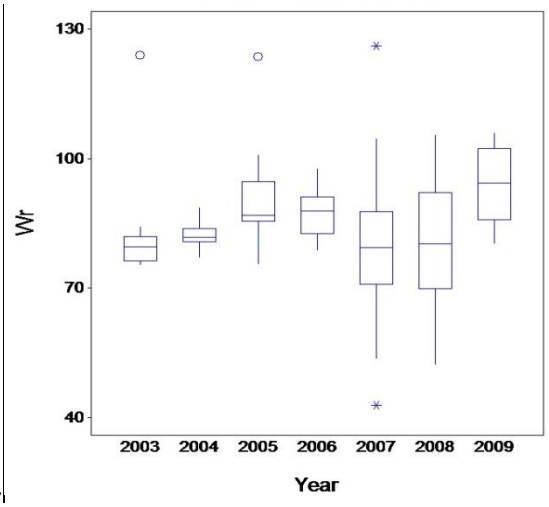


i.



e.



j.

Figure 8 continued. * = +/- 2 SD beyond the mean. o = +/- 3 SD beyond the mean.