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Summer Dispersal of Walleye in Calling Lake, 2002

Alberta Conservation Association

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Summer Dispersal of Walleye in Calling Lake, Alberta 2002.

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EXECUTIVE SUMMARY

In 1998, the walleye population of Calling Lake was classified as collapsed and the Province of Alberta implemented a catch-and-release management regulation for this sport fishery. In April 2002, the Alberta Government designated the north third of Calling Lake as an area closed to fishing, but allowed anglers to harvest 1 walleye and 2 pike (each, of any size) from the south two thirds of the lake. During the summer of 2002, the Alberta Conservation Association conducted a biotelemetry survey to examine the movements and home ranges of walleye in Calling Lake. Radio transmitters were implanted into a total of 12 walleye in 2002, and all 12 walleye survived implantation (i.e., mortality rate = 0%). Between 14 June and 28 August, these 12 walleye were located on 173 occasions. Analyses of walleye movement data showed that walleye do not preferentially occupy the area of the lake that is closed to angling. Rather, walleye are dispersed throughout the entire lake, and movement and dispersal did not appear to vary with walleye size. However, many fish had large home ranges that extended throughout much of the lake.

ACKNOWLEDGEMENTS

I thank Owen Watkins, Deanne Miskew and Ryan Popowich for assisting and conducting fieldwork. This crew and I thank: Alberta Community Development for the use of the seasonal residence at Calling Lake Provincial Park, Alberta Fish and Wildlife for the collaboration before, during and after the project and for the use of 2 boats during the survey; Human Resources and Development Canada for providing funding to support seasonal staff; Lotek Wireless Canada for their guidance in choosing telemetry equipment, The Fish'n Hole and the Sherwood Park Chapter of Alberta Fish and Game for providing funds to purchase 2 of the 12 biotelemetry transmitters.

Also, I would like to acknowledge Chris Davis (Alberta Fish and Wildlife), Dave Park (ACA) and Dr. Garry Scrimgeour (ACA) for providing comments on drafts of this report.

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1.0 INTRODUCTION

Walleye (Sander vitreus) populations in Alberta have been subjected to heavy fishing pressure for many years. Most populations show signs of over-harvest, with many experiencing significant population declines. Previous management strategies have focused largely on province-wide regulations designed to manage the walleye harvest at an average fishery. Passive management of the large recreational fishery and active management of the smaller commercial fishery failed to prevent declines and collapses of walleye stocks (Sullivan 2003). A new walleye management strategy was implemented in 1996 to assist with the recovery of existing fisheries and reduce further impairment of declining fisheries (Berry 1995). This strategy requires that each walleye population be managed as a separate entity. Under this management approach, individual walleye fisheries are evaluated in terms of its level of exploitation and then assigned to one of three management categories: i) collapsed fishery, ii) vulnerable fishery, or ii) stable fishery. Management regulations, including those governing angling, are assigned to individual lakes based on their management categories (e.g., collapsed, vulnerable, etc.) (Sullivan 1994).

After a creel survey in 1996, the walleye fishery at Calling Lake was deemed to be collapsed and assigned this management category in April 1998. As a result, the Province of Alberta implemented a catch and release (zero possession limit) angling regulation for walleye in this lake. Most anglers (65% of all people interviewed) surveyed during the 1996 Calling Lake creel survey were targeting walleye (Patterson and Sullivan 1997). Recent appraisals of Calling Lake's walleye fishery suggest that walleye populations were responding favorably to the catch and release regulation. Local anglers were reporting catches of large walleye and Fall Walleye Index Netting (FWIN) indicated strong 1997 and 1991 year-classes (Watters, in prep.).

In April of 2002, the Alberta Government designated the north third of Calling Lake closed to both recreational angling and commercial fishing. The south portion of Calling Lake was opened to angling from the Victoria Day long-weekend (usually the 3rd weekend of May) to 31 March each year, and the daily harvest of one walleye and two pike (each, of any size) was permitted.

This report describes movement patterns and home ranges of twelve walleye in Calling Lake based on radio telemetry surveys conducted between June and August 2002. The purpose of the survey was to assess the dispersal of walleye in Calling Lake.

2.0 STUDY AREA

Calling Lake (TWP 71-73, R 21-23 W4) is located approximately 55 kilometers (km) north of the Town of Athabasca (Figure 1). Calling Lake is a relatively large (surface area = 138 km^2, maximum water depth = 18.3 m), eutrophic lake (Mitchell and Prepas 1990) that is ice covered from December to June. The Hamlet of Calling Lake is located on the lake's south eastern shore. Members of the Bigstone Cree Indian Band live along the east shore of Calling Lake in Indian Reserve No. 183. These are the only residential areas located in the lake's catchment (1090 km^2), which is largely forested and contains an abundance of wetlands (Mitchell and Prepas 1990).

Calling Lake Provincial Park is located along the south shore of the lake. Rock Island River, which flows from Rock Island Lake into Calling Lake at the north west end, is the main inflow to the lake. The outlet, Calling River, flows into the Athabasca River approximately 25 km downstream. Several intermittent streams flow into Calling Lake along the west and east shores (Mitchell and Prepas 1990).

Calling Lake also supports populations of northern pike (Esox lucius), yellow perch (Perca flavescens), lake whitefish (Coregonus clupeaformis), cisco (Coregonus artedii), burbot (Lota lota), white sucker (Catostomus commersoni), longnose sucker (Coregonus catostomus), spottail shiner (Notropis hudsonius) and Iowa darter (Etheostoma exile) (Mitchell and Prepas 1990).

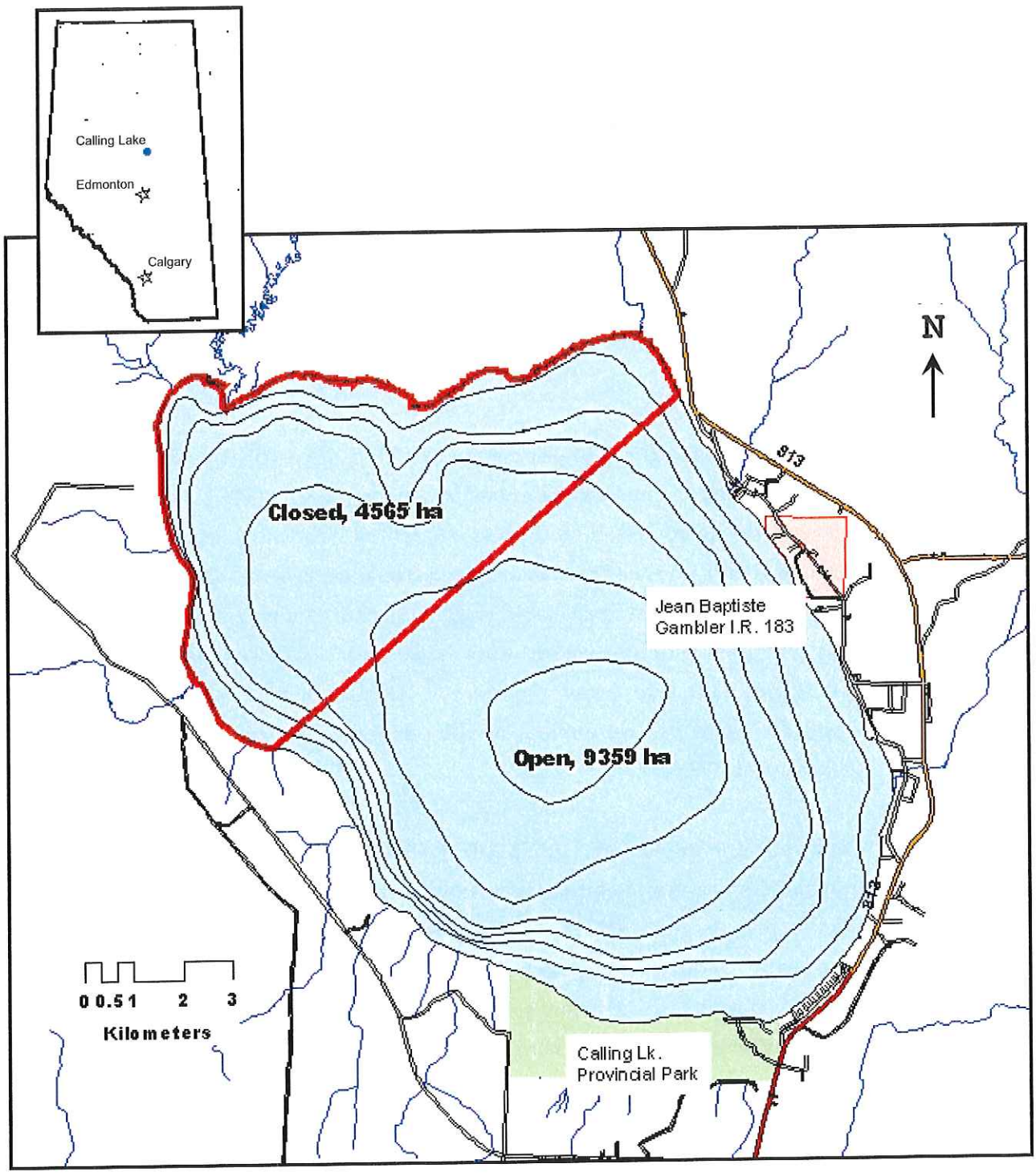

Figure 1. Location of areas open and closed to angling in Calling Lake, Alberta.

3.0 MATERIALS AND METHODS

Summer movements of walleye were assessed utilizing radio telemetry. To minimize bias of walleye movements in the open versus the closed areas of Calling Lake, I collected 6 fish (by angling) from each area of the lake. I recorded the location where each fish was collected, fight time, water depth and general physical condition of fish. These factors were used to determine whether walleye were appropriate candidates for surgical implantation of transmitters. Transmitters were implanted in suitable walleye (Range in fork length = 354 to 665 millimeters (mm), range in wet mass = 360 to 2330 grams (g)) and the fish were subsequently released to the exact location where they were caught.

Walleye were anaesthetized using eugenol (oil of clove, 85% by weight) diluted in lake water following the method described by Anderson et al. (1997) and Keene et al. (1998). Transmitters were tested and then implanted following techniques described by Bidgood (1980), and modified based on personal experience. During implantation, fish were placed on the surgical table (Figure 2) and continuously misted (both external body and gills) with lake water. After surgery each walleye was returned to a holding tank filled with lake water (Figure 3). Details of each surgery are provided in Appendix 1 and fish were released when they regained normal swimming behaviour (Hikasa et al. 1986).

Walleye were implanted with Lotek CART 16_1 series (combined acoustic/radio) transmitters as recommended for walleye in Alberta lakes (D. Watters, M. Sullivan, J. Walker pers. comm., Alberta Sustainable Resource Development). These combined transmitters allow for the detection of signals even if fish move between shallow and deep environments. Transmitters (diameter and length = 16 mm X 60 mm) are cylindrical in shape and also consist of a 40 cm whip antenna and weigh 16.3 g (Figure 4).

We quantified the location of transmitter-implanted walleye using a Lotek's SRX_400 receiver and a folding directional Yagi antenna mounted on a 1.5 m pole. The pole can be easily rotated and aids in fixing locations using triangulation of each radio signal (Figure 5). A hydrophone was also tested for signal retrieval but after using it for

Figure 2. Surgical table used to implant radio transmitters in walleye in Calling Lake, Alberta.

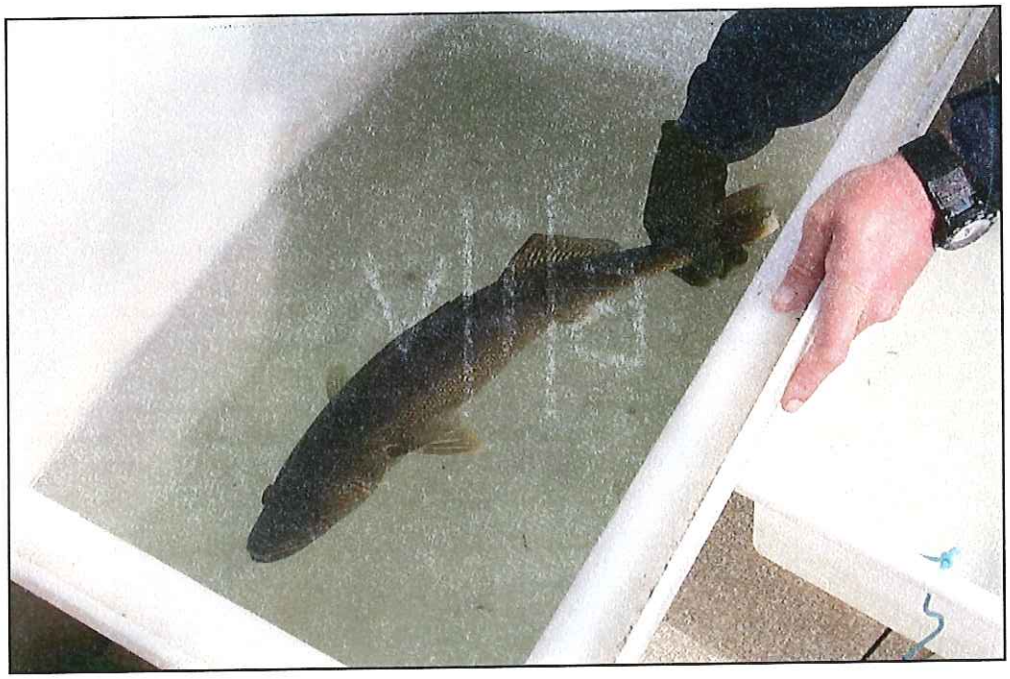

Figure 3. A walleye being revived in the recovery and holding tank prior to release.

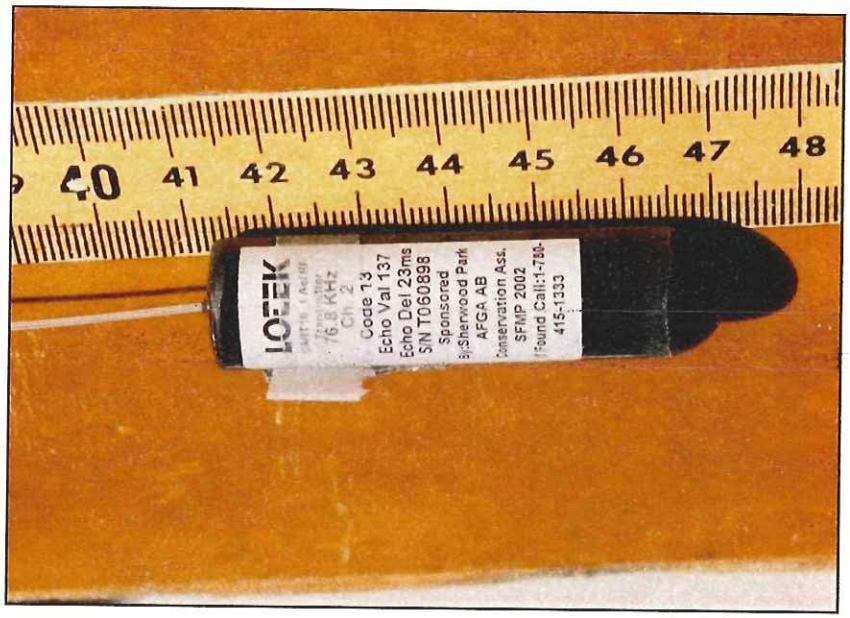

Figure 4. Lotek's CART 16_1 series transmitter.

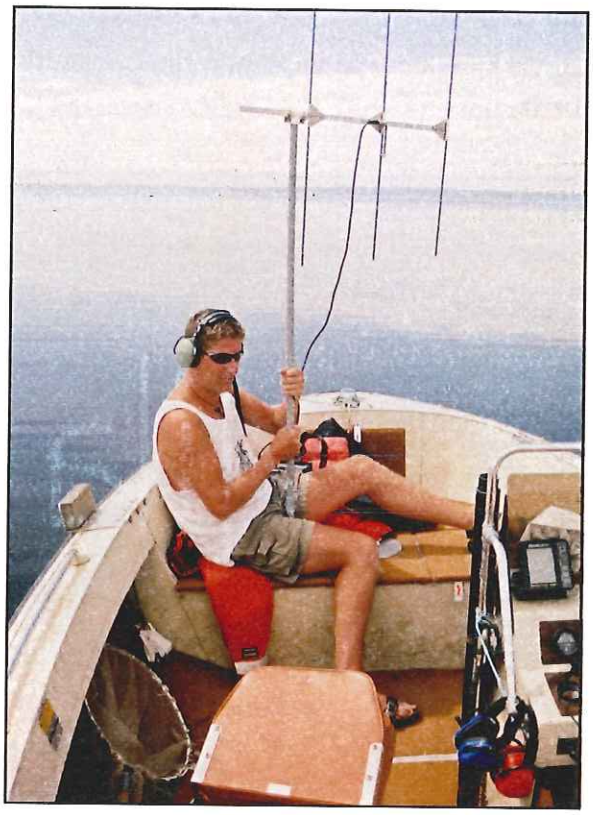

Figure 5. Boat set-up to locate walleye implanted with transmitters in Calling Lake, Alberta.

several surveys it became apparent that this equipment was unsafe and very time consuming given the large lake size, wind and wave conditions, and the attenuation of the acoustic signal. Use of the hydrophone in this survey was, therefore, unacceptable and its use was discontinued.

Thirty-six biotelemetry surveys were conducted by boat between 14 June and 28 August, 2002. To facilitate the division of each biotelemetry survey into multiple transects transmitter and receiver performance was determined by comparing Global Positioning System (GPS, NAD1983 datum) waypoints of initial transmitter reception to the final position of the transmitter. Subsequently, each survey was divided into a series of 3 transects (Figure 6), each approximately 2 km wide. During the surveys the boat traveled at approximately 30 km / h, and each complete survey of Calling Lake took 6 – 8 hours. I also varied direction of travel to overcome a potential bias in survey results. However, lake size and winds complicated some surveys, and survey direction was often modified to account for weather conditions. Signs were placed at public access locations notifying anglers of the biotelemetry project and requested that they release all walleye with transmitters (Figure 7).

The Universal Transverse Mercator (UTM) locations of each study walleye was recorded on data sheets along with date, time, water depth (metres, m), condition of the lake water surface, and prevailing wind and weather conditions (Appendix 2). ESRI ArcGIS was utilized to analyze the geodatabase created from survey and map data and Microsoft Excel 2000 was used to complete statistical analyses. Following Minns (1995), I calculated minimum convex polygons (MCP) to enclose each walleye's biotelemetry locations.

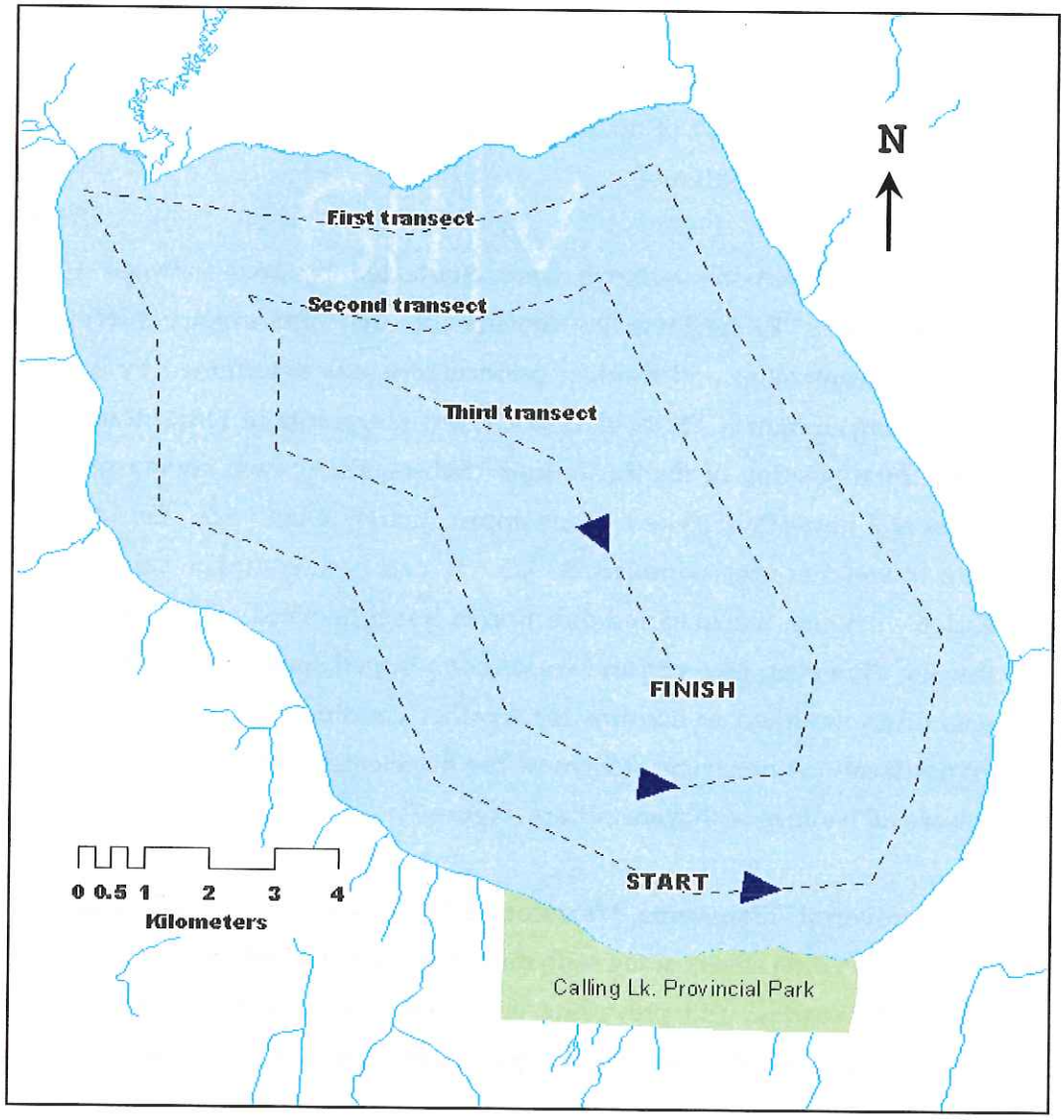

Figure 6. Typical travel paths to complete telemetry surveys in Calling Lake. Arrows indicate direction of travel. The location of the Calling Lake Provincial Park in the southern region of Calling Lake is highlighted in green.

Figure 7. An example of a public information sign placed at access points in Calling Lake 2002.

4.0 RESULTS

Radio-tagged walleye were located a total of 173 times during the study period, and I was often able to document positions of individual walleye more than once during a single surveys. I randomly selected only 1 position per individual fish on a given survey to include in analyses (Table 1). All radio-tagged walleye were not located in every survey (mean days between encounters = 6.3, SE = 0.7), however, all 12 walleye were located throughout the survey period (Figure 8). Paragamian (1989) notes that the mortality of radio-tagged fish is most likely to occur immediately after implantation. All radio-tagged walleye survived implantation and were alive at the end of the study period (i.e. zero mortality).

Table 1. Summary of walleye location information during telemetry surveys in Calling Lake, 2002. Number of locations, mean water depths, travel rate, home ranges and mean number of days between encounters are provided for each radio-tagged walleye.

Tag number	Number of locations	Mean depth (m)	Travel rate (km/day)	Home range (ha)	Mean number of days between encounters
2	10	3.1	1.1	3,681	9.8
3	11	5.5	1.7	6,439	8.3
4	12	2.8	1.5	8.189	8.0
5	8	5.9	1.2	1,972	11.2
6	13	5.4	1.5	9,185	7.4
7	22	3.6	1.2	8,390	3.9
8	28	3.2	0.8	1,787	3.1
9	18	3.1	0.7	464	5.0
10	15	3.2	1.3	1,398	5.1
11	8	3.0	0.9	4,681	3.8
12	14	3.1	0.5	1,999	4.3
13	4	3.7	0.8	3,202	28.9
Mean	14	3.8	1.1	4,282	8.2

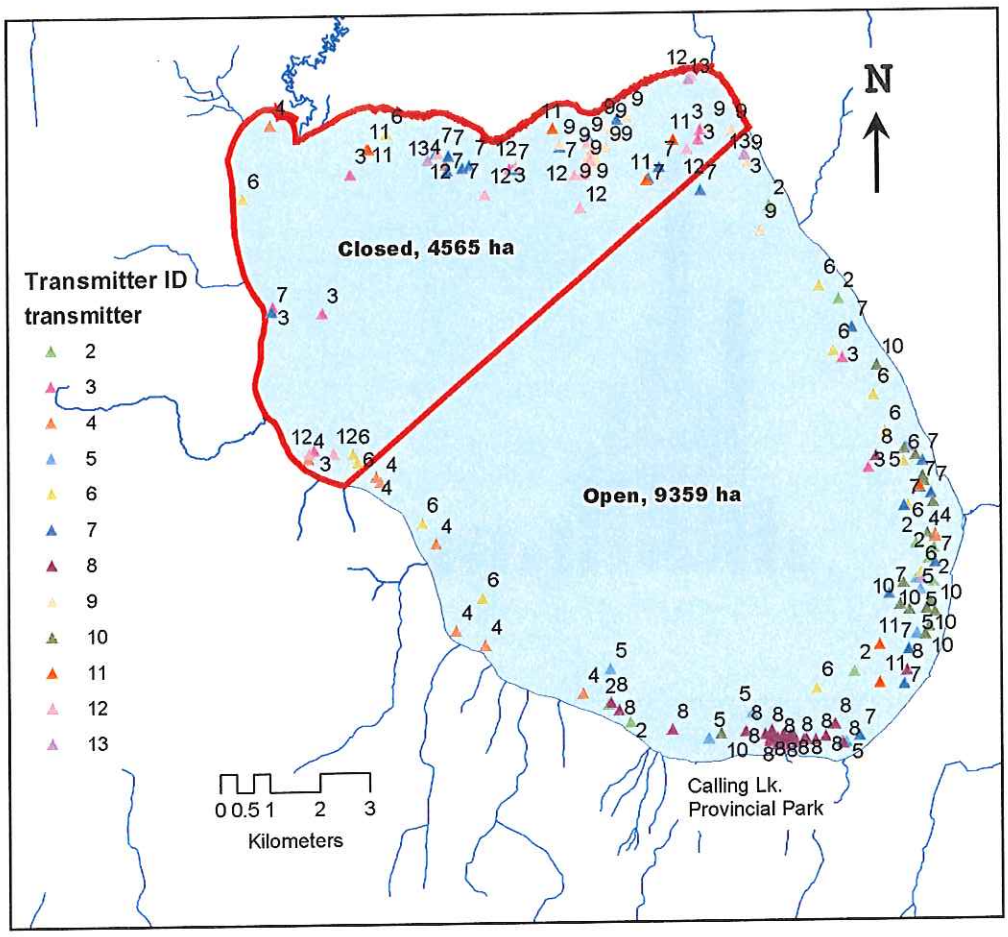

Figure 8. Locations of walleyes during the survey period, Calling Lake, 2002. Symbols are numbered with transmitter identity.

4.1 Depth of water at walleye locations

On average, walleye were located in Calling Lake at water depths of 3.8 m (SE=0.2 m, n=140). The distribution of water depths at which walleye were located (0.8–13.6 m) was highly skewed towards shallow water (Figure 9). The proportion of walleye in each depth category was significantly different from random (Chi square <0.001, P<0.001, n=173), indicating that fish selected shallow water (Table 2). The distribution of the angler locations (Appendix 6.4) during a roving creel survey (Patterson 2004) appeared to be similar to the distribution of the biotelemetry locations of walleye. Results from Fall Walleye Index Netting (FWIN) suggested that walleye distribute themselves to deeper environments during the fall period (Fisheries Management Information System [FMIS] query).

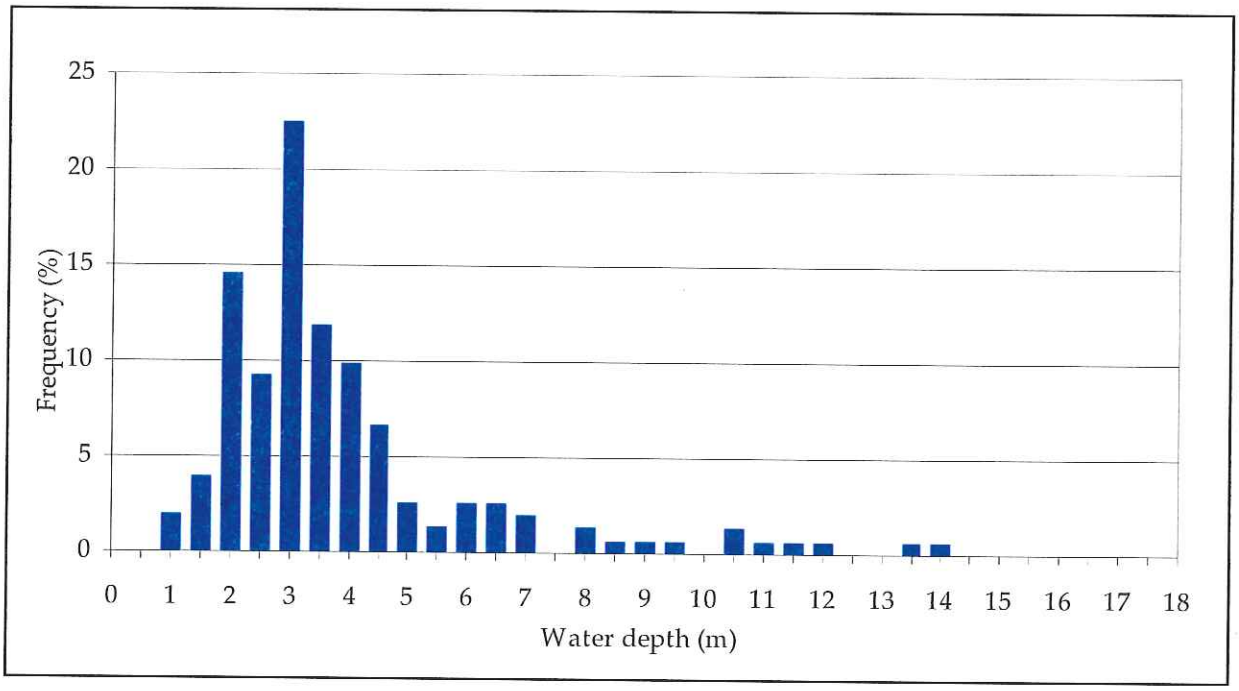

Figure 9. Distribution of water depths where radio-tagged walleye were detected in Calling Lake, 2002.

Table 2. Comparison of the detections of radio-tagged walleye per depth strata in Calling Lake in 2002.

Depth strata (m)	% Lake per strata	% Walleye per strata
< 3	12.3	37.0
3 - 6	13.3	44.5
6 - 9	10.2	15.0
9 - 12	15.2	1.7
12 - 15	24.2	1.7
15 - 18	19.7	0.6
> 18	5.2	0.6

4.2 Movement of walleye

Walleye on average traveled 1.01 km per day (SE=0.10, n=150, distribution range = 0.003–5.8 km/day) (Figure 10). Linear regression showed that mean movement rates were not significantly related to walleye body length (P>0.05, R^2=0.01, n=12). Walker et al. (1996) observed summer movement of McLeod River walleye as significantly higher than that in the winter and significantly smaller than spring movement. However, there is no significant difference between movement in the summer and fall. The movement data of walleye in our study follow Paragamian's (1989) results, in that this walleye stock is highly mobile.

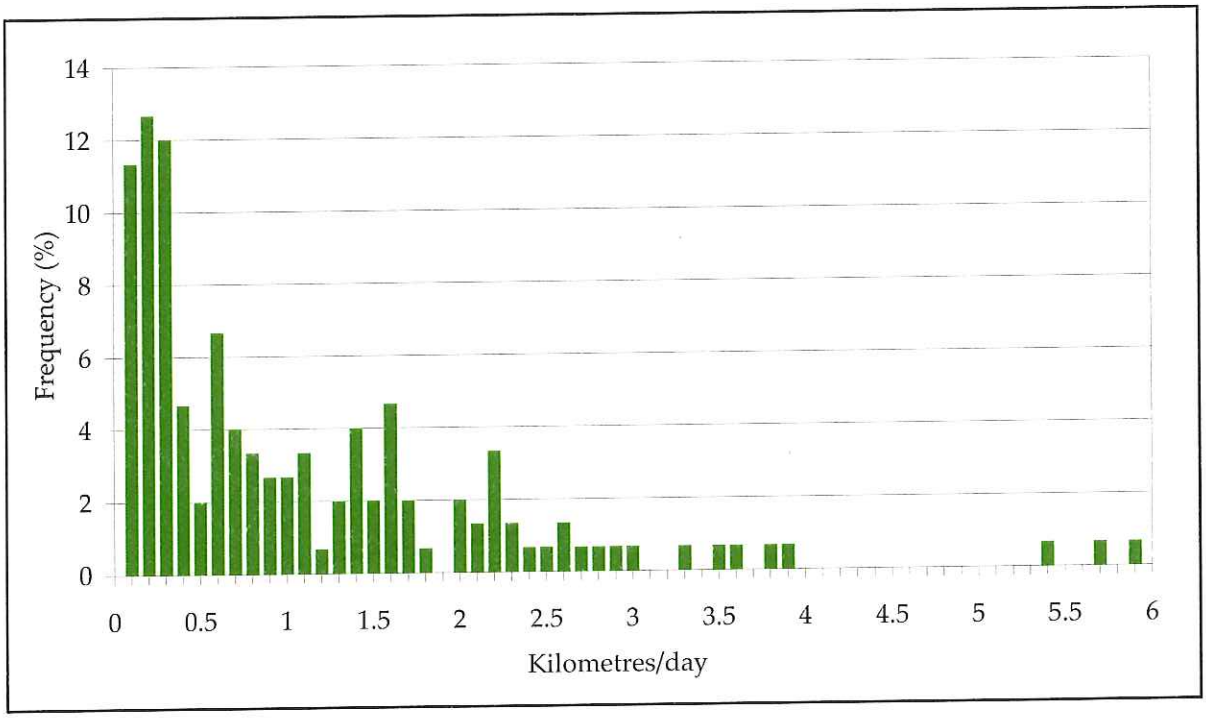

Figure 10. Frequency distribution of daily travel distances by walleyes in Calling Lake, 2002.

4.3 Closed area

The area closed to angling in Calling Lake is 4,565 ha and represents 33% of the total surface area of Calling Lake. The proportion of walleye locations in the closed area was not significantly different than the proportion of locations in the open area (Chi square

test, P=0.27, n=173) indicating fish were not selecting the closed area (Table 3). The expected values were based on the 33% (closed) versus 67% (open).

Additional analysis showed that tagged walleye did not show a seasonal preference for either the open or closed areas, as the difference between the expected and actual numbers of tagged walleye in the open zone compared over time was not significantly different from a flat line (F=0.52, R^2=0.11, P=0.65) (Figure 11).

Table 3. Summary of a Chi-square test comparing the percentage of radio-tagged walleye located in the area closed to angling with that expected based on the relative size of the area in Calling Lake, 2002.

Zone	Actual	% Actual	Expected	% Expected	P
Closed	65	37.8	57	32.8	**0.271**
Total locations	173		173		

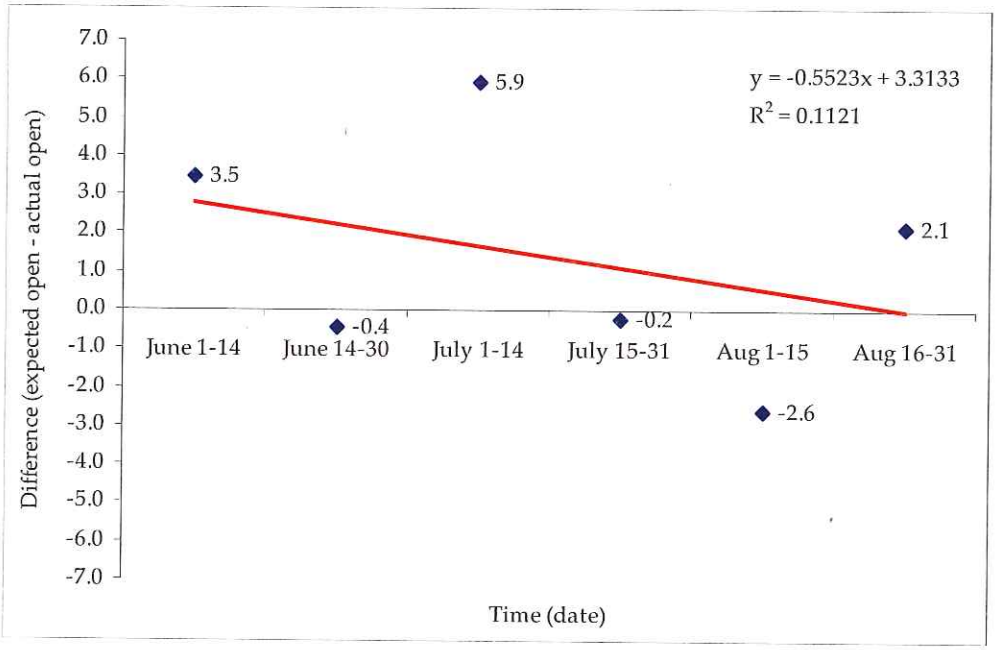

Figure 11. Linear regression of the difference in expected vs. observed use of the open area by walleye in Calling Lake throughout the summer of 2002.

4.4 Dispersal of walleye

Gerking (1953, 1959) demonstrated that fish occupy home ranges and defined these as "the area over which an animal normally travels." I identified home ranges of walleye in Calling Lake by delineating areas of use through the application of a minimum convex polygon (MCP) approach (following Minns 1995). Using this method, I quantified home ranges for all 12 study fish (individual home ranges are provided in Appendix 6.3.). The mean size of the home ranges was 4,282 ha (n=12, range=464 to 9,185 ha). Most walleye located during biotelemetry surveys exhibited extensive home ranges. Itinerant fish tended to have larger home ranges (Linear regression, R^2=0.46, P = <0.05, n=12). When these data are dissolved into a single home range for all 12 study individuals, walleye used about 89% (12,355 ha) of the total area of Calling Lake (Figure 12).

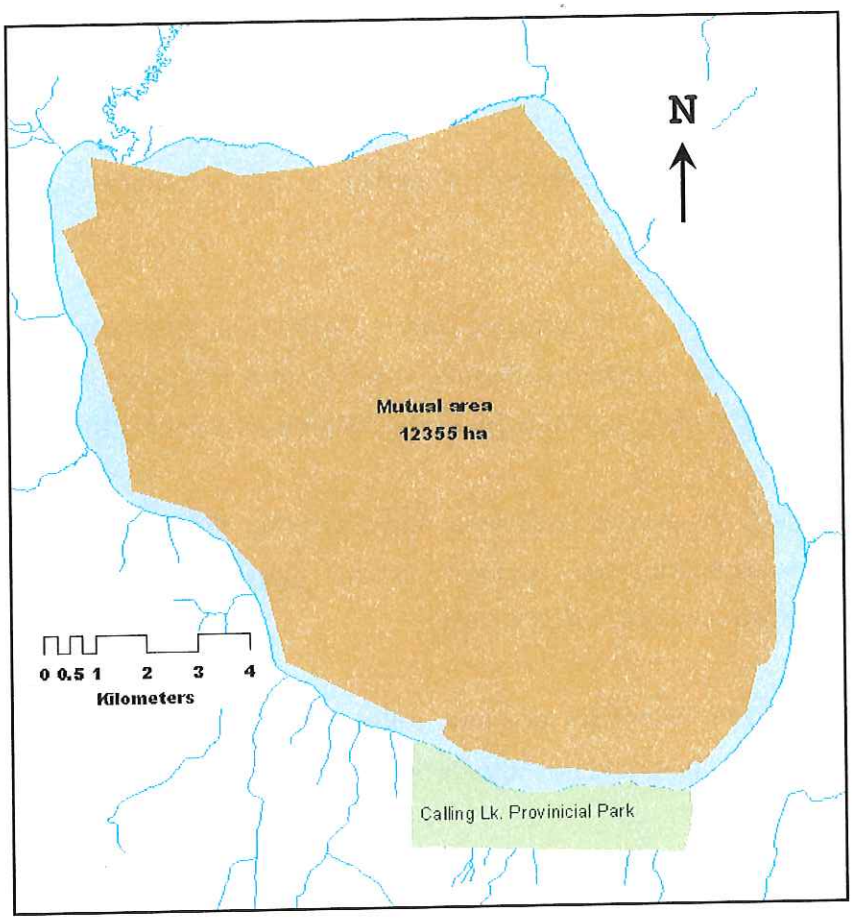

Figure 12. The area representing overlap in walleye home ranges, Calling Lake 2002.

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6.0 APPENDICES

6.1 Appendix 1. Summary of surgery and physical characteristics of 12 radio-tagged walleye in Calling Lake, Alberta, June – August, 2002.

Fish number	Date tagged	Drops/ litre	Time to anaesthetize (min)	Time of surgery (min)	Time to recover (min)	Elapsed time (min)	Location (Easting/ Northing)	Transmitter (Mhz/Khz/code)	Regulation zone	FL (mm)
2	1-Jun	1.5	5	5.75	25	35.75	359456 / 6119709	149.340 / 76.8 / 2	Open	660
3	6-Jun	1.5	4.75	6.25	8.5	19.5	346523 / 6126335	149.340 / 76.8 / 3	Closed	618
4	1-Jun	2	5.75	4	30	39.75	359456 / 6119709	149.340 / 76.8 / 4	Open	544
5	1-Jun	1.5	6.5	5.5	23.25	35.25	359456 / 6119709	149.340 / 76.8 / 5	Closed	600
6	1-Jun	1	17	6.75	6.75	30.5	349513 / 6122006	149.340 / 76.8 / 6	Open	633
7	6-Jun	1.5	4	5.75	10.25	17	346499 / 6126234	149.340 / 76.8 / 7	Closed	485
8	5-Jun	1.5	5	4.5	6.75	16.25	356642 / 6117644	149.340 / 76.8 / 8	Open	488
9	5-Jun	1.5	4	5	7	16	355778 / 6129768	149.340 / 76.8 / 5	Open	547
10	5-Jun	1.5	4.2	5.75	12.5	22.45	358676 / 6125065	149.340 / 76.8 / 10	Open	354
11	4-Jun	1.5	4	5	11	20	352190 / 6129824	149.340 / 76.8 / 11	Closed	487
12	2-Jun	1.5	4	4.75	9	17.75	354970 / 6130851	149.340 / 76.8 / 12	Closed	556
13	2-Jun	1.5	4	4.75	13	21.75	354919 / 6130788	149.340 / 76.8 / 13	Closed	665
	Mean	1.5	5.7	5.3	13.6	24.3			6 Open 6 Closed	

6.2 Appendix 2. Summary of data collected from biotelemetry surveys in Calling Lake between 14 June and 28 August 2002.

Surface conditions are: 1 = calm, 2 = riffle, 3 = chop, 4 = waves, 5 = heavy waves. Wind direction is: 1 = N, 2 = NE, 3 = E, 4 = SE, 5 = S, 6 = SW, 7 = W, 8 = NW. Weather condition codes are: 1 = sunny, 2 = partially cloudy, 3 = drizzle, 4 = rain, 5 = moderate rain, 6 = heavy rain.

Radio-tag	Encounter	Date	Time	UTM Easting	UTM Northing	Depth (m)	Surface condition	Wind direction	Weather condition	Distance (km)	Days	Km/day
2	1	1-Jun	17:32	359456	6119709							
2	2	14-Jun	18:32	353685	6117998	1.5	2	2	1	6	13.2	0.5
2	3	17-Jun	15:00	353239	6118357	2.4	4	2	3	0.6	3	0.2
2	4	21-Jun	16:54	356523	6128254	2.8	5	8	1	10.4	4.1	2.6
2	5	14-Jul	19:42	357914	6126382	2.6	4	6	1	2.3	23.3	0.1
2	6	18-Jul	18:05	359448	6121501	3.9	1	0	1	5.1	4.1	1.3
2	7	25-Aug	17:05	359790	6120742	2.4	2	4	2	0.8	37.5	0
2	8	26-Aug	22:34	358202	6118965	6.1	1	0	2	2.4	1	2.4
2	9	27-Aug	13:41	359804	6121410	3.1	1	0	1	2.9	1	2.9
2	10	28-Aug	16:50	359691	6121193		3	5	1	0.2	1	0.2
3	1	6-Jun	15:34	346523	6126335							
3	2	13-Jun	16:45	357989	6125213	8.5	2	7	2	11.5	7.1	1.6
3	3	14-Jun	15:11	359315	6123428	1.5	1	6	1	2.2	1	2.2
3	4	17-Jun	12:00	358508	6123024	8	4	2	3	0.9	3	0.3
3	5	20-Jun	12:04	355152	6129774	1.9	1	5	2	7.5	3	2.5
3	6	20-Jun	17:23	355109	6129583	2.5	3	6	2	0.2	0.2	0.9
3	7	21-Jun		356058	6129278	2.7	5	8	1	1	1	1
3	8	10-Jul	17:01	351313	6129039	1.7	1	5	1	4.8	19.3	0.2
3	9	14-Jul	18:10	347351	6123470	4.5	4	7	1	6.8	4.1	1.7
3	10	16-Jul	10:05	347519	6126197	10.5	1	1	1	2.7	2	1.3
3	11	26-Aug	21:40	348094	6128960	10.2	1	0	2	2.8	40.6	0.1
3	12	28-Aug	15:50	359952	6129656		3	5	1	11.9	2	5.9
4	1	1-Jun	16:45	359456	6119709							
4	2	20-Jun	19:20	350785	6119557	2.7	2	6	1	8.7	19.3	0.5
4	3	21-Jun	21:20	352731	6118580	2.7	1	8	1	2.2	1	2.1
4	4	28-Jun	20:46	348582	6122928	1.8	2	8	1	6	7.1	0.8
4	5	6-Jul	13:08	349795	6121591	8.9	3	7	2	1.8	8.1	0.2
4	6	7-Jul	14:58	350199	6119845	2	2	2	1	1.8	1	1.8
4	7	9-Jul	14:31	346489	6129946	2.6	1	0	2	10.8	2	5.3
4	8	10-Jul	16:24	350033	6129127	2.1	1	0	1	3.6	1	3.6
4	9	14-Jul	0:00	347229	6123304	2	4	7	1	6.5	4.1	1.6
4	10	16-Jul	9:28	348674	6122827	0.8	1	1	1	1.5	2	0.8
4	11	27-Aug	13:44	359825	6121630	2.5	1	0	1	11.2	41.6	0.3
4	12	28-Aug	16:42	359825	6121687		3	5	1	0.1	1	0.1
5	1	1-Jun	17:05	359456	6119709							

6.2 Appendix 2. Continued.

Radio-tag	Encounter	Date	Time	UTM Easting	UTM Northing	Depth (m)	Surface condition	Wind direction	Weather condition	Distance (km)	Days	Km / day
5	2	17-Jun	15:19	355259	6117653	4.7	4	2	3	4.7	16.2	0.3
5	3	18-Jun	10:04	357936	6117566	3.2	3	1	2	2.7	1	2.6
5	4	18-Jun	15:03	358035	6117556	3.1	3	2	2	0.1	0.2	0.5
5	5	21-Jun	17:16	359261	6123427	2.6	5	8	1	6	3	2
5	6	10-Jul	18:32	359535	6120587	3.1	1	5	1	2.9	19.3	0.1
5	7	14-Jul	17:30	353286	6119059	13.6	4	7	1	6.4	4.1	1.6
5	8	18-Jul	17:49	359466	6120812	3.2	1	0	1	6.4	4.1	1.6
5	9	18-Aug	9:49	356139	6118160	10.9	2	6	1	4.3	30.4	0.1
6	1	1-Jun	13:56	349513	6122006							
6	2	14-Jun	17:12	345930	6128494	1.7	3	2	2	7.4	13.2	0.6
6	3	20-Jun	14:00	348219	6123231	2.2	2	7	2	5.7	6.1	0.9
6	4	20-Jun	18:00	348130	6123392	3.9	3	6	2	0.2	0.6	0.3
6	5	21-Jun	21:54	350729	6120501	13.3	1	0	1	3.9	1	3.8
6	6	28-Jun	19:34	357802	6125364	8	3	8	2	8.6	7.1	1.2
6	7	4-Jul	17:31	358831	6123732	3.8	5	2	2	1.9	6.1	0.3
6	8	10-Jul	16:00	348828	6129748	2.9	1	0	1	11.7	6.1	1.9
6	9	14-Jul	20:26	357432	6118635	11.3	4	6	1	14.1	4.1	3.5
6	10	16-Jul	11:16	359535	6120917	3.3	1	2	1	3.1	2	1.5
6	11	18-Jul	18:11	359281	6122264	4.1	1	0	1	1.4	2	0.7
6	12	25-Aug	16:42	357524	6126651	4.9	2	4	1	4.7	37.5	0.1
6	13	27-Aug	15:02	359200	6123141	4	2	1	1	3.9	2	1.9
6	14	28-Aug	16:31	358601	6124468		3	5	1	1.5	1	1.4
7	1	6-Jun	17:45	346499	6126234							
7	2	13-Jun	11:55	359295	6119392	4.2	4	8	2	14.5	7.1	2
7	3	13-Jun	15:40	358296	6117687	2.6	2		1	2	0.2	12.4
7	4	14-Jun	14:43	359200	6118714	3.3	1	6	1	1.4	1.0	1.3
7	5	20-Jun	11:35	359543	6122612	2.3	1	0	2	3.9	6.1	0.6
7	6	20-Jun	16:56	359831	6121120	2.1	3	6	2	1.5	0.2	6.6
7	7	21-Jun	17:30	359750	6122503	3	5	8	1	1.4	1	1.4
7	8	28-Jun	20:08	352329	6129457	3.9	3	8	2	10.2	7.1	1.4
7	9	4-Jul	17:53	358998	6125960	3.9	4	2	2	7.5	6.1	1.2
7	10	6-Jul	11:30	354097	6128817	5.9	4	8	1	5.7	2	2.8
7	11	9-Jul	13:54	351387	6129019	2.9	1	0	2	2.7	3	0.9
7	12	10-Jul	17:18	353473	6129995	2	1	5	1	2.3	1	2.3
7	13	14-Jul	19:07	349836	6129359	1.6	4	7	1	3.7	4.1	0.9

6.2 Appendix 2. Continued.

Radio-tag	Encounter	Date	Time	UTM Easting	UTM Northing	Depth (m)	Surface condition	Wind direction	Weather condition	Distance (km)	Days	Km/ day
7	14	16-Jul	10:29	352913	6129563	1.1	1	4	1	3.1	2	1.5
7	15	18-Jul	20:58	350060	6129006	3.1	3	8	2	2.9	2	1.4
7	16	20-Jul	13:19	350088	6129310	1.6	4	8	3	0.3	2	0.2
7	17	27-Jul	21:00	355150	6128576	11.7	4	8	4	5.1	7.1	0.7
7	18	1-Aug	18:05	358914	6120508	6.3	3	8	2	8.9	4.1	2.2
7	19	2-Aug	18:23	359937	6123273	5.5	3	2	3	2.9	1	2.9
7	20	4-Aug	17:10	359212	6122251	4	4	4	2	1.3	2	0.6
7	21	18-Aug	11:04	354310	6129048	5	1	6	1	8.4	14.2	0.6
7	22	25-Aug	16:10	352903	6129648	1	2	6	1	1.5	7.1	0.2
7	23	26-Aug	21:47	350377	6129062	1.3	1	0	2	2.6	1	2.6
7	24	27-Aug	16:36	350516	6129108	1.1	3	1	1	0.1	1	0.1
8	1	5-Jun	21:00	356642	6117644							
8	2	14-Jun	18:01	353459	6118242	3.1	2	2	2	3.2	9.1	0.4
8	3	17-Jun	14:46	353301	6118383	2.6	4	2	3	0.2	3	0.1
8	4	18-Jun	14:35	354520	6117840	2.7	1	7	2	1.3	1	1.3
8	5	20-Jun	10:45	356641	6117530	1.8	2	7	2	2.1	2	1.1
8	6	20-Jun	19:46	356720	6117655	1.8	2	4	2	0.1	0	
8	7	21-Jun	20:59	356796	6117514	1.6	1	8	1	0.2	1	0.2
8	8	28-Jun	16:42	356811	6117526	2.7	3	8	3	0	7.1	0
8	9	28-Jun	22:36	356535	6117741	3	2	8	1	0.3	0.2	1.4
8	10	3-Jul	14:00	359255	6118975	4.2	3	3	2	3	5.1	0.6
8	11	4-Jul	16:25	357610	6117679	3.2	2	8	2	2.1	1	2.1
8	12	5-Jul	19:26	356892	6117713	4.8	5	8	2	0.7	1	0.7
8	13	5-Jul	21:13	357210	6117622	2.8	5	8	2	0.3	0.1	4.5
8	14	7-Jul	9:29	356493	6117631	2.7	2	8	1	0.7	2	0.4
8	15	7-Jul	15:29	356565	6117626	2.7	2	8	1	0.1	0.3	0.3
8	16	9-Jul	12:35	357410	6117609	2.7	2	2	2	0.8	2	0.4
8	17	9-Jul	15:30	357163	6117610	2.7	2	2	2	0.2	0.1	2
8	18	10-Jul	13:52	356604	6117618		2	5	2	0.6	1	0.6
8	19	13-Jul	17:14	356521	6117805	4.2	4	7	1	0.2	3	0.1
8	20	16-Jul	8:48	356749	6117726	4	2	2	2	0.2	3	0.1
8	21	18-Jul	22:32	356494	6117589	2.6	1	1	1	0.3	2	0.1
8	22	19-Jul	17:06	356603	6117652	1.3	5	1	4	0.1	1	0.1
8	23	20-Jul	12:22	356397	6117727	2.6	5	8	5	0.2	1	0.2
8	24	27-Jul	19:22	356917	6117640	3.2	4	8	4	0.5	7.1	0.1
8	25	2-Aug	18:34	358659	6123259	6.7	3	2	2	5.9	5.1	1.2

6.2 Appendix 2. Continued.

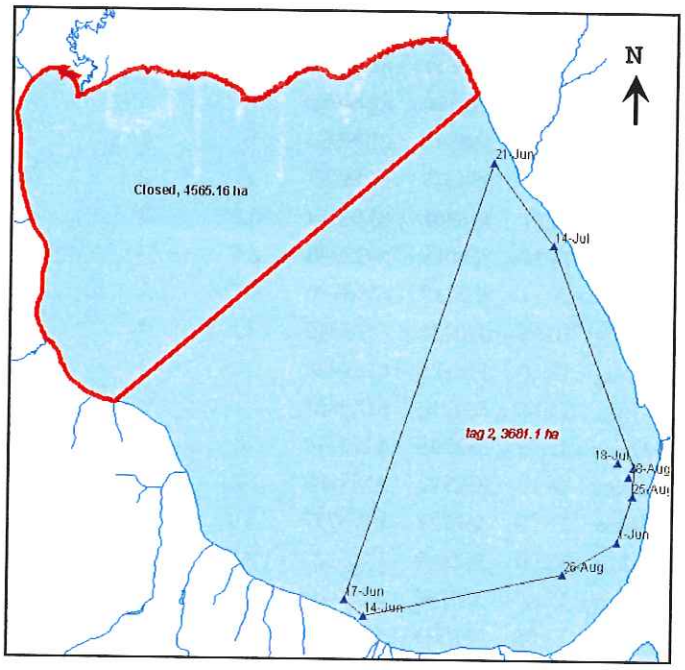
Radio-tag	Encounter	Date	Time	UTM Easting	UTM Northing	Depth (m)	Surface condition	Wind direction	Weather condition	Distance (km)	Days	Km/ day
8	26	3-Aug	14:00	357972	6117538	2.9	1	0	2	5.8	1.0	5.7
8	27	4-Aug	17:48	356941	6117714	4.2	2	4	2	1	1	1
8	28	5-Aug	9:59	357799	6117913	3.6	4	2	6	0.9	1	0.9
8	29	25-Aug	12:53	356522	6117748	5.1	4	4	1	1.3	20.3	0.1
8	30	26-Aug	22:45	357017	6117545	2.4	1	0	2	0.5	1	0.5
8	31	27-Aug	17:46	356012	6117784	2.4	1	1	1	1	1	1
8	32	28-Aug	12:55	356654	6117512		2	5	1	0.7	1	0.7
9	1	5-Jun	12:29	355778	6129768							
9	2	13-Jun	17:30	355325	6129825	2	1	7	2	0.5	8.1	0.1
9	3	17-Jun	13:32	353015	6129402	2.7	4	2	3	2.3	4.1	0.6
9	4	18-Jun	10:56	353013	6129322	4.3	3	8	2	0.1	1	0.1
9	5	21-Jun	16:11	352959	6129120	3.8	5	8	1	0.2	3	0.1
9	6	28-Jun	20:10	352307	6129507	3.6	3	8	2	0.8	7.1	0.1
9	7	4-Jul	18:07	356348	6127776	3.9	5	2	2	4.4	6.1	0.7
9	8	5-Jul	20:27	352937	6129341	1.7	2	8	8	3.8	1	3.7
9	9	6-Jul	11:52	353073	6129145	5.8	4	7	1	0.2	1	0.2
9	10	7-Jul	12:54	353689	6130037	2.7	1	0	1	1.1	1	1.1
9	11	10-Jul	17:25	353472	6129655	3.4	1	5	1	0.4	3	0.1
9	12	14-Jul	19:25	352974	6129256	3	4	7	1	0.6	4.1	0.2
9	13	18-Jul	20:40	353166	6129880		3	8	1	0.7	4.1	0.2
9	14	18-Aug	10:55	352845	6129191	2.4	1	6	1	0.8	30.4	0
9	15	25-Aug	16:17	353241	6129442	2.9	3	4	1	0.5	7.1	0.1
9	16	26-Aug	22:02	353356	6129808	2.4	1	0	2	0.4	1	0.4
9	17	27-Aug	16:21	352865	6129535	1.8	3	1	1	0.6	1	0.6
9	18	28-Aug	16:06	356088	6129143		2	5	1	3.2	1	3.2
10	1	5-Jun	21:50	358676	6125065							
10	2	13-Jun	16:15	359451	6123264	1.6	2	7	1	2	8.1	0.2
10	3	18-Jun	12:45	355499	6117748	4.5	1	7	2	6.8	5.1	1.3
10	4	20-Jun	11:15	359311	6120189	3.4	1	7	2	4.5	2	2.2
10	5	20-Jun	16:38	359628	6119688	3	3	6	2	0.6	0.2	2.6
10	6	21-Jun		359700	6119841					0.2	1	0.2
10	7	28-Jun	18:13	359734	6120353	3.4	3	8	2	0.5	7.1	0.1
10	8	3-Jul	13:00	359194	6120720	4.2	3	6	1	0.7	5.1	0.1
10	9	6-Jul	10:40	359680	6121706	3.6	4	8	1	1.1	3	0.4
10	10	7-Jul	11:28	359611	6122736	1.7	2	8	1	1	1	1
10	11	9-Jul	13:00	359787	6122339	3.2	1	0	2	0.4	2	0.2
10	12	10-Jul	18:34	359654	6120200	3.1	1	5	1	2.1	1	2.1
10	13	14-Jul	19:58	359221	6123394	3	4	6	7	3.2	4.1	0.8

6.2 Appendix 2. Continued.

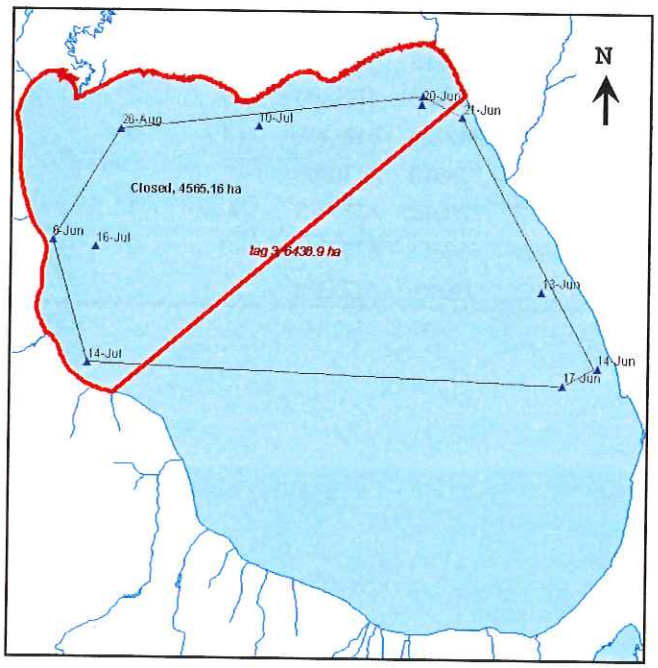
Radio-tag	Encounter	Date	Time	UTM Easting	UTM Northing	Depth (m)	Surface condition	Wind direction	Weather condition	Distance (km)	Days	Km/ day
10	14	16-Jul	11:41	359818	6120142	1.9	2	2	1	3.3	2	1.6
10	15	18-Jul	18:33	359591	6122849	1.7	1	0	1	2.7	2	1.3
10	16	27-Jul	21:30	359131	6120291	3.8	4	8	4	2.6	9.1	0.3
11	1	4-Jun	12:13	352190	6129824							
11	2	13-Jun	17:40	354594	6129584	6	1	7	2	2.4	9.1	0.3
11	3	14-Jun	17:23	354065	6128789	6	2	2	2	1	1	0.9
11	4	3-Jul	14:11	358702	6118740	6.2	3	8	2	11.1	19.3	0.6
11	5	10-Jul	18:17	359518	6122648	2.5	1	5	2	4	7.1	0.6
11	6	2-Aug	19:14	358710	6119490	6.7	3	2	2	3.3	22.3	0.1
11	7	18-Aug	10:35	348431	6129440	9.1	2	6	1	14.3	16.2	0.9
11	8	28-Aug	13:50	348474	6129448		1	0	1	0	10.1	0
12	1	2-Jun	11:27	354970	6130851					6.6		
12	2	13-Jun	17:55	352993	6129410	2	1	7	2	2.4	11.2	0.2
12	3	14-Jun	16:13	352932	6129185	2	2	2	2	0.2	1	0.2
12	4	18-Jun	11:00	352725	6128257	2.4	4	2	3	1	4.1	0.2
12	5	20-Jun	13:00	352819	6128925	2.8	1	5	2	0.7	2	0.3
12	6	20-Jun	17:55	352760	6128902	3	3	6	2	0.1	0.2	0.3
12	7	21-Jun	16:05	352893	6129558	0.9	5	8	1	0.7	1	0.7
12	8	3-Jul	12:17	354879	6129389	6.7	1	6	1	2	12.2	0.2
12	9	6-Jul	12:00	352867	6128995	3	4	7	1	2.1	3	0.7
12	10	7-Jul	13:14	352610	6128903	6.2	1	0	1	0.3	1	0.3
12	11	9-Jul	13:53	351440	6129075	3.1	1	0	2	1.2	2	0.6
12	12	10-Jul	16:46	349870	6129353	1.7	1	6	1	1.6	1	1.6
12	13	14-Jul	19:13	350815	6128541	3	4	7	1	1.2	4.1	0.3
12	14	18-Jul	21:21	347243	6123400	2.9	2	8	1	6.3	4.1	1.5
12	15	27-Jul	20:12	347741	6123405	4.1	3	8	2	0.5	9.1	0.1
13	1	2-Jun	11:48	354919	6130788							
13	2	10-Jul	16:15	349672	6129225	4	1	0	1	5.5	38	0.1
13	3	16-Jul	11:28	359557	6120798	3.3	2	7	1	13	6.1	2.1
13	4	28-Aug	15:57	356040	6129284		3	5	1	9.2	42.6	0.2

6.3. Appendix 3. Minimum Convex Polygons (MCP) of radio-tagged walleye in Calling Lake, 2002.

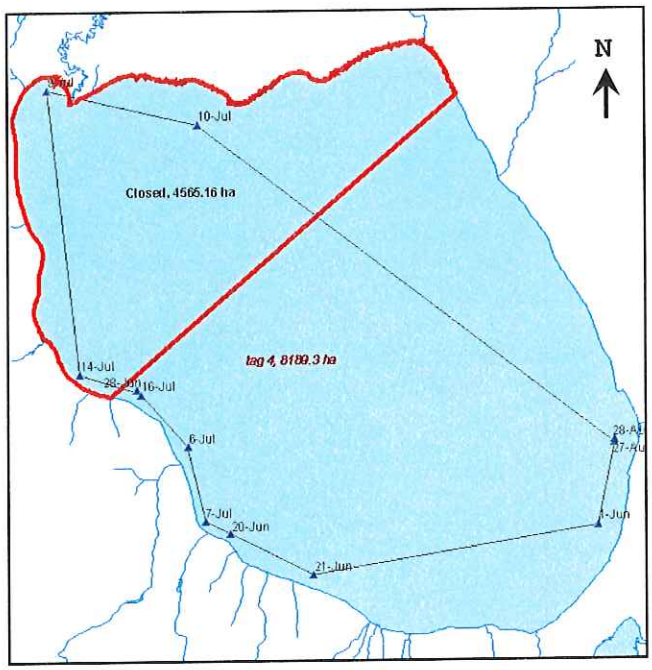
6.3.1. MCP of radio-tagged walleye #2.



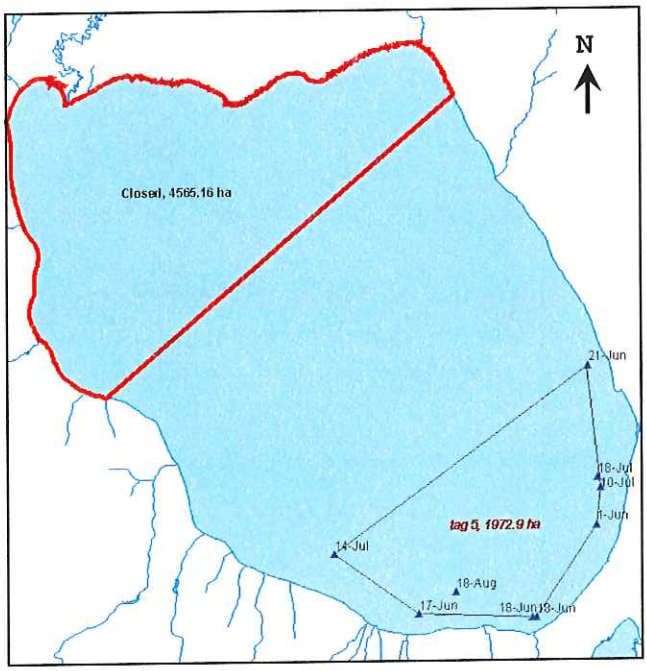
6.3.2. MCP of radio-tagged walleye #3.



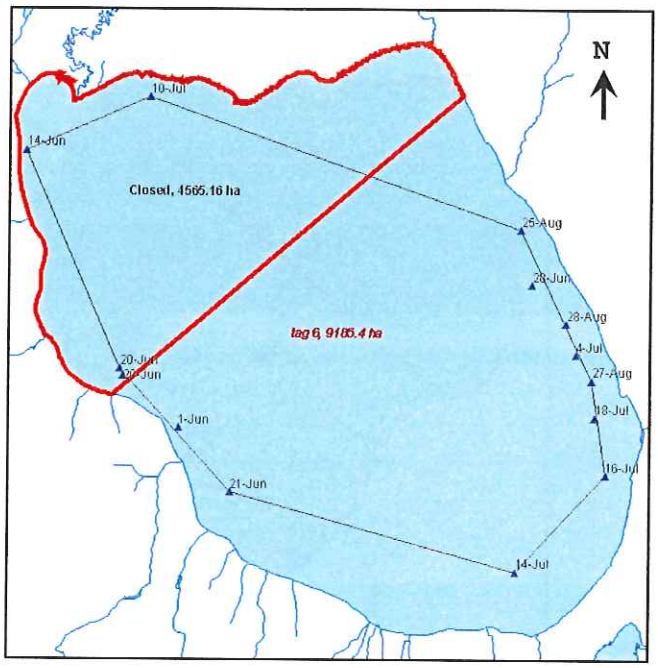
6.3.3. MCP of radio-tagged walleye #4.



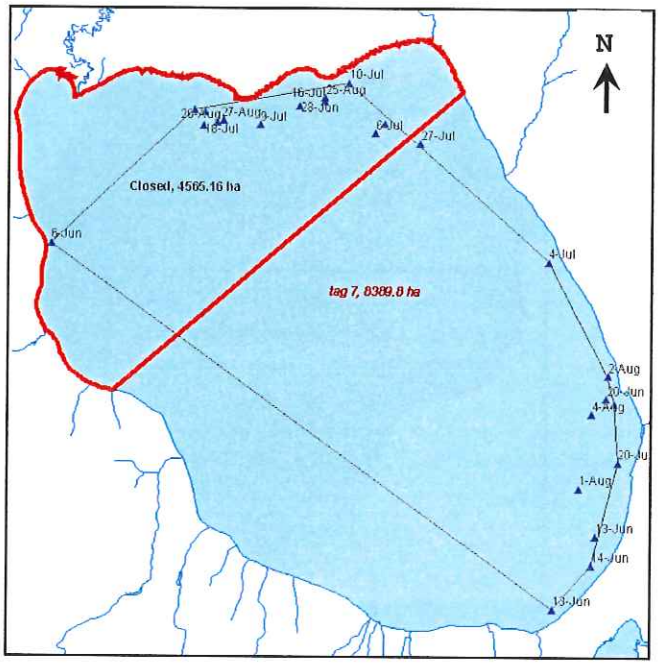
6.3.4. MCP of radio-tagged walleye #5.



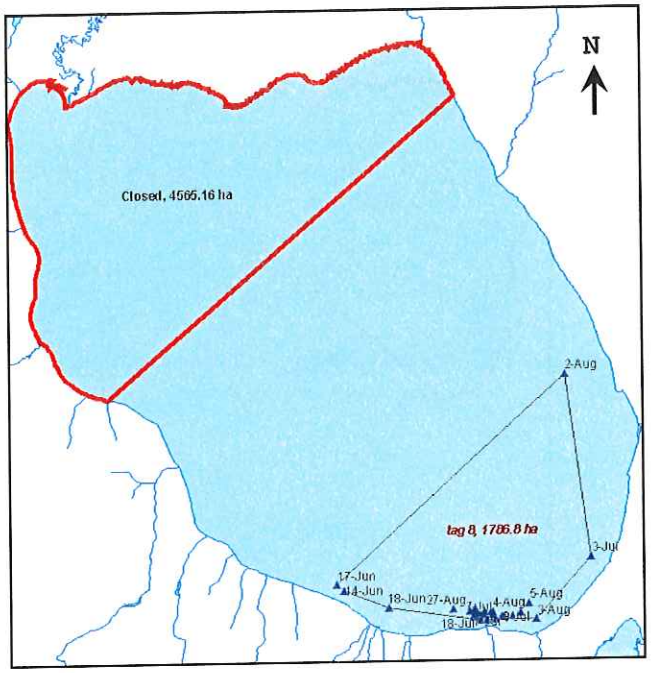
6.3.5. MCP of radio-tagged walleye #6.



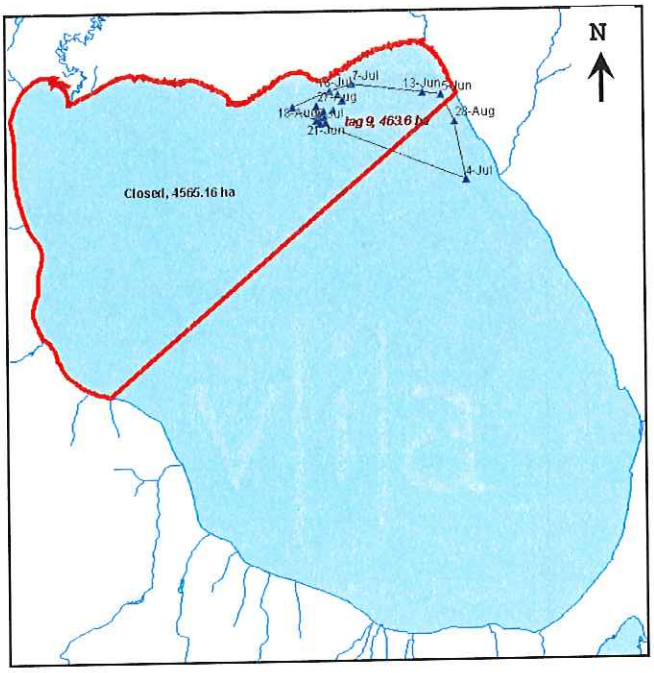
6.3.6. MCP of radio-tagged walleye #7.



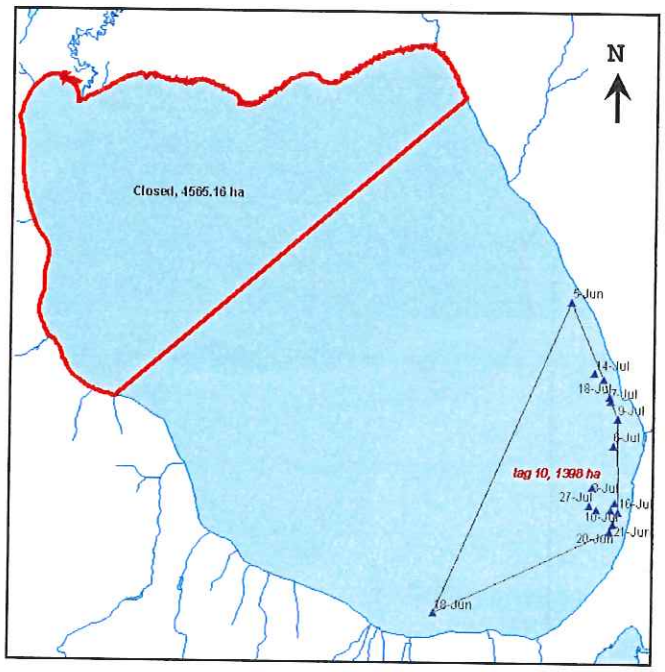
6.3.7. MCP of radio-tagged walleye #8.



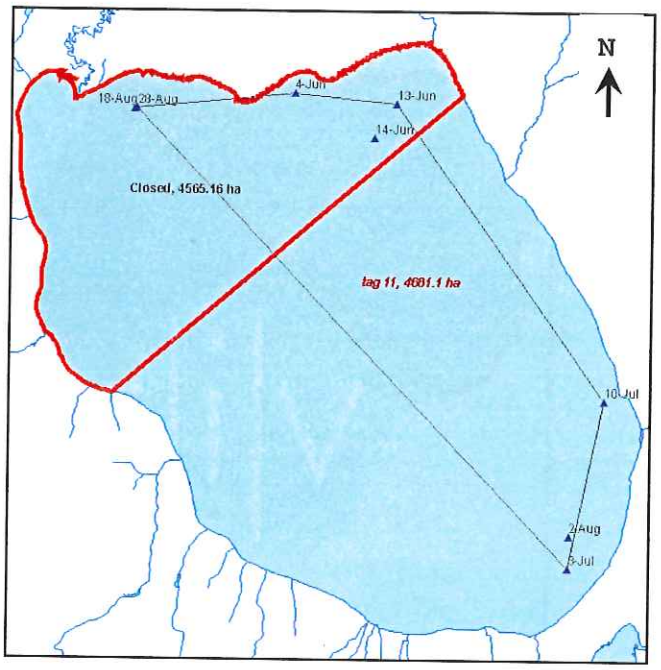
6.3.8. MCP of radio-tagged walleye #9.



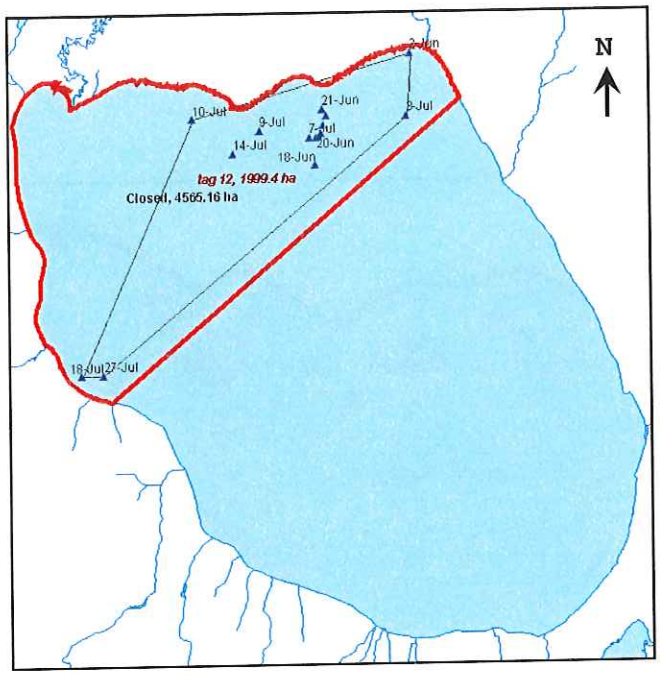
6.3.9. MCP of radio-tagged walleye #10.



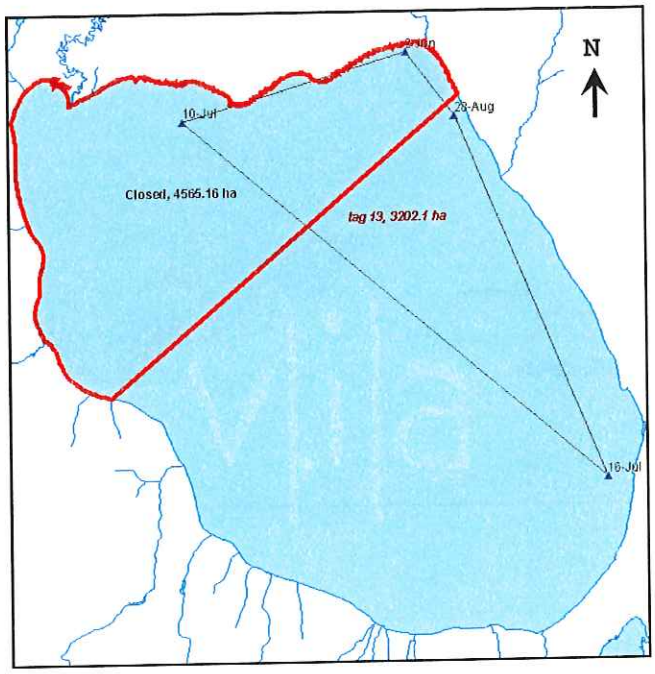
6.3.10. MCP of radio-tagged walleye #11.



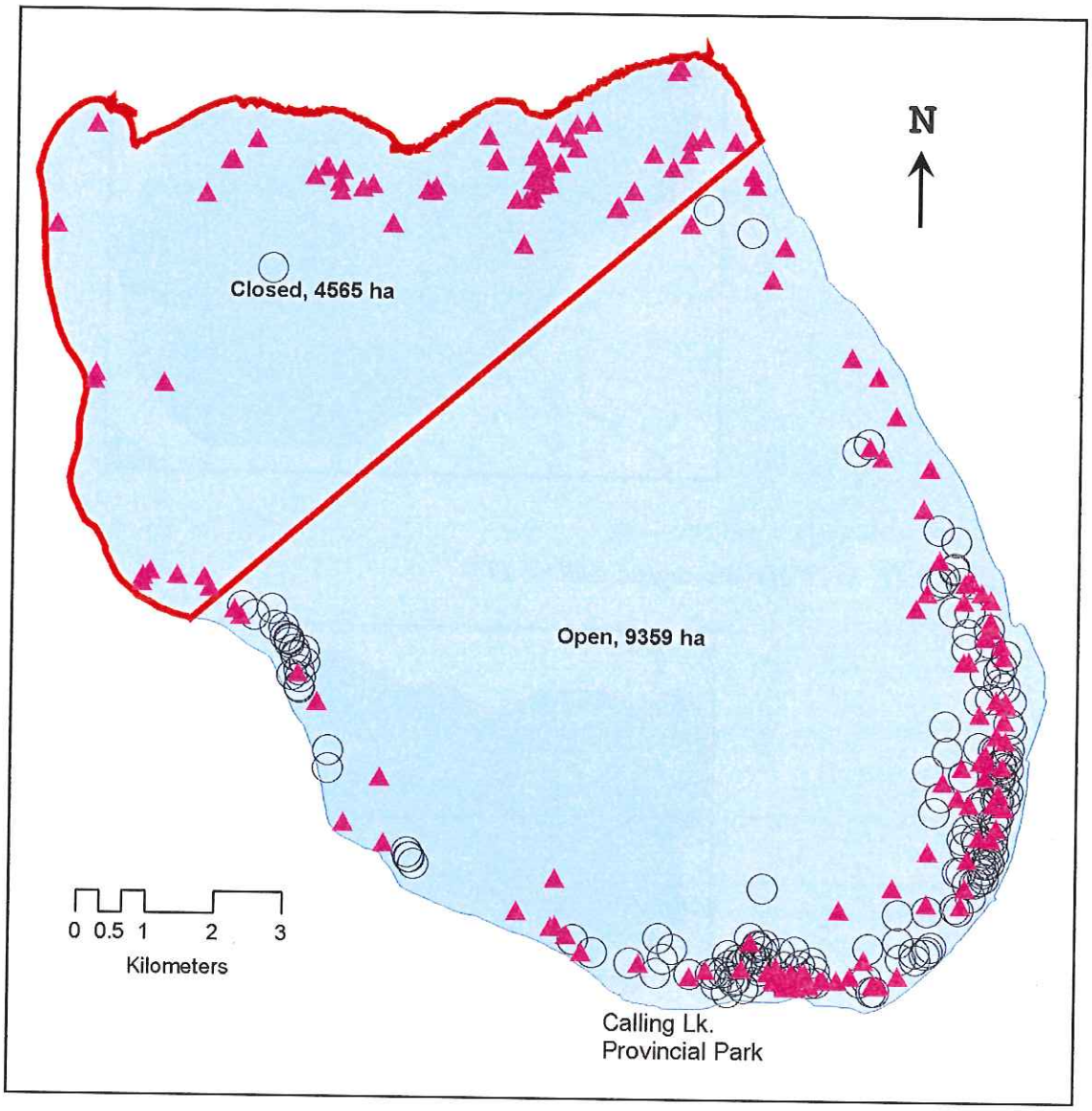
6.3.11. MCP of radio-tagged walleye #12.



6.3.12. MCP of radio-tagged walleye #13.



6.4. **Appendix 4. Walleye and angler locations in Calling Lake, 2002.** Pink triangles denote biotelemetry locations and black circles denote angler locations.



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